

# Management Challenges in Uncertain Environment

Selected Papers of the  
Twelfth AIMS International Conference on Management



*Editors*

**Shivprakash Agrawal  
Omprakash K. Gupta**

# Management Challenges in Uncertain Environment

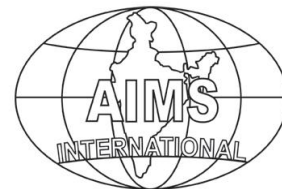
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*Editors*

**Shivprakash Agrawal**  
*Parul University*

**Omprakash K. Gupta**  
*University of Houston-Downtown*



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## PREFACE

We are currently at the door of digital era, where we can expect great changes in the way businesses are carried out. Organization needs to see opportunities of digital era, manage the risks associated with operating under this environment, and develop strategies to sustain and grow in the market place. Therefore, the theme of the Twelfth AIMS International Conference on Management (AIMS-12) was kept as, "Management Challenges in Uncertain Environment."

This conference was jointly organized by Indian Institute of Management Kozhikode ([www.iimk.ac.in](http://www.iimk.ac.in)), AIMS International - The Association of Indian Management Scholars ([www.aims-international.org](http://www.aims-international.org)) and International Forum Of Management Scholars ([www.infoms.net](http://www.infoms.net)).

The Conference proceedings consist of 35 papers organized in 7 categories: Finance & Banking, General Management, Higher Education, Human Resource Management, Information Technology, Marketing and Operations Management. We hope these proceedings will serve as a valuable reference to managers and academics for many years to come.

Several people have worked hard behind the scene to organize this conference and produce the proceedings. We wholeheartedly thank the Conference Patron, IIMK Director Prof. Kulbhushan Balooni and Conference Co-chair Dr. R. Radhakrishna Pillai for their support. We are also grateful to Mrs. Minaxi Agrawal, Mr. Mukund Pimplaskar and Ms. Punam Makwana for their valuable contribution in the preparation of the proceedings.

We also gratefully acknowledge the support given by the academic colleagues all around the world by sending their papers and participating in this conference.

Omprakash K. Gupta  
University of Houston-Downtown  
Houston, USA

Shivprakash Agrawal  
Parul University  
Vadodara, India

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# Structural Adjustments of Bank Rate on Assets and Liability Management in India



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**P.Baba Gnanakumar**  
Sri Krishna Arts and Science College  
(gnanakumar12000@yahoo.com)

*Bank rate adjustments made by RBI with the aim of reducing the rupee volatility during 2013-14 increased the gap between the relative values of assets and liabilities ALM in banks. This research explores the impact of bank rate volatility in ALM. Based on the RBI data collected for the period 2012-14, we measured the impact of bank rate on ALM by applying variance analysis and estimated the relationship with Granular model. We found that bank rate influence the volume of liquidity flows but not the value of cash flows. Hence to reduce ALM gap the costs of cash outflows could be managed in accordance to bank rate. In other way, the ALM gap can be narrow down by balancing long-term deposits and loans during the bank rate revision period.*

## 1. Introduction

Post reforms period in India has observed marvellous development of the Indian money markets. Banks and other financial institutes have been able to meet the high expectations of short-term funding of key sectors like the industry, services and agriculture. Operating under the regulation and control of the Reserve Bank of India (RBI), the Indian money markets have also presented the required maturity and resilience over the previous two decades. The stake holders of the banks are considering the money market rates while investing in banking companies. The monetary policy regulator (RBI) of India had done six revisions in the Bank rate during the financial year 2012-13; while it was two revisions in the previous year. Even though the revisions in bank rate aimed at curtailing the rupee volatility, the gap in Asset and Liability of banks increased by two times (CRISL, 2014). The NPA increased to 4% in 2013-14 from 3.3% (RBI, 2014). The deposits liquidating in one year to total deposits had shown one-third increase (BT, 2014). The gap in ALMs is due to the increasing deviation in the tenors of loans and deposits. In public sector banks, there is a shortage of a ready collateral that could be used to REPO with the Reserve Bank in a liquidity squeeze period. The India rating of Economic times reports quoted that the trend of increasing funding gaps in the banking system is unjustifiable, particularly as the economic revival may require continued bank funding for longer tenor infrastructure loans. In this context, the present research was done with the purpose of identifying the cascading effect of bank rate volatility in ALM during the liquidity squeeze period.

## 2. AIM

This paper seeks to address the effect of bank rate adjustments in the Assets and Liability management metrics of Indian banks. We aim to find out the gap created between assets and liabilities by the Bank rate. This enables the banks to change the ALM policies during the liquidity squeeze period. This research paves the way for bank rate risk exposure management.

## 3. Significance

Indian banks are demanding to reduce the bank rates. The percentage of maturity value of demand deposit to total deposits of Public sector banks in 2002 was 29%; whereas it raised to 50% in 2012. In the same period, loans maturing in one year to total loans reduced from 42% to 34%. This ALM gap increased from 4% in March 2002 to 17.5% in March 2012. This paper proposes a method to decrease the ALM gap created at the time of revisions in bank rate by the RBI.

## 4. Review of Literature

The liberalisation measures have increased competition and eroded banks' market power. RBI has been successful in its implementation of various measures to improve the transparency in the corporate governance of public sector banks in order to broad base ownership and control. (Lakshmi, 2011). The monetary policy changes are having more impact on short-term and medium-term lending. (Sumon Kumar Bhaumika, September 2011). The banks with lower charter values tend to have lower equity-assets ratios (lower solvency) and to experience higher credit risk (Vicente, 2003). Macro interest-rate unpredictability found to have a significant effect on bank. Macro policies reduced interest-rate volatility (Anthony, 2000). The bank rate influences the credit policy (Fasea, 1995). The transparency of ALM decreases the chance of severe banking problems and improves overall financial stability (Nier, 2005). Jurg's research contended that a reduction in debt service lowers bank equity, and, because of capital adequacy requirements, this in turn reduces bank lending and industry investment. (Jurg blum, 1995). Banks with lower charter values tend to have lower equity-assets ratios (lower solvency) and experience higher credit risk (Vicente Salasa, December 2003). In Indian banking system, the use of technology, increased availability of lendable resources, heightened competition, a trend towards the market-driven interest rate system and improve the asset quality (Sunil Kumar, 2014). Rangan's research quote that there is a relation between NPA's and interest rates. (Rangan, 2012). Research conducted on ALM revealed that 2/3rd banks are not exposed to interest rate risk. Houston's research found



that the relationship between bank borrowing and the importance of growth opportunities depends on the number of banks the firm uses and whether the firm has public debt outstanding based on the bank rate. (Houston, 1996). But the present research aims to identify the relationship between Bank rate adjustment's impact on the assets and liabilities of the banks.

## 5. Methodology

India's banking sector could become the fifth largest banking sector in the world by 2020 and the third largest by 2025. The assets and liabilities value of the Indian banks are expanding. We collected the total value assets, liabilities and cash flows value of 232 banks from the RBI database for the period between April 2012 and March 2014 on a monthly basis. Bank rate announced by the RBI is considered as the independent variable. The bank rate has been revised nine times during the study period. The exhibit-1 shows the bank rate revisions made by RBI.

**Exhibit 1** Bank Rate Revisions



The analyses have been conducted in three stages. In the first stage, the variations between the ALM variables (the total value of the assets, liabilities and cash flows of the banks) and bank rate are identified by using "F" test. In the second stage, the relationship between ALM variables and bank rate are predicted using Granular model. Under the Granular model, idiosyncratic volatility is constructed by first removing the correlated component of bank rate with a statistical factor model, then volatilities of the residuals are calculated using the following equation (Bekaert, Hodrick, and Zhang (2010).

$$V_i(g_{i,t+1}^2) \approx \sigma_i^2 \left( 1 + \frac{1}{\rho_{i,t}} \gamma^2 H_t - \left[ \frac{S_{i,t}}{NE[S_{i,t}]} + \gamma H_t \right]^2 \right)$$

The R2 value of Granular model is calculated for each ALM variables. If the R2 values are greater than 0.7, then we assume that the ALM variables are influenced by the changes in bank rate. In the third stage, we use the homogeneity test using Levene statistic and Brown-Forsythe statistics to find out the group variance within the ALM variables having R2 values greater than 0.7. The significance of the test implies that ALM variables grouped based on the bank rate revision periods have unequal variations. For a cash flow analysis, only "F" test was performed as they are highly volatile due to external factors other than the bank rate. The output of the stages is used to determine the impact of the bank rate on ALM variables.

## 6. Analysis

### 6.1 Impact on Assets

Total banking assets in India stood at US\$ 1.8 trillion in FY13 and are projected to cross US\$ 28.5 trillion in FY25. Interest rate is sensitive and correlated with assets and liabilities. This widens the Assets and Liabilities gap (James, 1984). To study the relationship between the Bank rate and assets, we identify the twenty-seven liquid assets values on a monthly basis, and they are grouped based on the bank rate revision periods. We apply 'F' test to assess that whether the group means of assets values as classified based on the bank rate differs significantly from each other. Bank rate has been considered as an independent variable. There exist nine groups; as the bank rate was revised nine times during 2012 and 2013. Two revisions are made with the same value; hence seven groups are created. The square of the deviation of each group mean of external factors from the overall mean in the corresponding group is considered as "between-group sum of squares" (BSS). The square of the deviation of each observation from the corresponding group of external factor mean is considered as "within group sum of squares" (WSS). We establish the statistical hypothesis of ANOVA as follows:

**H0** (Null Hypothesis) = There is no significant variation between the assets value as grouped based on the bank rate.

**Ha** (Alternative Hypothesis) = There is a significant variation between the assets value factors as grouped based on the bank rate.

In order to test the above hypothesis, we use the F-test. The F-ratio is computed as:

$$F = \frac{BSS / df_{BSS}}{WSS / df_{WSS}} = \frac{Mean_{BSS}}{Mean_{WSS}}$$

The BSS portrays how large the effect of bank rate on assets, while the WSS indicates the random variation due to other uncontrolled variables. The results of F test and Granular R2 values are displayed in table 1.

**Table 1** Bank Rate vs. Assets – ANOVA

S.No	Assets	F Value	Sig.	Granular Quintile-R <sup>2</sup>
1	Cash in hand	26.762	0.000	0.56
2	Balance With RBI All Schedule Bank	9.502	0.000	0.32
3	Balances with bank	91.105	0.000	<b>0.72</b>
4	Balances In current Account	3.282	0.009	0.23
5	Balances In other Accounts	97.488	0.000	0.62
6	Other Assets	3.845	0.003	0.24
7	Investment In India	55.228	0.000	<b>0.71</b>
8	Central and State Government Securities	55.625	0.000	0.54
9	Other approved securities	127.217	0.000	0.64
10	Bank Credit	68.226	0.000	<b>0.74</b>
11	Food Credit	5.004	0.000	0.44
12	Non Food Credit	66.384	0.000	0.46
13	Loan cash credit and overdrafts	67.847	0.000	<b>0.78</b>
14	Inland Bills Purchased	32.109	0.000	0.45
15	Inland Bills Discounted	109.768	0.000	0.50
16	Foreign Bills Purchased	21.573	0.000	0.31
17	Foreign Bills Discounted	39.247	0.000	0.38
18	SLR Securities	55.228	0.000	0.49
19	commercial paper Book Value	11.308	0.000	0.10
20	Shares Public Sector undertakings Book Value	14.818	0.000	0.14
21	Shares Private Corporate Sector Book Value	19.080	0.000	0.15
22	Investments at Book Value	2.561	0.032	0.02
23	Bonds Public Sector undertakings Book Value	26.004	0.000	0.28
24	Bonds Private Corporate Sector Book Value	47.807	0.000	0.42
25	Others (Bonds) Book Value	15.132	0.000	0.13
26	Units of UTI and Other mutual funds Book Value	17.709	0.000	0.19
27	Shares Public Financial Institutions Book Value	37.950	0.000	0.30

The calculated value of F is greater than the table value of F with the degrees of freedom, and. Hence, the null hypothesis is rejected at the 95% confidence limits. We accept the alternative hypothesis. We conclude that there is a significant variation between bank rate and liquid assets. The revisions made on the bank rate influence the liquid assets values. However, we cannot conclude that the bank rate is only one factor that influences the assets before conducting post hoc multiple comparisons. R2 values are greater than 0.7 only in four cases. It implies that monthly balances with banks, investments, bank credits and cash credit loans have an immediate impact when the bank rates are revised.

In the second stage, we test the homogeneity among the clusters created for assets value based on the bank rate. We compare assets values having Granular R2 values more than 0.7. Levene's test (Levene 1960) is used to test the equal variances among the clusters. The hypotheses are established as follows;

**H<sub>0</sub>** (Null hypothesis): There is no significant variation within the groups created based on the bank rate.

**H<sub>a</sub>** (Alternative Hypothesis): There is significant variation within the groups created based on the bank rate

The Levene statistic test results are portrayed in table 2.

**Table 2** Test of Homogeneity of Variances on Assets

Assets	Levene Statistic	df1	df2	Sig.
Balance with banks	13.122	5	95	0.000
Investment in India	11.966	5	95	0.000
Bank credit	13.957	5	95	0.000
Loan cash credit and cash credit	14.128	5	95	0.000

As calculated value of Levene statistic is greater than the table value, we reject the null hypothesis at the 0.05 significance level. There is sufficient evidence to claim that the variances are not equal within the groups. Thus, group variances among

the assets are not assumed to be equal. As group variances are not equal, the assets such as deposits in other banks, investment in India, bank credit, cash credits are highly influenced by changes in bank rates as announced by RBI. Since equal variances are not assumed within the external factors, we move to the next stage to check the robustness of equality of means of assets value as grouped based on the bank rate. If the group variances are statistically equal, then F test is invalid. Hence, robust test of equality of means is applied. We applied the Welch and Brown-Forsythe statistics which shows the F test from an ANOVA where the response is the absolute value of the difference of each observation and the group median (Brown and Forsythe 1974). The hypotheses are formulated as follows.

**H<sub>0</sub>** (Null hypothesis): The variation among the group as created based on the bank rate is not having equal variations.

**H<sub>1</sub>** (Alternative hypothesis): The variations among the group as created based on the bank rate is having equal variations.

The results of Welch and Brown-Forsythe statistics are portrayed in table 3

**Table 3 Robust Tests of Equality of Means on Assets**

S.No	Assets	Test	Statistic	df1	df2	Sig.
1.	Balance with banks	Welch	470.617	5	32.43	0.000
		Brown-Forsythe	85.344	5	24.84	0.000
2.	Investment in India	Welch	179.127	5	33.16	0.000
		Brown-Forsythe	55.106	5	31.71	0.000
3.	Bank credit	Welch	375.028	5	28.05	0.000
		Brown-Forsythe	70.188	5	28.73	0.000
4.	Loan cash credit and cash credit	Welch	363.475	5	28.03	0.000
		Brown-Forsythe	69.521	5	28.661	0.000

Since the p value is smaller than  $\alpha$ , we reject the null hypothesis. This implies that the variations among the groups are equal. This also supports the validity of F test. Past researchers proved that even the continuous increase or decrease in variables would result in equality of variations among different groups. We conclude that the short-term loans and investments are immediately affected by the changes in bank rate, and these are considered as sensitive assets.

The bank rate widens the ALM gap, which reflected in short-term loans and investments from the assets side. Short-term loans of the Indian banking sector are showing increasing trend. It is growing at a CAGR of 18.1 percent, and it will be US\$ 2.4 trillion by 2017. The credit growth of ICICI Bank is 141.6 per cent during financial year 2014 (Report of Emkay Global Financial Services). It is also due to credit card business which is growing at CAGR of 31.1 per cent. These assets provide a buffer in times of market freezes as banks can liquidate these holdings to meet liabilities.

## 6.2 Impact on Liabilities

A change in bank rate is having impact on banks' borrowing costs. This influence both lending and fixed deposit rates. The bank deposits are growing at CAGR of 21.2 per cent. Hence, we have to explore the impact of bank rate in liabilities. The variance analysis and Granular test are performed in a similar method used for assets. The results are tabulated as follows

**Table 4 Bank Rate vs. Liabilities – ANOVA**

S.no	Liabilities	F	Sig.	Granular Quintile-R <sup>2</sup>
1	Demand and time deposits from bank	18.129	0.000	0.28
2	Liquid Liabilities to the Banking System	14.617	0.000	<b>0.71</b>
3	Borrowing from banks	6.059	0.000	0.26
4	Other demand and time liabilities to banking system	5.519	0.000	0.21
5	Aggregate deposits	234.192	0.000	0.56
6	Demand Deposits to Others	21.078	0.000	0.44
7	Time Deposits to Others	222.856	0.000	<b>0.73</b>
8	Borrowings (Other than from RBI, NABARD, EXIM bank)	69.643	0.000	<b>0.75</b>
9	Other demand and time liabilities to Others	31.720	0.000	0.45
10	Borrowings from RBI All Scheduled Banks	85.136	0.000	<b>0.71</b>

The results indicate that the liabilities are influenced by the bank rate. Among the liabilities, liquid liabilities, time deposits are borrowings are having direct impact. The Levene statistic test results are portrayed in table 5.

**Table 5 Test of Homogeneity of Variances - Liabilities**

Liabilities	Levene Statistic	df1	df2	Sig.
Liquid Liabilities to banking system	4.735	5	95	0.001
Time deposits to others	13.340	5	95	0.000
Barrowings other than RBI	7.003	5	95	0.000
Barrowing from RBI all Scheduled banks	28.862	5	95	0.000

As group variances are not equal, the liabilities such as liquid liabilities, time deposits and borrowings are not the only one factor that influenced the bank rate. The robustness test results on liabilities are tabulated in table-6.

**Table 6 Robust Tests of Equality of Means**

S.No	Liabilities	Model	Statistic	df1	df2	Sig.
1.	Liquid Liabilities to banking system	Welch	14.808	5	30.355	0.00
		Brown-Forsythe	8.040	5	40.041	0.00
2.	Time deposits to others	Welch	273.815	5	34.209	0.00
		Brown-Forsythe	54.835	5	29.728	0.00
3.	Barrowings other than RBI	Welch	61.331	5	23.210	0.00
		Brown-Forsythe	44.438	5	31.738	0.00
4.	Barrowing from RBI all Scheduled banks	Welch	172.308	5	20.851	0.00
		Brown-Forsythe	23.184	5	32.502	0.00

Since the p value is smaller than  $\alpha$ , we reject the null hypothesis. This implies that the variations among the groups are equal. This also supports the validity of F test. We conclude that liquid liabilities, time deposits and borrowings are sensitive to the bank rate. The deposits matured created a gap in ALM from the liabilities' side. The deposits maturing within one year increased to 50% from 33% within two years (2012-14). If a bank has long term deposits, then it can hold long-dated debts without costing much to bank rate risk.

### 6.3 Impact on Cash Flows

The ALM of the bank's balance sheet is nothing but future cash inflows or outflows. (Singh & Tandon, 2012). To study the relationship between the bank rate and cash flows, we use 'F' test in the same procedure as applied for assets. We have identified thirty-four liabilities to compare with bank rate. Table -7 shows the results.

**Table 7 Bank Rate vs. Cash Flows – ANOVA**

S.No	Cash flow	Value		Volume	
		F value	Sig.	F – value	Sig.
1	RTGS	0.552	0.783	5.089	0.003
2	Customer Transactions	1.311	0.307	5.535	0.002
3	Interbank Transactions	0.651	0.709	1.589	0.209
4	Interbank Clearing	1.758	0.166	5.343	0.003
5	CCIL Operated Systems	4.537	0.006	1.950	0.127
6	CBLO	15.979	0.000	6.740	0.001
7	Govt. Securities Clearing	4.248	0.008	2.553	0.057
8	Outright Payments	3.841	0.012	2.498	0.061
9	Repo Payments	6.173	0.001	2.972	0.034
10	Forex Clearing	1.300	0.312	1.292	0.315
11	Paper Clearing	0.871	0.550	0.657	0.704
12	Cheque Truncation System	45.387	0.000	66.627	0.000
13	MICR Clearing	35.174	0.000	40.612	0.000
14	RBI Centres clearing	55.468	0.000	44.527	0.000
15	Other Centres Clearing	9.984	0.000	20.063	0.000
16	Non-MICR Clearing	0.336	0.926	1.370	0.283
17	Retail Electronic Clearing	10.117	0.000	21.781	0.000
18	ECS DR	2.131	0.100	6.780	0.001
19	ECS CR (includes NECS)	3.199	0.026	1.866	0.143
20	EFT/NEFT	9.649	0.000	24.048	0.000
21	Immediate Payment Service (IMPS)	74.844	0.000	86.148	0.000
22	Cards Remittance	10.249	0.000	16.254	0.000
23	Credit Cards	10.934	0.000	13.696	0.000
24	Usage at ATMs	3.236	0.025	6.302	0.001
25	Usage at POS	10.939	0.000	13.716	0.000
26	Debit Cards	10.072	0.000	15.141	0.000
27	Usage at POS	4.541	0.006	8.289	0.000
28	Prepaid Payment Instruments (PPIs)	2.034	0.114	23.551	0.000

29	m-Wallet	11.847	0.000	24.493	0.000
30	PPI Cards	7.409	0.000	10.927	0.000
31	Paper Vouchers	0.626	0.728	0.927	0.512
32	Mobile Banking	65.813	0.000	25.116	0.000
33	Cards Outstanding	5.635	0.002	37.691	0.000
34	Total Remittance	1.808	0.155	12.368	0.000

We use 95% confidence limits to test the hypotheses. The result indicates that bank rate is not having impact in five variables. It includes inter-bank transactions, forex clearing, paper clearing, non MICR clearing and paper vouchers. The bank rate is not having impact in the values of six variables. It includes RTGS, customers' transactions, inter-bank clearing, ECS (Dr), pre-paid payment instruments and total remittance. Bank rate is not having any impact on the volume of four variables. It includes CCIL operations, Government securities clearing; out-right payments and ECS (Cr). The revision in bank rates will have an impact on the remaining nineteen variables. We have grouped those variables and named as 'retail cash flows'.

## 7. Findings and Implications

The findings of the research clearly indicates that the revisions made in bank rate will have a direct impact is having impact on ALM variables. Short-term loans, short investments, liquid liabilities, time deposits, short-term borrowing and retail cash flows are influenced by changes in bank rates. The remittance system in values is not influenced by the bank rate; whereas remittance in volume is affected by changes in bank rate. Exhibit-2 shows the results.

Exhibit 2 ALM Risk Exposure



Funding the long-term assets with short-term funds is attracting the interest rate exposure. However, long-term assets and liabilities are not directly influenced by the bank rate. Hence, ALM gap can be reduced by cash flows from long-term loans and deposits.

## 8. Conclusion

The volatility in the bank rate is having an effect on the volume of cash flows but not on the value of cash flows. Hence, we conclude that if the costs of cash outflows increases in proportion with bank rates, the ALM gap can be decreased during the period of the liquidity squeeze. On the other hand, managing with long-term loans with deposits decreases the bank rates exposure.

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# Derivatives and Price Risk Management: A Study of Nifty



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Vasantha G  
T. Mallikarjunappa  
Mangalore University  
Dept. of Business Administration  
(naikvasantha@gmail.com)  
(tmmallik@yahoo.com)

*Price risk management is the primary function of derivatives. Several price risk management techniques have been evolved over the years and their applicability is still debatable. This study deals with constant and dynamic hedging models using intraday data from spot and derivatives market of National Stock Exchange of India Ltd. (NSE) Nifty index. The OLS, VECM and D-VECH GARCH models are used for estimation of constant and dynamic hedge ratios. We compare the performance of these hedge ratios. This study found that dynamic hedge ratios are preferred as they provide highest hedging effectiveness.*

**Keywords:** Derivatives, NSE-Nifty, Hedge ratio, Price risk management, Hedging effectiveness, VECM.

## Executive Summary

Managing the price risk using instruments like futures and options and hedging effectiveness has become an interesting area of study for the investors, policy makers, researchers and academicians. Since the Indian derivatives market is new and the volumes in this market are increasing at an increasing rate, it is important and interesting to analyze the utility of derivatives as a hedging instrument. The study of hedging effectiveness is important because the success of any capital market depends on how effectively risk can be managed using the available instruments in the derivatives market. In this study, we have estimated constant and time varying hedging ratios for stock derivatives market taking in to NSE Nifty spot and its futures contracts. We use intraday data observed at one minute interval of six months from 1 January 2014 to 30 June 2014. We use OLS and VECM models for constant hedge ratios and Generalized Autoregressive Conditional Heteroscedasticity model (GARCH) for time varying hedge ratio. Stationarity tests reveal that the price series are non-stationary and return series are stationary. Among the constant hedge ratio models VECM gives highest hedge ratio (0.8824). The hedge effectiveness of this model is approximately 82%. The D-Vech GARCH model gives highest hedging effectiveness, though the average hedge ratio of this model is lesser than (0.8537) constant hedge ratios. Therefore, our study concludes that time varying hedging models are preferable than the constant hedge ratios.

## 1. Introduction

Managing the financial risk has become an important issue due to the volatile financial and economic environment. Therefore, hedging the risk helps financial market participants to protect their positions against the unexpected price movement in the market. Hedging is harmonizing the positions in the two markets, one in the spot or cash market and the other in the derivatives market. With a variety of products in the financial market, various hedging techniques such as futures, forwards, options etc have been developed in the market. Futures contracts, like any other hedging instruments, can be used as an effective instrument to cover the unexpected fluctuations in the prices. Hedging with futures contracts involves purchase (sale) of futures in combination with another commitment, usually with the expectation of favourable change in relative prices of spot and futures market (Castelino, 1992). Since the objective of hedging is to control or reduce the risk of adverse price changes in the market, it is a critical issue to the investor to decide the number of futures contract he should buy (sell) for each unit of short (long) position in the spot market. This is called as the optimal hedge ratio in the derivatives market. To decide the optimal hedge ratio an appropriate model selection is important so that it is possible to obtain a reliable ratio.

The effectiveness of a hedge becomes relevant only in the event of a significant change in the value of the hedged item (Kenourgios, 2008). When the price movements of the hedged item and the hedging derivative instrument nullify or offset each other, then hedge is termed as effective hedge. It is believed that the effectiveness of hedging determines the success of any financial futures contract. Hence, price volatility management through hedging has become an interesting area of research since the previous researches failed to give a generalised solution for the volatility problem

A number of studies have measured the hedging effectiveness using the simple Ordinary Least Squares (OLS). However, this model is severely criticised by many authors because of its inappropriateness to estimate hedge ratios since it does not consider the problems of serial correlation in the OLS residuals and the heteroskedasticity in cash and futures price series (Herbst, Kare and Marshall, 1993). Another problem faced while estimating the hedge ratio is the nature of co-integration between the spot and future contract prices. As noticed by Ghosh (1993) the presence of co-integration leads to an under-hedged position. This is because of misspecification of the pricing behaviour between these two markets (Ghosh, 1993).

Many empirical works have been done in the international level in the field of estimation of hedge ratios and quantifying their efficacy using different methodologies, asset classes and time frames. However, our literature review reveals that, the studies enquiring the fundamental objectives of derivatives, i.e., how far derivatives are efficient in price risk management, are limited in number in India. The possible reason for this is the nascent stage of Indian derivatives market. Some of the

prominent Indian studies are of Bhaduri and Durai (2008), Kumar, Singh and Pandey (2008), Gupta and Singh (2009), Rao and Thakur (2010), Srinivan (2011). Our literature review further found that the estimation of optimal hedge ratio and hedging effectiveness differs from method to method and drawing a unanimous conclusion about the ultimate and unique method to use is very difficult. Broadly, two types of hedge ratio estimation methods are identified; they are, constant and dynamic. In this study, our primary objective is to compare the hedge ratio and its efficiency from these two estimation methods and to suggest the Indian investors. Further, among the constant and dynamic methods there are several statistical and econometric models. We also interested to check the suitability of some these models in Indian context. With this background an attempt has been made to compute the hedge ratio and to test the hedging effectiveness using different models.

This paper is organized in six sections. The second section discusses the important studies in this area, section 3 explains data and models used in the study for estimating the hedge ratio and hedging effectiveness, section 4 presents the details of the sample and data used for the study and its characteristic features; empirical results are presented in section 5 and section 6 concludes.

## 2. Review of Literature

Literature on hedging offers a wide variety of alternative models that can be used to model and quantify the hedge and hedge effectiveness of derivatives products. However, the results on the performance of these models have been mixed. We present a brief review of some important studies under two subsections such as international studies and Indian studies respectively.

### 2.1 International Studies

An early investigation of hedging includes **Ederington (1979)**. He examines the hedging performance of Government National Mortgage Association (GNMA) and T-Bill of Chicago Board of Trade. He used nearby contracts (3–6 months, 6–9 months and 9–12 months) and a hedging period of 2 and 4 weeks for the study. Using OLS he found that some of the hedge ratios are not different from zero and the hedging effectiveness increases with the length of hedging period. The hedge ratio also increases (closer to unity) with the length of hedging period.

**Figlewski (1984)** studied the hedging performance and basis risk using US stock data over the period June 1982 to September 1983. He found that the minimum variance hedge ratio (MVHR) give the most effective hedge. Based on the comparison of hedge effectiveness over the time periods, he concluded that one-week hedges perform better than the overnight hedges but no improvement was found when the duration is extended to 4 weeks. His study found that exclusion of dividend does not have any impact over the hedge performance. Similarly, timing of the expiration of the futures has little impact on hedge performance. **Junkus and Lee (1985)** tested the hedging effectiveness of three USA stock index futures; Kansas City Board of Trade, New York Futures Exchange and Chicago Mercantile Exchange; using four futures hedging models such as, a variance-minimizing model introduced by Johnson (1960), the traditional one to one hedge, a utility maximization model developed by Rutledge (1972), and a basis arbitrage model suggested by Working (1953). They found that the MVHR was most effective at reducing the risk of a cash portfolio comprising the index underlying the futures contract. **Lee, Bubnys and Lin (1987)** tested the temporal stability of the minimum variance hedge ratio. They found that the hedge ratio increases as maturity of the futures contract nears.

**Cecchetti, Cumby and Figlewski (1988)** derived the hedge ratio by maximizing the expected utility. A third-order linear bivariate ARCH model was used to get the conditional variance and covariance matrix. A numerical procedure is used to maximize the objective function with respect to the hedge ratio. It was found that the hedge ratio changes over time and is significantly less than the MV hedge ratio (which also changes over time). Certainty equivalent is used to measure the effectiveness. They concluded that utility-maximizing hedge ratio performs better than the MV hedge ratio.

**Myers and Thompson (1989)** generalized the estimation of optimal hedge ratios to account for conditioning information that is available at the time a hedging decision is made. The authors argue that the traditional approach of using a simple regression of cash price levels on futures price levels or cash price changes on futures price changes are correct only under a very restrictive set of assumptions. They suggested a regression approach, where the cash price level is regressed against the futures price level plus a set of conditioning variables. The conditioning variables include lags of futures and cash prices and any variables thought to influence prices such as stocks, exports, and storage costs. In an example using corn and soybeans, the authors show that the generalized optimal hedge ratio can vary substantially from the unconditional ratio estimated with price levels; but, they argue that the unconditional hedge ratio estimated with price changes may provide a reasonable estimate of the generalized hedge ratio.

**Baillie and Myers (1991)** investigated the distribution of cash and futures prices for six different commodities, and applied the results to the problem of estimating the optimal futures hedge ratio. Six different commodities are examined using daily data over two futures contract periods. Bivariate GARCH models of cash and futures prices are estimated. This study found that constant hedge ratios are inappropriate since time varying hedge ratios estimated through the GARCH Model are more appropriate and advanced hedge ratios.

**Ghosh (1993, 1995)** argued that the minimum variance hedge ratios are biased downwards due to misspecification. Author opines that the standard OLS approach is not well specified in estimating hedge ratios because it ignores lagged values. He suggested that if the spot and futures are co-integrated, an error correction term (ECT) should be used to remove the misspecification in the regression. His studies proved the superiority of error correction model over OLS model for estimating the hedge ratios. **Chou, Denis and Lee (1996)** estimated and compared the hedge ratios of the conventional and the error correction model for Japan's Nikkei Stock Average (NSA) index and the NSA index futures with different time intervals for

the period 1989 to 1993. Examining an out-of-sample performance, they found that the error correction model outperformed the conventional approach, while the opposite position holds when the in-sample portfolio variance was evaluated.

**Holmes (1996)** examines hedging effectiveness for the FTSE-100 stock index futures contract from 1984 to 1992 for intervals of one, two and four weeks. He investigates the appropriate econometric technique to use in estimating minimum variance hedge ratios by undertaking estimations using OLS, an ECM and GARCH. He found that simple OLS outperforms more complex econometric techniques. Additionally, the study examines the impact of hedge duration and time to expiration on estimated hedge ratios and hedge ratio stability over time. It is found that hedge ratios and hedging effectiveness increase with hedge duration, hedge ratios approach unity as expiration approaches and while hedge ratios vary over time they are stationary. **Lypny and Powalla (1998)** examined the hedging effectiveness of the German stock index; DAX futures and showed that the application of a dynamic hedging strategy based on a GARCH (1, 1) process is economically and statistically the most effective model.

**Kavussanos and Nomikos (1999)** studied constant vs. time-varying hedge ratios and hedging efficiency in the Baltic International Financial Futures Exchange (BIFFEX) market. The authors modeled the spot and futures returns as a vector error correction model (VECM) with a GARCH error structure. An augmented GARCH (GARCH-X) model where the error correction term enters in the specification of the conditional covariance matrix is also introduced to link the concept of disequilibrium (as proxied by the magnitude of the error correction term) with that of uncertainty (as reflected in the time varying second moments of spot and futures prices). In- and out-of-sample tests are employed to assess the effectiveness of the futures contract. The tests revealed that GARCH-X model provides greater risk reduction than a simple GARCH and a constant hedge ratio. **Park and Switzer (1995)** examined the risk-minimizing futures hedge ratio for three stock index futures, S&P-500 Index Futures, Major Market (MM) Index Futures and Toronto-35 Index Futures. Using a bivariate co-integration model with a generalized ARCH error structure they estimated optimal hedge ratio as a ratio of the conditional covariance between spot and futures to the conditional variance futures. Both within sample comparisons and out-of-the sample revealed that the dynamic hedging strategy based the bivariate GARCH model improves the hedging performance over the conventional constant hedging strategy.

**Malliaris and Urrutia (1991)** estimated the minimum variance hedge ratio using regression auto correlated errors model for five currencies such as British pound, German mark, Japanese yen, Swiss franc, Canadian dollar. Using overlapping moving windows, the MV hedge ratio and hedging effectiveness are estimated for both in-sample and out-of-sample cases for the time period from March 1980 to December 1988 (weekly data). In the in-sample case, the 4-week hedging horizon is more effective compared to the 1-week hedging horizon. However, for the out-of-sample case the opposite is found to be true. **Benet (1992)** using weekly data for Australian dollar, Brazilian Cruzeiro, Mexican Peso, South African Rand, Chinese Yuan, Finish Markka, Irish Pound and Japanese Yen studied direct and cross-hedging. For minor currencies, the cross-hedging exhibits a significant decrease in performance from in-sample to out-of-sample. The minimum variance hedge ratios are found to change from one period to the other except for the direct hedging of Japanese Yen. On the out-of-sample case, he reports that the hedging effectiveness is not related to the estimation period length. However, he found that the effectiveness decreases as the hedging period length increases.

**Kroner and Sultan (1993)** combine the error-correction model with the GARCH model considered by Cecchetti et al. (1988) and Baillie and Myers (1991) in order to estimate the optimum hedge ratio for the five currencies (Co-integration heteroscedastic method). Both within-sample and out-of-sample evidence shows that the hedging strategy proposed in the study is potentially superior to the conventional strategies. **Park and Switzer (1995)** estimated the risk-minimizing futures hedge ratios for three types of stock index futures: S&P-500 index futures, major market index (MMI) futures and Toronto-35 index futures. Using a bivariate co-integration model with a generalized ARCH error structure, they estimated the optimal hedge ratio. Both within-sample comparisons and out-of-sample comparisons revealed that the dynamic hedging strategy based on the bivariate GARCH estimation improves the hedging performance over the conventional constant hedging strategy.

**Lafuente and Novales (2002)** studied the optimal hedge ratio under discrepancies between the futures market price and its theoretical valuation according to the cost-of-carry model using data from the Spanish stock index futures market. To estimate the optimal hedge ratio, they employ a bivariate error correction model with GARCH innovations. Ex-ante simulations with actual data reveal that hedge ratios that take into account the estimated, time-varying, correlation between the common and specific disturbances, lead to using a lower number of futures contracts than under a systematic unit ratio, without generally losing hedging effectiveness, while reducing transaction costs and capital requirements. Their empirical results and ex ante simulations indicate that hedge ratios lead into using a lower number of futures contracts than the one under a systematic unit ratio.

**Butterworth and Holmes (2001)** studied the hedging effectiveness of FTSE-100 and FTSE-mid250 index future contracts for underlying indexes and stocks of 32 investment trust companies. The results of the study showed that the futures contracts could reduce risks of underlying index at a rate between 50 to 70%. However, the risk reduction of investment trust company stocks was limited with 20% at most. They also found that the OLS method performs better on the FTSE-mid-250 futures contract when outliers were omitted from the analysis.

**Yang (2001)** computes the optimal hedge ratios from the OLS regression model, the bivariate vector autoregressive model (BVAR), the error-correction model (ECM) and the multivariate diagonal Vec-GARCH Model for All Ordinary Index and SPI futures on the Australian market. The hedging effectiveness is measured in terms of in-sample and out-of-sample risk-return trade-off at various forecasting horizons. The study found that the GARCH time varying hedge ratios provide the



greatest portfolio risk reduction, particularly for longer hedging horizons. **Floros and Vougas (2004)** examined hedging in Greek stock index futures market, focusing on various techniques to estimate constant or time-varying hedge ratios. They used standard OLS regressions, simple and vector error correction models, as well as M-GARCH models and found that Greek stock index futures, M-GARCH models provide best hedging ratios.

## 2.2 Indian Studies

Though the derivatives products are not new to India, the formal stock related derivatives are introduced in early 2000s. However, the studies related to the hedge ratio and hedging efficiency are not ample. A few important studies came out after 2008 during this period the economic crisis out broke. **Rao and Thakur (2008)** studied of hedging of Nifty price risk through index futures and options using high frequency data for the period from 01.01.2002 to 28.03.2002. They find that estimates of optimal hedge ratio based on competing models, HKM in case of futures (Herbst, Kare and Marshall, 1993) and fBM in case of options are better than those estimated using benchmark models (JSE (Johnson, 1960; Stein, 1961; and Ederington, 1979) for futures and BSM Black-Scholes model for options, respectively). However, the returns on hedged positions using the superior optimal hedge ratios are not significantly different.

**Bhaduri and Durai (2008)** investigated the optimal hedge ratio and hedging effectiveness of S&P CNX Nifty index futures by employing four models such as OLS, VAR, VECM and multivariate GARCH model. Their results revealed that the time varying M-GARCH performs better in the long run where as OLS is best in the short duration. Similar study was conducted by **Kumar, Singh and Pandey (2008)** by including Nifty index and three commodities. Their results revealed that time varying hedge ratio performs better than the constant hedge ratios. **Kumar and Pandey (2011)** examines hedging effectiveness of four agricultural (Soybean, Corn, Castor seed and Guar seed) and seven non-agricultural (Gold, Silver, Aluminium, Copper, Zinc, Crude oil and Natural gas) futures contracts traded in India. They applied VECM and CCC-MGARCH model to estimate constant hedge ratio and dynamic hedge ratios respectively. Their study concluded that agricultural futures contracts provide higher hedging effectiveness (30-70%) as compared to non-agricultural futures (20%). The results were same for both constant and dynamic hedge ratios. **Gupta and Singh (2009)** estimated the optimal hedge ratio for the Indian derivatives market through the examination of three indices viz. Nifty, Bank Nifty and CNX IT, and 84 most liquid individual stock futures traded on National Stock Exchange of India Ltd. The results suggested that hedge ratio calculated through VAR model and VEC Model performs better and this is due to presence of co-integration between spot and futures markets. **Srinivasan (2011)** found that empirical results for the in-sample hedging performance comparison showed that the conventional OLS regression method generates better hedge ratio than VAR, VEC and GARCH in terms of variance reduction. His study found that VEC Model outperformed the other hedging models for the out-of-sample period in terms of minimizing the risk. **Kumar (2012)** studied the volatility and hedging behaviour of four notional commodity futures indices of Multi Commodity Exchange (MCX) of India using 2175 observations from 6/8/2005 to 8/18/2012. Models like DVECH-GARCH, BEKK- GARCH, CCC-GARCH and DCC-GARCH were used to estimate the time varying hedge ratio. Further, an in-sample performance analysis, in terms of hedged return and variance reduction approaches, of the hedge ratios estimated from the different bivariate GARCH models are also carried out. This study found that all the models are able to reduce the exposure to spot market as perfectly as possible in comparison with the unhedged portfolio and in doing so the advanced extensions of bivariate GARCH models viz DCC-GARCH and CCC-GARCH have a clear edge over DVECH-GARCH and BEKK-GARCH.

The above analysis of literature shows that the results of the evaluating hedging performance of futures markets seem to be ambiguous. With this back ground, our study emphasizes on determining the optimal hedge ratio and hedging effectiveness for the futures in India by taking NSE Nifty spot and futures.

## 3. Data, Sample and Methodology

The National Stock Exchange of India Ltd. (NSE) is the leading stock exchange of India with maximum transparency and regulatory framework. NSE recorded an exponential growth in its derivatives segment in a very short time span of a decade. Approximately, 92 percent of total trading value of NSE came from the derivative segment in the year 2013-14 (NSE fact book-2014 p.03). Currently NSE offers variety of derivatives instruments including stock and index futures and options and currency futures. NSE-Nifty is one of the important indices of NSE which includes fifty prominent stocks of Indian capital market. NSE-Nifty is treated as a major indicator of Indian economy. We use intraday data of Nifty spot and futures, recorded at one minute interval for the period from 01/01/2014 to 30/01/2014. A time series is constructed using the near month data and hence there are 45840 observations in spot and futures price series individually. Near month data is used as the market is more active in the month of contract expiry than the other months. We use three different methods for estimating the hedge ratio and hedging effectiveness. First two models estimate the constant hedge ratio and the third model estimates the time variant hedge ratio. A brief discussion of these models is given below,

### 3.1 Ordinary Least Square (OLS) Method

OLS is treated as the simple conventional method for calculating the constant hedge ratio which is given by the following linear regression model,

$$Return_{spot} = Constant (\alpha) + \beta Return_{futures} + \varepsilon_t \quad (1)$$

Here the value of  $\beta$  provides the optimal hedge ratio. That is, it is the ratio of covariance between spot and futures returns and variance of spot returns. The coefficient of determination ( $R^2$ ) of the model indicates the hedging effectiveness. Higher the  $R^2$  more efficient will be the hedge ratio and vice versa.

### 3.2 The Vector Error Correction Model

The OLS method is criticised for not considering the existence of autocorrelation in the residuals (E.g. Myers and Thompson, 1989; Cecchetti, Cumby and Figlewski, 1988 etc.). If two or more sets of series are co-integrated, then there exists a valid error correction representation (Engle and Granger, 1987). This is also confirmed by Ghosh (1993), Lien and Luo (1994); Lien (1996) etc. The error correction framework is shown in the models (2) and (3) below.

$$R_{St} = \alpha_S + \sum_{i=2}^k \beta_{Si} R_{St-i} + \sum_{j=2}^l \gamma_{Fj} R_{Ft-j} + \lambda_S Z_{t-1} + \varepsilon_{St} \quad (2)$$

$$R_{Ft} = \alpha_F + \sum_{i=2}^k \beta_{Fi} R_{Ft-i} + \sum_{j=2}^l \gamma_{Sj} R_{St-j} + \lambda_F Z_{t-1} + \varepsilon_{Ft} \quad (3)$$

Where the  $\alpha$ ,  $\beta_S$ ,  $\beta_F$ ,  $\gamma_S$  and  $\gamma_F$  are parameters and residuals  $\varepsilon_{St}$  and  $\varepsilon_{Ft}$  are independently identically distributed (iid) random vector.  $Z_{t-1} = S_{t-1} - \delta F_{t-1}$  is the error correction term with  $(1 - \delta)$  as co-integrating vector. Once the residual series are generated, hedge ratio is calculated as follows,

$$h^* = \frac{\sigma_{sf}}{\sigma_f} \quad (4)$$

Where,  $h^*$  = hedge ratio,  $\sigma_{sf} = Cov(\varepsilon_{St}, \varepsilon_{Ft})$  and  $\sigma_f = Var(\varepsilon_{Ft})$ .

### 3.3 The Vech GARCH Model

Bollerslev, Engle and Wooldridge (1988) proposed a Vech GARCH model to estimate the time varying hedge ratios. The main advantage of this model is that it simultaneously models the conditional variance and covariance of two integrated series. In the Vech model, every conditional variance and conditional covariance is a function of all lagged conditional variances and co-variances, as well as lagged squared returns and cross-products of returns. A common specification of the vech model is,

$$Vech(H_t) = c + A vech(\varepsilon_{t-1} \varepsilon_{t-1}') + B vech(H_{t-1}) \quad (5)$$

$$\varepsilon_t | \psi_{t-1} \sim N(0, H_t)$$

Where  $H_t$  is a 2 X 2 conditional variance-covariance matrix,  $\varepsilon_t$  is a 2X1 error (disturbance) vector,  $\psi_{t-1}$  represents the information set at time t-1. C is a 3X1 parameter vector, A and B are 3X3 parameter matrices and vech denotes the column-stacking operator applied to the upper portion of the symmetric matrix. The model requires the estimation of 21 parameters. The above vech model is elaborated with the following sub set of models for better understanding.

$$H_t = \begin{bmatrix} h_{11t} & h_{12t} \\ h_{1t} & h_{11t} \end{bmatrix}, \varepsilon_t = \begin{bmatrix} u_{1t} \\ u_{2t} \end{bmatrix}, C = \begin{bmatrix} C_{11} \\ C_{21} \\ C_{31} \end{bmatrix},$$

$$A = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}, B = \begin{bmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{bmatrix}$$

The Vech operator takes the upper triangular portion of a matrix and stacks each element into vector with a single column. For example, in the case of vech ( $H_t$ ), this becomes

$$Vech(H_t) = \begin{bmatrix} h_{11t} \\ h_{22t} \\ h_{12t} \end{bmatrix}$$

Where  $h_{iit}$  represent the conditional variances at time t of the two-asset return series used in the model and  $h_{ijt}$  ( $i \neq j$ ) represent the conditional co-variances between the asset returns. In the case of vech ( $\varepsilon_t \varepsilon_t'$ ), this can be expressed as

$$vech(\varepsilon_t \varepsilon_t') = vech\left(\begin{bmatrix} u_{1t} \\ u_{2t} \end{bmatrix} \begin{bmatrix} u_{1t} & u_{2t} \end{bmatrix}\right) \quad (6)$$

$$= \text{vech} \begin{pmatrix} u_{1t}^2 & u_{1t}u_{2t} \\ u_{1t}u_{2t} & u_{2t}^2 \end{pmatrix} \tag{7}$$

$$= \begin{bmatrix} u_{1t}^2 \\ u_{2t}^2 \\ u_{1t}u_{2t} \end{bmatrix} \tag{8}$$

The vech model in full given by,

$$h_{11t} = c_{11} + a_{11}u_{1t-1}^2 + a_{12}u_{2t-1}^2 + a_{13}u_{1t-1}u_{2t-1} + b_{11}h_{11t-1} + b_{12}h_{22t-1} + b_{13}h_{12t-1} \tag{9}$$

$$h_{22t} = c_{21} + a_{21}u_{1t-1}^2 + a_{22}u_{2t-1}^2 + a_{23}u_{1t-1}u_{2t-1} + b_{21}h_{11t-1} + b_{22}h_{22t-1} + b_{23}h_{12t-1} \tag{10}$$

$$h_{12t} = c_{31} + a_{31}u_{1t-1}^2 + a_{32}u_{2t-1}^2 + a_{33}u_{1t-1}u_{2t-1} + b_{31}h_{11t-1} + b_{32}h_{22t-1} + b_{33}h_{12t-1} \tag{11}$$

Thus, it is clear that the conditional variances and conditional co-variances depend on the lagged value of all of the conditional variances of and conditional co-variances between, all of the asset returns in the series, as well as the lagged squared errors and the error cross-products.

The above mentioned vech model is quite cumbersome task as the model contains 21 parameters to estimate even if at least two assets are included in the sample. If the sample size increased there would be a large number of parameters to estimate which will become infeasible. To overcome this problem a reduced form of vech model is introduced in which the vech model's conditional variance-covariance matrix has been restricted and hence reduced the number of parameters to be estimated is to 9. This model is called as the diagonal vech model and is expressed as follows,

$$h_{11t} = c_{11} + a_{11}u_{1t-1}^2 + b_{11}h_{11t-1} \tag{12}$$

$$h_{22t} = c_{21} + a_{23}u_{1t-1}u_{2t-1} + b_{22}h_{22t-1} \tag{13}$$

$$h_{12t} = c_{31} + a_{32}u_{2t-1}^2 + b_{33}h_{12t-1} \tag{14}$$

### 3.4 Hedging Effectiveness

For estimating the effectiveness of calculated hedge ratio reductions in the variance in the hedged position is compared with the variance reduction of un-hedged position. This can be shown in the following equation,

$$\frac{\text{Variance Unhedged} - \text{Variance of Hedged}}{\text{Variance of Unhedged}}$$

Where variance of un-hedged =  $\sigma_s^2$

Variance of hedged =  $\sigma_s^2 + h^2\sigma_f^2 - 2h\sigma_{sf}$

## 4. Results and Analysis

### 4.1 Graphical Analysis

The tentative inference about the behaviour and formation of the price series of Nifty spot and futures can be drawn from the graphical analysis. Figure 1 shows the time series plots of Nifty spot and futures prices. We can observe from the time series plot that the study period had seen a steep but steady increase in the price.

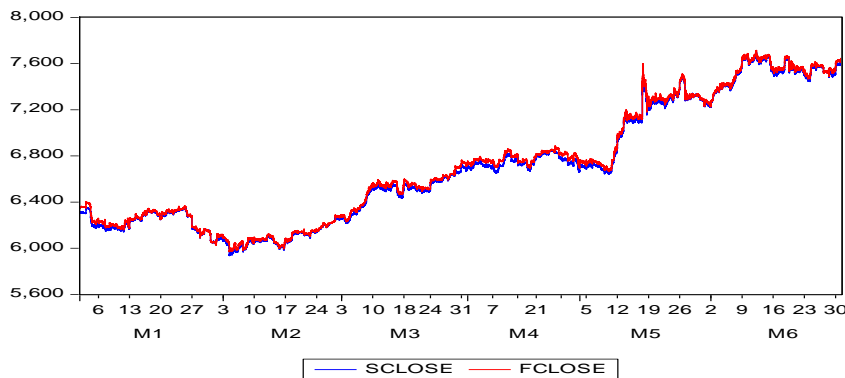


Figure 1 Time Series Plot of Nifty Spot and Futures Prices

Time series normally depicts volatility clustering or volatility persistence. Volatility clustering manifests itself as periods of tranquillity interrupted by periods of turbulence (Mandelbrot, 1963). The change between these two extreme regimes is a slow process so that large returns slowly decline until a relatively tranquil state is reached (Mandelbrot, 1963). In other words, time series indicates phenomena in such a way that lower volatility is followed by further low volatility and higher volatility is followed by higher volatility. In the figure 2 we have presented the volatility clustering in both the return series of Nifty spot and futures.

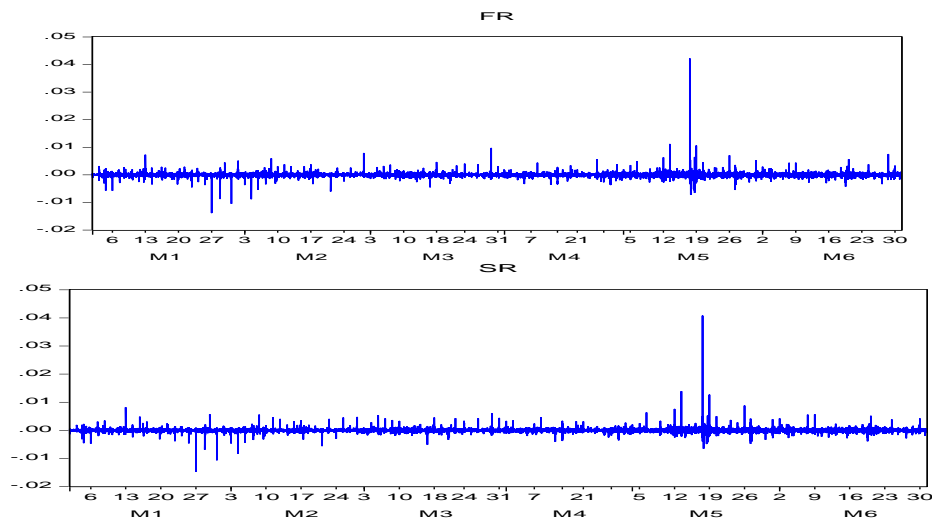


Figure 2 Spot and Futures Return Series Plots

### 4.2 Descriptive Statistics

Statistical properties of the return series are presented in the Table 1, where it is clear that the mean returns of both the market are almost same. The variation, expressed in the standard deviation, in returns is higher in the futures market than the spot market. Clear non-normality is exhibited in the high positive skewness, kurtosis and Jarque-Bera statistics. Both the return series show excess kurtosis implying that fatter tail than the normal distribution and are skewed to the right.

Table 1 Descriptive Statistics

	Futures Returns	Spot Returns
Mean	3.97E-06	4.04E-06
Median	0.00000	6.64E-06
Maximum	0.042143	0.040737
Minimum	-0.013770	-0.014712
Std. Dev.	0000475	0.000461
Skewness	15.20423	15.60912
Kurtosis	1409.513	1419.734
Jarque-Bera	3.78E+09	3.84E+09
Probability	0.000000	0.000000
Observations	45840	45840

### 4.3 Unit Root Test

Before performing any type of regressions, it is essential to test whether the series contains unit root or not. Presence of unit root implies that the time series under study has a time varying mean or time varying variance or both. The series which contain unit root are called as non-stationary series. If two or more non-stationary series are regressed the results will be spurious. In such a case, it becomes necessary to remove the unit root either by differencing the series or by taking log series before further econometric analysis.

The Augmented Dickey-Fuller (1979) and Philips-Perron (1988) are two popularly used stationarity tests in the financial literature. These tests are known for their simplicity and accuracy in estimating the degree of differencing necessary to make the series stationary. The results of these tests indicate the form in which the data series should be used for subsequent estimations (E.g. At level, first or second difference form). We present the unit root test results in the Table 2. We separately show the test statistics and the probability values for the price series and the return series. The required numbers of lags are selected based on the Schwartz's Bayesian information criterion (SIC). It is very clear from the Table that price series are

non-stationary and return series are stationary for both spot and futures market. This guides us that we can use the return series than the price series for any further analysis.

**Table 2 Unit Root Test Results**

Variable	ADF Statistics	P value	PP Test statistics	P value
Futures Price	0.1479(55)	0.9693	0.2383	0.9750
Spot Price	0.1394(55)	0.9687	0.2827	0.9775
Futures Returns	-28.6124 (55)	0.0000	-213.9629	0.0001
Spot Returns	-27.6615 (55)	0.0000	-208.9116	0.0001

**Note** Figures in Parenthesis Indicates number of lags Used

#### Empirical estimation of hedge ratio and hedging effectiveness

In this section, we present the results of alternative methods used for estimation of hedge ratio and their effectiveness.

#### 4.4 OLS Method

**Table 3 OLS Results**

Symbol	Coefficients	t-statistics	p-value
A	5.67E-07	0.6149 (9.21E-07)	0.5386
B	0.8755	451.8877 (0.001938)	0.0000
R <sup>2</sup>	0.8167		

**Note** Standard Error Is Given in the Parenthesis

Table 3 shows that the hedge ratio calculated from OLS method is 0.8755 and hedging efficiency is represented by R<sup>2</sup> which is 82%. To check the validity of the model used, diagnostics tests of residuals obtained from the above OLS are conducted and the results are presented below.

**Table 4 Diagnostic Test Results**

Diagnostic tests	Test statistics	P. value
Jarque-Bera Null (H <sub>0</sub> ) : Residuals are normally distributed	5711952	0.000
Breusch Godfrey Serial Correlation LM Test Null (H <sub>0</sub> ) : No serial correlation between residuals	3996.311	0.000
White Heteroscedasticity Test: Null (H <sub>0</sub> ) : Residuals are homoscedastic	249.3995	0.000

It is very clear from the diagnostic test results of OLS that, in all three tests the null hypothesis are rejected at one percent level of significance. This shows that the model suffers from the problem of serial correlation, heteroscedasticity and non-normality. Since the results are spurious, they cannot be used for further analysis and decision making. Therefore, we estimate the hedge ratio using a bivariate VECM model which is discussed in the next section.

#### 4.5 VEC Model Results

An augmented VAR model with error correction term as one of the independent variables is used to capture the long run as well as the short run relationship simultaneously as simple VAR model ignores the possibility that the two variables have long run relationship or the existence of co-integration. If the two price series are found to be co-integrated, a VAR model should be augmented using an error correction term which accounts for the long run equilibrium between spot and futures price movement (E.g. Gosh (1993), Lien and Luo (1994) and Lien (1996)). First, we use Johansen's co-integration test to examine the long-run relationship (co-integration) between spot and futures market. The results are presented in the Table 5. Johansen's maximum Eigen value and trace statistics indicate that at least one co-integrating vector is present at 0.05 level in the Nifty spot and its derivatives.

**Table 5 Test for Co-Integration**

Hypothesis	Eigen value	Trace test	p-value	L max test	p-value
None (r = 0)	0.223466	20481.20	0.0001	11592.36	0.0001
At most 1 (r ≥ 1)	0.176285	8888.834	0.0000	8888.834	0.0000

Since the co-integration is present between the two markets we use error correction term to the VAR model, so that any disequilibrium will be normalised. A VECM (6, 1) is used for our analysis where 6 denotes the maximum lags which is

selected based SIC and 1 denotes the rank order. The VECM results are presented in Table 6 and 7 for futures and spot market respectively.

**Table 6** Estimates of VEC Model for Futures Market

Symbol	Coefficient	Std. Error	t-Statistic	Probability
$\alpha_F$	0.0000	0.0000	1.8321	0.0669
$\lambda_F$	-0.0490	0.0189	-2.5950	0.0095
$\gamma_{F1}$	-0.9367	0.0185	-50.5702	0.0000
$\gamma_{F2}$	-0.8594	0.0163	-52.8128	0.0000
$\gamma_{F3}$	-0.6964	0.0150	-46.3474	0.0000
$\gamma_{F4}$	-0.5051	0.0123	-41.0616	0.0000
$\gamma_{F5}$	-0.3223	0.0091	-35.4147	0.0000
$\gamma_{F6}$	-0.1491	0.0061	-24.5760	0.0000
$\beta_{S1}$	0.0859	0.0200	4.2841	0.0000
$\beta_{S2}$	0.1331	0.0176	7.5613	0.0000
$\beta_{S3}$	0.1018	0.0158	6.4483	0.0000
$\beta_{S4}$	0.0557	0.0123	4.5176	0.0000
$\beta_{S5}$	0.0052	0.0091	0.5751	0.5652
$\beta_{S6}$	-0.0144	0.0063	-2.2848	0.0223

**Table 7** Estimates of VEC Model for Spot Market

Symbol	Coefficient	Std. Error	t-Statistic	Probability
$\alpha_S$	0.0000	0.0000	-9.5186	0.0000
$\lambda_F$	1.5446	0.0146	106.0773	0.0000
$\gamma_{F1}$	-1.1750	0.0144	-81.8680	0.0000
$\gamma_{F2}$	-0.9530	0.0122	-78.0917	0.0000
$\gamma_{F3}$	-0.7374	0.0109	-67.5437	0.0000
$\gamma_{F4}$	-0.5297	0.0090	-58.6663	0.0000
$\gamma_{F5}$	-0.3329	0.0061	-54.6581	0.0000
$\gamma_{F6}$	-0.1515	0.0036	-42.1682	0.0000
$\beta_{S1}$	0.4630	0.0154	30.0682	0.0000
$\beta_{S2}$	0.3675	0.0132	27.7426	0.0000
$\beta_{S3}$	0.2507	0.0119	21.1496	0.0000
$\beta_{S4}$	0.1530	0.0092	16.5581	0.0000
$\beta_{S5}$	0.0588	0.0062	9.4226	0.0000
$\beta_{S6}$	0.0114	0.0038	3.0247	0.0025

The coefficients of the error correction terms,  $\lambda_S$  and  $\lambda_F$  in VECM (6, 1) are significant at 5% level implying that the long run co-integrating relationship between the spot and futures returns has been appropriately considered in VECM equations. In other words, the error correction co-efficient in futures equation is negative and significant, indicating that the speed of adjustment of spot towards long run equilibrium is significant and the difference between spot and futures prices is positive. The futures market will fall next period to restore the equilibrium. On the other side, the error correction co-efficient in spot equation is positive and significant, indicating rise in futures price towards the equilibrium in the next period. The lags of spot and futures markets are significant in both equations indicating mutual dependency of the two markets. This mutual dependency of the two markets gives important clues to the hedgers about the movement of the market in the immediate future. The residuals of the VECM are used to estimate the hedge ratio and hedging effectiveness which is presented in Table 8.

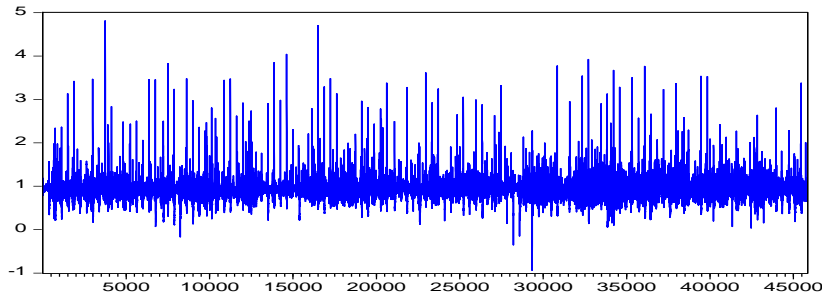
The hedge ratio obtained from VECM model is 0.8824 which is more than that of OLS model. VECM provides 82% (approx) hedging effectiveness which is in line with the OLS model. Therefore, our two constant models gave two different hedge ratios but the effectiveness of these models are equal (82%). Since, both constant hedge ratios provide similar hedging effectiveness a clear conclusion can be drawn about the superiority of the models at this stage. In the next part we provide the results obtained from the GARCH model.

**Table 8** VECM Hedge Ratio Results

<b>Cov (<math>\varepsilon_S, \varepsilon_F</math>)</b>	<b>2.27E-07</b>
Var $\varepsilon_F$	2.27E-07
Hedge ratio	0.8824
Variance (Hedged)	3.89E-08
Variance (Unhedged)	2.12E-07
Hedging Effectiveness	0.8166

#### 4.6 GARCH Model

D-Vech GARCH Model is used to estimate the time varying hedge ratio. The resulting time varying hedge ratio is presented in figure 6 and summary statistics are given in the Table 9.

**Figure 3** Dynamic Hedge Ratio**Table 9** Descriptive Statistics of Dynamic Hedge Ratio

	<b>Hedge Ratio</b>
Mean	0.8537
Median	0.8480
Maximum	4.8148
Minimum	-0.9386
Std. Dev.	0.2227
Skewness	3.0101
Kurtosis	32.3165
Jarque-Bera	1710528
Probability	0.000000

As shown in the Figure 3, the dynamic hedge ratios are less stable and exhibit fluctuations. This suggests that the hedgers of Nifty futures market have to adjust their futures positions more often. As reported in the Table 9, the average hedge ratio for the study period is 0.8537 and it ranges from a minimum -0.9386 to a maximum of 4.8148. Also a high Jarque-Bera suggests that the distribution of hedge ratio is not normal. Based on this time varying hedge ratio, we estimate the variances of hedged and unhedged portfolio to calculate the hedge effectiveness. The estimation reports that hedging with the dynamic hedge ratio of Nifty futures is 83% effective.

Finally, a summary of hedging performance obtained by all three models is presented in Table 10. Comparison of hedge ratios estimated from the four models reveals all the three models give significant hedging effectiveness. As observed by many studies GARCH family models can perform better in estimation of time varying hedge ratios and hedging effectiveness and we also found that the D-Vech GARCH model provides highest hedging effectiveness.

**Table 10** Comparison of Hedge Ratio and Hedging Effectiveness

Model	Hedge ratio	Hedging effectiveness
Ordinary least squares	0.8755	81.67%
Vector Error Correction	0.8824	81.67%
D-Vech GARCH	0.8537 (Mean)	83%

## 5. Conclusions

Managing the price volatility by using hedging instruments like futures and options and hedging effectiveness has become an interesting area of study for the investors, policy makers, researchers and academicians. Since the Indian derivatives market is new and the volumes in this market are increasing at an increasing rate, it is important and interesting to analyze the utility of derivatives as a hedging instrument. The study of hedging effectiveness is important because the success of any capital

market depends on how effectively risk can be reduced in using the instruments of derivatives market. In this study, we have estimated the constant and time varying hedging ratios for Indian derivatives market taking into account one of the most active stock derivatives market i.e., NSE Nifty spot and its futures contracts. We use OLS and VECM models for constant hedge ratios and Generalized Autoregressive Conditional Heteroscedasticity model (GARCH) for time varying hedge ratio. Our study found that both time varying and constant hedge ratio models provide relatively similar hedge ratios. As for as the hedging effectiveness is concerned, GARCH family model out performs the other two models. Further studies can be carried out including more time varying models and the results can be compared between these models.

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# Return Linkages Among Returns from Stock Markets



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**Mrinalini Srivastava**

**Gagan Deep Sharma**

Guru Gobind Singh Indraprastha University

(mrinalinisrivastava26@gmail.com)

(gagan.is.sharma@gmail.com)

*This paper studies inter-linkages among returns from stock markets in Japan, USA, England, India and China. Daily closing levels of benchmark indices in five countries are taken for period 6<sup>th</sup> January 2003 to 21<sup>st</sup> September 2013. Augmented Dickey-Fuller unit-root test is applied to check stationary nature of the series; Regression analysis, Granger's causality model, Vector Auto Regression model, and Variance Decomposition Analysis to find out the linkages between returns. The study leads to two major findings. First, that there exist opportunities for diversification for the investors, and second is the domestic factors (macro economic variables) that influence stock markets.*

## 1. Introduction

Stock markets have emerged as one of the preferred destinations for investors who find this a highly rewarding avenue. However, the impact of uncertainty on investment is a major concern to the investors due to market risks i.e. risk increases with increase in volatility and return decreases. Therefore, there is a strong relationship between volatility and market behavior. Investors contract risk for they expect higher return, but they tend to diversify their investment portfolio to safeguard their exposure to higher risk.

Higher risk in stock markets, as seen empirically in global market, is generally different in developed and developing countries. Per capita GDP is a factor that often determines pattern of investors' portfolio. Stated in simple terms, growth in per capita GDP in developing countries provides a funding base to invest in stock markets. The correlation and integration of the global stock markets has remained an issue of keen financial interest as the potential of economic growth of developing countries got highlighted. The growing relevance of developing economies is also visible from the growth in GDP since 1990s. GDP growth in developing economies led the investors to invest in the equity markets of emerging economies.

In fact risk is lower in less correlated securities in the portfolio. Risk is represented by the dispersion of returns around the mean and return is measured as a dispersion of Coefficient of Variation. Returns on securities are much less correlated across countries than within a country. Intuitively, this is so because economic, political and institutional factors affecting securities returns tend to vary a great deal across countries. This results in a relatively low correlation among international securities. *Eun and Resnick (1984)* reveal that the intra-country correlation is higher than the inter-country correlation with respect to USA with Germany and Japan with United Kingdom. The relationships between international stock markets have become increasingly important since *Grubel (1968)* analyzes the benefits of international diversification. Studies have been conducted in large numbers to test the linkages and integration between stock exchanges of the developed nations, namely the USA, Canada, Europe and Japan (*Kasa, 1992; Richards, 1995; Choudhry, 1996; Kanas, 1998a; Hamori and Imamura, 2000; Ahlgren and Antell, 2002*). Inter-linkages among BRICS is also explained (*Sharma and Bodla, 2011*). Some other studies focused on the developing and under-developed nations, have studied the linkages of those with the developed nations. Not much work has been done on developed and developing nations together. Stock exchanges serve as an important measure of financial activity in a country. Therefore, the present research concentrates on studying the inter-linkages, the return patterns and risk and volatility behaviour among USA, England, Japan, India and China.

## 2. Objectives

This paper aims to achieve the following research objectives

1. To study and compare the return patterns among stock markets of selected developed and developing countries;
2. To observe the risk and volatility behaviour in stock markets of selected developed and developing countries;
3. To establish the inter-linkages between returns from selected developed and developing countries.

This paper is organized in six parts. The first part introduces the study; second part delineates objectives of the study; third part reviews the literature; fourth part elaborates the research methodology; fifth part presents the empirical analysis; and the sixth part enshrines the conclusion.

## 3. Review of Literature

Various empirical studies are performed by different researchers on return patterns of some other researchers have also studied the inter-linkage among the stock markets. *Salomons and Grootveld (2002), Yang and Ye (2010), Hunjra, Azam and Azam et al. (2011), Pandey and Prachetas (2012), Safarzadeh and Nazarian (2012), Aleksandar Naumoski (2012), Samphantharak and Townsend (2013)* have studied the risk and return in emerging markets. Volatility is a fast moving trend in stock markets across the world. The studies of *Schwert (1989), Yan-Ki Ho and Cheung (1994) Bekaert and Harvey (1997), Aggarwal et al. (1999), Li et al. (2005), Batra (2004), Hammoudeh and Li (2008), Chiou, Lee & Lee (2009) Neville*

*Mandimika (2010), Fayyad and Daly (2010)* have studied the volatility in emerging markets. *Chan et al. (1997), Chaudhuri (1997), Masih et al. (1997), Elyasiani et al. (1998), Pan et al. (1999), Bala and Mukund (2001), S. Poshakwale and V. Murinde (2001), Sharma and Wongbangpo (2002), Worthington et al. (2003), Yang et al. (2003), Nath and Verma (2003), Bodla and Turan (2006), Hoque (2007), Rajiv Menon et al. (2009), Sharma and Bodla (2011)* find the evidence of inter linkage among emerging markets (BRICS).

Numerous studies have been done on different countries that focus on a wider number of objectives related to risk and return, volatility and inter-linkages among these countries. *Salomons and Grootveld (2002)* study the ex-post equity risk premium in a number of international markets with special attention to emerging ones. *Yang and Ye (2010)* study Return Correlation of China's Real Estate and Stock Markets. *Hunjra and Azam et al. (2011)* attempts to study the Risk and Return Relationship in Stock Market and Commodity Prices of Pakistani Markets. *Pandey and Prachetas (2012)*, study the testing of risk anomalies in Indian equity market by using monthly average risk & return. *Safarzadeh and Nazarian (2012)* study the comparative analysis of Indian stock market with international markets. *Naumoski (2012)* study the country risk premium in emerging markets Republic of Macedonia. *Samphantharak and Townsend (2013)* study risk and return in village economies. *Schwert (1989)* studies time variation in market volatility which can be explained by macroeconomic and microstructural factors. *Yan-Ki Ho and Cheung (1994)* found that there existed day-of-the-week variations in volatility in many of emerging Asian stock markets. *Bekaert and Harvey (1995)* examined the emerging equity market characteristics in relation to developed markets. *Harvey (1995)* found that serial correlation in emerging market returns are much higher than observed in developed markets. *Bekaert et al. (1998)* argued that emerging markets returns are highly non- normally distributed and exhibit positive skewness in it. *Aggarwal et al. (1999)* examined the events that caused large shifts in volatility in emerging markets. Both increases and decreases in variance were identified first and then events around the period when volatility shifts occurred were identified. *Li et al. (2005)* examined the relationship between expected stock return and volatility based on parametric EGARCH-M model. *Batra (2004)* analysed time variation in volatility in the Indian stock market during 1979-2003 and examined if there had been an increase in volatility persistence in Indian stock market on account of financial liberalization process in India.

Further, it also examined the shifts in stock price volatility and the nature of events that apparently cause the shifts in volatility. *Li et al. (2005)* examined the relationship between expected stock return and volatility. *Hammoudeh and Li (2008)* examined the sudden changes in volatility in emerging markets i.e. five Gulf area Arab stock markets. *Chiou, Lee & Lee (2009)* study shows how the legal environment in a country influences return and risk of stock across countries at different developmental stages and of various rules of jurisdiction. *Mandimika (2010)* study the risk-return relationship as well as the behaviour of volatility of the South African equity markets using both aggregate, industrial level and sector level data. *Fayyad and Daly (2010)* attempts to study the volatility of market returns of emerging versus mature markets. The studies of *Chan et al. (1997), Chaudhuri (1997), Elyasiani et al. (1998), Pan et al. (1999), Bala and Mukund (2001), Sharma and Wongbangpo (2002), Worthington et al. (2003), Yang et al. (2003), Nath and Verma (2003), Bodla and Turan (2006), Hoque (2007), Rajiv Menon et al. (2009)*, point towards the non-existence of linkages between the stock markets under their studies. On the other hand, *Wong et al. (2004), Narayan et al. (2004), Chuang et al. (2007), Weber (2007), Singh et al. (2008), Elyasiani et al. (1998), Nair and Ramanathan (2003)* find evidence of linkages between the stock markets under study. *Sharma and Bodla (2011)* study the inter-linkages between stock markets of India, Pakistan and Sri Lanka. *Sharma and Mahendru (2013)* study the inter-linkages between stock markets of Brazil, Russia, India, China and South Africa with the help of benchmark indices of these stock exchanges. *Wong et al (2004)* investigate the long-run equilibrium relationship and short-run dynamic linkage between Indian stock market and stock markets of major developed countries.

Researchers have employed a wide array of statistical tools. *Salomons and Grootveld (2002)* have used descriptive statistics, time series analysis of returns, auto correlation, Wicoxon tests, Sharpe and Sortino ratios for equal weighted indices. *Yang and Ye (2010)* used Descriptive Statistics and Augmented Dickey Fuller tests. *Hunjra, Azam and Azam et al. (2011)* applied ADF Test to examine the stationary of the return series of data. The significance of Portmanteau Q-Test indicated that all commodities and stock prices return series confirmed the presence of volatility clustering. Further, the effect of volatility was captured through ARCH type's models. The asymmetric and nonlinear relationship between risk and return is observed on the basis of GARCH-MEAN and E-GARCH modelling approach. *Pandey and Prachetas (2012)* determined the volatility of stocks through Standard deviation of the stock returns. They also used VaR and LPSD. The cumulative histogram of VaR also established increased downside risks with higher probability for HV and market portfolio when compared with LV portfolio. *Safarzadeh and Nazarian (2012)* tested all the exchange rate and stock return data for the presence of unit roots in the individual time series. In the study, they have tested for unit roots using the Augmented Dickey-Fuller (ADF) Test, (1979), and the Phillips-Perron (1988) Test. The tests showed that stock indices of five countries in the study were non-stationary. However, a test of co-integration among the stock indices showed that the null hypothesis, existence of at least one co-integrating vector, could not be rejected at 95% level of significance. *Naumoski (2012)*, have used CAPM model for calculation of cost of capital invested in emerging markets. *Samphantharak and Townsend (2013)* have used a risk-sharing benchmark and predicted only aggregate covariate risk contributes to the risk premium and an autarky benchmark predicts that overall fluctuation, idiosyncratic plus aggregate, is the only concern.

*Schwert (1989)* used descriptive statistics to estimate volatility of stock returns. Autoregressive models to estimate the relation between stock returns and leverage. *Ho and Cheung (1994)* used the Levene Test, and found that there exists day-of-the-week variations in volatility in many of emerging Asian stock markets. *Bekaert and Harvey (1997)* used their time-series and cross sectional models that volatility is different across emerging markets, at the time of capital market reforms in

particular. Aggarwal *et al.* (1999) used ICSS to identify the shocks/sudden changes in variance of each stock market and how long the shift lasts. Li *et al.* (2005) used both a parametric and a semi parametric method to examine the relationship between stock market returns and volatility, they also used GARCH-model to recognise time varying pattern of stock market volatility. Batra (2004) used Descriptive statistics to relate the sensex based stock returns in India and Stock return volatility is estimated using asymmetric GARCH (E-GARCH) methodology. Chiou, Lee & Lee (2009) used both T-test and Mann-Whitney test to investigate the cross-nation variation and risk-return measurements Sharpe ratio and global Treynor index. Mandimika (2010) used Descriptive statistics to investigate the behaviour of volatility in each industry sectors and the benchmark series focussing on whether volatility is symmetric or asymmetric. GARCH-M, EGARCH-M and TAR-M models under the Gaussian, Student-t and the GED to capture the risk return relationship. Fayyad and Daly (2010) used a multivariate generalised autoregressive conditional heteroskedasticity (MGARCH) to identify the source and magnitude of volatility.

The researchers have used Granger's causality model very extensively. Wong *et al.* (2004), Narayan *et al.* (2004), Mukherjee and Mishra (2005), Nair and Ramanathan (2003) apply the Engle-Granger residual based test of co-integration. Wong *et al.* (2004) apply the Granger's causality model in addition to the co-integration model applied by them in their study. Chuang *et al.* (2007), Wang and Gunasekarage (2005) apply the Vector Auto Regression (VAR) model to carry out their research. Chuang *et al.* (2007) use the VAR model in their paper to investigate the volatility interdependence in six East Asian markets under study. Wang and Gunasekarage (2005) investigate the interdependence of world's fifteen indices including India in a framework of VAR. The studies of Bala and Mukand (2001), Wong *et al.* (2004), Hoque (2007), Menon, Subha, Sagarani (2009), Nath and Verma (2003), Dwyer and Wallace (1992) apply co-integration model in order to arrive at their research objectives. Bala and Mukand (2001) use the theory of co-integration to study the interdependence between the BSE, NYSE and NASDAQ. Their data consists of daily closing prices for the three indices from January 1991 through December 1999. Wong *et al.* (2004) investigate the pair-wise, multiple and fractional co-integrations between Indian stock market and developed stock markets such as USA, UK and Japan. Sharma and Bodla (2011) have used line charts, correlogram and unit-root test are applied to check the stationary nature of the series; Granger's causality model, vector auto regression (VAR) model and variance decomposition analysis to study the inter linkages between South Asian countries.

Numerous results were derived from the researches under review. Salomons and Grootveld (2002), find that the equity risk premium in emerging markets is significantly higher than in developed markets. Secondly, the extent to which emerging stock markets reward investors is varying through time, and observed that differences are of a more cyclical nature. Yang and Ye (2010) found that Monday returns, in general, have the lowest volatility for all the emerging Asian markets except Korea. Three of the five markets that have significant day-of-the-week effect in volatility have the lowest volatility on the last trading day of the week. It is also found in their study that the close-market effect is not a good explanation of the volatility pattern across day-of-the-week. Hunjra, Azam and Azam *et al.* (2011) indicated in their findings that asymmetric and seasonal effect is present in commodities market and stock market. But the asymmetric properties and seasonal effect is most dominant in stock market prices comparative to other commodities. Pandey and Prachetas (2012) established high risk high returns paradigm is a fallacy in capital markets. The analysis gave higher average monthly rate of returns for low volatility stocks when compared with high volatility and market portfolios. Safarzadeh and Nazarian (2012) find that the BRIC Index Fund (BKE) and Emerging Markets Index Fund (EEM) allocations of funds are not consistent with the optimum allocations of funds derived from the Mathematica simulation whether the risk of exchange rate volatility is factored in or not.

Aleksandar Naumoski (2012) finds that investments in emerging countries are riskier than investments in developed countries. The return on investment in emerging countries should be rewarded with a country risk premium over the return on an equivalent investment in developed countries. There is empirical evidence confirming the strong relation between the country risk and the returns on investment in emerging countries, but no such dependency in developed countries. Samphantharak and Townsend (2013) arrived at the inference from semi-urban and rural Thai households with extensive family networks quantify that idiosyncratic risk is the dominant factor in total risk, but aggregate risk captures a much larger share of total risk premium. Exposure to aggregate and idiosyncratic risk is heterogeneous across households as are the corresponding risk-adjusted returns, with important implications for vulnerability and productivity.

Schwert (1989) suggest that the amplitude of fluctuations of aggregate stock volatility is difficult to explain using simple models of stock valuation during Great depression. Bekaert and Harvey (1997) find that the capital market liberalizations often increase the correlation between local market returns and world market but do not dry up local market volatility.

Aggarwal *et al.* (1999) find high volatility is marked by several shifts during 1985-1995 and there were seven shifts in Argentina. Also large changes in volatility seem to be related to country-specific political, social and economic events and include Mexican peso crisis periods of hyperinflation in Latin-America, the Marcos-Aquino conflict in the Philippines, and the stock market scandal in India. They suggest the October 1987 crash is the only global event in the last decade that caused a significant jump in the volatility of several emerging stock markets. Li *et al.* (2005) find a positive but insignificant relationship between stock return and volatility. By using semi parametric specification of conditional variance, they find a significant negative relationship between expected return and volatility in six out of 12 markets during January 1980 to December 2001. Hammoudeh and Li (2008), found that most of the Gulf Arab stock markets were more sensitive to global events compared to local or regional events. This finding is in sharp contrast to the study of Aggarwal *et al.* (1999), which found dominance of local events in causing large shifts in volatility. Chiou, Lee & Lee (2009) explain that equities in countries with English common-law origin have higher risk premiums than those in civil law countries, particularly for countries of the French/Spanish code.

The indicators representing high efficiency, low corruption, strong legal protection of investors' rights, and reliable political environment are associated with low risk and high performance. The elements of legal procedural formalism, however, have differing effects on volatility and return. *Mandimika (2010)* suggests there is no clear relationship between risk and return, and finds volatility is asymmetrical implying that bad news has a greater effect on volatility than good news in the South African equity market. Also reveal that the TAR-ARCH-M model under the GED was found to be the most appropriate model and volatility increases during financial crises and major global shocks. Also volatility is generally not priced on the South African equity markets. *Fayyad and Daly (2010)* show that the market daily returns have the indication of volatility clustering and Leverage effects since the relation between the regional markets of (Kuwait & UAE) and the Global markets of (USA & UK) is increased during the financial crises. Also it is noticeable that UAE market is relatively highly correlated with the advanced markets return of UK and USA comparing to Kuwait market which is highly bidirectional correlated to the regional markets in the Gulf area. *Elyasiani et al. (1998)* find no significant interdependence between the Sri Lankan market and the equity market of the USA and other Asian countries. Examining the nature and extent of linkage between the US and the Indian stock markets, *Bala and Mukund (2001)* find that the Indian stock market was not affected by the movements in US markets for the entire sample period. Examining the interdependence of three major stock markets in South Asia, namely India, Singapore and Taiwan, *Nath and Verma (2003)* find no cointegration between the stock market indices during the entire study period. *Hoque (2007)* establishes that USA and India do not have any impact on Bangladesh market. Referring to the Indian scenario, the study shows that it is not affected by its own lag or by USA or Japan. The study of *Rajiv Menon et al. (2009)* suggests the absence of cointegration between the Indian stock markets and the American Stock markets. The study further observes that the Indian stock markets and Hong Kong markets operate independently of each other.

On the other hand, *Wong et al. (2004)*, *Narayan et al. (2004)*, *Chuang et al. (2007)*, *Weber (2007)*, *Singh et al. (2008)*, *Elyasiani et al. (1998)*, *Nair and Ramanathan (2003)* find evidence of linkages between the stock markets under study. *Wong et al (2004)* investigate the long-run equilibrium relationship and short-run dynamic linkage between the Indian stock market and the stock markets in major developed countries. *Sharma and Bodla (2011)* stock markets under study are influenced by each other but not to a great extent and suggested that there exist opportunities for diversification for the investors among the stock exchanges of BRICS. Also, there are domestic factors (macro economic variables) that influence the stock markets.

#### 4. Research Methodology

This paper analyses the relationship of risk in stock markets among developed and developing countries. One of the major reasons behind this study is the limitation that most of the research studies have been done either on developed markets or on developing markets. This paper takes into consideration the major developed markets of Japan, US, England and emerging markets of India, China. The study here will examine the linkages return pattern and risk and volatility between the returns of the aforementioned markets. This study takes into account the daily index data for all the countries from 6<sup>th</sup> January 2003 to 21<sup>st</sup> September 2013.

In this research, we study the linkages between the stock exchanges of Japan, US, England, India, China. The study uses one stock exchange from each of the twenty countries as a representative of the respective country. The stock exchange with the largest volumes from each of the country has been chosen for the study. Tokyo Stock Exchange of Japan, New York Stock Exchange from US, London Stock Exchange, LSE from England, Bombay Stock Exchange (India), Shanghai Stock Exchange (China). From Japan, Nikkei225 is used. For USA, NYSE Arca Major Market Index is used. From England FTSE 100 index is taken as representative. From India, the BSE Sensex is taken as representative index. SSE Composite Index is used as the representative index for China. The daily closing levels of the five representative indices for a period beginning on 6<sup>th</sup> January 2003 through 21<sup>st</sup> September 2013 are considered the reference period. In this way, the data of total 125 months are taken for the purpose of the study. Out of the time for which data is taken, it is found that on few days, one or two of the exchanges were open while other(s) was (were) closed. The study takes the data for all the days on which any of the twenty stock exchanges were open. As a result, there are missing values in the data of some of the stock exchanges for some days. There has been much research about filling such missing data points [Mitchel and Stafford (2000), Fuller et al (2002), Moeller et al (2003), Aktas et al (2007)]. The study fills the missing values going by the most advocated method of taking the average of the two nearest cases.

Data has been examined by applying econometric system of studies which is performed on series of stationary nature. In order to confirm the random nature of the series, correlation is computed for each of the series. Augmented Dickey-Fuller Unit Root test has been used to verify whether the series are stationary or not. Further analyses has been made on the daily return observed in relation to five stock exchanges which is technically defined as "log of the series". The variable log series are named as DJAPAN, DUSA, DENGLAND, DINDIA and DCHINA. At the stationary log series of the twenty stock exchanges, the study performs the Granger's causality model in order to observe whether the return at each stock exchange granger causes the return at the stock exchanges. The *Granger causality test (1969)* has been applied to study if any change is caused by x into y, and to correlate whether lagged value of x justifies y. It has been further studied to confirm whether x can help to determine y. Therefore, it is generally seen that x granger causes y and y granger causes x, though this may not always be held that y is the result caused by x. Hence, this two way process of cause and effect is a study made under Granger Causality test. Vector autoregression (VAR) Model and Granger Causality test are the methods generally followed to predict the inter-linked series and to study the impact of unforeseen disturbances on the variables of stock market system. The VAR technique overrides the values of internal variables in structured system of stock market. This paper is aimed to explore the possibilities under Variance Decomposition Analysis whether indices are mutually affected internally. The way that this is

achieved in practice is by expressing the VAR model as a VMA -that is, the vector autoregressive model is written as a vector moving average. Provided that the system is stable, the shock should gradually die away.

The ARCH model of Engle (1982) and the GARCH of Bollerslev (1986), and different extensions to these models have been extensively used in recent empirical studies (Appiah-Kusi and Menyah 2003; Chinzara and Aziakpono 2009). In order to address the objective regarding the nature of the risk-return relationship we analyse the volatility of each of the stock exchanges with GARCH(1,1) model. We then analyse the parameter for risk and if that parameter is statistically significant, then the increase in risk, given by an increase in the conditional variance, leads to a rise in the mean return. Below is a discussion of the models and the procedures that will be used in analysing volatility and to determine the relationship between risk and return.

The mean equation- First step in modelling volatility is to specify an appropriate mean equation. The equation can take the form of a standard structural model, an autoregressive (AR) model, or a combination of the two.

The ARCH(1), GARCH (1,1), models are estimated for the series of stock market, interest rates and exchange rate returns respectively to choose the best fitting volatility for forecasting the conditional volatility of the return series.

Finally, in order to test whether there are any remaining ARCH effects in the residuals is calculated by regressing the squared residuals on a constant and p lags. The correct number of lags in the model have been selected using AIC and SIC information criterion. The AIC and SIC criterion is lowest for GARCH /TARCH, therefore we have used GARCH/TARCH (1,1) model in the study.

## 5. Empirical Analysis

**Table 1** Descriptive Statistics of Returns of Major Developed and Developing Markets

	Mean return (daily)	Mean % Return (daily)	Std. Dev.	Skewness	Kurtosis	Jarque- Bera	Probability	Coefficient of Variation
RJAPAN	0.0002	0.0151	0.0150	-0.7975	10.7388	6974.3140	0.0000	99.4636
RUS	0.0002	0.0209	0.0134	-0.3585	13.3836	12101.8000	0.0000	64.0144
RENGLAND	0.0002	0.0158	0.0122	-0.1219	11.2090	7534.3560	0.0000	77.1582
RINDIA	0.0006	0.0642	0.0157	-0.1047	11.4772	8032.6650	0.0000	24.4190
RCHINA	0.0002	0.0168	0.0163	-0.1512	6.8189	1639.3800	0.0000	96.8393

Table 1 shows that the average daily return at the Tokyo Stock Exchange (Japan), New York Stock Exchange(US), London Stock Exchange, LSE(England), Bombay Stock Exchange (India), Shanghai Stock Exchange (China) is 0.01510%, 0.02090%, 0.01580%, 0.06420%, 0.01680%, respectively.

There are a total of 2681 observations for a period of 10.45 years. Hence, the total returns over a period of 10.45 years can be computed by multiplying the mean daily return with 2681. Going by this, over the period of 10.45 years, stock Exchanges of Japan, US, England, India, and China give returns of 40.4831%, 56.0329%, 42.3598%, 172.1202%, 45.0408% respectively. Going by this and dividing these total returns by 10.45 years, we get the average annual returns for the exchanges under study. In this way, the average annual returns for the five stock exchanges come out to be 3.8740%, 5.3620%, 4.0536%, 16.4708%, 4.3101% respectively. It means that on an average, the return at the Bombay Stock Exchange (India) is the maximum out of the five, followed by the New York Stock Exchange (US), Shanghai Stock Exchange (China), London Stock Exchange LSE (England), and Tokyo Stock Exchange (Japan) respectively.

Table 1 also depicts that the Coefficient of Variation of Tokyo Stock Exchange is 99.46358, which shows the highest risk in the Japanese stock market followed by the China (96.83929), England (77.15823), US (64.01435), and India (24.41900). The Jarque-Bera probability value 0.00000 for all the five stock exchanges indicates that the null hypothesis of normality can be rejected for all the five stock exchanges. However, the non-normality is not a problem for the return series so far as those don't have fat tails (Brooks, 2008). All the five series are leptokurtic in nature as the kurtosis statistic for all the five happens to be more than 3 (Kurtosis for normal distribution is 3).

**Table 2** Correlation

		RJAPAN	RUS	RENGLAND	RINDIA	RCHINA
RJAPAN	Pearson Correlation	1	.509**	.367**	.162**	-.046*
RUS	Pearson Correlation	.509**	1	.623**	.314**	.085**
RENGLAND	Pearson Correlation	.367**	.623**	1	.404**	.136**
RINDIA	Pearson Correlation	.162**	.314**	.404**	1	.225**
RCHINA	Pearson Correlation	-.046*	.085**	.136**	.225**	1
**. Correlation is significant at the 0.01 level (2-tailed).						
*. Correlation is significant at the 0.05 level (2-tailed).						

It is convention that if this value is less than .05, then the correlation is considered to be significant (meaning that the researcher can be 95% confident that the relationship between the two variables is not due to chance). The values of the Pearson Correlation range from -1 to +1 with negative numbers representing a negative correlation (as one variable increases, the other variable decreases) and positive numbers representing a positive correlation (as one variable increases, the other also increases). The closer the value is to -1 or +1, the stronger the association is between the variables. In Table 2 we find that the association between Japan and US, England, China, and India is significant. Similar results were found with the association between US and Japan, England, India, China; England and Japan, US, India, China; India and Japan, US, England, China; China and Japan, US, England, India which appears to be significant.

**Table 3 Regression R-Square Table**

REGRESSION ANALYSIS		
Dependent Variable	R Square	Adjusted R square
Rjapan	0.295	0.29
RUS	0.775	0.774
REngland	0.841	0.84
RINDIA	0.378	0.374
RCHINA	0.186	0.18

The higher the R-squared statistic, the better the model fits the data. R-Square varies between 0 and 1. The independent variables in the regression model account for 29.5% of total variation in dependent variable i.e. RJAPAN. The independent variables in the regression model account for 77.5% of total variation in dependent variable i.e. RUS. The independent variables in the regression model account for 84.1% of total variation in dependent variable i.e. RENGLAND. The independent variables in the regression model account for 37.8% of total variation in dependent variable i.e. RINDIA. The independent variables in the regression model account for 18.6% of total variation in RCHINA.

**Table 4 Regression Analysis**

INPUT	DEPENDENT VARIABLE									
	RJAPAN		RUS		REngland		RINDIA		RCHINA	
	B	SIG	B	SIG	B	SIG	B	SIG	B	SIG
RJapan			0.44	0	0.03	0.548	0.038	0.053	-0.06	0
RUS	0.112	0			-0.037	0.139	0.017	0.085	-0.015	0.066
REngland	0.004	0.548	-0.022	0.139			0.01	0.21	-0.012	0.053
RINDIA	0.037	0.053	0.065	0.085	0.062	0.21			0.005	0.771
RCHINA	-0.081	0	-0.083	0.066	-0.113	0.053	0.007	0.771		

Tables 4 depict the result of the application of the regression model on the returns of the Stock Exchanges of Japan, US, England, India, China. The p-value for each term tests the null hypothesis that the coefficient is equal to zero (no effect). A low p-value ( $< 0.05$ ) indicates that you can reject the null hypothesis. In other words, a predictor that has a low p-value is likely to be a meaningful addition to the model because changes in the predictor's value are related to changes in the response variable. Conversely, a larger (insignificant) p-value suggests that changes in the predictor are not associated with changes in the response. In RJAPAN the p-value for US and China is less than 0.05. In RUS the p-value for RJAPAN is less than 0.05. Similarly, in RCHINA, the p-value for RJAPAN is less than 0.05. There is significant cause and effect relations among all these Stock Exchanges. So there is a scope for the further study of these Variables.

**Table 5 Augmented Dickey-Fuller Test for Unit Root**

Null Hypothesis	Probability	Accept/Reject Null	Interpretation
JAPAN has a unit root	0.0001	Null Hypothesis is Rejected	The series is stationary
US has a unit root	0.0001	Null Hypothesis is Rejected	The series is stationary
ENGLAND has a unit root	0.0000	Null Hypothesis is Rejected	The series is stationary
INDIA has a unit root	0.0001	Null Hypothesis is Rejected	The series is stationary
CHINA has a unit root	0.0001	Null Hypothesis is Rejected	The series is stationary

Table 5 presents the summary of unit-root test and Augmented Dickey-Fuller test for the returns at the Tokyo Stock Exchange (Japan), New York Stock Exchange (US), London Stock Exchange, LSE (England), Bombay Stock Exchange

(India), and Shanghai Stock Exchange (China). The result shows that the probability value of unit-root tests for all the stock exchanges is less than 0.05, which indicate towards the fact that the null hypothesis is rejected and the series return at all Five Stock Exchanges are stationary in nature.

**Table 6** Granger Casuality Tests

NULL HYPOTHESIS	F-	PROBABILITY
CHINA does not Granger cause US	0.02395	0.9763
CHINA does not Granger Cause JAPAN	0.06840	0.9339
US does not Granger Cause JAPAN	0.08889	0.9149
CHINA does not Granger Cause ENGLAND	0.62357	0.5361
INDIA does not Granger Cause US	1.66409	0.1896
INDIA does not Granger Cause JAPAN	1.76147	0.172
ENGLAND does not Granger Cause US	2.54337	0.0788
CHINA does not Granger Cause INDIA	3.54203	0.0291
INDIA does not Granger Cause ENGLAND	4.13994	0.016
ENGLAND does not Granger Cause JAPAN	4.54783	0.0107
INDIA does not Granger Cause CHINA	6.06380	0.0024
ENGLAND does not Granger Cause INDIA	23.7086	6.00E-11
ENGLAND does not Granger Cause CHINA	24.8046	2.00E-11
US does not Granger Cause CHINA	35.8292	4.00E-16
US does not Granger Cause INDIA	79.6775	2.00E-34
JAPAN does not Granger Cause CHINA	92.9952	9.00E-40
JAPAN does not Granger Cause US	116.644	3.00E-49
US does not Granger Cause ENGLAND	200.271	9.00E-82
JAPAN does not Granger Cause INDIA	226.136	2.00E-91
JAPAN does not Granger Cause ENGLAND	256.472	1.00E-102

Table 6 represents the result of Granger's Causality model to the stock exchanges of Developed and Developing markets. From the probability values of the Granger causality test, the acceptance and rejection decision for the Null hypothesis can be taken. While we accept the null hypothesis for the cases with probability value above 0.05, we reject the ones with lesser than 0.05 probability value. Going by this RULE, we reject the null hypothesis in the following cases, where we accept the alternate hypothesis.

Table 7 indicates Vector autoregression (VAR) Model at the stock exchanges of Japan, US, England, India, China. It has been observed that the integration of a stock exchange with the other can be established if the table value is more than 1.96. Following inferences can be drawn from Table7-

1. RChina (Return in China) at the lag of 1 has no significant influence. Also, at the lag 2 it has no influence on any other stock exchange.
2. REngland (Return in England) at the lag of 1 has influence on China, England. With the lag of 2, REngland has no influence on other stock exchanges.
3. RIndia (Return in India) at the lag 1 has no significant influence on any other stock exchange. With the lag of 2 Rindia has its influence on England, India.
4. RJapan (Return in India) at the lag of 1 has influence on China, England, India, US. With the lag of 2, it has influence on China, England, India, US.
5. RUS (Return in US) at the lag of 1, it has influence on England. With the lag of 2, it has influence on England, India, US.

**Table 7** Vector Autoregression Analysis

Vector Auto Regression Estimates					
Standard errors in ( ) & t-statistics in [ ]					
	RCHINA	RENGLAND	RINDIA	RJAPAN	RUS
RCHINA(-1)	-0.00756	-0.00789	-0.00869	0.00038	0.011422
	[-0.36417]	[-0.55772]	[-0.46077]	[ 0.01937]	[ 0.68058]
RCHINA(-2)	0.010069	0.007237	0.025809	0.012834	0.003545
	[ 0.48525]	[ 0.51198]	[ 1.36958]	[ 0.65422]	[ 0.21125]
RENGLAND(-1)	0.160562	-0.22657	-0.07873	-0.06439	0.074853
	[ 2.48913]	[-5.15617]	[-1.34394]	[-1.05584]	[ 1.43508]



RENGLAND(-2)	-0.06352	-0.01404	0.082975	0.002227	-0.0487
	[-0.99858]	[-0.32393]	[ 1.43634]	[ 0.03703]	[-0.94689]
RINDIA(-1)	0.009495	0.005614	-0.01858	0.009833	-0.0044
	[ 0.38336]	[ 0.33277]	[-0.82617]	[ 0.41997]	[-0.21990]
RINDIA(-2)	0.023545	0.034047	-0.06103	-0.00404	0.032127
	[ 0.95305]	[ 2.02305]	[-2.72023]	[-0.17316]	[ 1.60820]
RJAPAN(-1)	0.240727	0.275611	0.37503	-0.04409	0.28472
	[ 9.78295]	[ 16.4421]	[ 16.7819]	[-1.89514]	[ 14.3095]
RJAPAN(-2)	-0.06638	0.052055	0.058866	0.029002	0.102547
	[-2.29841]	[ 2.64605]	[ 2.24446]	[ 1.06225]	[ 4.39138]
RUS(-1)	0.073128	0.375461	0.044213	0.064999	-0.2138
	[ 1.39719]	[ 10.5306]	[ 0.93014]	[ 1.31360]	[-5.05163]
RUS(-2)	0.09006	0.138221	0.157419	0.04763	-0.09759
	[ 1.74746]	[ 3.93700]	[ 3.36328]	[ 0.97756]	[-2.34185]
C	9.90E-05	5.70E-05	0.00045	8.96E-05	0.000153
	[ 0.32102]	[ 0.27126]	[ 1.60632]	[ 0.30744]	[ 0.61176]

Variance Decomposition Analysis: The Variance Decomposition Analysis of the twenty stock exchanges is presented in the table 8. The table decomposes the returns at the twenty stock exchanges for a period ranging from 1 to 10.

**Table 8** Variance Decomposition Analysis

Variance Decomposition of RCHINA						
Period	S.E.	RCHINA	RENGLAND	RINDIA	RJAPAN	RUS
1	0.015677	98.71105	0	0	0	0
2	0.016301	91.34999	0.253074	0.045671	3.957371	0.064637
3	0.016385	90.4244	0.367074	0.082884	4.009653	0.191216
4	0.016393	90.33023	0.366925	0.083415	4.005526	0.210034
5	0.016396	90.30411	0.367102	0.083548	4.006055	0.211437
6	0.016396	90.29733	0.367084	0.083546	4.005877	0.212758
7	0.016397	90.29588	0.367085	0.083546	4.0064	0.212755
8	0.016397	90.29579	0.367095	0.08355	4.006399	0.21278
9	0.016397	90.29572	0.367096	0.083551	4.006406	0.212782
10	0.016397	90.29572	0.367096	0.083551	4.006406	0.212782
Variance Decomposition of RENGLAND						
Period	S.E.	RCHINA	RENGLAND	RINDIA	RJAPAN	RUS
1	0.010679	0.014123	45.37203	0	0	0
2	0.012124	0.132931	36.66494	0.033932	12.149	3.080234
3	0.012256	0.158041	35.99372	0.19645	11.8895	3.261229
4	0.012278	0.157463	35.92417	0.217894	11.88543	3.303648
5	0.012285	0.157327	35.88771	0.217845	11.92226	3.315196
6	0.012286	0.157312	35.88466	0.217842	11.92488	3.315113
7	0.012286	0.157322	35.8837	0.217978	11.92478	3.315113
8	0.012286	0.157323	35.88348	0.217978	11.9247	3.315146
9	0.012286	0.157323	35.88347	0.217983	11.9247	3.315144
10	0.012286	0.157323	35.88346	0.217984	11.9247	3.315144
Variance Decomposition of RINDIA:						
Period	S.E.	RCHINA	RENGLAND	RINDIA	RJAPAN	RUS
1	0.014238	1.315484	0.911034	76.11122	0	0
2	0.015665	1.398812	0.753732	62.8718	11.10127	0.025585

3	0.015775	1.431685	0.830037	62.2057	10.96162	0.182155
4	0.015796	1.428568	0.855037	62.03802	11.0095	0.1899
5	0.0158	1.428518	0.856505	62.01032	11.03126	0.195997
6	0.015801	1.428429	0.856741	62.00641	11.03099	0.196088
7	0.015801	1.428411	0.856789	62.00562	11.03085	0.196135
8	0.015801	1.428405	0.856794	62.00534	11.03109	0.196135
9	0.015801	1.428404	0.856795	62.00532	11.03109	0.196135
10	0.015801	1.428404	0.856795	62.00531	11.03109	0.196135
<b>Variance Decomposition of RJAPAN</b>						
<b>Period</b>	<b>S.E.</b>	<b>RCHINA</b>	<b>RENGLAND</b>	<b>RINDIA</b>	<b>RJAPAN</b>	<b>RUS</b>
1	0.014821	0.737174	1.812884	0.161482	74.9944	0
2	0.015017	0.724529	1.786569	0.164571	73.07668	0.060175
3	0.015103	0.717137	1.810345	0.162697	72.30899	0.059502
4	0.015129	0.717888	1.804144	0.164514	72.23789	0.098214
5	0.015133	0.718001	1.807847	0.166064	72.20501	0.102783
6	0.015134	0.717941	1.808035	0.166055	72.19835	0.102807
7	0.015134	0.717932	1.808027	0.166066	72.19793	0.102819
8	0.015134	0.71793	1.808035	0.166078	72.1977	0.102861
9	0.015134	0.71793	1.808035	0.166078	72.19769	0.102865
10	0.015134	0.71793	1.808035	0.166078	72.19769	0.102865
<b>Variance Decomposition of RUS</b>						
<b>Period</b>	<b>S.E.</b>	<b>RCHINA</b>	<b>RENGLAND</b>	<b>RINDIA</b>	<b>RJAPAN</b>	<b>RUS</b>
1	0.012677	0.075868	2.805494	0.003603	1.749434	19.98724
2	0.013396	0.077431	2.549688	0.011499	8.147899	18.71599
3	0.01345	0.078357	2.730222	0.138558	8.090289	18.59656
4	0.013475	0.080274	2.727973	0.148397	8.237991	18.53083
5	0.013476	0.080283	2.727693	0.150339	8.238436	18.52642
6	0.013477	0.080314	2.727905	0.151533	8.238077	18.52466
7	0.013477	0.080322	2.72789	0.151547	8.238015	18.52452
8	0.013477	0.080322	2.727903	0.151571	8.238007	18.52448
9	0.013477	0.080322	2.727904	0.151573	8.238015	18.52448
10	0.013477	0.080322	2.727903	0.151573	8.238014	18.52448
Cholesky Ordering: RCHINA RENGLAND RINDIA RJAPAN RUS						

The Variance Decomposition Analysis as presented in Table 8 entails following-

1. In the case of Shanghai Stock Exchange (China), return of China in Lag 1 depends 98.711% on its own. In Lag 2 it depends again on its own with 91.34999%. The Table8 reveals that in the case of Shanghai Stock Exchange there is some visible impact of China.
2. In the case of London Stock Exchange (England), return of England depends 45.372% on its own. In Lag 2 it again depends on its own or on Japan and USA. The above table reveals that there is an impact of USA on London Stock Exchange from period 2 to 10.
3. In the case of Bombay Stock Exchange (India), the return of India depends 76.11122% on its own. In Lag 2 it depends on its own or on Japan. The Table reveals that there is some visible impact of India and Japan on Bombay Stock Exchange from periods 2 to 10.
4. In the case of Tokyo Stock Exchange (Japan), return of Japan depends 74.9944% on its own. In Lag 2 it again depends on its own. There is some visible impact of Japan on its own stock exchange i.e. Tokyo Stock Exchange from periods 2 to 10.
5. In the case of New York Stock Exchange (US), the returns of US in Lag 1 depends 19.98724% on its own or on England. In Lag 2 it depends again on its own or on England and Japan. The Table reveals that there is significant visible impact of US, England and Japan on New York Stock Exchange from periods 2 to 10.

Table 9 Mean Equation

Markets	Coefficient	Standard Error	z-statistics
Japan	0.000304	0.000227	1.33712
US	0.000246	0.000166	1.485513
England	0.000155	0.00016	0.973159
India	0.000842	0.000214	3.930967
China	6.43E-05	0.000256	0.251447

1. it is observed, it is observed from the best fit estimated GARCH equation, that the value of RESID (-1) -0.014991 is smaller in magnitude, which implies that the shocks to conditional variance take lesser time to die out. It becomes imperative to observe that In Japan, it is observed from the best fit estimated GARCH equation, that the value of RESID (-1)0.05227, is smaller in magnitude, which implies that the shocks to conditional variance take lesser time to die out. It becomes imperative to observe that the GARCH (-1) value 0.878444, is large enough in magnitude, to imply that volatility reacts intensely to the market movements.
2. In US, the GARCH (-1) value 0.93604, is large enough in magnitude, to imply that volatility reacts intensely to the market movements.
3. In England, it is observed, it is observed from the best fit estimated GARCH equation, that the value of RESID (-1)-0.010066, is smaller in magnitude, which implies that the shocks to conditional variance take lesser time to die out. It becomes imperative to observe that the GARCH (-1) value 0.913598, is large enough in magnitude, to imply that volatility reacts intensely to the market movements.
4. In India, it is observed, it is observed from the best fit estimated GARCH equation, that the value of RESID (-1) 0.060218, is smaller in magnitude, which implies that the shocks to conditional variance take lesser time to die out. It becomes imperative to observe that the GARCH (-1) value 0.861864, is large enough in magnitude, to imply that volatility reacts intensely to the market movements.
5. In China, it is observed, it is observed from the best fit estimated GARCH equation, that the value of RESID (-1) 0.043418, is smaller in magnitude, which implies that the shocks to conditional variance take lesser time to die out. It becomes imperative to observe that the GARCH (-1) value 0.9401, is large enough in magnitude, to imply that volatility reacts intensely to the market movements.

Table 10 Variance Equation

MARKET	AIC	SIC	RESID(-1)^2		RESID(-1)^2*(RESID(-1)<0)		GARCH(-1)		GARCH = C(2) + C(3)*RESID(-1)^2 + C(4)*RESID(-1)^2*(RESID(-1)<0) + C(5)*GARCH(-1)
			COEFFICIENT	PROBABILITY	COEFFICIENT	PROBABILITY	COEFFICIENT	PROBABILITY	
JAPAN	-5.8899	-5.8789	0.0523	0.0000	0.0910	0.0000	0.8784	0.0000	-0.0001
US	-6.4076	-6.3966	-0.0150	0.0368	0.1273	0.0000	0.9360	0.0000	0.0000
ENGLAND	-6.4761	6.4651	-0.0101	0.2486	0.1608	0.0000	0.9136	0.0000	0.0000
INDIA	-5.8484	-5.8374	0.0602	0.0000	0.1161	0.0000	0.8619	0.0000	-0.0001
CHINA	-5.6035	-5.5925	0.0434	0.0000	0.0134	0.0315	0.9401	0.0000	0.0000

## 6. Conclusion

The study concludes that the annual returns from the stock exchanges vary from 3.8740%, to 16.4708%. The average annual return is maximum among the annual returns at Bombay Stock Exchange (India), New York Stock Exchange (US), Shanghai Stock Exchange (China), London Stock Exchange LSE (England), and Tokyo Stock Exchange (Japan). The application of correlation suggests that the association between Japan and US, England, China, and India is significant. Similar results were found with the association between US and Japan, England, India, China; England and Japan, US, India, China; India and Japan, US, England, China; China and Japan, US, England, India which appears to be significant. In RJAPAN the p-value for US and China is less than 0.05. In RUS the p-value for RJAPAN is less than 0.05. Similarly, in RCHINA, the p-value for RJAPAN is less than 0.05. There is significant cause and effect relations among all these Stock Exchanges. Further the results of Variance Decomposition Analysis show that the extents to which the returns at stock markets under study are influenced by the returns at each other differ significantly.

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# Investment Risk Identification and Classification in Small Hydro Power projects



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**Neha Chhabra Roy**  
Alliance University  
(nehang201112@gmail.com)

**Krishna Kumar Pandey**  
**Sumeet Gupta**  
University of petroleum & Energy Studies  
(Krishan.pandey@gmail.com)  
(sumeetgupta@ddn.upes.ac.in)

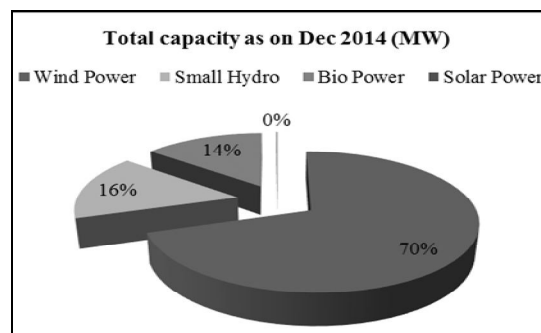
*This paper is contribution in hydro power area research with investment risk identification in small hydro power projects (SHP's). The SHP's project investment is phase specific as construction, operation, pre-construction and renovation and modernization. This paper focus area is construction and operational phase projects. The methodology opted for this study is literature review and further a semi structured interview with experts is performed. The validation of the risk factor identification and taxonomy has been performed using statistical methods as Zscore value. The outcome of this paper helps investors of SHP's firstly to get the clear idea about various investment related risk factors and secondly the phase specific risk factors are also segregated. This helps policy makers, further investors and risk management team to proceed further.*

**Keywords:** Risk Identification, Investment risk, Risk taxonomy; Small Hydro power Project, Operational Stage; Construction stage

## 1. Introduction

The world is increasingly aware that fundamental changes will be necessary to meet the growing demand for energy. There are many possible scenarios which may emerge in the foreseeable future. Indian economy has to grow at 8.5% per cent, it is imperative for the power sector to grow at 8.1 per cent per annum.(IEA Report, 2014.) Today, India is the ninth largest economy in the world, driven by a real Gross Domestic Product (GDP). The growth of GDP is 8.7% in the last 5 years (7.5% over the last 10 years) (Energy statistics, 2014) . In 2010 itself, the real GDP growth of India was the 5th highest in the world.(Gates, 2011) This high order of sustained economic growth is placing enormous demand on its energy resources. The demand and supply imbalance in energy is pervasive across all sources requiring serious efforts by Government of India to augment possible energy supply. India's energy basket has a mix of all the resources available including renewables. Other renewables such as wind, geothermal, solar, and small hydro represent the Indian fuel mix.

There are few problems that power sector is facing as reforms of power market to encourage competition (IEA, 2013), Rising prices of electricity and Greenhouse Gas Emission . Above all worldwide escalating energy demand requires developing "clean energy" source as the future energy source. Hydroelectricity is considered as the best source of "clean energy" resource and low price source of electricity (Berchmans, 2013). The Eleventh Plan calls for grid connected renewable energy to exceed 30000 MW by 2020 (Zelenakova, Zvijakova, & Purcz, 2013) Renewable energy technologies are being deployed at industrial facilities to provide supplemental power from the grid, and over 70% of wind installations are used for this purpose. Biofuels and solar energy have not yet reached a significant scale in India (Fig 1).



**Figure 1** Plan Period Wise Capacity Addition in Grid Connected Renewable Energy based Power Generation Installed Capacity (in MW); Source: MNRE, Government of India

Energy exploration and exploitation, capacity additions, clean energy alternatives, conservation, and energy sector reforms are critical areas for energy security. (Nandy & Bhattacharya, 2012); (GOI Report, 2008). Conservation and efficient utilization of energy resources play a vital role in narrowing the gap between demand and supply of energy (Tongtao & Cunbin, 2014).

Challenges in front of government emphasize on and safety and clean source of energy yet small hydro power is considered as best source of clean energy (Ghosh & Kaur, 2009). Small Hydro Power energy constitutes more than 15% of the overall renewables mix as shown in Fig1.

**1.1 Indian Small Hydro Power Sector**

Small hydro power sector in Indian context is defined as that hydro power project whose installation capacity is less than 25 MW. The small size and clean source of energy makes SHP development is one of the thrust areas of power generation from renewables in the ministry of Renewable and energy resources (MNES). However, contribution from Small Hydro Power plants towards the hydro energy generation in India is much unexploited as most of the hydro energy generated is only through large or medium hydro power projects.

Major hydro electricity generation states in India are Himachal Pradesh, Uttarakhand, Jammu and Kashmir, and Arunachal Pradesh etc. Potential wise Himachal ranked first followed by Uttarakhand (Fig.2). However installed capacity of Uttarakhand is more as compare to Himachal which is around 23% (fig. 2) so Uttarakhand is having high scope for harnessing the potential.

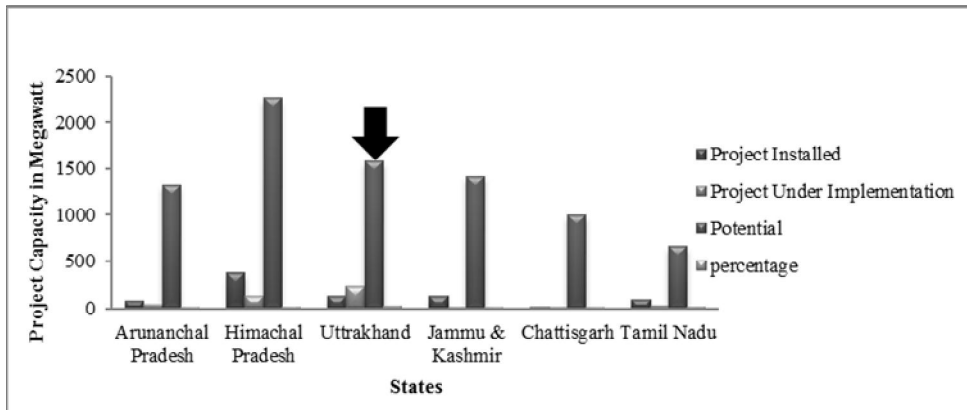


Figure 2 State Wise Estimated Small Hydro Power Potential of India as on 31-03-2013(In MW)

There is vast potential for development of Small Hydro Power projects, enormous funds shall be required to tap this potential. Considering the large requirement of funds, it may not be possible alone by Government to provide adequate finances. To mobilize additional resources for the Small Hydro Power, private sector participation has to be encouraged in many states; private sector has been invited to tap the hydro power resources for captive use as well for commercial purpose. Private sector participation in renewable energy has also increased significantly in recent years as Government of India has opened the power sector to private sector participation.

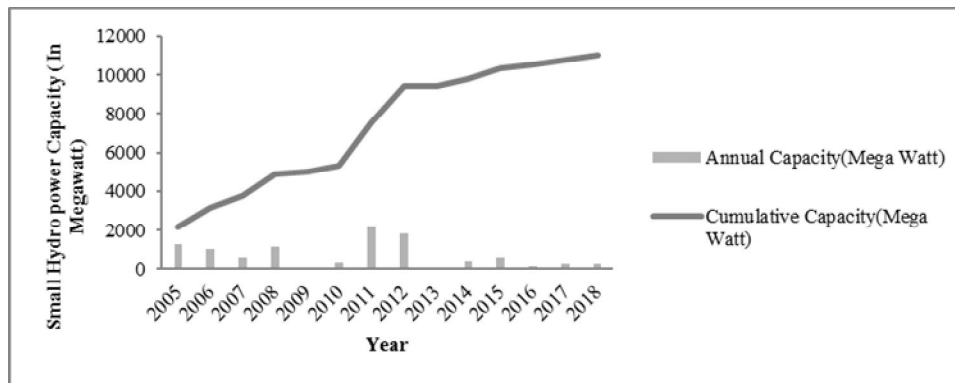


Figure 3 Planned Hydropower Capacity Additions Through 2018

Uttaranchal is currently a net importer of electric power, but generates a seasonal surplus and plans to become a net exporter of power by 2015 by expanding its hydropower and high voltage transmission capacity. Total capacity expansion of 10,000 megawatts (MW) is planned through 2018. Currently 14 projects totaling 5,525 MW are under construction and expected to be commissioned by 2020. An additional 4,791 MW are under development, with expected commissioning dates after 2010, and another 9,090 MW are planned. Fig. 6 shows the projected annual and cumulative capacity additions from 2005 through 2018.

### 1.2 Major Investment Stages in SHP Projects

In Small Hydro Power projects the investors are integrated with all phases of power production mentioned in the Fig.4. The major four stages in Small Hydro Power projects are described as primarily the initial phase where the power projects are under pre construction or detailed project Report (DPR) phase. The stage when the plant is proposed after detailed prefeasibility study by the investors. Pre-construction *or* DPR Phase includes two sub stages as feasibility study and general design. Feasibility Study has three components: Preliminary Design, Hydropower study and Financial Analysis. After preconstruction approval secondly project construction will start. Construction phase of small hydro power project also includes two sub stages which are detailed Design and commissioning & running in process.

Operation followed construction which sustains for the longer duration. Under operational phase one major stage that is assigned as trouble shooting and investigation. The major activities in this stage are monitoring regular operations and provide troubleshoot. On other hand this stage is quite sensitive as all the previous stages are turn up in revenue in this phase. Regular watch on operations & maintenance cost and Working capital requirement is considered in this phase. With continuous operations and usage of power project wear and tear starts in project. With need of technological advancements and high cost overrun investor rethink about renovation and modernization of the existing plant with latest practices.

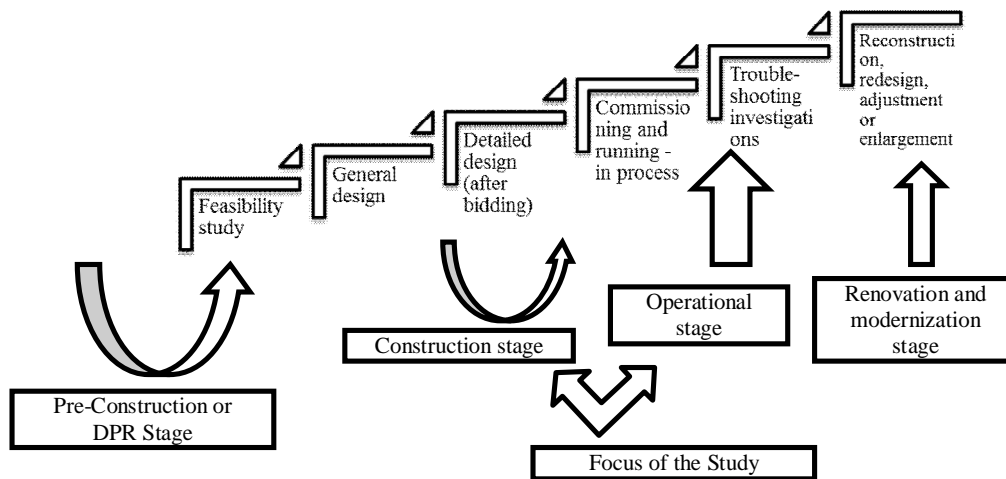


Figure 4 Detailed Stages of Investor Involvement in Hydro Power Projects

### 2. Investment Scenario in SHP's

Investors are associated with hydro power projects in major three stages as mentioned in fig. 5 firstly generation, secondly transmission and lastly distribution. Investment contribution is maximum over transmission and distribution stage as it covers dam construction, turbine, generators etc.

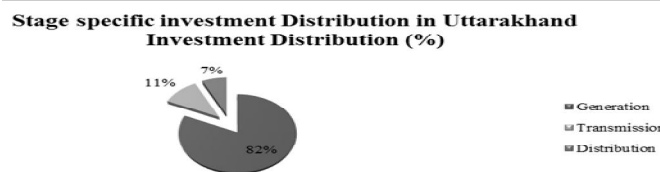


Figure 5 Investment Program 2006-12 \$ Million

The Small Hydro Power plants of Uttarakhand are classified into four different categories as pre construction, under construction, under operation, and under development discussed in previous section.

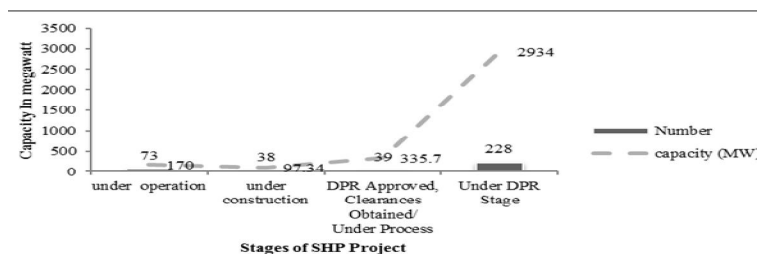


Figure 6 Small Hydro Power Type Distribution based on Capacity and Number



Fig. 6 discussed the existing potential needs to harness in uttarakhand a small hydro power project which shows large in number. Investors are ready to invest in the projects but they face certain challenges which stop them to proceed further. This section highlights on several investment challenges that investors face while investing.

### 2.1 Investment Challenges for SHP's in Uttarakhand

The challenging issue facing by hydro power sector is the fact that, despite the high power shortage that has continued over the past several years, there has been little progress in developing new power projects to meet power demand. Behind this is a negative spiral rooted in uttarakhand price regulation policy that keeps electricity prices. (Kesharwani, 2006).

In particular, with regard to small-medium sized hydropower projects, many domestic private companies (particularly small and medium companies) from other industries flocked to the power sector in an investment boom in the midst of soaring economic growth, but with little know-how and experience in developing as well as unrealistic funding plans, in many cases construction had to be halted due to shortages of funds and the partially constructed waterway abandoned. (Thomas et al., 2004) infers that investment in hydro power remain limited in part of because of federal and nonfederal financial constraint, uncertainty in electricity generation, policy deregulations and price fluctuation.

(Popovski, Gnjezda, Niederbacher, Naunov, & Milutinovic, 2000) concludes Considerable investment is needed to harness the potential of renewable energy and more efficiency energy use to reduce carbon emissions and provide energy essential for economic growth more investment required for economic growth. (Pejovic, Karney, Zhang, & Kumar, 2007); (Chaurasiya, Prasad, & Khare, 2013) mentioned investment in hydro power in Nepal is considered as best source for the development of women and children but societal development and policy deregulations works as a major issue. (Lundmark & Pettersson, 2007) mention technical issues of modeling via proving that there is roughly a ten percent chance that the investment occurs in hydro power sector of Norway. (Ghosh & Kaur, 2009) highlights the two major challenges for hydro power investment as uncertainty and irreversibility he mentioned clearly that risk and uncertainty not highlighted in the modeling. (Zhang, 2012) emphasis that a better investment model is always useful for investors as clarity about the risk and uncertainties mentioned. (R.V.Shahi, 2006) lukewarm response for investments in Indian power sector in last ten years has been the less reliability on hydro power DPR's, Environmental aspect, rehabilitation and resettlement issues, Dam security, construction time and creditworthiness of the sector. (Berchmans, 2013) Major challenges with this approach are input uncertainty and risk assessment. (Han, Kwak, & Yoo, 2008) highlights on the infrastructure projects in electrical power industries have two important characteristics: one is taking much time and the other need of a big amount of capital. Therefore, a long time is needed for taking results from capital for performing any activity which needs large Investments. For this reason, it has a high risk for the investor. (Yang, 2007) said that risks and uncertainties often compel investment in flexible power production technologies with short periods of ROI, brief construction times and the capacity to switch between fuels. (Filippini & Luchsinger, 2002); investments in the power sector in a regulated market and conclude that the possibilities to invest is better when electricity price is regulated, at least for projects requiring large capital investments per unit of output. The main problem for raising money for projects in the, small hydro power market is lack of investor confidence (Wiemann, 2011).

To sum-up all the above mentioned investment issues the conclusion drives to identify the various risks for the investors who have interest in investing but still they have lack of confidence of generating better profit to overcome this problem this research will help investors to invest in SHP's with more clarity and with less fear.

## 3. Methodology

Investment Risk identification for small hydro power sector the current paper focus primarily on the literature based on Risks in small hydro power sector which is an exploration method based on secondary data analysis. This intricate initially, classifying the whole variety of risks that are available and, secondly deciding which of these risks are the most appropriate for small hydro power operational and construction phase investors. It demanded cautious thought of factors such as the business environment of the small hydro power sector.

The various classes of risk factors have been determined based on the detailed literature review followed by expert interviews. The risk factors from literature review starts with global literatures available for small hydro power project which further funnel down to India and Uttarakhand. Not only has this literature review covered major regions of Uttarakhand Ganga, Yamuna & Bhagirathi. Total 37 risk variables have been identified from literature review.

Once the risk variables identified from literature review for the confirmation of those risk whether applicable for Uttarakhand a semi structured interview is taken from 40 officials of Small hydro power projects experts (investors, Developers, Researchers and approvers) having 15- 18 years of average experience involved with hydro power as a developer, approver, and investors. Only 40 responses collected because the risk variables are repeated every time within this sample range. Judgmental sampling used for this objective due to limited expertise in the area. The responses of experts were further validated and significance checked using Z score in equation 4.1.

$$z_{score} = \frac{p - P}{\sqrt{\frac{pq}{N}}} \quad \text{--- (3.1)}$$

Where p-possibility of getting result (32);

q- Possibility of not getting result (0.8);  
 P- Respondents responded/total sample (0.2);  
 N- Sample Size (40) (Hofstede, G.; 2008)

Using  $Z_{score}$  the acceptance & rejection criterion is validated lies in the range between +3 to -3, the risk factors are accepted. The maximum responses for any one specific stage based on responses of experts help researcher to segregate risk variables in various stages. The risk factors have been further classified into construction and operation stage small hydro power project based on the expert opinion collected.

## 4. Result & Discussion

### 4.1 Risks Identification in Small Hydro Power Projects

(Knutsen & Poulsen, 2010) describes risks as a situation where probabilities cannot be objectively assigned and where all future contingencies may not be known. ; (Salling, 2005) explained risk is uncertainty that occurs in future which needs to be coped so as to evade variation of penalties ranging from negative wonders to enduring loss. All the risk variables which are applicable for Uttarakhand small hydro power projects which come after semi structured interview with officials are categorized further in specific phases of SHP investment.

Globally addressed small hydro power risks are explored. Although studies shows that few authors only worked on investment related risk which explore types of significant risks faced by investors in small hydro power projects. So far no study which explores investment related risks in junctures of small hydro power sector so this paper fills this gap. The risk in small hydro power projects of Uttarakhand are arranged in few major groups.

- **Technical Risk:** (Bazmi & Zahedi, 2011) mentioned technological impacts related with construction duration which change capital investment, investment timing and technology choice are of principal interest to not only to policy makers but also to the various market participants. (Fleten, Juliussen, & Revdal, 2007) mentioned that investment decision is affected by factors influencing the cash flows of the project in which Operation and maintenance cost is one of them. They found O&M cost increased to double from estimated as per DPR, reason behind that is obsolete technology. This factor is one of the major factor in hydroelectric power project as it is long run project where O&M is keep on increasing. (Uhr, 2006). (Madlener & Wickart, 2006) in his study on Dam of hydroelectric power projects the breakdown in machinery impacts the operational stage of project which creates cost overrun. He also mentions regular cash flow for preventive maintenance, if increased create cost overrun. Several risk variables has found from literature review for convenience the risk variables are compiled in different groups.
- **Construction Risk:** construction is major area in small hydro power sector as this project needs huge capital investment during construction stage that affect investors (Gajewska & Ropel, 2011) mentioned in his paper the impact of construction schedule which varies and disturb the cost of the project. construction budget (Aird, 2000) is another associated variable which was found due to construction schedule delay.
- **Financial Risk:** (Knutsen & Poulsen, 2010); mentioned the impact of sources of finance, exchange rate risk, interest rate, tax rate. In hydro power sector investment has seen in the form of foreign direct investment so purchasing power of two currencies affects today's exchange rate of two currencies which affect investment directly. (Pejovic et al., 2007); showed the impact of project management risk due to human errors and technological defects in small hydro projects. (Fleten et al., 2007) mentioned currency risk is greater for shorter term investments, which do not have time to level off like longer term foreign investments. The main factors deciding the annual cash flows are the revenues from the electricity price and potentially the support scheme, the operational and maintenance costs, the income tax, the resource tax and the property fee.
- **Legal Risk:** (T. Wang, 2003); considered electricity supply industry reforms unfold the resultant deregulation brings in several market regulatory and trade related risks on the investment area. (Castaldi, Chastain, Windram, Ziatyk, & Sciences, 2003); (Kai & Tiong, 2008) applied policies and regulatory factors like carbon emission trading schemes and cross subsidies of renewable energy production schemes may bring along additional risk to investors that makes investors demand a higher rate of return on their investments, which again leads to a slower investment rate in emission-reducing technology. (Lamech & Saeed, 2003); identified Clearances from Ministry of Environment & forestry (MOEF), Pollution control board, central electricity authority and central water commission are the requirement before the construction of small hydro power plants. (Berchmans, 2013) focused on High court and Supreme Court stays for hydro power construction is one of the major impacts on investor's perception towards investment.
- **Business Risk:** (Swider & Weber, 2009); (Wong & Kelley, 2010); (Tongtao & Cunbin, 2014) proved the relationship between price volatility and the probability of investment in hydro power sector investment. (Naik & Rathod, 2008); (Xue, Liang, & Boulton, 2008) identified price uncertainty and generation of electricity in the power sector in a regulated market and concludes that the possibilities to invest is better when electricity price is regulated, at least for projects requiring large capital investments per unit of output such as small hydro power. (Pindyck, 1990); shown market uncertainty impact on Investment and sunk costs associated to disinvestment. In their analysis, demand uncertainty is modeled using a stochastic process on output price, deemed to be acted by random shocks. (J.-J. Wang, Jing, Zhang, & Zhao, 2009)., 2010d); (Lundmark & Pettersson, 2007), mentioned market risk is one of the predominant risks in small hydro power sector industry. The variation in electricity generation also a dominant risk factor which impacts revenue that generates on generated electricity sale, (Wiemann, 2011). Modeling techniques for investment evaluation if based on older version work as hidden risk factor. (Kalantzopoulos, Hatzigeorgiou, & Spyridis, 2008).
- **Environmental Risk:** In this series various risk factors are explained by authors as (Harrison, Whittington, Gundry, & Management, 2004), presented very crucial unsystematic Climatic risk impacts on the electrical system as well as shows the investment performance of hydroelectric plant with climate impact using empirical method to enable analysis of the impact. (Fleten & Heggedal, 2009) also addressed climatic risk in Norway hydroelectric power project. (Kucukali, 2011)

mentioned various external factors such as site geology, grid connection, and environmental issues in the Construction of river type hydropower plants. A fresh look at the environmental impacts of dams on an ecologically diverse and partially protected river in China found that small dams can pose a greater threat to ecosystems and natural landscapes than large dams, (Zelenakova et al., 2013). (Maingi & Marsh, 2002) addressing risk factors river flow and river precipitation which impact the environment as well as it is impacting machinery of hydroelectric project as well. Forest clearance is sometime requirement in the case of dam construction in that case forest is removed for those clearances are required from ministry of environment and forestry. This activity misbalanced the ecology of the system addressed by (Girmay, 2006).

- **Socio Economic Risk:** (Hossain, 2006.) In his study described rehabilitation and resettlement cost associated with Tipaimukh dam in Bangladesh which increase investment cost. Considering the current socio economic scenarios of Uttarakhand here, the investors are dominated by farmers and other local landowners in this particular region near to hydro power dam in Uttarakhand in Ganga & Yamuna Basin (Kesharwani, 2006). Many socio economic and environmental risk factors as water quality, soil erosion, employment, flora and fauna, noise pollution, tourist attraction, are discussed by (Kucukali, 2011) which impact small hydroelectric power projects investors.

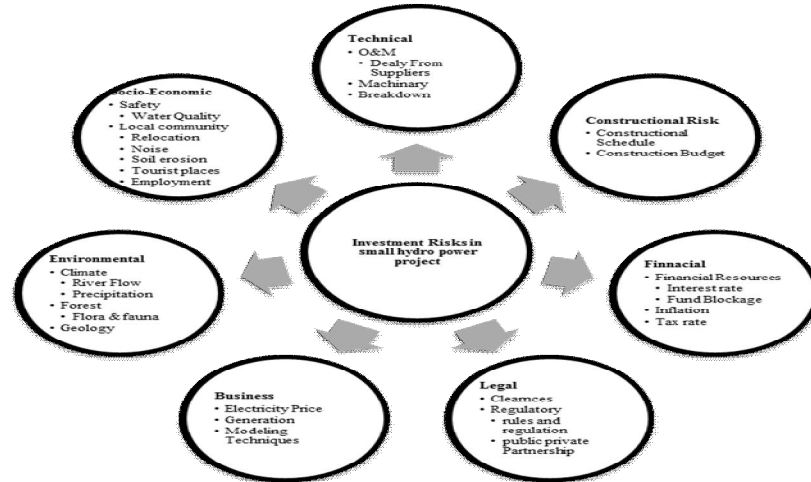


Figure 7 Small Hydro Power Sector of Uttarakhand Risks Classification

From literature survey there were around 37 risk variables found with small hydropower projects investment across the world.

Table 1 Z Score Values of Risk Variables

Risk Variable	Z score	Accept/Reject	Risk Variable	Z score	Accept/Reject
machinery	2.77	Accept	Exchange rate	-10.28	Reject
breakdown	-2.37	Accept	Delay of supplies	3.16	Accept
Preventive maintenance	-12.65	Reject	Approval by authorities	2.77	Accept
Regulatory	3.16	Accept	Financial resources	3.16	Accept
clearances	3.16	Accept	clearance	2.77	Accept
Electricity Price	1.19	Accept	Relocation	3.16	Accept
System procedures	-8.30	Reject	Human factor	-12.65	Reject
Competitors	-12.65	Reject	local Community	1.19	Accept
evaluation techniques	2.37	Accept	Relocation cost	-9.49	Reject
Financial Resources	3.16	Accept	Employment	1.58	Accept
generation	1.98	Accept	Tourist Places	1.19	Accept
Public private partnership	2.77	Accept	dam site	-10.67	Reject
terrorism	0.00	Accept	Tourist Revenue	0.40	Accept
Communication	-11.46	Reject	flora and fauna	1.19	Accept
Fund Blockage	0.79	Accept	Financing	2.37	Accept
River Flow	1.98	Accept	Interest rate	0.00	Accept
soil erosion	2.37	Accept	tax rate	1.19	Accept
precipitation	1.19	Accept	inflation rate	1.58	Accept
construction time	2.37	Accept	Climate	-0.40	Accept
Competency	-12.25	Reject	Noise pollution	0.79	Accept
Budget Construction	3.16	Accept	drinking water quality	0.40	Accept
Cost Overrun	-7.51	Reject			

The risk variables which come out from study has been validated using  $Z_{score}$  values which lie between -3 to +3 values and the result is validated using table 1.

#### 4.2 Risk Taxonomy in Small Hydro Power project

Globally risk taxonomy is based on tangibility, area specific, phase specific etc. but in this research the risks are classified primarily based on behavior of risk. First classification shows linguistic and nonlinguistic behavior of variables and another classification based on macro factors as technological, legal, financial, socio-economic, environmental, business, strategic i.e. some sub factors are also which goes in each category which addressed

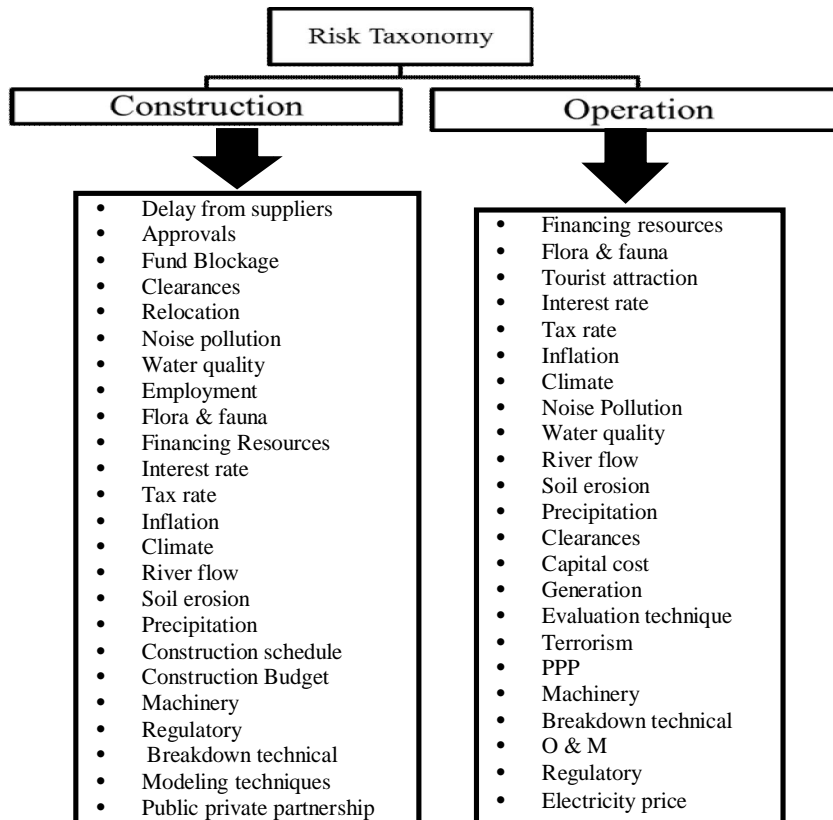


Figure 8 Risk Taxonomy in Construction & Operation Stage

Risk classification is performed for operational & construction stage small hydro power project. Based on the questionnaire responses taken from experts of small hydro power projects of Uttarakhand the risk variables has been classified into operational & construction stages. 25 & 23 risk variables has been categorized in Construction and operational stages mentioned in fig 8. The same risk variables can be used for risk assessment further.

### 5. Conclusion

The main challenges in front of small hydro power sector investors in the 21st century were identified in this paper. The effects of these challenges on the Uttarakhand small hydro power sector were examined. This highlight the growing complexity of the business environment of those investors associated with small hydro power projects that has prompted increasing interest in risk assessment for decision analysis in the sector. The paper also classify the identified risk into operational and construction phases based on expert opinion which is altogether new practice in this area. The current paper helps investors, decision makers, and policy makers of this area to perform further risk management in more systematic way.

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# Service Quality: A Study of Private Banks in NCR



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**Rupa Rathee**  
**Pallavi Rajain**

Deenbandhu Chhotu Ram University of Science and Technology

(ruparathee@gmail.com)

(pallavirajain@gmail.com)

*This study deals with the assessment of service quality in the banking industry. The 22 items SERVQUAL scale was used for analyzing the gaps. A sample size of 100 was taken using quota sampling. Gap analysis and t - test were applied using SPSS to find the difference between male and female perception and expectation in the private banks of NCR. The highest gaps were found regarding reliability and empathy dimensions. Moreover, it was found that even though males and females had similar perception regarding most of the attributes of the service quality, they perceived few attributes in different manner.*

## 1. Introduction

Service quality is a comparison of expectations with performance. From the viewpoint of business administration, service quality is an achievement in customer service. It reflects at each service encounter. A customer's expectation of a particular service is reflected by factors such as recommendations by peers, personal needs and past experiences. The expected service and the perceived service sometimes may not be equal, thus leaving a gap. The service quality model or the 'GAP model' developed by the researchers- Parasuraman, Zeithaml and Berry at Texas and North Carolina in 1985, highlights the main requirements for delivering high service quality. It identifies 'gaps' that cause unsuccessful delivery of service. Customers generally have a tendency to compare the service they 'experience' with the service they 'expect'. If the experience does not match the expectation, there arises a gap.

An important sector of the service industry is the banking sector. In the beginning all the banks in India were private banks, which were founded in the pre-independence era in order to serve the banking needs of the people. In 1921, three major banks i.e. Banks of Bengal, Bank of Madras, and Bank of Bombay, merged to form Imperial Bank of India. In 1935, the Reserve Bank of India (RBI) was established and it took over the central banking responsibilities from the Imperial Bank of India. In 1955, after the declaration of first-five year plan, Imperial Bank of India was later on transformed into State Bank of India (SBI). The banks, which came in operation after 1991, with the introduction of financial sector reforms and economic reforms are called "new private-sector banks". Banking regulation act was then amended in 1993, which allowed the entry of new private sector banks in the Indian banking sector. At present, Private Banks in India includes leading banks like ICICI Banks, ING Vysya Bank, Yes Bank, Karnataka Bank, Kotak Mahindra Bank, HDFC BANK etc. Undoubtedly, being tech-savvy and full of expertise, private banks have played a major role in the development of Indian banking industry.

The inception of competition from the private players and initiation of banking reforms since early 1990s have led to an increased emphasis on efficient customer service. Moreover, the sturdy competitive arena in which these banks operate today, maintaining the quality of service is a pre – requisite for survival. Therefore, measurement of service quality has increasingly created an interest among the service providers and scholars alike. It is so because service quality is being used to position the banks in the market place. However, to measure the service quality is hard. In case of banking services, the multifarious service products being offered and their interface with the information technology like banking on internet, electronic delivery channels, etc. help the banks in seizing the market and be the greatest winners.

Despite this understanding, conceptualization and measurement of service quality have been the most controversial and disputed topics in service marketing literature. There has been notable research as to how service quality should be measured. Therefore the following five dimensions have been developed which define service quality, these are empathy, reliability, responsiveness, assurance and tangibility.

## 2. Review of Literature

Author Name	Year	Title	Major Objectives	Research Methodology	Major Findings
Jain, V, Gupta, S and Jain, S	2012	Customer Perception on Service Quality in Banking Sector: With Special Reference to Indian Private Banks in Moradabad Region	1-To learn and understand the customer perception regarding service quality 2- To learn and understand the different dimension of service quality in banks	Sample size-100 Sample Universe- Moradabad. The service quality model developed by Zeithamal, Parsuraman and Berry (1988) has been used in the present study	The analysis reveals that among the private sector banks all the dimensions of service quality are equally important.
Dash, M.Dash, S and Sharma, JP	2012	A Study on the Relationship between Customer Satisfaction	The main objective of the study was to analyze the data collected from the customers	Sample size-237 Sample Universe-Odisha Sampling Technique-	The results revealed that the impact of the service attributes upon overall customer satisfaction of customers is

		and Service Attributes Offered by Public Sector and Private Sector Banks in India	to understand their banker's behavior and how customers perceive the service value offered by the bankers	Convenience sampling The research objective for this study included exploration and description. Regression Model is used for analysis	high which is consistent with the previous study carried out by a few other researchers
R, Rakesh	2012	Quality Assessment of Banking Industry Using the Servqual Model	First, based on the existing SERVQUAL model, using both qualitative and quantitative scale development methods to develop a revised set of scales. Second, utilising that new instrument with a culturally valid set of scales Finally, this model was subsequently evaluated for its applicability for assessing customer perceptions of service quality.	Sample Size-242 The SERVQUAL instrument has been the predominant method used to measure consumers' perceptions of service quality	As can be seen from the results, the customer expects most from the Reliability and Empathy dimension of the banking service
Santhiyavalli, G	2011	Customer's perception of service quality of State Bank of India - A Factor Analysis	To study the customer's perception of service quality of the select branches of State Bank of India To study the major factors responsible for their satisfaction	Sample size-250 Sample Universe- SBI Sampling Technique Convenience sampling Analysis was done using factor analysis	The overall customer satisfaction towards the service rendered by the State Bank of India regarding the four factors namely reliability, responsiveness, empathy and tangibility stood at 90.105 per cent
Roy,R, Vaijyanthi, P and Shreenivasan, KA	2011	Service Quality Gap of Foreign Banks in India using PZB Service Quality Model – an Empirical Study	The study was carried out with an objective to understand the gap of the service offered by the foreign Banks	Sample Size-275 Sample Universe-Chennai The customer satisfaction was evaluated by applying Gap Model of service quality proposed by Parasuraman, Zeithaml, and Berry	The researcher finds gaps between Service Quality Specifications and Service Delivery, Perceived Service and Expected Service and Customer Expectation and Management Perception
Singh, SP and Khurana, S	2011	Analysis of Service Quality Gap and Customers' Satisfaction In Private Banks	To examine Gender wise customers' expectations and perceptions of service quality provided by the Private banks in Hissar District To identify the main attributes of service quality in which male & female (separately) are more satisfied or dissatisfied	Sample Size-300 Sample Universe- Private banks in Hissar Sampling Technique- Quota Sampling A questionnaire consisting of 22 items based on SERVQUAL model was administered on the sample	The results indicated that the quality of services private banks provide was below customers 'expectations
Mishra, U S, Sahoo, K K, Mishra, S and Patra, S K	2010	Service Quality Assessment in Banking Industry of India: A Comparative Study between Public and Private Sectors	<ul style="list-style-type: none"> <li>• Make a comparative study of service quality perceptions of banks, under study, with service quality expectations of their respective customers;</li> <li>• Know whether the banks are at, above or below the perceptions of their respective customers; and</li> <li>• Suggest, on the basis of study results, ways and means for improving service quality in banks with a view to make overall banking service more effective and efficient</li> </ul>	Sample Size-387 Sample Universe- Public and private banks Sampling Technique- Stratified Random The questionnaire containing all the 22 numbers of statements of SERVQUAL instrument developed by Parsuraman et al for customer survey was used	The analysis of responses clearly reveals that there exists a small perceptual difference among customers regarding overall service quality with their respective banks.
Ananth, A, Ramesh, R and B, Prabakaran	2010	A Service Gap Analysis in Private Sector Banks- an Empirical Study of Customers' Expectations vs. Perceptions	<ul style="list-style-type: none"> <li>• To evaluate the Quality of Service in selected private sector banks (ICICI &amp; CUB).</li> <li>• To identify the gap between customer expectations and their perceptions.</li> <li>• To identify the areas that needs to be</li> </ul>	Sample Universe- CUB and ICICI The study followed SERVQUAL as a framework and one dimension (accessibility) was added to the previous dimensions to fit into the study	The gap analysis shows that empathy shows a larger gap between customer expectation and perception of service quality. The multi - regression analysis shows that the dimension Empathy- Reliability-Assurance positively influences the banking service quality.



Brahmbhatt, M and Panelia, D	2008	An Assessment of Service Quality in Banks	improved to deliver a superior quality of service.  Foremost aim of this research is to comparatively examine and measure of service quality and customer satisfaction among private sector, public sector and foreign bank and to offer suggestion based on results of the study	Sample size-246 Sample universe-Ahmedabad and Gandhinagar Sampling Technique- Stratified random The five dimensions of SERVQUAL as proposed by Parasuraman et al. (1988), Othman and Owen (2001, 2002) and Jabnoun and Al-Tamimi (2003) were adapted and modified in this study	They conclude from the study that Foreign Banks is better than public sector banks and private sector banks
Hinson, R, Mohammed, A and Mensah, R	2006	Determinants of Ghanaian Bank Service Quality in a Universal Banking Dispensation	The purpose of the study is to compare service quality across these three banks and to determine the most important factors contributing to service quality	Sample size-250 Sample Universe- Ghana An adaptation of the SERVQUAL model was used for this study	The study revealed that all the service quality dimensions contributed significantly to the prediction of service quality in Ghana. Among all the service quality dimensions, human element of service quality was found to be highly predictive of perceived service quality

From the above table of literature review we found that almost all the authors have used the SERVQUAL model developed by Zeithamal, Parsuraman and Berry (1988) to find the service quality gaps in banking industry including public, private and foreign banks. In the study by Jain et. al. the analysis showed that among the private sector banks all the dimensions of service quality are equally important. In another study by Rakesh it was seen from the results, that the customer expects most from the Reliability and Empathy dimension of the banking service. Also the research by Ananth et. al. showed through gap analysis that empathy has a bigger gap between customer expectation and perception of service quality. The multi - regression analysis shows that the dimension Empathy-Reliability-Assurance positively influences the banking service quality. On the other hand looking at the study of public sector banks by Santhiyavalli it was found that the overall customer satisfaction towards the service rendered by the State Bank of India regarding the four factors namely reliability, responsiveness, empathy and tangibility stood at 90.105 per cent. In a comparative study by Mishra et. al. the analysis of responses clearly revealed that there exists a small perceptual difference among customers regarding overall service quality with their respective banks. Brahmbhatt and Panelia in their study on Foreign, Public and Private Banks concluded that Foreign Banks are better than public sector banks and private sector banks. Singh and Khurana in their study also indicated that the quality of services private banks provide was below customers' expectations. Another study on foreign banks by Roy et. al. finds gaps between Service Quality Specifications and Service Delivery, Perceived Service and Expected Service and Customer Expectation and Management Perception. Dash et. al. after analysing the results revealed that the impact of the service attributes upon overall customer satisfaction of customers is high which is consistent with the previous study carried out by a few other researchers. Lastly, Hinson et. al. revealed through their study that all the service quality dimensions contributed significantly to the prediction of service quality in Ghana. Among all the service quality dimensions, human element of service quality was found to be highly predictive of perceived service quality.

### 3. Objectives

- To identify the gap between customer expectation and their perception of service quality provided by private banks.
- To identify the main attributes of service quality in which customers are more satisfied or dissatisfied in private banks.
- To examine gender wise customers' expectations and perception of service quality provided by the private banks.

### 4. Hypotheses

- $H_0^1$ : No significant difference exists between the perception of males and females regarding service quality of private banks.  
 $H_1^1$ : Significant difference exists between the perception of males and females regarding service quality of private banks.  
 $H_0^2$ : No significant difference exists between the expectation of males and females regarding service quality of private banks.  
 $H_1^2$ : Significant difference exists between the expectation of males and females regarding service quality of private banks.

### 5. Research Methodology

Descriptive-cum-exploratory research design has been used in this research. Primary data has been collected through structured questionnaire where perception and expectation of private bank's customers has been obtained under five dimensions based on the service quality 'SERVQUAL' model developed by Zeithamal, Parsuraman and Berry (1988). In order to ascertain the perceptions and expectations of service quality, Likert's 5-point scale has been used for its suitability to estimate the range and variations in the perceptions and expectations. The scale 1 – 5 represents '5' as highly agree and '1' as highly disagree. The data has been collected from NCR region using quota sampling and sample size of 100. The banks

covered under the study were ICICI, IDBI, Yes, HDFC, Axis and Dena Bank. SPSS version 20 was used to apply t-test, mean and standard deviation. Secondary data related to previous studies has been obtained from authentic sources like books, magazines and journals.

## 6. Findings

**Table 1** Service Quality Gaps Score for Private Banks

Perception		Expectation		Gap Score
Tangibility	P	Tangibility	E	P-E
Does the bank have modern looking equipment	3.65	Excellent banking companies will have modern looking equipment	4.82	-1.17
Are the Bank's physical facilities visually appealing	3.50	The physical facilities at excellent banks will be visually appealing	4.55	-1.05
Are the Bank's reception desk employees neat appearing	3.54	Employees at excellent banks will be neat appearing	4.61	-1.07
Are the physical facilities associated with the service (such as pamphlets or statements) visually appealing	3.53	Physical facilities associated with the service (such as pamphlets or statements) will be visually appealing at an excellent bank	4.64	-1.11
Average				-1.10
Reliability	P	Reliability	E	P-E
When the bank promises to do something by a certain time, it does so	3.33	When excellent banks promise to do something by a certain time, they do	4.66	-1.33
When you have a problem, the bank is sympathetic and reassuring	3.36	When a customer has a problem, excellent banks will be sympathetic and reassuring	4.59	-1.23
Does the bank performs the service right the first time	3.26	Excellent banks will perform the service right the first time	4.66	-1.40
Does the bank provide its service at the time it promises to do so	3.49	Excellent banks will provide the service at the time they promise to do so	4.75	-1.26
Does the bank insist on error free records	3.54	Excellent banks will insist on error free records	4.85	-1.31
Average				-1.31
Responsiveness	P	Responsiveness	E	P-E
Do the Employees in the bank tell you exactly when services will be performed	3.50	Employees of excellent banks will tell customers exactly when services will be performed	4.59	-1.09
Do the Employees in the bank give your prompt service	3.59	Employees of excellent banks will give prompt service to customers	4.70	-1.11
Are employees in the bank always willing to help you	3.62	Employees of excellent banks will always be willing to help customers	4.61	-.99
Employees in the bank are never too busy to respond to your request	3.25	Employees of excellent banks will never be too busy to respond to customers' requests	4.67	-1.42
Average				-1.15
Assurance	P	Assurance	E	P-E
Does the behaviour of employees in the bank instil trust in you	3.55	The behaviour of employees in excellent banks will instil trust in customers	4.62	-1.07
Do you feel safe in your transactions with the bank	3.59	Customers of excellent banks will feel safe in transactions	4.69	-1.10
Are the employees in the bank area polite with you	3.51	Employees of excellent banks will be polite with customers	4.79	-1.28
Do the employees in the bank have the knowledge to answer your questions	3.63	Employees of excellent banks will have the knowledge to answer customers' questions	4.81	-1.18
Average				-1.16
Empathy	P	Empathy	E	P-E
Does the bank give you individual attention	3.32	Excellent banks will give customers individual attention	4.59	-1.27
Does the bank have employees who give your personal attention	3.26	Excellent banks will have employees who give customers personal attention	4.66	-1.40
Do the employees of the bank understand your specific needs	3.47	The employees of excellent banks will understand the specific needs of their customers	4.59	-1.12
Does the bank have your best interest at heart	3.37	Excellent banks will have their customer's best interests at heart	4.67	-1.30
Does the bank have operating hours convenient to all its customers	3.79	Excellent banks will have operating hours convenient to all their customers	4.65	-.86
Average				-1.19

**Table 2 Un-weighted Score**

Categories	Gap score
Average gap score for Tangibility	-1.10
Average gap score for Reliability	-1.31
Average gap score for Responsiveness	-1.15
Average gap score for Assurance	-1.16
Average gap score for Empathy	-1.19
Total	-5.91
Un-weighted Score (Average Total/5)	-1.18

The views of the sample respondents regarding the services offered by the private banks under study are presented in Table 1. Referring to the Table; the comparison of customer expectations and perceptions of private banks, it is observed that the sample customers have very similar opinion as indicated from the values of different dimensions.

The gap (P - E) as shown in the Table 2, is negative for all the factors indicating dissatisfaction of the customers. Further, component- wise analysis indicates that the higher level of dissatisfactions are observed in factors like; i) promises to do something by a certain time; ii) performs the service right the first time, iii) Employees in the bank are too busy to respond to your request, iv) give customers individual attention, v) give customers personal attention.

**Table 3 Descriptives for Perception**

Statements	Mean	Std. Deviation
P1 Does the bank have modern looking equipment	3.68	.902
P2 Are the Bank’s physical facilities visually appealing	3.55	.987
P3 Are the Bank’s reception desk employees neat appearing	3.58	1.058
P4 Are the physical facilities associated with the service (such as pamphlets or statements) visually appealing	3.54	1.009
P5 When the bank promises to do something by a certain time, it does so	3.35	1.156
P6 When you have a problem, the bank is sympathetic and reassuring	3.34	1.097
P7 Does the bank performs the service right the first time	3.33	1.015
P8 Does the bank provide its service at the time it promises to do so	3.45	1.183
P9 Does the bank insist on error free records	3.55	1.070
P10 Do the Employees in the bank tell you exactly when services will be performed	3.53	1.119
P11 Do the Employees in the bank give your prompt service	3.61	1.065
P12 Are employees in the bank always willing to help you	3.62	1.023
P13 Employees in the bank are never too busy to respond to your request	3.21	1.030
P14 Does the behaviour of employees in the bank instil trust in you	3.59	.995
P15 Do you feel safe in your transactions with the bank	3.60	1.180
P16 Are the employees in the bank area polite with you	3.55	1.008
P17 Do the employees in the bank have the knowledge to answer your questions	3.60	1.152
P18 Does the bank give you individual attention	3.34	1.078
P19 Does the bank have employees who give your personal attention	3.28	1.127
P20 Do the employees of the bank understand your specific needs	3.48	.886
P21 Does the bank have your best interest at heart	3.37	1.121
P22 Does the bank have operating hours convenient to all its customers	3.84	1.075

**Table 4 Descriptives for Expectation**

Statements	Mean	Std. Deviation
E1 Excellent banking companies will have modern looking equipment	4.41	1.083
E2 The physical facilities at excellent banks will be visually appealing	4.39	.751
E3 Employees at excellent banks will be neat appearing	4.47	.747
E4 Physical facilities associated with the service (such as pamphlets or statements) will be visually appealing at an excellent bank	4.41	.866
E5 When excellent banks promise to do something by a certain time, they do	4.48	.825
E6 When a customer has a problem, excellent banks will be sympathetic and reassuring	4.37	1.041
E7 Excellent banks will perform the service right the first time	4.55	.672
E8 Excellent banks will provide the service at the time they promise to do so	4.65	.702
E9 Excellent banks will insist on error free records	4.74	.605
E10 Employees of excellent banks will tell customers exactly when services will be performed	4.36	.839
E11 Employees of excellent banks will give prompt service to customers	4.58	.606
E12 Employees of excellent banks will always be willing to help customers	4.42	.784
E13 Employees of excellent banks will never be too busy to respond to customers’ requests	4.32	.898

E14 The behaviour of employees in excellent banks will instil trust in customers	4.43	.769
E15 Customers of excellent banks will feel safe in transactions	4.52	.689
E16 Employees of excellent banks will be polite with customers	4.57	.746
E17 Employees of excellent banks will have the knowledge to answer customers' questions	4.73	.529
E18 Excellent banks will give customers individual attention	4.45	.702
E19 Excellent banks will have employees who give customers personal attention	4.39	.818
E20 The employees of excellent banks will understand the specific needs of their customers	4.28	.937
E21 Excellent banks will have their customer's best interests at heart	4.33	.821
E22 Excellent banks will have operating hours convenient to all their customers	4.38	.838

After analysing the means for perception and expectation from table 3 and table 4, it was found that the value of expectation was higher than perception.

**Table 5 Independent Samples T-Test between Gender and Perception of Service Quality**

	Levene's Test for Equality of Variances		t-test for Equality of Means			
	F	Sig.	T	df	Sig. (2-tailed)	
P1	Equal variances assumed	2.701	.103	-.108	98	.915
	Equal variances not assumed			-.108	96.733	.915
P2	Equal variances assumed	.641	.425	-1.182	97	.240
	Equal variances not assumed			-1.181	95.481	.241
P3	Equal variances assumed	.625	.431	-2.537	97	<b>.013</b>
	Equal variances not assumed			-2.538	96.904	<b>.013</b>
P4	Equal variances assumed	8.346	.005	-.342	97	.733
	Equal variances not assumed			-.341	87.464	.734
P5	Equal variances assumed	.363	.548	-1.480	98	.142
	Equal variances not assumed			-1.480	97.646	.142
P6	Equal variances assumed	.019	.890	-1.292	98	.199
	Equal variances not assumed			-1.292	97.973	.199
P7	Equal variances assumed	.342	.560	-3.159	96	<b>.002</b>
	Equal variances not assumed			-3.159	95.969	<b>.002</b>
P8	Equal variances assumed	2.306	.132	-1.838	97	.069
	Equal variances not assumed			-1.834	93.496	.070
P9	Equal variances assumed	.688	.409	-2.767	97	<b>.007</b>
	Equal variances not assumed			-2.763	94.705	<b>.007</b>
P10	Equal variances assumed	.028	.869	-2.087	97	.040
	Equal variances not assumed			-2.089	96.360	.039
P11	Equal variances assumed	.004	.952	-1.773	98	.079
	Equal variances not assumed			-1.773	97.910	.079
P12	Equal variances assumed	.747	.389	-2.672	98	<b>.009</b>
	Equal variances not assumed			-2.672	95.892	<b>.009</b>
P13	Equal variances assumed	1.581	.212	.874	98	.384
	Equal variances not assumed			.874	93.979	.384
P14	Equal variances assumed	2.962	.088	-.290	98	.772
	Equal variances not assumed			-.290	95.843	.772
P15	Equal variances assumed	.196	.659	-.428	98	.670
	Equal variances not assumed			-.428	97.550	.670
P16	Equal variances assumed	.018	.893	-1.903	97	.060
	Equal variances not assumed			-1.902	96.733	.060
P17	Equal variances assumed	.001	.977	-.786	98	.434
	Equal variances not assumed			-.786	97.653	.434
P18	Equal variances assumed	.595	.443	.339	97	.736
	Equal variances not assumed			.338	95.175	.736
P19	Equal variances assumed	1.783	.185	.116	97	.908
	Equal variances not assumed			.116	94.954	.908
P20	Equal variances assumed	1.475	.228	-.983	98	.328
	Equal variances not assumed			-.983	96.411	.328
P21	Equal variances assumed	.262	.610	-.272	98	.786
	Equal variances not assumed			-.272	97.471	.786
P22	Equal variances assumed	2.805	.097	.094	98	.925
	Equal variances not assumed			.094	94.048	.925

For determining whether significant difference exists between the male and female respondents' perception towards service quality t-test was employed.

Levene's test checks for equality of variance among various groups. Significance value of Levene's test > 0.05 indicates that equal variance is assumed. In the given **table 5**, all the groups have equal variances. T-test statistics (significance value) less than level of significance (0.05) indicate that the two categories of independent variables (male and female) differ significantly towards their response to the various statements.

In this case no significant difference was observed as all significance value are greater than 0.05 except for statements P3, P7, P9 and P12. Thus it can be concluded that male and female respondents partially perceive service quality in same manner.

**Table 6** Independent Samples T-Test between Gender and Expectation of Service Quality

	Levene's Test for Equality of Variances		t-test for Equality of Means			
	F	Sig.	T	df	Sig. (2-tailed)	
E1	Equal variances assumed	.096	.758	-.092	98	.927
	Equal variances not assumed			-.092	96.935	.927
E2	Equal variances assumed	.515	.475	-2.314	98	<b>.023</b>
	Equal variances not assumed			-2.314	93.005	<b>.023</b>
E3	Equal variances assumed	.307	.581	-1.424	97	.158
	Equal variances not assumed			-1.422	95.443	.158
E4	Equal variances assumed	10.746	.001	-2.239	98	<b>.027</b>
	Equal variances not assumed			-2.239	82.511	<b>.028</b>
E5	Equal variances assumed	.284	.595	-.670	97	.505
	Equal variances not assumed			-.672	91.376	.503
E6	Equal variances assumed	4.710	.032	-2.049	98	<b>.043</b>
	Equal variances not assumed			-2.049	88.076	<b>.043</b>
E7	Equal variances assumed	5.609	.020	-1.344	98	.182
	Equal variances not assumed			-1.344	90.224	.182
E8	Equal variances assumed	13.963	.000	-2.178	98	<b>.032</b>
	Equal variances not assumed			-2.178	73.975	<b>.033</b>
E9	Equal variances assumed	7.990	.006	-1.327	93	.188
	Equal variances not assumed			-1.307	72.677	.195
E10	Equal variances assumed	4.049	.047	-2.506	97	<b>.014</b>
	Equal variances not assumed			-2.517	82.635	<b>.014</b>
E11	Equal variances assumed	5.892	.017	-2.010	98	.047
	Equal variances not assumed			-2.010	95.262	.047
E12	Equal variances assumed	3.913	.051	.309	97	.758
	Equal variances not assumed			.311	81.433	.757
E13	Equal variances assumed	4.170	.044	-2.037	98	<b>.044</b>
	Equal variances not assumed			-2.037	97.063	<b>.044</b>
E14	Equal variances assumed	.894	.347	-1.173	98	.244
	Equal variances not assumed			-1.173	93.444	.244
E15	Equal variances assumed	1.897	.172	-1.164	98	.247
	Equal variances not assumed			-1.164	96.209	.247
E16	Equal variances assumed	1.217	.273	-.811	96	.419
	Equal variances not assumed			-.811	94.456	.419
E17	Equal variances assumed	.849	.359	-.565	98	.573
	Equal variances not assumed			-.565	97.756	.573
E18	Equal variances assumed	.344	.559	-1.876	98	.064
	Equal variances not assumed			-1.876	97.678	.064
E19	Equal variances assumed	.491	.485	-1.058	97	.293
	Equal variances not assumed			-1.056	94.794	.294
E20	Equal variances assumed	.660	.419	-1.542	97	.126
	Equal variances not assumed			-1.541	95.496	.127
E21	Equal variances assumed	.322	.571	-1.062	97	.291
	Equal variances not assumed			-1.061	95.934	.291
E22	Equal variances assumed	9.685	.002	-2.188	98	<b>.031</b>
	Equal variances not assumed			-2.188	91.497	<b>.031</b>

For ascertaining whether significant difference exists between the male and female respondents' perception towards service quality t-test was employed.

Levene's test checks for equality of variance among various groups. Significance value of Levene's test  $> 0.05$  indicates that equal variance is assumed. In the given **table 6**, all the groups have equal variances. T-test statistics (significance value) less than level of significance (0.05) indicate that the two categories of independent variables (male and female) differ significantly towards their response to the various statements.

In this case no significant difference was observed as all significance value are greater than 0.05 except for statements E2, E4, E6, E8, E10, E13 and E22. Thus it can be concluded that the expectation of male and female respondents regarding service quality is more or less same but they differ in some dimensions.

**Table 7** Descriptives- Means of P3, P7, P9 and P12

Statement	Gender	Mean
P3	Male	3.32
	Female	3.84
P7	Male	3.02
	Female	3.63
P9	Male	3.26
	Female	3.82
P12	Male	3.36
	Female	3.88

From table 7 we find that the mean value of P3 for males is 3.32 and females is 3.84 which shows that female employees generally give more importance to neat appearance of staff reason being that females give more importance to cleanliness. The mean value of P7 for males is 3.02 and females is 3.63 which shows that most females give more importance to performance of service right the first time reason being that the females generally pay more attention to timely service. The mean value of P9 for males is 3.26 and females is 3.82 which shows that women insist more on error free records reason being that the females are particular about errors or mistakes in work done. Lastly the mean value of P12 for males is 3.36 and females is 3.88 which shows that women are concerned about the willingness of employees to help because female customers generally like caring attitude.

Thus it can be concluded that no significant difference exists between the perception of males and females respondents except few dimensions of service quality of private banks. Hence, **null hypothesis  $H_0^1$  is accepted partially.**

**Table 8** Descriptives-Means of E2, E4, E6, E8, E10, E13 and E22

Statement	Gender	Mean
E2	Male	4.44
	Female	4.66
E4	Male	4.58
	Female	4.70
E6	Male	4.44
	Female	4.74
E8	Male	4.68
	Female	4.82
E10	Male	4.48
	Female	4.70
E13	Male	4.56
	Female	4.78
E22	Male	4.56
	Female	4.74

From table 8 we find that the mean value of E2 for males is 4.44 and females is 4.66 which shows that women expect excellent banks to be more visually appealing reason being that females generally give more attention to visual appearances. The mean value of E4 for males is 4.58 and females is 4.70 which is similar to the previous statement reason being the same as before that females give more importance to visual appeal. The mean value of E6 for males is 4.44 and females is 4.74 because mostly females expect employees to be more sympathetic and reassuring reason being that the females are more influenced by sympathetic behaviour. The mean value of E8 for males is 4.68 and females is 4.82 which shows that females expect the employees to deliver the service at the expected time because females give more importance to timely service. The mean value of E10 for males is 4.48 and females is 4.70 which shows that females expect the employees to tell when the service will be performed because females like it when work is done on time. The mean value of E13 for males is 4.56 and females is 4.78 which suggests that females expect that employees are never be too busy to respond to customers' requests because females are happy when attention is paid to their work. Lastly the mean value of E22 for males is 4.56 and females is 4.74 as females expect banks will have operating hours convenient to all their customers because females have household responsibilities.

Thus it can be concluded that no significant difference exists between the expectation of males and females respondents except a few dimensions of service quality of private banks. Hence, **null hypothesis  $H_0^2$  is accepted partially.**

## 7. Conclusion

From the present study it can be concluded that the highest gap was found in the dimension of reliability and empathy. The banks have to reduce this gap giving individual personal attention to understand customer specific needs. The customers trust the public sector banks. These banks have existed in the market for a longer period than the private sector banks. The reliability factor is a positive factor for these banks. Therefore private banks should position themselves in the market on the basis of this dimension and promote themselves aggressively. Last but not the least, the customer base of the public sector banks is very big as compared to the private sector banks, therefore it is important to retain them with the banks. It becomes imperative for the private sector banks to train their employees to treat the customers with empathy.

Also it was found that difference in opinions of males and females occurs regarding certain dimensions which have been discussed during the analysis. But overall it was concluded that since no significant difference exists between the perception of males and females respondents except a few dimensions of service quality of private banks therefore the null hypotheses  $H_0^1$  is accepted partially. Also it was concluded that since no significant difference exists between the expectation of males and females respondents except a few dimensions of service quality of private banks therefore the null hypotheses  $H_0^2$  is also accepted partially.

## 8. Suggestions

- Private Banks should position themselves in the market on the basis of reliability dimension and should not promote themselves aggressively.
- Making timely and personal communications with customers should be a key part of the strategy as customers like when empathetic behaviour is shown by banks.
- Banks may follow a feedback system to know the customers' expectations for improving the level of customer satisfaction to the maximum level. Responses on service reliability should be continuously obtained from customers.
- Employees should be encouraged to respond effectively to customer problems and should give them the proper and necessary means to do so.
- Banks should have a strong customer relationship management system that would indicate the worth of the customers and the ability to understand their needs while interacting with them.
- Skill sets of employees need to be up graded so as to make them more comfortable with the latest technology that will increase their comfort level while educating customers to use the same in their day to day dealings. The customers should be encouraged to complain and they should be made aware of the procedure to do so.

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# Role of MIDC in the Development of the Engineering Enterprises in Navi Mumbai



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**Anil P. Sarode**  
M.J.College, Jalgaon  
**Prashant H. Bhagat**  
Chetana College, Mumbai  
(prashantbhagat1209@gmail.com)

*The engineering industry has been titled the 'engines of growth'. The tremendous impact and influence it has on industrialization and consequently the economy can be clearly seen from the economic scenario the world over. These units have contributed to productive capital, value added products, exports of engineering goods. The engineering units have a history of more than 46 years advancing through technical collaborations, joint ventures and indigenous research and development. Today, these units have a capacity of manufacturing heavy equipments. These units largely depend on the urban and rural demand. The total units in this sector were scrutinized based on the available data from survey. In capacity building process of engineering enterprises in Navi-Mumbai MIDC is playing significant role. In the current paper Research students trying to bring the unique support and services to the engineering enterprises in Navi-Mumbai in Maharashtra.*

**Keywords:** Engineering, Development, MIDC, Services,

## 1. Introduction

The Engineering enterprises are the hub of many economic activities in developing country like India. The role played by engineering enterprises in the economic activity of advanced industrialized countries is also very significant. The socio-economic transformation of India cannot be achieved without paying adequate attention to the development of this labour intensive and capital sparing sector. The most significant aspect of engineering enterprises development is that this sector has stimulated economic activity of a far reaching magnitude and has created a sense of confidence among a huge number of small entrepreneurs about their strength and validity. Engineering enterprises contribute significantly to social and economic development objectives such as labour absorption, income distribution, rural development, poverty eradication, regional balance and promotion of entrepreneurship.

It generates immediate employment opportunities with relative low capital, promotes more equitable distribution of national income, makes effective mobilization of untapped capital and human skills and leads to dispersal of manufacturing activities all over the country, leading to growth of villages, small towns and economically lagging regions. Particularly in developing countries, small labour intensive industries have been favored basically to create employment opportunities in an economy with abundant unskilled labour even though such industries may not always be supported on grounds of economic efficiency. In addition to this, a low capital requirement given an appropriate market environment is believed to stimulate growth of numerous indigenous industries with wide regional dispersal. This helps to promote balanced growth, more equitable income distribution as well as increased utilization of national resources.

In Thane-Trance Creel (TTC) MIDC area, Engineering enterprises units have greater importance in terms of production of variety of goods and services. Similarly, it has good profile on the part of providing employment opportunities for male as well as female employees. In the entire MIDC area, there are more than 2500 Engineering enterprises have been established, which are engaged in the production of different kinds of products and supply them throughout the nation. In these way engineering enterprises units of TTC, MIDC areas are a major contributor to the national income of economy.

The key historical policy decision taken by MIDC units certainly changed the socio-economic scenario of the Maharashtra state as its activities spread to the interior parts of Maharashtra providing basic and essential infrastructure like water supply, roads, streets, lights, tree plantation etc. The TTC MIDC units is one of the important industrial sector comprising of a large industrial area in Thane district including more than 80% engineering enterprises producing a variety of goods and services and at the same time providing gainful employment opportunities for people residing in nearby areas in Thane district. It also helps to improve the standard of living of the people and enable them to become self-reliant.

## 2. Role of Engineering Enterprises

Engineering Enterprises play a strategic role in the progress of the country. These industries, by and large, represent a stage in economic transition from traditional to modern technology. The transitional nature of this process is reflected in the diversity of these industries. Some small – scale units use simple skills and machinery, while many others use modern and sophisticated technology. The challenge of economic growth is to accelerate the productivity of agriculture and industry by improving their techniques of production. So far as industries are concerned, this will involve the adoption of a progressively superior technology, particularly in semi-urban and rural areas.

The role of Engineering Enterprises is mentioned below:

1. Development of Engineering Enterprises fits both in the short- term and long-term strategy of industrial development .besides; Engineering Enterprises permit greater distributive justice.



2. In the short-term , Engineering Enterprises help not only in conserving scarce inputs like capital , technical and managerial skill , but in fact also permit greater mobilization of these scarce inputs. For instance Engineering Enterprises provide employment opportunities at a relatively smaller capital cost.
3. The objective of balancing the development of “capital heavy” large scale industries with the development of “capital light” methods for production can provides a sheet anchor for development of Engineering Enterprises.
4. Furthermore, this sector requires comparatively lesser technical and management proficiencies which are scarce in the country. in facts , technical and managerial proficiencies requires for this sector can be development more readily and in a relatively shorter period when compared to that required for large – scale industrial complexes
5. Engineering Enterprises also help in mobilizing untapped resources of capital and skill that many otherwise remain unutilized or underutilized in any country.
6. Beside, the Engineering Enterprises serve as a nursery for technical and managerial skill in the country.
7. It may also be mentioned that Engineering Enterprises help in cultivating industrial culture and in creating a class odd artisans. Both of these factors are quite essential and conducive to industrial growth in any country, more so in any developing country.
8. Engineering Enterprises are a very potent instrument for regional development and dispersing the benefits of industrial growth over a wider area.
9. In helps taking the jobs to the people rather than people to the jobs since Engineering Enterprises when compared to large – scales units are more foot – loose and can be more widely dispersed.

### 3. Overview of Industries in Navi Mumbai

#### 3.1 Area Detail

Maharashtra Industrial Development Corporation established an industrial estate at Thane Belapur Road, Navi Mumbai in 1963 which is often known as TTC MIDC Estate. The Estate is located along Thane Belapur Road towards Northern side of road and total area of the industrial estate is 27 sq.kms. There are about 2200 industrial units of various category engaged in the manufacture of chemicals, dyes, dye-intermediates, Bulk drugs, pharmaceuticals, Textile auxiliaries, Pesticides, Petrochemicals, Textile processors, Engineering units etc.

*TTC MIDC Location in Navi Mumbai*

Location : Name of the Industrial cluster	TTC MIDC area, Thane Belapur Road, Navi Mumbai.
Area	Approx. 27 Sq.km.
Surroundings	East: Parsik Hill range. West : Thane Municipal Area North: Parsik Hill South : Thane Belapur Road , and Navi Mumbai Township.

(Source CIDCO Industrial Survey Report, 2007)

#### 3.2 Industrial Area

- |   |         |
|---|---------|
| 1. TTC (Trans Thane Creek)                    | 2562 Ha |
| 2. Tajola Industrial Estate                   | 900 Ha  |
| 3. Jawahar Co-operative Industrial Estate     | 28 Ha   |
| 4. Panvel Industrial Co-Operative Estate Ltd. | 12 Ha   |

#### 3.3 Total No. of Plots

- |  |         |
|--|---------|
| 1. 1. TTC (Trans Thane Creek)                | 3824 Ha |
| 2. Tajola Industrial Estate                  | 1200 Ha |
| 3. Jawahar Cooperative Industrial Estate     | 248 Ha  |
| 4. Panvel Industrial Co-Operative Estate Ltd | 103 H   |

### 4. Engineering Enterprises Development in the Navi Mumbai

Thane-Belapur Industrial Belt (TBIB) also known as the Trans Thane Creek Area (TTCA) is situated in Zone II of Mumbai Metropolitan Region Development Authority (MMRDA). It is one of the major industrial belts in the country. TBIB mainly covers a strip between Thane Creek on the west, reserved forest land on the east; CBD, Belapur on the south and Thane city limit on the north admeasuring approximately 162 sq.km. The industrial development in TBIB commenced in 1961, along with declaration of Maharashtra Industrial Development Corporation (MIDC). The objective was primarily to promote chemical, engineering and other auxiliary industrial units. Subsequently MMRDA, along with City and Industrial Development Corporation (CIDCO) has developed a number of residential and commercial zones within this area, apart from a large number of villages that are situated in this belt.

Navi Mumbai's economic base was expected to be unique - more dependence on private sector activities like wholesale trading and processing activities in agricultural produce, iron and steel stockyards and wholesale markets, port based commercial and industrial activities, private and public sector offices, training and R & D centers in selected District Business

Centers (DBC's) and Central Business District (CBD) and last, but not the least, the fast emerging industrial belts along Thane - Belapur Road and at Talaja. In fact, at the time of formation of CIDCO in 1970-71, the only economic input available was about 16,000 industrial jobs in the Thane - Belapur belt; huge amounts of money were being spent by each company in transporting their workers to and from Mumbai.

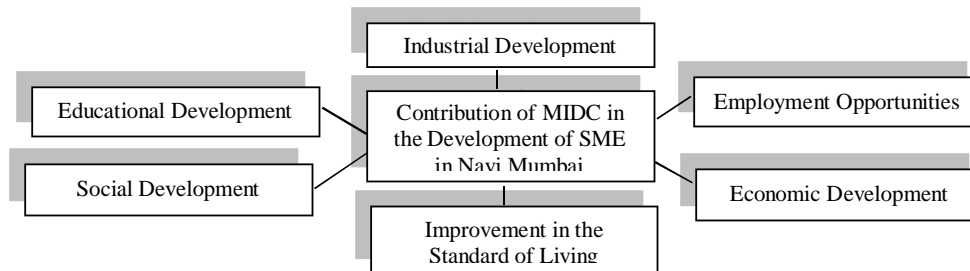
### 5. MIDC in Action in Navi Mumbai

The Maharashtra Industrial Development Corporation popularly known as MIDC-is one of the most widely known organizations across Maharashtra not only among those involved with industry but among the public at large. After the formation of Maharashtra State on the 1st day of May, 1960 under Government of Maharashtra Constituted a Board of Industrial Development (BID) on 1st October, 1960 under the chairmanship of Shri S. G. Barve, Indian Civil Service (ICS). The Board of Industrial Development framed the legislation and it was passed in the form of "Maharashtra Industrial Act" which gave birth to MIDC as a separate corporation on the 1st day of August, 1962 in a small ceremony held at Wagle Estate, Thane under the chairmanship of the former Chief Minister Shri Yashwantrao B. Chavan. Shri Y. B. Chavan, Chief Minister, presented the house of Industrial Development Corporation Bill for discussion on 27th November, 1962. "He said that it was necessary to establish a statutory corporation so as to bring about the industrial development of the State. He added that the State would need any such bodies to tackle the multifarious industrial problems.

MIDC has planned the culture of industrialization firstly in India and then in other states followed by the same. MIDC does not fly from social responsibility but keeps pace with it. The planned and systematic industrial development in the state of Maharashtra has continuously placed Maharashtra at number one position in India for highest productivity, economic performance and business efficiency of overall competitiveness. MIDC units play a vital role in the national economy by setting up the industrial area all over the state of Maharashtra. It can be represented with the help of chart given as under Chart 5.1 indicates the clear picture of contribution made by MIDC in the development of Maharashtra State. Thus it can be stated that MIDC has played a pivotal role not only in Industrial development but also importantly in the socioeconomic development of the state and its people. Maharashtra Industrial Development Corporation (MIDC) areas are spread all over the state of Maharashtra. The MIDC started in 1st August, 1962 with Waglee state, Thane as its first industrial area and as the premier industrial infrastructure development agency of Government of Maharashtra; conceiving basic objectives of MIDC units are explained as under:

1. To set up Industrial Areas for planned and systematic industrial development.
2. To function as a special planning authority in development of industrial areas.
3. "Prosperity to all though Industrialization" is the corporate Philosophy of MIDC.

#### 5.1 Chart 5.1: Contribution of MIDC in the Development of Maharashtra State



#### 5.2 Achievements by Maharashtra Industrial Development Corporations

There are some prominent achievement's has made by Maharashtra Industrial Development Corporations in India. They are highlighted as under:

MIDC has built 233 industrial complexes with 58,889.65 hectares of land. It has developed specialized parks for different industrial sectors, including IT, BT, Special Economic Zones, Wine (Grape Processing) parks, Silver Zone Gems and Jewellery, Textiles, Leather, Chemical Industry, Electronics, Food Processing and so on. There are tremendous development and changes made by Maharashtra Industrial Development Corporation in the State of Maharashtra. They have been explained as follows:

1. **Industrial Development:** There is prominent industrial development has taken place due to establishment of Maharashtra Industrial Development Corporation in State of Maharashtra. It always helped in providing the basic requirements for the development of business industries, hence as compared to other states; Maharashtra state is able to make sufficient development in industrial sector.
2. **Employment Opportunity:** Due to formation of Maharashtra Industrial Development Corporation in Maharashtra State, there are a number of industrial sectors that came in to existence. As a result, the qualified unemployed as well as less qualified people were able to get employment opportunities in various industries. It helps to improve their standard of living, in this way MIDC units helped in providing employment opportunities to large number of people in India.

3. **Economic Development:** Maharashtra Industrial Development Corporation helps in economic development of our country by providing employment opportunities and at the same time helps in increase the market size in terms of production and income, it makes possible for Government of Maharashtra to increase the national income by imposing tax on production of various kinds of goods and services. In this way MIDC units also help to make economic development of the nation.
4. **Standard of living:** Before existence of Maharashtra Industrial Development Corporation, the life style of people in Thane district was very simple and financially weak. After formation of MIDC units in state of Maharashtra, it helped to increase standard of living of the people by providing various job facilities and supply of various quality of goods towards ultimate consumer, it also help to create awareness among them relate to their health etc. In this way MIDC units in Thane district enable people to improve their day to day life.
5. **Education Development:** MIDC Units provides maximum number of employment opportunities, it induce to get highly qualified employees in order to handle new advance machineries, adapt new techniques in production etc. hence indirectly there are number of ITI colleges, Engineering Colleges, Bio-technology colleges etc came into existence to fulfill the requirement of various industries existing into the market. Ultimately there is development taken place in education field and its credit goes to MIDC only.
6. **Social development:** There are maximum numbers of changes that have taken place in the society due to existence of MIDC units in Thane district. Every person in the society gets goods services and employment. It helps them to become self-sufficient. MIDC units also help to upgrade the standard of living of people by providing good facilities, good education, quality goods etc. In this way there is overall social development taken place due to MIDC units existing in state of Maharashtra.

## 6. Contribution of MIDC in the Development of Engineering Enterprises in Navi Mumbai

1. **Acquisition & Disposal of Land:** The land for industrial areas is acquired by the Government of Maharashtra under Chapter VI of the MIDC Act, 1961 and handed over to the Corporation for further disposal. Likewise, wherever available, the Government land is also handed over to the Corporation as an industrial area. The Government pays for the compensation for the private land from its own fund. The Corporation in turn plans the area and disposes the land in suitable plots by leasing out for 95 years. For this purpose the Corporation recovers the premium lease money at different rates for different industrial areas. Also the Corporation constructs built-up accommodations like Sheds and Flatted units and sale them out to the prospective industrialists together with the land there under on lease basis. As on 31.3.2002 the Corporation has planned 673.72 (Hectares) of land against which 591.02 Hectares of land has already come in possession of the Corporation.
2. **Provision of Infrastructure Facilities:** In terms of the provision of the MID Act, 1961 and the relationship prescribed by the government in that regard, the corporation is required to provide infrastructure facilities like roads, streetlight, drainage, water supply schemes and buildings for common facilities like post & telegraphs, canteen, bank, and telephone etc. The corporation meets the expenditure on such works (facilities) generally from the premium lease money received by it from the allottees. The relationship further prescribes that the industrial area, after it is fully developed, should be returned back to the Government/handed over to such agency or authority as the State Government may directs, after striking out the account of the industrial area concerned. The surplus/deficit generated out of such operations is to be made good to or recovered from the state government as the case may be.  
 As the development of an industrial area is a long process and instant objective, the government has prescribed certain scale of interim annual payments which are termed as on account advance payment to government. In this connection it may stated that the powers to fix the rates of premium for land for different industrial areas rest with the corporation. Since it is the aim of the government and the corporation to achieve a balanced development of the entire State with special emphasis on the development of backward regions of the state, the Corporation follows a policy of cross subsidization rate structure on A B C D zones pattern, in that the rates of land premium in developed and semi developed parts of the State are higher compared to the rates in developing and backward regions.
3. **Providing of Services:** The Corporation provides the following services to the units in its industrial areas:-
  - a) **Assured Water Supply**  
 From among the various services provided by the Corporation, an assured pure water supply can be regarded as a unique specialty of the MIDC. The investment on the water supply scheme (Head works) made by MIDC as on 31st March, 2002 is over Rs.5 crores with installed capacity of water supply of 25 MLD. For the purpose of regulating the water supply operations of the Corporation the Government of Maharashtra has prescribed a legal and financial relationship between the Government and the Corporation.
  - b) **Maintenance of Industrial Areas**  
 This is a municipal function requiring the Corporation to maintain the Roads, Street lights, Fire stations (in few areas) during the transitory period up to handing over of the industrial area either to Government or other agency as the Government may decide. The MIDC Act, vide Section 56, provides for the exits policy after the purpose of industrial development as contemplated in the Act is fulfilled. However, this has seldom become possible in the absence of a

substitute agency to take over the responsibility, except in few cases like that of Marol, Wagale Estate, Pimpri Chinchwad etc. where the Corporation could hand over only the roads and street lights to local Municipal Corporations. In other areas, the Corporation carries on this function as a committed obligation. For this purpose the Corporation recovers service charges to defray the expenditure on such services.

**c) Drainage (effluent disposal) and CETP Schemes**

The Corporation has effluent disposal (drainage) schemes only in selected Industrial areas having chemical industries. Such schemes are designed to collect and discharge the treated effluent only. In such areas the Corporation recovers drainage cess to defray the expenditure on maintenance and to partially recover the capital cost. Also with a view to arrest pollution, the Corporation has started the operations like Hazardious waste Management and common effluent plants on Joint venture basis with the help of local industries associations.

**d) Other Services**

These include providing and maintaining Common Facility Centers like P&T, Banks etc. Though the Corporation does not levy any specific cess for the purpose, the C. F. C. building is subject to rentals. Such rental together with other miscellaneous income from the area covers the maintenance cost of such CFCs. The policy decisions taken by TTC MIDC certainly changed the social economic scenario of the city as its activities spread in the interior. The important policy decision of setting up "independent filtered /potable water supply system of adequate capacity" as essential infrastructure for industrial development was the most intelligent step taken by TTC MIDC right in the beginning. It stabilized the population base near the industrial areas. The strategically wise decision taken simultaneously to provide water supply to nearby domestic population from the capabilities created by TTC MIDC of their own water supply system resulted in a phenomenal urban growth in the nearby small towns and villages.

## 7. Suggestions

- a) Land acquisition policies of the MIDC should be updated and reframed as per the locational advantage and location disadvantage. Land acquisition and allotment policies will be incomplete if the locational advantage to the engineering enterprises is not good. Need based approach should be followed while allocating the land to the engineering enterprises.
- b) Plotting of land should be as per the alphabetical orders or some sequential order for easy identification of industrial unit in MIDC area. In many cases order of plotting is disordered. So, MIDC should rearrange the identification code for the engineering enterprises.
- c) Cost of land in Thane Belapur industrial belt in Navi Mumbai is very high as compared to the cost of land in other MIDC Area in Maharashtra. MIDC officials should consider the cost of land by which future migration of engineering enterprises will stop.
- d) Licensing part for getting approval should be simplified more for avoiding the constraints of the engineering enterprises in Navi Mumbai.
- e) Power is the basic requirement for industrial development. Therefore its supply will effect on the profitability of the engineering enterprises. MIDC officials should take care for un-interrupted source of power supply. If MSEB has burden of supplying power supply then private energy companies can be allowed.
- f) Power subsidy will decides the use of power and cost of product of the engineering enterprises. To survive the engineering enterprises into the competition it will be helpful. Therefore, MIDC authority should take care of providing power subsidy to the engineering enterprises.
- g) As industries needs more power for functioning, energy infrastructure plays important role in providing regular supply of electricity. Energy infrastructure decides the distribution of power network to the engineering enterprises. Up gradation of energy infrastructure reduces the chances of losses due to the shortage of power. MIDC officials should plan for timely up gradation of energy infrastructure in MIDC area.
- h) Cost of electricity and use of electricity by engineering enterprises decides their profitability. To maintain efficient use of power to engineering enterprises technical surveys are needed on periodical basis. As engineering enterprises are suffering from shortage of finance they cannot afford the cost for such technical surveys. Therefore, MIDC should conduct such kind of surveys at reasonable rates.
- i) Engineering enterprises can raise their profitability by practicing energy audit. Energy audit helps in minimizing cost of production and reducing environmental defects. MIDC officials should conduct energy audit on periodic basis and keep the record of energy consumption of engineering enterprises for further action.
- j) Regular power supply is bringing positive impact on engineering enterprises development in Navi Mumbai. Availability of enough power will retain survival and growth of engineering enterprises in Navi Mumbai. It is observed that many a times the power supply are irregular or frequently uninterrupted power supply in MIDC area. The MIDC authorities should ensure regular power supply to the engineering enterprises located in Navi Mumbai MIDC area by keeping dialogue between MSEB.
- k) Total installed capacity of the water supply system is 1940 mld and 1286 mld is utilized sufficiently for industries. Total reservation for industrial use is 4055 mld which indicate the extent to which MIDC has right to draw water

from rivers, irrigation projects and other sources. with this right, MIDC can satisfy the needs of the industrial users in Navi Mumbai.as it was identified that additional jobs taken by the engineering enterprises unites at same installed capacity of water. Specially, chemical unites needs more water supply. Therefore, special efforts should be taken by MIDC to increase the installed capacity for industrial use in general and for chemical unites in particular MISCs water infrastructure includes 69 schemes having five dams. so, it is possible to MIDC to provide regular water supply to the industrial unites in Navi Mumbai.

- l) MIDC has develops 2864 kms length of pipelines in Maharashtra. Maintenance and repairing of pipelines is major challenge to the MIDC .maintenance of pipeline should be done periodically and if possible, subcontracting of maintenance of pipeline can be undertaken.
- m) MIDC should ensure that fire protection of the building which will help to fight the fire before arrival of fire. This will help to minimize loss of precious human life and salvaging national properties. this will help to create fire safe environment in its industrial areas by way of its 'development control rules'(dc rules) and it is a need of all industries in industrial areas in Navi Mumbai.as per growth of industries in Navi Mumbai, MIDC should increase the number of fire stations.
- n) MIDC should ensure fire prevention engineering at the planning stage of any building in MIDC area .this includes selection of location of building, approaches of roads for the plots and surrounding activities of the plot, which will facilitate fire risk free surrounding to the engineering enterprises in Navi Mumbai.
- o) there are many risks are available for engineering enterprises in Navi Mumbai for that technical support provides framework of powers and duties which will equip fire and rescue authorities to meet the challenges of the 21<sup>st</sup> century. Therefore, MIDC authorities should provide strong basis for fire and rescue authorities' ability to respond to the range of risks set out in their integrated risk management plans.
- p) Dealing with the emergencies such as flooding, terrorist attack, fighting fires and protecting people fire brigade service is required at short distance from the unit. For maintaining law and order in MIDC area police security should be increased.
- q) In many MIDC areas there is no safe roads are available for transportation and travelling in Thane Belapur industrial belt in Navi Mumbai. Safe roads are always expected by industrialist for carrying their raw materials and finished goods. As well for safe driving also safe road is compulsory thing at industrial areas. The state's road network consists of national highways, state highways, major district roads, other district roads and village roads. The road development works in the state are carried out by pwd, zp, municipal corporations, cantonment boards (cb), forest department, MIDC and cidco.MIDC officials should take serious efforts for construction and maintenance of rods as per the need of industrial areas in Navi Mumbai.
- r) In MIDC area heavy vehicles are moving at regular extent, so it is risky that same road is used by employees by walk and also industrial vehicles. Therefore MIDC needs to construct footpath facility on both the side of roads in MIDC area on the road side in Thane Belapur industrial belt in Navi Mumbai.
- s) To avoid industrial theft and robbery MIDC needs to take care of safety and security of industrial material and waste.
- t) MIDC should provide proper disposal and drainage system along with other infrastructure facility in thane trance creek in Navi Mumbai.
- u) As per the environmental protection act, 1986 engineering enterprises are expected to provide primary treatment to effluent, for which proper environmental education is necessary. Therefore, MIDC should spread environmental awareness in Thane Belapur industrial belt in Navi Mumbai.
- v) MIDC should encourage for the set up with green design and environment friendly in Navi Mumbai.

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# Assessment of Inclusive Economic Growth in Major Indian States



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**Paramasivan S Vellala**

*Institute of Technology, Nirma University*  
(param.vellala@nirmauni.ac.in)

**Mani K Madala**

**Utpal Chhattopadhyay**  
*National Institute of Industrial Engineering*  
(manimadala@gmail.com)  
(utuchat@rediffmail.com)

*The shift in development economics is evident in the ongoing discourse in economic literature on inclusive economic growth. Inclusive economic growth is a broad-based growth which is both an outcome and a process. Ensuring that the benefit of growth reaches everybody in general and the poor in particular, it further ascertains that the poor participates in the process of growth. This paper assesses inclusive growth outcome in major Indian states by constructing Composite Inclusive Growth Index using Principal Component Analysis and cross sectional data for 2001 and 2011 with a set of socio-economic variables.*

## 1. Introduction

### 1.1 Shift in Development Economics

Development economics is witnessing a paradigm shift towards fostering inclusive economic growth with broader perspectives. This paper investigates the assessment of inclusive growth across major Indian states. While pro poor growth is only an outcome inclusive growth is both an outcome and process. The paradigm shift in development economics created new discourse in global policymaking towards achieving inclusive growth. This paper is organized in the following manner. Section 2 deals with literature review followed by Section 3 which deals with methodology; Section 4 describes the result and finally Section 5 concludes.

## 2. Literature Review and Research Gaps Identification

The inclusive economic growth literature can be traced from the knowledge products of International Monetary Fund (IMF), World Bank, Asian Development Bank (ADB) and some path-breaking individual research papers by different economists across the world. Social opportunity function has been used by Ali and Son (2007). Employability skill of the poor has been used in the inclusive growth analytical framework designed by Elena and Susana (2010) of World Bank. Growth with equal socio-economic and institutional opportunities can be termed as inclusive economic growth Raumiyyar and Kanbur (2010).

Inclusive growth is economic growth that results in a wider access to sustainable socio-economic opportunities for a broader number of people across various regions while protecting the vulnerable—all being done in an environment of fairness, equal justice and political plurality (ADB,2013). Ramos et al (2013) follow the concept of benefit sharing and participation to measure inclusiveness in the growth process. Exchange rate coordination, improved international tax capacity, coordinated fiscal stimulus, global resource system, issue of macro-economic balances are some of the key drivers of inclusive growth dynamics in developing countries(Maritns and Lucy, 2013). Inclusiveness of growth is the growth elasticity of poverty (Han and Thorat, 2013) in the sense that poverty reduction is the overall objective of any policy debate over a period of time which depends upon the income growth and the distribution thereof.

**2.1 Literature Related to Measurement of Inclusive Growth:** The existing literature on the measurement of inclusive growth unearths the following studies which have made sincere efforts in measuring the complex phenomena of inclusive growth.

### **Inclusive Growth Criteria and Indicators: An Inclusive Growth Index for Diagnosis of Country Progress (McKinley, 2010)**

McKinley (2010) constructed this index covering the two dimensions of inclusive growth: (1) achieving sustainable growth that creates and expands economic opportunities and (2) ensuring broad access to these opportunities so that all the people can participate and benefit from them. The overall objective of this index was to guide the Asian Development Bank in providing foreign aid to the countries to foster inclusive growth. The Index was tested in six different countries – Bangladesh, India, Indonesia, the Philippines, Cambodia and the Uzbekistan.

### **China's Inclusive Growth: Measurement and Evaluation (Min and Xiaolin, 2012)**

The inclusive growth index was prepared to measure the sustainability of economic growth, income poverty and equity, fair access to economic opportunities as well as social security. The authors made sincere attempts to evaluate the level of inclusive growth in China and determined the impact of specific factors on inclusive growth. The biggest lacuna in this index is that they relied on expert opinion on weightage scheme of the indicators.

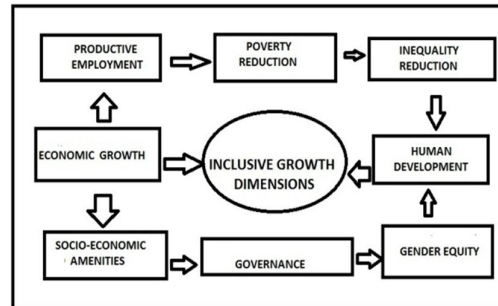
## 2.2 Research Gaps Identification

The current study emanates from the following research gaps identified from the above literature review.

1. The studies so far did not offer a comprehensive theoretical framework for inclusive economic growth, thereby offering scope for further investigation.
2. In the existing studies there is no evidence of the measurement of inclusive economic growth though McKinley (2010) used composite index for inclusive economic growth for diagnosis of the country's progress with limited case studies
3. The scanning of existing literature on inclusive economic growth shows that the weightage scheme is either fixed arbitrarily or equally among various variables and indicators which need further investigation.

## 3. Methodology

**3.1 Inclusive Growth Theoretical Model:** This paper moves from the construction of inclusive growth theoretical model (Vellala et al, 2014) to the assessment of inclusive growth outcome.



From the above theoretical model of inclusive growth, the following drivers of inclusive growth have been identified.

1. **Economic Growth:** High real GDP per capita growth alone can trigger inclusive growth. However researchers very often use the per capita income as the indicator. It must be kept in mind that per capita income will not show the qualitative change in the standard of living of the people. The monthly per capita consumption expenditure can be a better indicator which can show the increase in the people's consumption expenditure with change in the standard of living of the people.
2. **Employment:** Employment generation is one of the macro-economic objective and therefore the cornerstone of inclusive growth theoretical model is the capacity of the economy to generate productive employment to the people.
3. **Poverty Reduction:** The ultimate objective of inclusive economic growth is poverty reduction. The Tendulkar Report (GOI, 2009) has a concept of inclusive growth (Alog,2010)
4. **Inequality Reduction:** Inequality reduction is an important objective of macro-economic management. Therefore inequality reduction is an integral part of the theoretical model for inclusive growth (Vellala P et all, 2014). Measures are needed to reduce the income inequality which will have a positive bearing on the inclusive economic growth (McKinley, 2010).
5. **Human Development:** We need to focus on enhancing the human capabilities of the people which can increase the productivity of the people. The Kerala model of growth has widely been appreciated across the world since it emphasises human capabilities. The human development is nothing but the supply side of the inclusive growth. Macro-Economic stability, human capital and structural changes are found to be the key determinants of inclusive growth in the emerging world (Anand et al, 2013).
6. **Gender Equity:** Many governments across the world have initiated various programmes for achieving the gender equity. Gender equity can foster inclusive growth (McKinley, 2010).
7. **Basic Socio-Economic Infrastructure:** Access to safe drinking water, electricity, housing, toilet and transport etc. empower the capacity of the people to actively participate in the process of economic development.
8. **Financial Inclusion:** Financial inclusion is an integral part of the theoretical model for inclusive growth. Ensuring access to financial services and timely and adequate credit is essential for financial inclusion (Rangarajan, 2008).
9. **Sustainability Dimension:** Inclusive growth needs sustainable economic growth in the long run. Therefore there is an urgent need for policy intervention to protect the environment.
10. **Governance:** The governance standards also determine inclusive growth since the implementation of inclusive growth policies need effective, accountable and transparent governance. In this study the social sector allocation is used as an outlay variable and the much appreciated MGNREGA data set has been used as an outcome variable in measuring the governance dynamics of inclusive economic growth in this study.

**3.2 Identification of Major Indian States:** Present study constructs the inclusive growth composite index for 15 major Indian states which have been identified on the basis of following three criteria.

**Table 3.1** Identification of Major Indian States

States	Geographical Area Lac Sq.Km.	% of Population to that of India	% of SDP to India's GDP
Andhra Pradesh	2.75	7.00	7.65
Assam	0.78	2/58	1.61
Bihar	0.94	8.68	2.89
Gujarat	1.96	4.99	6.84
Haryana	0.44	2.09	3.70
Karnataka	1.92	5.05	5.49
Kerala	0.38	2.76	3.85
Madhya Pradesh	3.08	6.0	3.48
Maharashtra	3.08	9.29	14.04
Odisha	1.56	3.47	2.71
Punjab	0.50	2.29	3.36
Rajasthan	3.42	5.67	4.09
Tamil Nadu	1.36	5.96	6.88
Uttar Pradesh	2.41	16.49	8.35
West Bengal	0.89	7.55	7.18
<b>Total Share (%)</b>	<b>25.47 Lac sq.km. (77%)</b>	<b>89.77 %</b>	<b>82.12 %</b>

Source Census, 2011

### 3.3 Selection of Indicators and Sources of Data

This study considers a large number of variables which can be grouped into the following dimensions – Economic, Amenities, Gender Equity and Financial Inclusion, Human Development, Sustainability and Governance. The data sources are given below.

**Table 3.2** Selection of Indicators and Sources of Data

Indicators	Dimension	(Base Year-01-02)	(Current Year-11-12)
Income – MPCE	ECONOMIC	2004-05 – NSSO 60 <sup>th</sup> Round	NSSO 68 <sup>th</sup> Round July 2011 to June 2012
Poverty		Planning Commission 2004-05	Planning Commission 2011-12
Employment		Census 2001	NSSO – 68 <sup>th</sup> Round
Inequalities(Gini Coefficient)		Planning commission	Planning Commission
Per Capita consumption of Electricity	AMENITIES	Central Electricity Authority, Ministry of Power, GOI	Central Electricity Authority, Ministry of Power, GOI
Access to Drinking Water		Census-2001	Census-2011
Access to Toilet		Census-2001	Census-2011
Pucca Houses		Census-2001	Census-2011
Transport – Road Length per 100 Sq.km.		Economic Survey of Maharashtra – 2005-06	Economic Survey of Maharashtra – 2012-13
% of women in LWF	GENDER EQUITY	Census-2001	Census-2011
% of Girls in School Ed	and	Census-2001	Census 2011
% of HH with banking	Financial Inclusion	Census-2001	Census-2011
Literacy Rate	Human Development	Census-2001	Census-2011
Life Expectancy		Census-2001	Census-2011
Health – IMR		SRS Bulletin 2005-06	SRS Bulletin Oct.2012
% of State Finance (Budget) to Social Sector	GOVERNANCE	State Finances: A Study of Budgets of 2013-14, RBI	State Finances: A Study of Budgets of 2013-14, RBI
No. of man days of Employment		MGNREGA Report 2006-07	MGNREGA Report 2011-12
MGNREGA Wage		MGNREGA Report 2006-07	MGNREGA Report 2011-12
% of Women in participation of MGNREGA		MGNREGA Report 2006-07	MGNREGA Report 2011-12
Crime Rate	Sustainability	National Crime Records Bureau, Home Ministry, GoI-Report-2001	National Crime Records Bureau, Home Ministry, GoI-Report-2011
Air Quality		CPCB,GoI, 2004	CPCB,GoI, 2011



### 3.4 Principal Component Analysis (PCA)

After the components have been extracted from the principal component analysis the factor loadings of each of the variables on the components are calculated. The factor loadings are the correlation between the latent components and a variable. The aggregation of the scores of the components was done on the basis of weights assigned to the components, *the weights being the proportion of variance explained by the component* (Prabhu and Sarkar, 1992). The factor loading is multiplied by the weight of the component to get the individual score. The Composite Inclusive Growth Index Score for each state is derived by summing up the component scores for each dimension of the inclusive growth framework – Economic, Amenities, Financial and Gender Equity, Sustainability and Governance. From the rotated factor loadings and the corresponding total variance explained in the rotated sum of squared loadings it is found that the weights for economic indicators are as follow (For example the highest rotated factor loading against first component is poverty with .971 and the total variance explained against the first component in the rotated sum of squared loadings is 34.423% and therefore the weight assigned to poverty is .34 or 34%. Likewise the weights are determined for other indicators with highest rotated factor loadings in the remaining components and the weights are determined as follows. All the dimensions have been given equal weightages but within the dimension the weightage of different indicators are determined according to the PCA output using the SPSS software.

### 3.5 The Weights Assigned to Indicators- Year 2001 and 2011

**Table 3.3** Weightage Mechanism

Indicators	Dimension	2001	2011
Income – MPCE	Economic	0.02	0.15
Poverty		0.34	0.24
Employment		0.21	0.20
Gini – Rural		0.22	0.20
Gini – Urban		0.21	0.21
	Total	100%	100%
Per Capita consumption Of Electricity	Amenities	0.10	0.20
Access to Drinking Water		0.20	0.21
Access to Toilet		0.03	0.20
Pucca Houses		0.46	0.21
Transport – Road Length per 100 Sq.km.		0.21	0.18
	Total	100%	100%
% of women in LWF	Gender Equity and Financial Inclusion	0.33	0.33
% of Girls in School Ed		0.33	0.33
% of HH with access to banking		0.33	0.33
	Total	100%	100%
Literacy Rate	Human Development	0.37	0.36
Life Expectency		0.55	0.32
Health – IMR		0.08	0.32
	Total	100%	100%
% of State Finance (Budget) to Social Sector	Governance	0.25	0.25
No. of man days of Employment		0.25	0.25
MGNREGA Wage		0.25	0.25
% of Women in participation of MGNREGA		0.25	0.25
	Total	100%	100%
Crime Rate	Sustainability	0.50	0.50
Air Quality		0.50	0.50
	Total	100%	100%

## 4. The Result

### 4.1 Construction of Composite Inclusive Growth Index – 2001

Actual data is converted into z-score for each dimension which is multiplied by the concerned weight to get the value of each indicator. Then the index value of all the indicators are aggregated to get the index of each dimension and the sum of score of all the dimensions have been taken as the composite score for a state. This paper has developed the composite inclusive growth index in Indian context as follows.

**Table 4.1 Inclusive Growth Composite Index 2001**

States	Economic	Amenities	HD	GEFI	SUS	GOV	Composite Score	RANK
AP	1.07	0.01	-0.29	0.11	0.66	-1.13	0.43	6
Assam	0.19	-1.26	-0.86	-0.63	0.54	0.59	-1.43	10
Bihar	-0.34	-0.49	-1.16	-0.58	-0.33	-0.42	-3.32	13
Gujarat	0.31	0.4	0.06	0.18	-0.5	-0.05	0.40	7
Haryana	0.44	0.44	0.23	0.4	0.1	-0.04	1.57	3
Karnataka	0.31	0.12	0.3	0.53	-0.27	0.19	1.18	5
Kerala	-0.51	0.52	2.42	0.54	0.34	-0.14	3.17	2
MP	-0.30	-0.62	-0.97	-0.13	-0.28	0.76	-1.54	11
Maharashtra	-0.47	0.2	0.75	1.08	-0.77	-0.58	0.21	8
Odisha	-0.43	-0.83	-0.81	-0.67	1.03	0.38	-1.33	9
Punjab	0.91	1.42	0.73	0.15	1	-0.29	3.92	1
Rajasthan	0.43	-0.01	-0.58	0.05	-0.8	1.31	0.40	7
Tamil Nadu	-0.51	0.4	0.31	0.41	0.42	0.19	1.22	4
Uttar Pradesh	-0.79	0.02	-0.39	-0.83	-1.03	-0.39	-3.41	14
West Bengal	-0.32	-0.3	0.26	-0.63	-0.19	-0.38	-1.56	12

#### 4.2 Construction of Composite Inclusive Growth Index – 2011

The above exercise has been repeated for the year 2011 which produced the following Composite Inclusive Growth Index for the year 2011.

**Table 4.2 Inclusive Growth Index 2011**

Name of States	Economic	Amenities	HDI	GEFI	SUS	GOV	C Score	RANK
AP	0.89	0.32	-0.48	0.35	-0.43	1.16	1.81	4
Assam	-0.14	-0.58	-0.72	-0.99	0.41	-0.65	-2.67	12
Bihar	0.14	-0.61	-1.03	-0.58	-0.26	-0.69	-3.03	14
Gujarat	0.37	0.42	0.05	-0.08	-0.1	-0.2	0.46	8
Haryana	-0.08	0.68	0.2	-0.2	0.06	0.08	0.74	6
Karnataka	-0.50	0.03	0.09	0.49	0.03	0.34	0.48	7
Kerala	-0.08	0.24	2.52	0.88	1.14	0.4	5.10	1
MP	-0.40	-0.49	-0.9	0.14	-0.74	-0.5	-2.89	13
Maharashtra	0.09	0.15	0.88	0.68	-0.44	0.29	1.65	5
Odisha	-0.39	-0.59	-0.46	-0.6	0.47	0.74	-0.83	10
Punjab	0.27	1.04	0.55	0.05	1.45	-1.06	2.30	3
Rajasthan	0.26	-0.3	-0.72	-0.09	-0.73	0.5	-1.08	11
Tamil Nadu	0.33	0.14	0.76	1.03	0.36	0.32	2.94	2
Uttar Pradesh	-0.44	-0.16	-0.88	-0.49	-0.78	-0.54	-3.29	15
West Bengal	-0.36	-0.3	0.15	-0.47	0.54	-0.18	-0.62	9

Comparison between 2001 Composite Inclusive Growth Index and 2011 Composite Inclusive Growth Index

**Table 4.3 Rank of Major Indian States on Inclusive Growth Composite Index**

Name of the State	Rank – 2001	Rank - 2011
Andhra Pradesh	06	04
Assam	10	12
Bihar	13	14
Gujarat	07	08
Haryana	03	06
Karnataka	05	07
Kerala	02	01
Madhya Pradesh	11	13
Maharashtra	08	05
Odisha	09	10
Punjab	01	03
Rajasthan	07	11
Tamil Nadu	04	02
Uttar Pradesh	14	15
West Bengal	12	09

## 5. Conclusion

Perhaps for the first time in India an effort has been made to rank Indian states according to the inclusive growth outcome. The result can be interpreted to diagnosis the state progress in the inclusive growth and right kind of state policy intervention can be taken which is necessary for revamping the lagging states in fostering the inclusive growth. Further those states which are poorly ranked in the index can attract huge investment and foster expansion in production capacity. If we incorporate per capita income as the proxy variable for inclusive economic growth and regress with the socio-economic variables described in this paper it will further explain the cause and effect of shift in the position of different states in the composite inclusive growth index for 2001 and 2011 which provides scope for future directions in this study.

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# Conquering Configuration Management Conundrum



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**C. Suresh kumar**  
Indian Space Research Organization  
(c\_sureshkumar@lpssc.gov.in)

**Suresh Subramoniam**  
Kerala University  
(sureshsubramoniam@gmail.com)

*Configuration management (CM) is a tool for product data management. Over a period of time the nature and function of CM has changed to an active component of product development and applied throughout the product lifecycle. Initial application of CM is seen in complex military projects and aerospace programs followed by the evolution of CM standards and application of CM in other projects too. The CM application in present day product development, especially R&D projects, needs better understanding to resolve complex issues related to continuous changes in requirements, technology, environment or relevance of the project. Change management is the dynamic component in CM which involves decision making to optimize system performance. An attempt is made in this paper to formulate the decision making problem in CM as a decision matrix. The feasibility of obtaining an analytical solution to this problem using Multi-Criteria Decision Making (MCDM) methods is explored. Possible solutions to resolve challenges faced during CM implementation, and constraints are also briefly discussed here.*

## 1. Introduction

The nature and relevance of Configuration Management (CM) has changed a lot since its introduction in the 1950's. CM is originally developed to resolve the issues in complex military projects and aerospace programs, wherein the product development starts with a vague (technically) definition and components undergo a lot of change as part of system development. The situation is similar in most of the Research and Development (R&D) projects. Now, Configuration management is applied throughout the life cycle of the product, viz. development, production, deployment, operation and disposal [1]. The CM application in R&D projects needs better understanding to resolve complex issues related to continuous change in requirements, technology, environment or relevance of the project. It is high time to refine or evolve an analytical approach to solve decision making problem in CM.

The decision making problem in CM is either to select the best alternative to substitute an existing component or to select the best suitable component/subsystem to be added to the existing system, so that the overall system performance is optimized. Often this is done in a subjective manner. An attempt is made in this paper to formulate the decision making problem in CM as a decision matrix to eliminate the subjectivity in decision making. The feasibility of solving this problem, using Multi-Criteria Decision Making (MCDM) methods, is also explored. The issues associated with identification of criteria and difficulty in expressing all the criteria in the same unit is also highlighted. In addition, the challenges faced during CM implementation, possible solutions and constraints also form the topic of discussion here.

## 2. Configuration Management: An Overview

Configuration Management (CM) originated in 1950's as part of product management system, when the product complexity was in the increasing trend. The concept is developed in military systems and other defence oriented (aerospace) areas. As a result, a good number of standards are generated on how to practice CM.

Configuration management is defined as "Configuration Management is a management discipline that applies technical and administrative direction to the development, production and support lifecycle of a configuration item. The discipline is applicable to hardware, systems, processed materials, services and related technical documentation. Configuration management is an integral part of life cycle management" [2].

Over a period of time the scope of CM has increased in product realization and in the last two decades the concept of CM established its place throughout the product life cycle. Systematic procedure for the application of CM is already developed and available in almost all CM standards.

Generally, CM is applied as a passive mechanism which gives high priority for systematic recording and storage of data pertaining to a product during its evolution. This passive mode was sufficient to meet the CM requirements when the product development was taken up by a single agency in a sequential manner. In the present world of Concurrent Engineering (CE), configuration management needs to be redefined as an active data analysis and decision making system rather than a passive data recording and archival system.

Though, CM is introduced for products which are hardware oriented, of late the software industry has benefited a lot from the configuration management concept. This is mainly due to the modularity in software development. The subsystems (modules) are designed and developed by different System Development Agencies (SDA's) and this necessitated centralized control over the design, especially the interfaces (both physical and functional). CM takes up this role and it does the configuration control on an integrated level.

CM also plays an important role in streamlining the product life cycle. Agile Configuration Management is proposed as an approach to simplify and stream line the procedure to carry out the CM requirements [3] so that it gets aligned with the overall product development activities. Over a period of time, the CM approach is elevated to a management process to establish, monitor and achieve consistency of a product's physical and functional requirements with its design and operational information throughout its life.

The MIL-STD-973 (1992) [4] defined configuration management activities as:

- a. Identify and document functional and physical characteristics of Configuration Items(CIs);
- b. Control changes to a CI and its related documentation;
- c. Record and report information needed to manage CI's effectively;
- d. Audit CI's to verify conformance.

As a product data management system, CM needs to follow the above activities systematically to avoid losing track of product development as well as to evaluate the "as designed" and "as realized" conditions of a product. It is obvious that the role of CM was passive in product development and generally, it was treated as a subset of quality control activities.

In 1998 when ANSI/EIA 649 [5] National consensus standard is written to replace MIL-STD-973, CM got identified as an essential part of product development with better clarity to CM activities. The role of CM as per ANSI/EIA-649 is to maintain consistency between, the product definition and product configuration, and, the configuration management records. In this definition CM is transformed as an 'active system' to form part of successful product development. As a consequence, the change management and its importance got emphasized. The economic aspect of product development is one important consideration in the CM process. Maintaining consistency as demanded in the definition of a product is a big challenge when everything is in a state of change. Unless, CM is remodelled as a dynamic system with continuous interaction in product development this cannot be achieved. The success of CM application in the product life cycle management is to be viewed in this scenario. Studies indicate that proper implementation of CM achieves reduction in time for design, development and production of the system [6].

### 3. Product Life Cycle and Changes

A typical project by definition is constrained with cost, schedule and quality (triple constraints). The fundamental requirement of achieving project goal, satisfying the constraints, is firm planning and executing the plan as defined originally. Any change in the due course may lead to the violation of any one of the constraints. Example ranges from construction of a house to multi-billion establishments like oil refineries, Airports, etc.

A deviation from this classical project structure is necessitated even in early days (though very limited examples) due to reasons which are beyond the scope of thinking at the planning stage. In those days, these deviations got treated as exceptions. Let us consider the most ambitious and successful project in the recent human history, the Moon Mission, charted out by US President John F. Kennedy "landing a man on the Moon and returning him safely to the Earth" by the end of the 1960s, which he proposed on a May 25, 1961. When he set this goal, neither technology nor infrastructure nor expertise exists with any certainty. The project has under gone plenty of changes during the development. In fact, the systems are evolved through a series of iterations, yet it achieved the goal. One may think that this was an exceptional case at that point of time, but now this is the order of the day. In high-tech product development, ranging from rocket systems to mobile phones with fast changes in requirements, the design rules, process, materials, technology, environmental requirements and the like undergoes continuous change.

Now, let us consider the reasons for change. Peter F Drucker [7] explained the following points as the reasons for change in any system.

- a. Process needs
- b. Change in industry and market structure
- c. Change in demographics
- d. Change in meaning and perceptions
- e. New knowledge

Every industry which is involved in the product development faces these problems in an increasing manner. All the reasons that can be quoted for change can be classified under any one of the above five. The original requirements keep on changing due to different reasons and these changes in requirements need to be controlled and documented throughout the life cycle. Figure 1 illustrates the evolution of requirements.

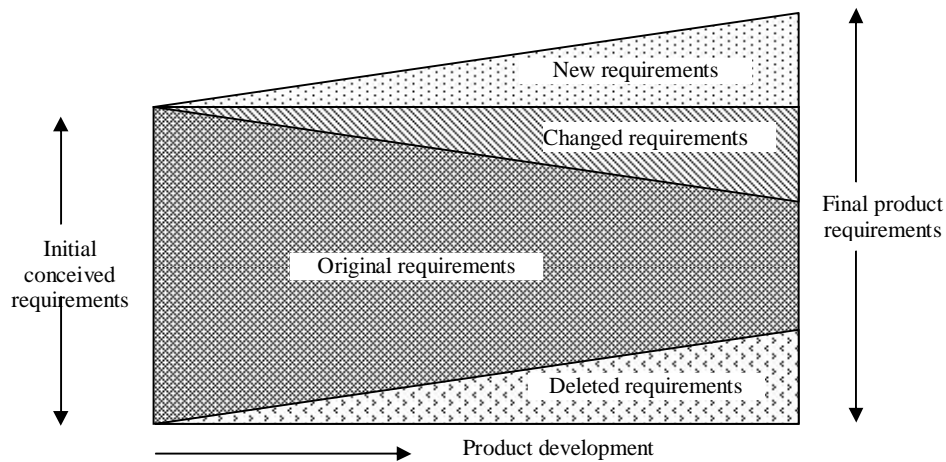


Figure 1 Evolution of Requirements [8]

#### 4. Configuration Management and Importance to Life Cycle

Notwithstanding the changes during the product life cycle, the basic constraints should be honoured to ensure project success. CM can play a major role in achieving this diverse objective. The present day design concepts like Concurrent Engineering (CE) or modularity aims to achieve optimal subsystem, but this local optimum may not yield a global optimum at product level. Every subsystem definition need to be oriented and controlled during the evolution so that it does not lose its integrity with other subsystems in terms of performance, interface (both physical and functional) quality, schedule or cost as the case may be. The relevance of CM in product life cycle is identified here. When a change is proposed in one subsystem due to any of the reasons as explained in the last section, the suitability of this change is to be assessed on a platform different from that of what the designer uses. This role is presently assigned to the CM team.

As the project progresses the subsystems are getting firm up in design, process, material, testing and so on. At that point of time, change in another subsystem need to be viewed in a different perspective. Though the change may be positive in one of the constraints, it may have negative impact on another. The constraints on yet another subsystem may have a different impact level. This is the situation that leads to subjectivity in decision making in CM. It is observed that as the complexity of the system is increased the changes occurred during development is increased in an exponential manner (figure 2).

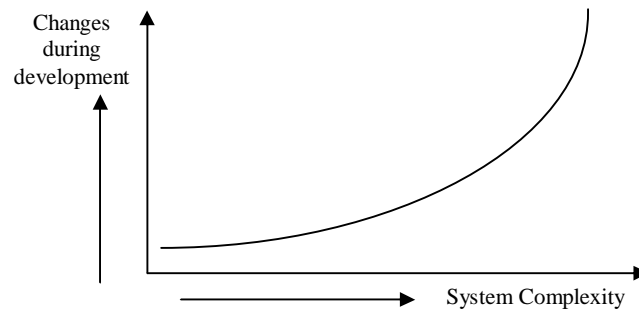


Figure 2 Changes Vs Complexity

In this scenario CM needs to act as a facilitator than as a passive onlooker and it needs to interact in a continuous manner during the product life cycle.

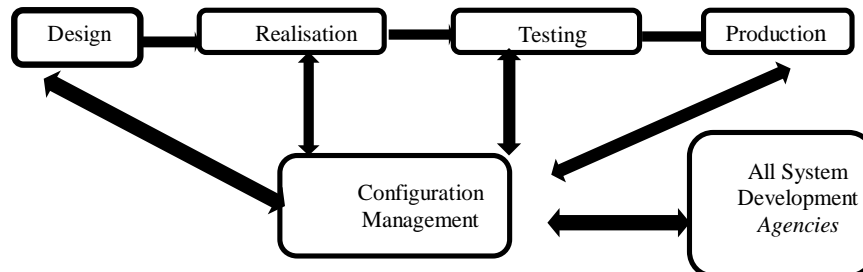


Figure 3 Represents the Role of CM in Product Development

## 5. Role of CM and Challenges

The basic functions of CM as defined in the standards or hand books remains unchanged, but the role changes. The change management becomes more and more relevant. In fact, in high-tech systems like aerospace systems development, the final authorization for a design to go for metal cutting is given by a CM team. In view of this CM needs a better systematic approach in dealing with changes and its management. At each stage of product development, the changes need to be discussed and accepted /rejected based on different criteria. At present this change management is practiced on a subjective manner. It needs a lot of expertise; even then bias cannot be eliminated. Research need to be focused on eliminating the subjectivity to a great extent so that the decision can be made with firm backup of analysis.

CM has a greater role in product development in terms of controlling changes in different phases of product development. However, it does not have any design responsibility. Though CM is aimed to improve the product performance, it does not involve in any of the quality control process. This intricate nature of CM makes management to think it as a complex system to be implemented. Often this led to identify CM as part of quality assurance [9] or integrated with project management [10]. However, slowly CM is evolving as an independent function and tries to achieve minimum difference between what is aimed and what is achieved when the system evolves through continuous changes.

A comprehensive review of CM practiced in the aerospace industry [11] indicates that the below par performance of CM in certain industry is due to the reason that the simple practice of standard CM solutions cannot achieve a high performance CM. The challenges in successful CM implementation is discussed elaborately in a white paper on CM[12]. The product configuration identification or base-lining and recording of change history are not an easy task. This challenge can be tackled by preparing a detailed system break down structure (SBS) to identify all Configuration Controlled Items (CCI) and then base-lining each of them using requirement documents, design documents and interface documents. The success of base-lining depends on the completeness of the above documents. Tracking of changes will become effective when a proper Configuration Control Data Base is established. Above all a dedicated CM team with identified position in the organisation structure is a must to have effective CM functioning.

Defining and establishing a reliable change process and change control mechanism in the fast changing environment, with an integrated approach, is difficult to achieve. This challenge can overcome only with the implementation of a dynamic change control system with analytical backup. The system should have the capability to take decisions on change proposals in an objective manner. Also it must have a procedure to implement the changes throughout the system wherever it is applicable. Unlike other functions of CM, change control is dynamic in nature. A change in one system aimed to improve its performance may have an adverse effect in another system, syet another alternative may give a better performance when the overall system is considered. The change control system should be able to select the best suited option among the alternates available. The attributes to be considered while taking the decision are very critical. Till now, in CM this decision making is done in a subjective approach, wherein decision is taken by experts based on the available information. This subjectivity can cause bias and may affect the overall system performance. To eliminate this subjectivity a new approach is suggested in this paper.

Extending CM to partners and at the same time protecting the interest of the industry as well as difficulty in concurrently addressing engineering and manufacturing requirements is yet another challenge. The integration of partners into CM process is a strategic decision and needs strong support from top management. Also the CM process is to be redefined to take care of change requirements from partners. The fundamental requirement of CM is to resolve the contradicting change requirements from different system development agencies involved throughout the product life cycle. A clear and effective change control process with frequent auditing can successfully tackle this issue.

## 6. Formulation of CM Problem as MCDM

To resolve the subjectivity issue in CM decision making one need to formulate this as an analytical problem. The analytical formulation requires identifying all possible alternatives when a change is proposed. Then each of these alternatives is to be evaluated against certain quantifiable criteria. Once this is done the problem can be solved using Multi Criteria Decision Making (MCDM) method. It is an analytical process in which alternatives and attributes are represented as rows and columns of a matrix (decision matrix) with each element  $a_{ij}$  represents the value of  $j^{th}$  parameter (criteria) for  $i^{th}$  alternative.

Three main steps in using MCDM are:

- a. Determining the relevant criteria
- b. Allocating weights (relative importance) to each criteria
- c. Process the decision matrix to determine the ranking of each alternative.

The parameters (criteria) are to be identified carefully so that they have sufficient sensitivity in decision making [13]. Weight for each parameter is to be fixed. Once this is done the problem become amenable for analytical approach. Multi-Criteria Decision Making (MCDM) is best suited for this situation.

Here, the alternatives are the candidates for changing an existing component/system. While doing an analysis the existing component/system will also form as one of the alternatives unless otherwise it is proved that the existing component cannot serve the indented function. Hence, at any point of time of decision making at least two alternatives are available. The parameters are the attributes that make an alternative to stand as a candidate. The finalisation of these parameters is an involved process. Generally, one can consider the three major parameters viz. cost, schedule and compatibility. However, the definition of cost and schedule may not be as straight as in project management. The definition of these parameters needs elaborate discussion. Once the parameters are finalized the weight assigned with each parameter is to be established.

Definitely, all parameters do not have equal weight in decision making and the necessary condition is that sum of all weights is equal to unity. Then the decision matrix is as given below:

		Parameters (criteria)				
		$P_1$	$P_2$	$P_3$	.....	$P_n$
		$W_1$	$W_2$	$W_3$	.....	$W_n$
Alternatives	$A_1$	$a_{11}$	$a_{12}$	$a_{13}$	.....	$a_{1n}$
	$A_2$	$a_{21}$	$a_{22}$	$a_{23}$	.....	$a_{2n}$
	$A_3$	$a_{31}$	$a_{32}$	$a_{33}$	.....	$a_{3n}$
	.	.	.	.	.....	.
	.	.	.	.	.....	.
$A_m$	$a_{m1}$	$a_{m2}$	$a_{m3}$	.....	$a_{mn}$	

**Figure 4** Decision Matrix

Where  $A_1, A_2, A_3, \dots$  are the alternatives;  $P_1, P_2, P_3, \dots$  are the parameters and  $W_1, W_2, W_3, \dots$  are the weights associated with each parameter. An alternative with highest ranking, derived by MCDM analysis, is to be selected to replace the existing one. Ranking of all the available alternatives is also an output of MCDM analysis. The MCDM techniques like Weighted Sum Model (WSM), Weighted Product Model (WPM) or Analytic Hierarchy Process (AHP) can be tried to solve the problem. The advantages of each of these methods and issues associated with are explained [13].

WSM can be used only if the units of measure of all parameters are the same. Definitely, it may not be so in real life. AHP analysis is slightly computationally intensive. For all practical purposes, WPM is sufficient to elicit the best alternative.

## 7. Conclusion

CM is an essential component of product life cycle data management system. CM begins with subsystems identification (CCD), change control, accounting and auditing. The role of CM is continuously changing since its introduction and now it plays a vital role in achieving project goals. This is evident from the number of standards evolved and the frequent updating on this. CM is identified as the management process which keeps the product development on target in the dynamic environment.

In order to equip CM with analytical tools, than procedural tools, a lot of research is to be done. A new approach to resolve the change management issue in CM is proposed in this study. The selection of best alternative, when a proposal comes for changing an existing component/system, is formulated as a decision matrix. The feasibility of solving this problem using MCDM is also established. The selection of appropriate parameters (criteria) is an involved activity. The issues associated with unit of measurement of criteria also need further research. The proposed analytical approach can reduce the subjectivity of decision making in CM to a great extent.

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# Learning Management & Leadership Lessons from Corporate Rhymes



ISBN: 978-1-943295-01-2

**Subhash Sharma**  
Indus Business Academy  
(re\_see@rediffmail.com)

*Models, mantras and metaphors with roots in rationality, creativity and wisdom, represent three broad approaches to development of management theories, concepts and insights. 'Corporate rhymes' being poetic, are rich in metaphors and wisdom. Sharma (2010) in his book, 'Shunya Poems: My Experiments with Corporate Rhymes' and other writings, provides his several corporate rhymes that he has tested in MDPs and MBA classes. These include his well-known songs viz. Light in My Heart, Matter and Anti-matter, Step by Step. Paper shares experience of this innovative poetic methodology to learn management and leadership concepts and ideas.*

**Keywords:** Corporate rhymes, Poetic approach to learning, Human Quality Development (HQD), Rhyme and Reason

## 1. Introduction

Management and Leadership ideas have been influenced by three revolutions viz. Industrial revolution, Knowledge revolution and Consciousness revolution. Underlying paradigms of three revolutions are represented by rationality, creativity and spirituality. Knowledge creation in contemporary context takes place through critical thinking, creative thinking and imaginative thinking in consonance with rationality, creativity and spirituality. This is reflected in terms of models, mantras and metaphors, wherein models are rooted in critical thinking & rationality, mantras are rooted in creative thinking & creative interpretations, and metaphors represent imaginative thinking rooted in wisdom and spirituality. In twenty first century, we find influence of all three revolutions and their underlying paradigms of thinking, on institutions and organizations, in human society as well as on human thinking.

## 2. Poetic Approach of Corporate Rhymes and Knowledge Creation

Poetic approach to knowledge creation and knowledge transfer is an ancient art. While philosophers relied on rationality and rational analysis, poets relied on their intuitive power to create new imagination through their deep insights. Practitioners learnt from both approaches. This is also true of contemporary times. Research based knowledge is created by thinkers, scholars and researchers using scientific approaches. In contrast, many times intuitive insights are expressed through poetic expositions. In essence, both reason and rhymes capture the essence of knowledge creation. Reason represents left brain activity and rhymes represent right brain activity and through their combination we arrive at new perspectives. Hence, both rhyme and reason, can play a complementary role in learning, particularly in the field of management and leadership.

India has a rich tradition of learning through the poetic approach. Kalidas, Kanakdas, Kabir, Tulsidas and others expressed their insights through poetic verses. Indian languages have rich repository of poetic verses which are based not merely on poetic imagination but also on keen poetic observations of the happenings in society. In addition to teaching lessons about human and spiritual values, their poetic verses also provide inspiration and motivation to human beings through their 'spiritual rhymes', *bhajans* and *dohas* etc. An analysis of their spiritual verses offers many lessons of Human Quality Development (HQD). In my visit to a rose garden in 2013, I captured the idea of HQD in terms of following poetic lines:

If everyone is like a rose,  
This world will be a great prose.

In fact world over we find poetic verses offering lessons to us through metaphors of cactus, rose, lotus and other flowers. Just as nursery rhymes are used widely for learning purpose, similarly 'corporate rhymes' are useful for knowledge creation as well as learning management, leadership and HQD (Human Quality Development) lessons. I have been experimenting with idea of 'poetic approach of corporate rhymes' and have documented the same in my books viz. Management in New Age: Western Windows Eastern Doors (2006), New Mantras in Corporate Corridors (2007) and Shunya Poems: My Experiments with Corporate Rhymes (2010). In my classroom experiments with respect to corporate rhymes, I have used material from my following books of corporate rhymes:

- I. Creation from Shunya (1993)
- II. Quantum Rope: Science, Mysticism & Management (1999)
- III. Arrows of Time: From the Black holes to Nirvana Point (2001)
- IV. Market's Maya: Lotus Millionaires from New Madhushala (2009)
- V. Shunya Poems: My Experiments with Corporate Rhymes (2010)

In testing the methodology of corporate rhymes as a learning tool, students make their own choice of poem/song from above indicated books and undertake self-reflection as well analyze it from the viewpoint of management and leadership lessons and write a short note on the same. Testing was initially undertaken at WISDOM (Women's Institute for Studies in Development Oriented Management) Banasthali University, Bansathali, over several years and also at Indian Institute of Plantation Management, Bangalore, and at Indus Business Academy (IBA), Bangalore and Greater Noida. In Dec. 2012, I was invited by IIM Ranchi to teach a module in a course on Indian Philosophy & Society: Inner Dimension, wherein I experimented with the idea of 'Corporate Rhymes for Inner Quality Development (IQD)'. Learning management, leadership and HQD concepts through poetic approach of corporate rhymes, has also been tested in several management development programs and at several other institutes of management with which I have been associated.

### 3. Illustrative Corporate Rhymes

In the discussion below following three corporate rhymes are presented as illustrations for learning management and leadership lessons. These have also been recorded by Radio Banasthali, Banasthali University, Banasthali, Rajasthan.

1. Light in My Heart (1993)
2. Matter and anti-matter (1999)
3. Step-by-Step (2001)

**Corporate Rhymes I:** Light in My Heart. It is a song of creativity, hope and wisdom. It indicates that there is a hello of creativity within all human beings. Once we listen to the hello within we get better insights and even revelations. This hello is also a stress buster as it invokes inner energy taking us towards positive approach and optimism. It is also known as 'Wisdom song' as it was adopted in 1996, by first batch of MBA students of Women's Institute for Studies in Development Oriented Management (WISDOM), Banasthali University, Banasthali, Rajasthan, as their institutional song. This corporate rhyme from my book, *Creation from Shunya* (1993, p. 33) is as follows:

#### Light in My Heart

There is light in my heart, it is there from the start,  
Its mystery you want to know, it says hello, hello,

It gives me a peep, into things that are deep,  
It has a beautiful glow, it says hello, hello,

This light is subtle, it blows a whistle,  
In the stars and in the snow, it says hello, hello,

It moves through the chakra, it goes for the yatra,  
It has its own halo, it says hello, hello,

It shows silver lines, bending space and time,  
In nature's beauty show, it says hello, hello,

This light is divine, it makes us fine,  
Its flow is very slow, it says hello, hello ...

**Corporate Rhyme II:** Matter and anti-matter. It is a song of 'enlightened leadership'. It points to the need for new solutions in the wake of dialectical tensions and dialectical intensities influencing society, organizations and individuals. It also suggests the need for synthesis of ideas originating from various sources. Further, it also suggests the need for Hope coupled with decision making from higher levels of consciousness. This corporate rhyme from my book, *Quantum Rope: Science, Mysticism and Management* (1999, p. 58) is as follows:

#### Matter and Anti- Matter

Matter and anti matter, create the quantum chatter,  
Actions and reactions, make vectors change directions,

Thesis and anti thesis. We look for the synthesis,  
We wonder at the basis, of manthan and oasis,

We look for new solutions, and ways of resolution,  
Many long for revolution, from manthan's evolution,

Churning of the ocean, by the quantum rope,  
Ocean shows its motion, and nectar is the hope.

**Corporate Rhyme III:** Step –by-Step. It is a song of success. It provides four metaphors that are relevant in any journey to success. The metaphor of climbing the mountain, indicates the difficulties that we have to overcome to reach the top of the mountain. Going to the moon is indicative of search for opportunities. Quantum jump implies taking a big leap like the kangaroo and thereby leapfrogging in taking various steps to success. The concept of move ahead and move ahead draws its inspiration from Buddha’s charaiveti, charaiveti (keep going, keep going) concept. This corporate rhyme represents the success mantra as a Step-by-Step process through a combination of small steps and quantum jumps. This rhyme is also known as ‘IBA song’ as it was adopted in 2006, by Indus Business Academy (IBA), Bangalore and Greater Noida as IBA song. This corporate rhyme from my book, *Arrows of Time: From Black holes to Nirvana Point* (2001, p. 84) is as follows:

#### **Step – by -Step**

Step by step, and step by step,  
We climb the mountain, step by step,  
Step by step and step by step,

We go to the moon, and take a new step,  
Step by step and step by step,

We take a quantum jump, and move ahead,  
Step by step and step by step,

We achieve the success, and move ahead,  
Step by step and step by step,

We move ahead, we move ahead,  
Step by step and step by step...

#### **4. Documentation of Corporate Rhymes Approach**

Corporate rhymes approach to learning management and leadership lessons is now well documented. It has received wide media attention. Times of India, Bangalore, Nov. 19, 2007, carried on its front page, a report on the same under the title, ‘MBA Students Sing Rhymes now’. Headlines Tonight on Nov. 22, 2007 carried a TV news under the title, ‘Nursery Rhymes to Corporate Rhymes’.

Corporate Rhyme, ‘Light in my heart’ (Wisdom song) was also presented at First Annual India Trade Conference at Los Angeles, May 28, 2008. Report on the Conference noted, “Dr. Sharma’s address added a key spiritual component to the proceedings and his poetic ending was a big hit with the audience.”

At the Indian School of Business (ISB), Hyderabad, I was invited to speak on ‘Creativity & Innovation in Wisdom Tradition’, during the First International Conference on ‘Igniting the Genius Within’, on Oct. 23-26, 2008. As concluding note, I presented my idea of corporate rhymes as illustrations for invoking creativity within. ISB report on the Conference took a note of it, “Ending his presentation, Sharma led the participants in reciting a couple of corporate rhymes, starting with, ‘There is light in my heart, it is there from the start’ and ‘Step by step & step by step, we climb the mountain step by step’.”

The idea of corporate rhymes was also presented in a Workshop on, Research on Teaching and Training on Corporate Governance, organized by Center for Corporate Governance & Citizenship, IIM Bangalore and supported by National Foundation for Corporate Governance (NFCG), on March 27-28, 2012. It has been documented as follows in the Workshop report ([www.nfcgindia.org/pdf/research\\_teaching.pdf](http://www.nfcgindia.org/pdf/research_teaching.pdf)).

“Prof. Subash Sharma of Indus Business Academy draws extensively on Indian and eastern traditions and value systems and attempts to link this with the western models. He uses the three D’s – discussion, dialogue and discourse to engage the students on the ethical dimensions. With the use of poetry and corporate rhymes, Prof. Sharma aims to raise the student consciousness in the field of ethics.”

(Source: Workshop Report, Research on Teaching & Training on Corporate Governance, IIM Bangalore, 2012, p. 21)

At least two corporate rhymes viz. Light in My Heart and Step –by-Step, are also available on You Tube on following links. Video recording for these corporate rhymes was done in June 2013, in Strasbourg, France, during my visit to France to conduct Workshops on ‘Wisdom & Consciousness from the East’:

<https://www.youtube.com/watch?v=WlvNwajjXpg> (Wisdom song by Dr. Subhash Sharma)

<https://www.youtube.com/watch?v=EBt-2CEIOzM> (Step By Step by Dr. Subhash Sharma)

My experience shows that corporate rhymes have inspirational value. In Dec. 2012 I taught Step –by-Step and Light in My Heart, songs to IIM Ranchi students. Nearly eleven months later, Akshat Gupta, a student of IIM Ranchi, in an email communication to me, on Nov. 08, 2013, wrote: “Just today we were singing songs that you taught us in class on our way back to hostel in bus.” I have received similar feedback from many students from various institutions where I tested the idea of ‘poetic methodology of corporate rhymes’. Many corporate executives during Management Development Programs have also reported that corporate rhymes such as Light in my heart, Matter and anti-matter, Step by Step, etc. not only invoke creativity but are also stress busters.

## 5. Concluding Comment

Three illustrations of corporate rhymes presented in this paper indicate that corporate rhymes can lead to us to some new perspectives and create a quest for creative expression. New perspectives can also be developed through modification of existing well known rhymes. Even nursery rhymes can be converted into corporate rhymes through appropriate modifications. As an example of new perspective, a single word change in the Pussy cat pussy cat, nursery rhyme can change our perspective. Modified rhyme from my book, 'Wisdom & Consciousness from the East' (2013, p. 156) is as follows:

Pussy cat pussy cat where have you been,  
I have been to London to **Teach** the queen.

Experiences of using corporate rhymes in various B Schools in India and in some Workshops and Conferences in India and outside India, suggest that this methodology is particularly useful in sensitizing students, executives and participants of MDPs to ideas related to Business Ethics, Human Values, Human Quality Development (HQD), Spirituality in Management, Self Development and Leadership Development etc. In essence, corporate rhymes are helpful in invoking inner creativity, developing managerial qualities and leadership competencies. They also point out that both rhyme and reason can be combined to develop insights and wisdom for leadership development.

## 6. Note

This paper is primarily based on experiments, experiences and earlier writings of the author. Readers may refer to the following books:

1. Sharma Subhash, Management in New Age: Western Windows Eastern Doors, New Age International Publishers, New Delhi, 2006
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4. Sharma Subhash, Wisdom & Consciousness from the East: Life, Living & Leadership, IBA Publications, 2013

# Dissecting Client-Based Projects in an Academic Setting: Modalities, Outcomes and Prospects



ISBN: 978-1-943295-01-2

**Kishwar Joonas**  
Prairie View A&M University  
(kajoonas@pvamu.edu)

*This paper examines the elements of undertaking client-based projects within a course. Theoretical moorings in from the 1968 Critical Pedagogy Thesis (Freire, 2006) are discussed, along with course setting, implementation, Moodle platform integration, and enhancing the project value beyond the classroom. Further, pedagogical perspectives are presented, along with issues faced, and directions for future projects.*

**Keywords:** Case studies, marketing education, online learning, service learning

**Track:** Marketing Education

## 1. Introduction

This case study is based on a project with roots in the 1968 Critical Pedagogy thesis of (Freire, 2006), which calls for the liberation of students from oppression, and recognizes their role in the creation of knowledge. Moreover, the project represented an implementation of the Social Constructivist Perspective (SCP) (e.g. Palincsar, 1998) via reciprocity, collaboration, and reflection. Further, the project encompassed Service Learning, which is defined as experiential learning that speaks to human and community needs through a structure created to enhance learning and development through reciprocity and reflection (Byars, 2007, Jacoby and Associates, 1996, Service-Learning Handbook, 2008). An essential aspect of the project relates to recent mandates of accreditation bodies, for evidence of the community impact of all institutional goals- teaching, research, and service- in higher education (e.g., Association to Advance Collegiate Schools of Business, 2013, Southern Association of Colleges and Schools, 2012). Project objectives included an enhancement of independent exploration of the core concepts of the integrated marketing communications, providing research and consultancy inputs to a client, and impacting business processes and outcomes of the client.

## 2. Course Setting

The project was set in an upper-level hybrid Marketing class in the College of Business (COB), comprising senior Marketing, Management and Communication majors. The course overview included the following goals:

“1. To provide the student with a basic understanding of the nature of an Integrated Marketing Communications (IMC) Plan and the process organizations use to implement the plan. 2. To provide an interface between students of the College of Business, and local community businesses and not-for-profit organizations, through a service learning experience. 3. To provide the student with an opportunity to study current practices of existing local businesses and not-for-profit organizations. 4. To allow students an opportunity to serve such local organizations by creating an integrated marketing communications plan.”

The class was invited to conduct research, and to develop creative material for integrated marketing communications plan the Executive MBA program offered at the Northwest Houston Campus of Prairie View A&M University (PVAMU). The project was listed in the syllabus, accounting for about 30% of the course grade. The project was completed on a volunteer basis, by students under close supervision of a professor serving as faculty advisor, and formed part of the course grade.

## 3. Implementation

The client or “community partner” visited with the class, and provided a comprehensive brief, along with samples of promotional materials for the EMBA program. Expectations and deliverables were established via a project document template created by the professor, which was mutually agreed upon by the client and students. Part of the project was funded by a University mini-grant. Students assigned into three teams worked independently for 14 weeks to develop the project.

### Moodle Interface

To facilitate team functioning, various functions of the Moodle 2.4.7 system (Moodle Pty 2014) were utilized. Moodle describes itself as “... a learning platform designed to provide educators, administrators and learners with a single robust, secure and integrated system to create personalized learning environments” (moodle.org/). This system is used campus-wide in PVAMU (Prairie View A&M University, 2014) to create a parallel online offering for every course offered. Relevant content, including project description, instructions, and samples of past cohort’s projects were posted under Moodle Resources. Selection of scholarly journal articles for research was restricted to the online Proquest LLC ABI Inform Index database, accessed through the Coleman Library web site link on Moodle (ProQuest LLC, 2014). Training was provided by

the professor, along with support from the Library Liaison to COB, in a computer laboratory. The ProQuest Boolean Search functions were utilized as filters, with selected key words from the Consumer Behavior and Higher Education domains serving as primary filters. In order to ensure that the research was current and relevant, the date range was limited to the previous five years. Each selection was validated and approved by the Liaison. Every student submitted a results list from Proquest ABI Inform Index database showing key search terms to support validation, accompanied by evidence of reading and noting by highlighted key points in a unique article.

A devoted discussion forum or Research Sandbox was set up for each team, as the prime communication tool to facilitate collaboration; however, this was treated more as a developmental area, and not used for grading purposes. The iMail function on Moodle was used as a backup communication tool for the project. A self-check for originality was conducted by each student via the Turnitin system integrated into Moodle, and a “clean” report formed a grading item. Training in the use of Moodle and Turnitin was provided by the professor, with support from the PVAMU Distance Learning IT specialist serving as Liaison to the COB, along with a senior student that had previously passed the course. APA style and formatting was completed with a review by the COB Center for Business Communication. Assignment Drop Boxes were created for submission of all digital materials pertaining to each stage of the project. Written feedback at each stage was provided via Moodle, along with a hard copy backup. Peer evaluations were elicited from each student, to ensure fair grading within the team. Finally, grades and comments were communicated via the Moodle Grade Book.

### Project Development

Following the step-by-step procedure prescribed by Clow and Baack (2010), each team independently conducted secondary as well as primary research, and outlined a creative brief (Sample 1), and means-ends chain, a theoretical framework, types of appeals to be utilized, a message strategy and executional framework (Sample 2). A concept advertisement was also created. This work was completed by Week 7 of classes, and written feedback from the client as well as professor was provided to students. Further, based on the above, teams proceeded to develop and dovetail the concept advertisement into a range of creative material for traditional and non-traditional media (Sample 3); sales promotion, media release, sponsorship, and networking. In addition, each student submitted a statement of reflections on how the project helped achieve institutional, professional, and personal goals (Sample 4). Hard output comprised a team binder of all components of the project, along with a disk that included audio/audio-visual creative material as well. In Week 14, papers and presentations were evaluated by internal as well as external judges. External judges from among industry, faculty, administration, and staff additionally evaluated the attainment of goals. Students submitted reflections, speaking to the achievement of institutional, course, and individual goals. Finally, the client provided feedback on the degree to which needs were met.

#### Sample 1 Advertising Design- Creative Brief

**Our product/offering** is the Executive MBA program at the Prairie View A&M University Northwest campus. This program includes a two year, 12 course workload packed with interactive, discussion-style curriculum and a trip to China to explore Chinese businesses.

**Our objective** is to increase awareness of the Executive MBA program at Northwest Prairie View A&M University campus

**Our target audience** is thirty (30) to forty-five (45) year old individuals with three (3) to five (5) years of leadership experience. These individuals usually already have full-time careers and families.

**Our message theme** for the EMBA Program is geared toward gaining Executive MBA degree, affordable cost, a structured 36 credit hour program, AACSB accreditation and international field trip.

**Our support points** are:

- a. The EMBA program is among best programs due to AACSB International accredited.
- b. Included in tuition is a trip to China to visit Chinese businesses
- c. Program for individuals aspiring to be a chief officer or high level manager.
- d. Includes Capstone Project which will give an opportunity for the student to participate in a real world project.
- e. Includes Executive MBA courses such as:
  - i. EMCO 5203: Executive Managerial Communication
  - ii. EMGM 5103: Data Analysis for Managerial Decision Making
  - iii. EMGM 5113: Executive Leadership
  - iv. EMGM 5303: Executive Topics in Strategy and Policy
- f. Highly prestigious and experienced instructors for coursework.
- g. Very Competitive Program

**Our constraints** are the Prairie View A&M seal, the NW campus phone number, physical address, fax number, web address, Prairie View purple and gold colors, PV College of Business logo, and AACSB logo.

## Sample 2 Advertising Design Means Ends Conceptualization of Components for Advertising Strategy

	ATTRIBUTE	BENEFIT/S	PERSONAL VALUE/S
1.	AACSB Accredited Program	Top-notch information and learning	Wisdom, Accomplishment, Self-fulfillment, Improvement, Competence, Knowledge
2.	Interactive, discussion-style learning environment	Application of material, No boring lectures	Practicality, Communication, Competence, Democracy, Freedom, Personal Growth
3.	Majority of program online	Flexible class time	Freedom, Self-Discipline
4.	Professional environment	Gives real life chief officer experience	Competence, Knowledge
5.	Trip to China to study Chinese businesses	International experience	Diversity, Knowledge, Merit
6.	Cost	Less expensive than other EMBA programs, financial assistance	Efficiency, Investing, Practicality, Reasonableness,
7.	Structured Program	Short 8 week classes, steady paced	Organization, Control
8.	Prestigious and Experienced Instructors	Quality education with professors who have had experience in high level positions	Credibility, Competence, Brilliance, Abundance, Expertise

**Strategy, Appeal, and Leverage Point**  
**Our message strategy is** “You will become equipped with the skills and knowledge necessary to excel in the workplace.”  
**Our appeal** is rationality.  
**Our executional framework** is a combination of slice-of-life and informative. The concept ad portrays everyday people, and provides information to persuade prospective students to buy into the product.  
**Our leverage point** is the phrase “Transforming to excellence”.

## Sample 3 Print Advertisement- Copy Sheet

Size: 30 cm X 5 columns
Color: B&W or 4-color
Headline: Transforming into Excellence
Sub heading: ADDRESSING THE NEEDS OF INDIVIDUALS WHO ARE LOOKING TO TRANSFORM THEIR CAREERS
Body Copy: We are welcoming you to transform into excellence with the experts. Our professors are seasoned professionals in their fields and they can offer you real world experiences. Their experiences range from corporate America to in the field experience. Our program is AACSB accredited and has the potential to meet the needs of today’s businesspeople. We are now offering scholarships. Don’t wait! Apply today!
Constraints: PV logo 9449 Grant Rd Houston, Texas 77070 Phone: 936-261-3311 www.pvamu.edu/emba

## Sample 4 Student Reflections

Achievement of Course Learning Goals			
No.	Item	Alignment with Academic Program	
1	Demonstrate an understanding of the IMC foundation	Goal 1: Mastery of Content	YES
2	Demonstrate an understanding of IMC advertising tools	Goal 1: Mastery of Content	YES
3	Demonstrate an understanding of the IMC promotional tools	Goal 1: Mastery of Content	YES
4	Demonstrate an understanding of the IMC integration tools	Goal 1: Mastery of Content	YES
5	Be able to create and present a team-based IMC plan verbally as well as in writing	Goal 1: Mastery of Content; Goal 5: Communications	YES
6	Be sensitized the various perspectives of the new business environment: ethical, social, political, legal, economic, global, and environmental.	Goal 1: Mastery of Content	YES

**Narrative** Upon the completion of this project I have acquired skills and capabilities that I believe will serve me great purpose as I continue my academic career. This project has enabled me to be full of charisma and discipline myself to work good in a team. The experience I have gained by working in this group will help me as I further my education because it has taught me to communicate effectively. Furthermore, I enjoyed working with my team members because they each demonstrated qualities that became assets for the team and that it made it pleasant to complete this project. I have grown as a student and individual because of this project because it has showed me that I can be creative ... in a team and still be open-minded to people’s ideas and opinions. I will leave Prairie View A&M University well prepared and capable to compete with other college graduates because of this course along with others has developed me into a great intellectual. Furthermore, I am grateful for my team for completing a high quality project and the instructor of this course for helping mold me into a more productive student and person overall.

#### 4. Beyond the Classroom

Towards mentoring and professional development, students were encouraged to include the completed projects as part of their professional portfolio. In addition, students were asked to enhance their resume by incorporating the project citation, and by highlighting this aspect in job interviews. Numerous students reported being distinguished by the project during recruitment, and several achieved successful placements mainly due to this differentiation.

Furthermore, the project was taken to the next level, as proposed in the mini-grant. It was presented to faculty under the COB Brown Bag Research and Teaching Seminar program, supported by Campus Announcements. In addition, it was presented at the First PVAMU Fall Service Learning Showcase 2013, as well as at the PVAMU Annual Research Symposium. Additionally, the project was shared with PVAMU's Department of Multicultural Affairs (G-Force) and the COB administration for use as a recruitment tool. Moreover, it was cited in a faculty workshop at an international academic conference in business. Finally, the project is being communicated to media, as well as Campusto Community Coalition of Texas, and networking organizations to spread the mantra of client-based projects in an academic environment.

#### 5. Some Project Outcomes

Based on feedback from students, judges, and other audiences, some outcomes of the project were determined. There was greater faculty engagement with students, that resulted in enhanced student engagement and learning, promoted student development, increase the level of student's critical skills, knowledge, and attitude, and developed awareness, accountability, focus, and compliance among students. An important outcome was improved employability of students lacking high academic achievement (needed for co-ops and internships) since industry considers research experience as an equivalent for relevant professional experience. There was also an increased sense of civic responsibility among students. Moreover, numerous benefits for the client, such as ready and usable research and promotional inputs, and potential for improved business processes and outcomes. Moreover, several institutional outcomes were enunciated, such as the fulfillment of PVAMU, COB, and course; and generation of data for research in Service Learning, providing artifacts to establish excellence in research and learning before accreditation bodies such as SACS and AACSB. In addition, institutional prestige is increased, student recruitment is attracted, and enrollment enhances, and attrition rates reduced. There is also fundraising potential. Overall, the project helped provide outreach and promotion for PVAMU, COB, associated schools, and departments, and created a sense of personal involvement among stakeholders of PVAMU.

#### 6. Limitations and Directions for Future Projects

A need was felt to ensure greater involvement from top administration of the University. The institution of support through intrinsic as well as extrinsic rewards would motivate faculty and students. Further, a concerted effort is needed to enlist the participation of prospective clients and the community. Moreover, it would be helpful to create a diverse panel of judges for project evaluation. Systematic documentation and dissemination of projects, along with programmatic impact evaluation is also in order. To conclude, while great strides have been made in client-based projects within the classroom, much effort still lies ahead in enhancing their 360 degrees impact.

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# Responsibilities of Academicians in Designing Management Education to prepare Managers for Uncertain Environment



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Namrata Vasudeo Jasrotia  
Alfred Toppo

*It is a great responsibility to design a programme for future managers to manage uncertain situation and to achieve the desired results. The article highlights the importance of innovative changes in management education which academicians should bring. The results of an innovation are better learning, greater effectiveness and a higher level of success. Innovations in management education encompass several things: willingness to assess all aspects of programme to bring about creative changes in them. This paper critically analyses different components of management education i.e. the curriculum, soft skills, extracurricular activities, exposure, internships, research work, placements, on-job trainings, and wellness management.*

## 1. Introduction

This article highlights the importance and relevance of innovative changes in Management Education System. The result of an innovation and creativity is greater effectiveness and a higher level of success for the development of the students in particular and the nation in general. Innovations in management education imply several things i.e. willingness to assess all aspects of management programme and its activities and bring about creative and innovative changes in them for a holistic development of the students. This article critically analyses different component of management education i.e. the curriculum, scheme of examinations, extracurricular activities, exposure, internships, research work, placements, and wellness management and how they have an impact in producing quality and competitive managers having skills as per the industry requirements.

## 2. Demand and Supply of MBAs

MBA as a carrier option is not very popular and attractive these days to the youth as there is a mushrooming and commercialisation of the B-schools across India. The colleges in the run for competition and to gain students have not paid heed to the four major components of management education i.e. Infrastructure, Faculty, Placements and Curriculum. As a result, they have lost on students in the long run and some of them are on the verge of closing down within a few years of starting.

In 2013, more than 220 B-schools from the cities of Delhi-NCR, Bangalore, Kolkata, Mumbai, Lucknow, Ahmadabad, Dehra Dun, etc. have closed down and 95 more are struggling to stay afloat. Around 450 institutes are now non-operational due to insufficient number of students, as per the reports.

There is a 9.5% decline in Common Admission Test (CAT) applications for premier B-schools in 2014, from 8.5% in 2013 (from 1.94 lakh applications in 2013 to 1.85 lakh in 2014). So far as MBA seat growth is concerned, as against 95,000 in 2006-07, it was 4, 68,000 in 2013. The compounded yearly growth rate is 30-35%, according to the survey data.

The quality of higher education in India across disciplines is poor and does not meet the skill set and the requirements of the corporate world. As per Associated Chambers of Commerce and Industry of India (ASSOCHAM) officials, although a number of management institutes have mushroomed in India in the recent years, they have not been able to maintain quality standards. The demand for MBA courses among students after completing their graduation has taken a nosedive due to the diminishing job prospects as well as remuneration in the current market scenario. In fact a number of seats in MBA courses remain vacant every year in various institutes in India. (Minglebox Communication Pvt Ltd, 2014)

These days there is no quality control, the placements are not commensurate with fees being charged, the faculty is not good enough and there is no infrastructure and the curriculum is obsolete and not as per the requirement of the corporate world. The biggest reason for the gap is the rapid mushrooming of tier-2 and tier-3 management education institutes that has unfortunately not been matched by commensurate uplift in the quality of management education. The need to update and re-train faculty in emerging global business perspectives is practically absent in many B-schools, often making the course content redundant.

On the other side the demand to recruit MBA graduates by organizations has witnessed a sharp decline in the last few years. A recent survey conducted by ASSOCHAM titled "Appetite for MBA tumbles down", only 18% of B-school graduates are able to secure suitable employment.

There are several factors leading to a decline of job opportunities for MBAs. The worldwide economic sluggishness, freezing of new projects, investors shying away from key sectors such as Financial Services, Infrastructure, Retail, Realty, Hotels, etc., have led to this phenomenon. There is a 40 to 45% dip in pay packages offered to B-school and engineering graduates this year, compared to last year, as per the survey.

The manufacturing sector has significantly cut down hiring MBAs. However, service sectors including Information Technology (IT)/IT-enabled Services, Finance, etc. have continued to hire management graduates, albeit in fewer numbers, add the survey reports. (Minglebox Communication Pvt Ltd, 2014) The decline for the demand of MBA in the corporate world is also because of so many scandals and scams done by management graduates from B schools across India.

### 3. Responsible Management Curriculum

#### Academic Creativity and Innovativeness in Technical Knowledge

Creativity and innovation are the buzz words in today's management curriculum and organizations. The pressure of continually developing new processes, products, and services at a faster speed to stay ahead of competitors has left no choices for organizations but to embrace the path of creativity and workplace innovation. The recent global financial crisis has also spelt for devising new policy measures with fiscal discipline, responsible spending and life style and sustainable practices. Hence, amidst such changes the basic question comes up about the new competencies expected of business school graduates and the role of business schools in developing mind sets among the future managers in alignment with changes in business environment.

The management practitioners and academicians need to bring in creativity and innovativeness in business programmes to prepare managers for uncertain times. Providing a quality management education program to produce competitive managers and business leaders involves a continuous process of curriculum review and enhancements and updation. The management curriculum should emphasis on developing capabilities of students with a broader and relevant perspective. Market relevant, connected and reflective business curriculum is what business students and practitioners now recognize as an essential way forward for responsible, sustainable management education. So that the managers can be capable of functioning in a global and diverse business environment with ethics and social responsibility.

The modern MBA student is a whirling dervish of activity: classes, cases, clubs, travel, recruiting, and more. But Daniel C. Feldman of University of Georgia's Terry College of Business says the whirling must stop, or at least slow down. Instead of involving students in every activity on campus, B-schools should focus on whether they are as engaged as they need to be. When it comes to extracurricular activities, he says, "less might mean more." When schools inundate students with tons of clubs and guest speakers, they tend to surf from event to event without actually participating in anything. Rarely does one learn anything from being a passive participant, Feldman writes. What schools should do, he argues, is make sure the activities they are offering align with their values and the school's mission. Students might have fewer options, but that should make it easier to pick the right ones. (De Meglio, 2013)

These days in management colleges the curriculum is filled with too many lectures, activities and events. The students are just moving from one activity to the other without actually internalising the lessons, the messages of the activities and events. They are always on the move. In the process of operations they just have no time to reflect and ponder over the sustainable aspect of education in one's life. As a result of which we are seeing so many crimes, so many health issues with the managers in general and students in particular. We read the newspaper, magazines all are filled with such issues. Is this the aim of the management education? To produce mentally and physically unhealthy managers for the nation. It is high time we academicians and policy makers need to contribute constructively and strongly in this aspect, to build a stronger nation.

In this era of globalization and uncertain business environment, education has a crucial role to play in preparing the students not only to face the future with confidence but to build it with sustainable purpose and responsibility. The importance of the role of education as an agent of change promoting tolerance, patience and understanding has never been more obvious than today. This can be brought about only through quality and responsible education. These days quality in education is difficult to define and comprehend in tangible terms. All the stakeholders in education should be sensitized on the quality aspect to that responsible manager are produced.

Responsible and quality education prepares the student for life and to face the unforeseen and uncertain environment. These days the students must be educated to prepare themselves not only for their personal lives (technically, socially and physically) but be equally prepared to participate in social, cultural, economic and political life of their societies. Values such as self-discipline, honesty, patience and respect for elders must be understood as basic fundamentals for quality education.

Increased quality awareness among teachers and helping teachers to improve their teaching methodology and skills will lead to quality in education also. Quality is not infrastructure dependent but largely depends on the teachers' knowledge, teaching skills, learning attitude and sound management policy of the institution.

Technical subjects are taught to the students with an aim to equip the students with the subject knowledge so that he can perform his basic responsibilities creatively and innovatively. But they are not sufficient to survive in the corporate world. One needs to learn the soft skills as well as practical skills so that they can work in organizations as assets and not as non-performing assets.

#### Individual Development - Soft Skills

Today's business climate requires that management students should not only know the technical aspects of their jobs, but also possess the necessary soft skills like attitude, communication skills, team building and leadership skills to be better effective and efficient managers. Most business colleges curriculum, however, focuses only on technical skills, and do not address the 'soft skills' in a formal setting or on a consistent basis. As managers compete for fewer jobs, management colleges must develop creative and innovative ways to give their students a competitive edge in the market. The business schools that incorporate these skills into the curriculum are likely have managers who are better prepared for success in the workplace.

Soft skills include change management, stress management, communication skills, interpersonal skills, teambuilding, motivation, attitude building and other business skills that the corporate value in hiring new recruits. Unfortunately these days most business college's curriculum focuses only on technical skills, and addresses the soft skill very subtly. Too often, this aspect of student development is left for the pre- placement training or dealt in the curriculum very subtly.

These days the colleges are also teaching ethics as a part of the soft skills. Ethically Responsible Manager is what the corporates are really looking in for these days. Ethics education has become increasingly important in the wake of corporate scandals and scientific misconduct. The pressure to achieve at all costs has created what Callahan (2007) called our Cheating culture. We recognize that our students need preparation, mentoring and positive role models to help them in recognizing ethical issues, analysing and reasoning carefully about them, and making responsible decisions in the face of difficult dilemmas. In addition to legal requirements, management colleges have employed a variety of creative approaches designed to promote integrity in personal and professional conduct.

To further enhance and improve the quality of managers, the academicians and the policymakers have tried to include social as well as development subjects and social exposures visits in the management curriculum. Social Emersion Programmes are a unique initiative, where the students who are the future managers are sensitized on various development issues affecting the poor, the marginalized sections of society and the mainly environment. This is done so that they can internalize and personalize the issues and contribute sustainably to the society. Through such processes of involvement, the main aim is to enable the students to be aware of the social realities around them as well as impart them with ideas of how they can contribute towards the upliftment of marginalized sections. Such social immersion programmes not only sensitize the students to the social reality but also helps students learn management better.

At IIMA, students have taken several voluntary steps to link up with larger social causes, be it relief work at earthquake time, or work for communal harmony, says Anil Gupta, faculty member at the institute. Students at IIMA have set up nature clubs and management assistance clubs for small enterprises.

In this they are not alone: IIMC has a centre called 'Management Centre for Human Values' (MCHV) to train its students on a range of issues from business ethics to corporate social responsibility (CSR). XLRI Jamshedpur and XIM, Bhubaneswar also has courses on ethics and offer student's opportunities to work on social initiatives.

While B-schools are making efforts to produce socially-sensitized MBAs, the enthusiasm is not truly reflected in the curriculum. Social and environmental issues have hardly been integrated into main stream management curriculum. Social issues are addressed at least to some extent, but environmental issues are addressed much more weakly in the management curriculum these days. As an academicians we feel, personally that like we have the Summer Internship Programme in the MBA programme for around 6 to 8 weeks in the corporate sector. We should also have in the curriculum apprenticeship in the developmental sector with students spending a month in a rural locale and working there on development issues. This would make them more technically and socially sensitive managers.

### **Wellness Management -To Improve the Quality of Life**

As academicians, we personally feel days that the youth these days is very weak mentally, physically and emotionally. They are not able to handle the challenges and stress in personal and professional life. They sleep over the problem or try to resolve them seeking a negative solution for the same. This is becoming a big problem for the family, the college, the society and the nation. The students seem to have problems ranging from anxiety and depression arising from difficult study issues / results / home sickness / family life issues/relationship issues/ self-esteem issues to more serious mental health problems. Life issues could include bereavement, relationship difficulties sickness, financial issues while mental health problems could include eating disorders, post-traumatic stress disorder (PSTD) or psychosis. These issues are very common in most of the colleges these days among students. As academicians we need to address these issues by bringing about modifications in the curriculum so that we can equip the students to handle these problems intelligently and in turn they are better prepared for the world.

Our management curriculum apart from including technical subject and soft skills should also include the wellness management like Yoga and Meditation, Physical Education and Eating Habits and Health Care like it is in the Military. One has to be technically as well as physically sound to perform better in life.

'Exercise and Children's Intelligence, Cognition, and Academic Achievement', which appeared in the Educational Psychology Review in 2008, is only one of a growing number of recent studies that support the assertion that physical activity is important for cognitive development. Most people today are probably unaware that more than 100 years ago, numerous physicians, neurologists, psychologists and physical educators already knew this. (Faur, 2010)

Physical education plays a critical role in educating the whole student. Research supports the importance of movement in educating both mind and body. Physical education contributes directly to development of physical competence and fitness. It also helps students to make informed choices and understand the value of leading a physically active lifestyle. The benefits of physical education can affect both academic learning and physical activity patterns of students. The healthy, physically active student is more likely to be academically motivated, alert, and successful and contributes constructively in all works.

Regular physical activity improves functional status and health during the middle and later adult years. Physical activity contributes to quality of life, psychological health, and the ability to meet physical work demands. Physical education can serve as a vehicle for helping students to develop the knowledge, attitudes, motor skills, behavioural skills, and confidence needed to adopt and maintain physically active lifestyles. The outcomes of a quality physical education program include the development of students' physical competence, health-related fitness, self-esteem, and overall enjoyment of physical activity.

A comprehensive, well-implemented physical education program is an essential component of the total education of students. It should also be a compulsory part of the curriculum of the management college. Physical education prepares students to maintain healthy, active lifestyles and engage in enjoyable, meaningful leisure-time pursuits.

Till date there is no consensus among the various stakeholders (employers, academicians, career counsellors, policymakers and students) on the degree of emphasis that should be placed on soft skills and wellness management in an academic setting and include wellness management like Yoga and Meditation, Physical Education and Eating Habits and Health Care etc. These subjects should have theory as well as practical aspects to sensitize the students on the issue.

The academicians must think broader and bigger for the student community and should motivate the policymakers to include in the management curriculum soft skills as well as wellness management skills. It should be given equal weight as given to technical skills in the curriculum so that we can produce sustainable and healthy managers who can handle risks of uncertain times very intelligently without any stress and anxiety. The pay off, however, will be managers who have a strong theoretical understanding paired with a portfolio of soft skills and wellness management skills that make them more employable in their profession and a contributing member in the family and the society in all ways.

Once the initial curriculum is accepted by the policy makers and has been developed, it must be updated continuously to assure that the course content reflect the latest research findings on all the three aspects. As these skills are now perceived by the business community as a priority in the work place. Continuous assessment of student learning is also essential to assure that objectives of the program are achieved.

We must mention the underlining made by UNESCO concerning to the Physical Education's features: Beneficial effect on solving social, political and economic problems, as a means to reduce the offence, violence, crime and addiction; Contribution to social integration, including the physically disadvantaged; Contribution to increasing labour productivity through better physical shape and health, Contribution to extend active working age, retirement, and to improve the situation of the elder people and the disabled ones. (Faur, 2010)

Such is the importance of physical education in one's life. Hence we all should understand its importance carefully and implement in our lives. A visionary management Institute/ college would try to implement this at the faculty level also to improve the quality of activities in the Institute.

Physical Education and Sports forms an important part of educational system even though it has never received the importance it deserves. Even though it is included as part of the curriculum from the early stages of education, it has never been taken seriously by the educational administrators, the academicians and the students.

At present compared to earlier years we see there is a decline in importance and implementation of physical education in the curriculum of even schools and colleges. As a result of which we are facing so many issues and challenges among the youth in the society. People are just running for accomplishing materialistic wealth and in the process they are losing their credibility, health and relationships.

Hence as academicians we need to perform a very responsible role and overcome the hurdles and battles to improve the curriculum to include wellness management as a part of the curriculum to improve the quality of life of the youth. In this way they can contribute constructively in the long run for the development of the nation.

#### 4. Conclusion

Comprehensive management education is very important education in today's uncertain environment as it prepares the students for the future. Hence all the stakeholders should carefully review the management curriculum regularly and make sure that it prepares sustainable and solidarity managers and not only technical managers in the long run. Sustainable and solidarity managers will be asset not only to themselves but also to their families and the society. They will contribute not only technically but also socially, environmentally and well as physically being available to all stakeholders in the long run without any health issues and ailments.

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# Attending Classes in a Premire Management Institute: Content or Convenience? – An Action Research



ISBN: 978-1-943295-01-2

**Dhayanithy D**

**D.A. Subhashree**

*Indian Institute of Management Kozhikode*

(deepak@iimk.ac.in)

(subhashreed17@gmail.com)

*Under-enrollment and falling applications even at prestigious schools highlight management education's crisis. The crux is whether management education is about content, skill and perspective (classroom); or simply a finishing school and filtering mechanism for industry to identify manpower development. It plays out, amongst students, in terms of relative priorities for "CV building" and academic experience. In this paper, we use fine grain attendance data to investigate what students value - management content or the opportunity to build their profile for success in the job market. This paper is an evidence based step toward informing Institutions' strategy for management education.*

## 1. Introduction

Under-enrollment and falling applications even at prestigious schools highlight management education's crisis<sup>1</sup>. Growth of specialized management subject areas, decrease in opportunities for trained general managers, as well as the long term secular growth of enrollments and graduations are all probable reasons. Within a b-school, there is an ongoing push-and-pull between academic, classroom pursuit and an effort among students to build a compelling profile for the job market. Student and faculty feedback systems are amongst the various systems employed in a business school that enable faculty members as well as students to continuously evaluate their position and trajectory of growth, within this larger and highly dynamic environment. Just as faculty members aspire to build a strong set of research skills, students also aspire to build a strong profile so that their classroom experience may be more meaningful and equip them for a highly competitive job market.

One reflection of this importance of experiential learning (via membership in committees with key student responsibilities and other interest groups) is the fact that 3 out of 10 business schools students in the premier business schools of India are members of these committees or groups (Exhibit 1). A number of anecdotal accounts exist regarding the classroom academic effort of students, and a way of measuring this is the attendance of students in classes. Of particular interest to the action researchers in this project was to assess the relationship between classroom investment of students and the involvement in various committees and special interest groups.

The second set of dynamics which were the focus of this study was the interaction between classroom attendance and time-of-day, day-of-week effects. It is again anecdotally understood that an efficient manner to undertake travel for students is to club a day or two off days from classes with the weekend. Both these anecdotal accounts point to students' choices, while pursuing the MBA, being driven by convenience. However, other anecdotal accounts accord high importance to student participation in committees and special interest groups. Students go through a fairly tough selection/election process to get inducted into one of the 16 committees and groups. This effort is justified, in addition to student passion for the particular committee's mandate, because recruiters are known to use committee and group membership as a quick proxy for assessing student quality. Should this advantage and additional experience come at the expense of the classroom experience, it would only help the student achieve the limited objective of being offered a 'good' job on campus.

## 2. Materials

MBA students undertake the core compulsory curriculum in the first year of the program. This consists of 24 core courses taught over 3 terms (each term approximately of 3 months duration). These courses span all the eight academic areas of the institution which are Information Technology and Systems, Economics, Finance, Accounting and Control (FAC), Humanities & Liberal Arts in Management (HLAM), Organizational Behavior & Human Resources (OBHR), Marketing, Quantitative Methods & Operations Management (QMOM) and Strategic Management (SM). These courses are taught by 53 faculty members covering each of the six sections into which the batch is divided.

The batch of students being studied consists of 364 students. The institution has a policy of penalizing students with a 'grade drop' should their class attendance fall below 80% in a particular course. In order to implement this policy, meticulous attendance records are kept by the administrative office of the MBA program and are indeed available on the IT systems at a very granular level. The student wise, class wise attendance information yields 175,648 rows of data. Each row has the following fields – Date, Roll number of the Student, Subject code and name, professor name, Class timing, Term, and whether the student was present for that particular class or not.

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<sup>1</sup> <http://www.forbes.com/sites/ronaldyeaple/2012/05/30/is-the-mba-obsolete/>

To this base dataset, using various emails sent by concerned student officials, information of student membership in each of 16 committees was obtained and subsequently appended to the base dataset using the Roll number field. Similarly, the MBA handbook was used to identify the timing of various campus events and these were appended to the base dataset by using the Date field.

### 3. Method

We estimated a logistic regression model where the event is a particular student attending a particular class and the non-event is a particular student missing a particular class. The model we estimated is as follows:

Event (Attend Class) =  $f(\text{Day of the Week, Professor, Committee Membership, Total Classes in Course, Class Timing, Free Bunks Remaining, Events, Bunks Allowed Remaining}-\text{Classes Remaining, Classes Remaining}) + e$

The 'free' bunks remaining, classes remaining and differences between free bunks remaining and classes remaining was computed in the dataset. Independent variables were encoded as dummy variables for carrying out the analysis. For example, 53 different dummy variables, each taking values of 0 and 1, were used to denote 54 faculty members. Similarly, 16 dummy variables, each taking values of 0 and 1, were used to denote different committees.

### 4. Results

Of the sixteen committees, students belonging to 7 actually have a higher, statistically significant probability of attending classes. Student members of 5 groups have a lower, statistically significant probability of attending classes.

Of the 53 faculty members who handled classes in the first year, in 8 faculty members' classes there was a statistically significant higher level of class attendance. 30 faculty members had statistically significant lower attendance levels in their classes.

Class timings did play an important role in the attendance levels in classes. Time slots just before and just after lunch had the highest levels of attendance whereas the morning class slot had the poorest. There was a popular perception that students very diligently utilized the bunks allowed without being assessed a grade drop. Our analysis points to the contrary. Students are more likely to attend classes when there is one bunk remaining, not necessarily so when there are no remaining bunks. Students are also more likely to attend classes when they have their full quota of bunks remaining. In between, they do not attend classes more or less simply because of their bunks remaining. As expected however, when the 'free' bunks remaining are more than the number of classes remaining to go, students are less likely to attend classes. Students also are more likely to attend classes on the days Tuesday to Friday as compared to a Monday. They are less likely to attend should the class be scheduled on a weekend. In line with anecdotal evidence, students are more likely to miss classes with only a few of the sessions remaining.

### 5. Conclusion

Our analysis of the student and scheduled class level attendance data confirms a couple of popularly held notions while revealing contrary to other popularly held notions. Allegiance to weekend and various activities that typically go on till late at night does impact propensity to attend the morning class (9:15 AM). Mondays see attendance propensities that are lower only to classes held on Saturdays or Sundays.

One popularly held notion that is debunked is the one pertaining to membership in one of the 16 student committees/groups. Membership in 12/ 16 student groups studied here have a statistically significant impact on the probability of attending classes. Of these membership in 7 of the groups is actually associated with higher probability of class attendance. 5/12 has a lower probability of class attendance, whereas the popular notion held was that all student group memberships came with a hard constraint on academic pursuit. Clearly there appears more to be understood in this direction.

Even with minimum attendance policy in place in the institution, there appear to be significant variations in attendance levels across faculty members. Of the 53 faculty members who taught the first year students, 38 had a statistically significant difference in the probability of students attending their classes. 8/30 had a higher and the remaining had a lower probability of students attending their classes. This reveals significant heterogeneity that may be worth looking into with a view to understanding best practices. It is also possible that those with a relatively lenient grading policy may have lower student attendance probability because the actual cost of a grade drop is bearable (a 'B+' to a 'B', not a 'C-' to a 'D+'). On the other hand, they may have a higher student turnout perhaps because going hand in hand with a lenient grading policy is a more relaxed learning environment.

A significantly lower probability of attending classes is also observed towards the end of a course. This could itself be a sign that there is broad student tendency to conserve bunks in order for them to be used up in the last couple of weeks of the course. Or it may simply be students spending their time close to end-term exams to prepare for examination (this is not seen for mid-term examinations though). A similar tendency to miss classes is observed toward the fag end of courses when some students may have more 'bunks to give' than classes remaining. The immediate week prior to examination (end-term or mid-term) as well as weeks corresponding to events and festivals on campus again sees a secular trend towards lower attendance probability.

### 6. Exhibits

**Exhibit 1** Student Committees\* and Membership counts (1<sup>st</sup> year members)

Committee	No: of 1 <sup>st</sup> year Student members
ALUMNI	6
EVENT-1	10
EVENT-2	9
CULTURAL	8
EDITORIAL BOARD	4
ENTREPRENEURSHIP AND INNOVATION CELL	4
INFORMATION TECHNOLOGY	6
INDUSTRY INTERACTION CELL	4
EVENT 3	5
MEDIA CELL	6
MERCHANDISING CELL	6
CAFETERIA AND FOOD	4
PLACEMENT COMMITTEE	12
STUDENT COUNCIL	6
SPORTS COUNCIL	5
SOCIAL SERVICE GROUP	6

\* Names Changed Except for Generic Committee Names

**Exhibit 2** Logistic Model of Classroom Attendance Y is Log Odds of a Given Student Attending a Given Class

X VAR	VAR LVLS	EST. BETA (ST)	STD. ERROR	Z	p >  z	95% FI Low	95% CI High
DAY OF WEEK							
	SUN	-0.62	0.12	-5.27	0	-0.86	-0.39
	MON						
	TUE	0.09	0.03	3.11	0.002	0.03	0.15
	WED	0.28	0.03	10.52	0	0.23	0.33
	THU	0.08	0.03	2.52	0.01	0.02	0.14
	FRI	0.01	0.03	0.28	0.781	-0.05	0.06
	SAT	-0.77	0.07	-1.76	0	-0.90	-0.64
PROFESSOR	(54)						
	...						
	3	-0.41	0.10	-4.13	0	-0.60	-0.22
	...						
	7	0.48	0.09	5.52	0	0.31	0.65
	...						
COMMITTEES	(16)						
	...						
	2	0.27	0.05	5.13	0	0.16	0.37
	...						
	6	-0.33	0.07	-4.62	0	-0.47	-0.19
	...						
CLASS TIMINGS	(4)						
	9:15AM	-0.32	0.02	-2.22	0	-0.37	-0.27
	12:15PM	0.20	0.03	7.18	0	0.14	0.25
	1:45PM	0.23	0.03	8.52	0	0.18	0.29





# Six Sigma Methodology in Blended Learning in Educational Sector



ISBN: 978-1-943295-01-2

**Rinu Vasanth C.R**

**R.Swapna Kumari**

Karunya University Business School

(rinuvasanth@gmail.com)

(swapnakumari@karunya.edu)

*The present study entitled 'SIX SIGMA METHODOLOGY IN BLENDED LEARNING IN EDUCATIONAL SECTOR' is intended to examine the impact of Internet Facilities on Students performance through a Blended Learning as a medium in an Academic Institution. It was examined that how the Blended Learning encompasses a variety of tools to create flexible, rich learning environments that stimulate learners and maximizes the potential for learning. Another objective is Application of Six Sigma methodology in this study is to improve the medium of learning i.e. Internet Connectivity through a set of procedures in an effective way. Blended Learning is defined as "the approach combines the best elements of online and face-to-face learning. It is likely to emerge as the predominant model of the future and to far more common than either one alone" (John Watson). Six Sigma can be again viewed as a discipline or an approach driven by data and methodology for eliminating defects in any process- from manufacturing to transactional and from product to service. Keeping the aforesaid two objectives in mind, data was collected from a sample of 119 students residing in various hostel blocks using stratified random sampling technique. One questionnaire was developed after an extensive literature review to measure the impact of Internet Connectivity in Blended Learning of the students. The Questionnaire to measure was based on the model developed by Shawn M.Glynn (2011).The scale was developed by referring to previous models developed by various authors to measure the impact of Internet Connectivity. The statistical analysis used was correlation and regression, reliability statistics, KMO, Bartlett's test and One-Way ANOVA. The data was entered into SPSS version 20.The study on Reliability test shows that questionnaire developed was valid. It is also revealed from KMO and Bartlett's test that the sampling done was adequate. The study also revealed that there is highly positive correlation between Internet Connectivity and student's performance. The Regression value accounts for 26% of variance in the influence of Blended Learning in educational sectors. One-Way ANOVA model revealed that the study is statistically significant.). The Six Sigma Methodology has a standard five-phase framework (DMAIC) for finding past, tuning present and forecast future. The application of six sigma is that to increase the sigma level from 1.33 to reduce the defects in Internet Connectivity and thereby to increase the student's performance. This study reviews that the main root cause of defect in internet connectivity is caused by physical interference (between that network itself and other networks) and the problem can be solved by blocking Rogue Access Points by sending traffic.*

**Keywords:** Blended Learning, Internet Facility, Students Performance, Six Sigma (DMAIC)

## 1. Introduction

Blended learning is just one piece of expanding technology landscape, but it has attracted particular attention for its potential to blend existing pedagogy and practice with new innovations in teaching and learning. "Blended learning is a formal education program in which a student learns at least in part through online delivery of content and instruction with some element of student control over time, place, path, and/or pace and at least in part at a supervised brick-and-mortar location away from home."(Staker and Horn-2012).India ranks fifteenth position in the world for service outputs and employs around 23% of workforce of the country. Since with the launch of Mangalyan, it is proved that India is innovating and Education has a vital role on these achievements. Six Sigma is a methodology which was used widely in manufacturing sector but now it is used in Service Sector to increase customer satisfaction and to reduce the defects. It is a data-driven approach. It can be said that, in an Educational Sector students are the products and the customers are companies that will recruit these students. According to Pande et al. (2002), most service organizations operate at sigma quality levels of 1.5-3.0 that is, a defect rate between 455000 and 66800. Since, Internet is a facilitator of Blended Learning and the student's performance has a positive relation with Internet. Application of Six Sigma methodology in this study is to improve the medium of learning i.e. Internet Connectivity through a set of procedures in an effective way.

## 2. Significance of the Study

The study will highlight the importance of internet resource for ensuring effective blended learning in educational organizations, since the blended learning comprises mainly of learning through internet (i.e) E-Learning. Since the internet resource is the essential one for such type of learning, the connectivity should be a effective thing and so the six sigma methodology is applied to reduce the defects and flaws in the internet connectivity (mainly internet speed) and make blended learning a successful one, so that students performance can be increased in the organizations.

### 3. Review of the Literature

**Dr. P. Ramasubramanian, (2012)** in their study titled “Six Sigma in Educational Institutions” to find success, institutions of higher education must demonstrate that they can offer what others cannot. This paper narrates the implementation of six sigma in a technical institution, the benefits of implementation and how six sigma may be used to improve the performance of all institutional operations from student graduation to recruitment.

**K.G Durga Prasad et al., (2012)** in their study titled “Application of Six Sigma Methodology in an Engineering Educational Institution” empirical testing to enhance the academic standards and credibility of the institution, conducted among six core engineering branches. The study found that five quality characteristics which are responsible for 80% of the effect (% of failure students). It is essentially required to improve the quality characteristics such as Motivated Faculty, Modern Communicational Facilities, Industrial-Institution Interaction and Opportunity for knowledge up gradation and Library modernization for achieving six sigma quality in an engineering educational institution.

**Vivekananth.P, (2014)** “Six Sigma in Education” this paper discusses the ways Six Sigma can be used to teach efficiently. The quality control philosophy a Japanese philosophy of participative culture is discussed.

**Buket Akkoyunluet al.,(2008)** in their research paper entitled “A Study of Student’s Perceptions in a Blended Learning Environment Based on Different Learning Styles” examined the students’ learning styles and their views on blended learning. Results revealed that students’ views on blended learning process, such as ease of use of the web environment, evaluation, face to face environment etc., differ according to their learning styles.

**Kifayah Amar., (2008)** in their research paper entitled “A Review of Six Sigma Implementation Frameworks and Related Literature” a study was made examine four implementation frameworks found in the literature from two perspectives. Firstly, from a critical success factor perspective and secondly from the perspective of Rogers’ diffusion of innovations theory. None of the frameworks examined comprehensively address issues suggested by Rogers’ diffusion of innovations theory. The most robust framework appears to be the one developed by Burton and Sams. Our research suggests a customized implementation framework needs to be designed for Indonesian SMEs based on Rogers’ diffusion of innovations approach, but also drawing from literature on critical success factors.

**Boyle, T et al., (2003)** in their research paper entitled “Using blended learning to improve student success rates in learning to program” their aim was to improve student success rates in learning to program. The project team introduced a number of changes in module organization, tutorial support and online resources. The blend represents a mixture of traditional and novel elements, with the novel elements more marked in the online developments. Results demonstrated marked improvements in pass rates. Evaluation of the students’ use of the new environment indicated a positive evaluation of the main elements of the blend and widespread use of the new online features.

**Dowling, C et al.,(2003)** in their research paper entitled “Do hybrid flexible delivery teaching methods improve accounting students’ learning outcomes?” investigated the association between the learning outcomes of students and two teaching modules: traditional face-to-face and hybrid flexible delivery. Results indicated that the hybrid flexible delivery model is more positively associated with students’ final marks and improved learning outcomes.

**Schweizer, K et al.,(2003)** in their study titled “Blended learning as a strategy to improve collaborative task performance” examined how groups of learners work together in blended learning and e-learning environments. Three pure e-learning courses were compared to one blended learning course were participants formed learning teams who met at three points in time. All participants received joint learning material, in order to build shared knowledge, and individualized information to build unshared knowledge. Variables analyzed include students’ extent of online activity, the groups’ task performance, and coherence of the groups’ discourse. **CASE STUDY**

### 4. Reliability

**Table 1** Reliability Statistics

Cronbach's Alpha	N of Items
0.606	27

**Interpretation:** The reliability co-efficient for the variables chosen for the study should have to be more than 0.50 to consider it as an acceptable value. In this study the reliability analysis shows that the alpha value is greater than 0.50 indicating the evidence of reliability of the instrument is 0.606. The factors and dimensions included for analysis carry a good degree of reliability to support the objective formulated. Hence it is concluded that the data collected in this study is highly reliable.

### 5. Factor Analysis

Table 2 KMO and Bartlett's Test<sup>a</sup>

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	0.579
Approx. Chi-Square	665.736
Bartlett's Test of Sphericity	351
Sig.	0.000

**Interpretation:** The KMO measures the sampling adequacy which should be greater than 0.5. For a satisfactory factor analysis to proceed. Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy is an index for comparing the magnitudes with the partial correlation coefficients. Large values of KMO measure indicate that a factor analysis variable is a good idea. The sample is worth enough to measure variables. Hence the above test shows the uniqueness and homogeneous.

### 6. Correlation

Table 3 Correlation

		University Internet Speed	Student's Performance
University Internet Speed	Pearson Correlation	1	-.159
	Sig. (2-tailed)		.085
	N	119	119
Student's Performance	Pearson Correlation	-.159	1
	Sig. (2-tailed)	.085	
	N	119	119

**Interpretation:** The table 3 shows the relationship between Satisfaction of University Internet Speed and Student Performance in Academics. This have a highly positive correlation and the value is 0.085. This shows that if there is any change in Satisfaction of University Internet Speed it may impact in Student Performance in Academics.

### 7. Regression

Table 4 Regression

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.510 <sup>a</sup>	0.260	0.214	0.954

a. Predictors: (Constant), Internet role skill development, University blocks Educational site, satisfaction e-learning, satisfaction Internal Assessment, Academic Performance, helps assignment, Internet role educational communication.

**Interpretation:** From the table 4, the R Square value is 0.260 and adjusted R-Square value is 0.214 and this enlighten that the Model account for 26% of variance in the influence of Blended learning in educational sectors study. This is the clear indication that this Model is a good Model.

### Anova

Table 5 Anova

ANOVA<sup>a</sup>

Model	Sum of Squares	Df	Mean Square	F	Sig.
1 Regression	35.610	7	5.087	5.586	.000 <sup>b</sup>
Residual	101.096	111	.911		
Total	136.706	118			

a. Dependent Variable: Happy to use Educational Sites

b. Predictors: (Constant), Internet role skill development, University blocks Educational site, satisfaction e-learning, satisfaction Internal Assessment, Academic Performance, helps assignment, Internet educational communication.

**Interpretation:** From the table 5, ANOVA table it is inferred that the F-Value is 5.586 and the significance is 0.000. As the significance is less than 0.05. It clearly reveals that the model taken for the study is statistically significant.

### 8. Coefficients

Table 6 Standardized Beta Coefficient

Model	Coefficients <sup>a</sup>				t	Sig.
	Unstandardized Coefficients		Standardized Coefficients	Beta		
	B	Std. Error				
(Constant)	.830	.650			1.276	.204
1 University blocks Educational site	.081	.068	.100		1.189	.237
satisfaction e-learning	.060	.075	.069		.804	.423
helps Assignment	.372	.091	.357		4.107	.000
Academic Performance	-.092	.083	-.097		-1.115	.267
Internet role educational communication	.125	.091	.122		1.376	.172
satisfaction Internal Assessment	-.033	.079	-.036		-.418	.677
Internet role skill development	.235	.074	.272		3.169	.002

a. Dependent Variable: Happy to use Educational Sites

The table 6 gives a measure of contribution of each variable to the model. T-Value of University blocks Educational site is 1.189 and the significance is .237 and the probability is greater than 0.05. Thus the University blocks Educational site is not influencing in the prediction of overall blended learning in educational sector. T-Value of satisfaction e-learning is 0.804 and the significance is 0.423 and the probability is greater than 0.05. Thus the satisfaction e-learning is not influencing in the prediction of overall blended learning in educational sector. T-Value of helps Assignment is 4.107 and the significance is 0.000 and the probability is greater than 0.05. Thus the helps Assignment is influencing in the prediction of overall blended learning in educational sector.

T-Value of Academic Performance is -1.115 & significance is 0.267 and the probability is greater than 0.05. Thus the Academic Performance is not influencing in the prediction of overall blended learning in educational sector. T-Value of satisfaction Internal Assessment is -0.418 & significance is 0.677. Thus the satisfaction Internal Assessment is not influencing in the prediction of overall blended learning in educational sector. T-Value of Internet role skill development is 3.169 & significance is 0.002 and the probability is greater than 0.05. Thus the Internet role skill development is influencing in the prediction of overall blended learning in educational sector.

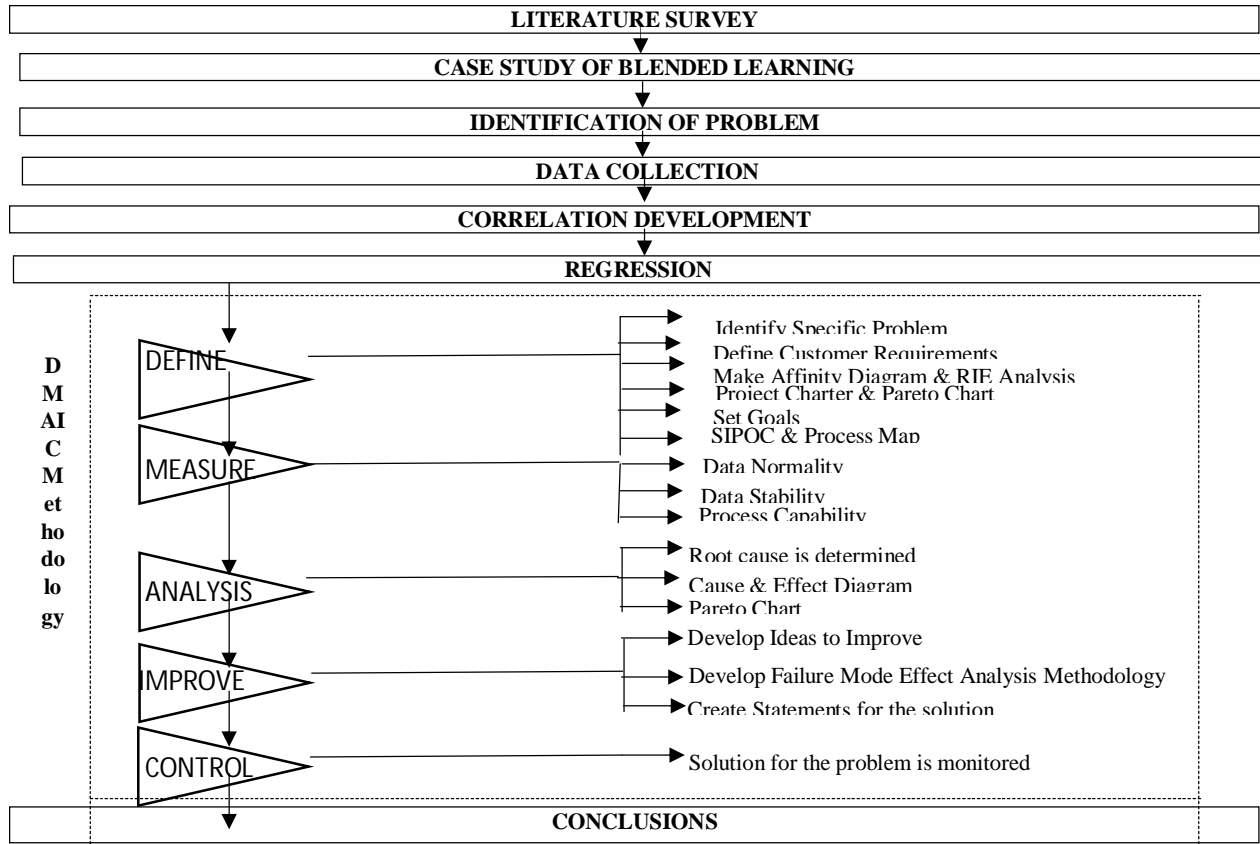


Figure 1 Flow Diagram of Methodology Adopted

A Case Study has been taken from a well reputed University which is located in south India. Through this study it is proven that Internet has a positive relationship with student’s performance. This case study depicts the fact of internet in their performance. In order to enhance the students’ performance the quality of Internet is increased by adopting Six Sigma approach. Six Sigma Methodology which is discussed early is carried out in this case study. For this Questionnaire has been collected from 119 samples from students (customer) in a random sampling manner.

### 9. Pre-Define Phase

#### Affinity Diagram

Table 7 Affinity Diagram

TECHNOLOGY	SERVICES	INFRASTRUCTURE
• High Speed Internet	• University Policy	• University Environment
• Stable Speed Internet	• Networking Staffs	• Transmitter Area
• Router/	• Services	
• Customer Computer	• Timely Maintenance	
• Firewall	• Timing	
• Virus		

#### RIE Analysis

Table 8 RIE Analysis

	TECHNOLOGY				SERVICES				INFRASTRUCTURE					
	R (0-10)	I (0-10)	E(0-5)	R+I/E	R	I	E	R+I/E	R	I	E	R+I/E		
High Speed Internet	8	8.3	3.3	4.94	University Policy	7	8.2	3.5	4.48	University Environment	7.8	7.2	4.3	3.48
Stable Speed Internet	7.3	7.7	3.1	4.84	Network Staffs	5.1	6.7	2.9	4.06	Transmitter Area	7.1	7	4.1	3.43
Router/	5.7	7.3	3.6	3.61	Services	5.1	5	3.4	2.97					
Customer Computer	4.5	2	4.6	1.41	Maintenance	7.1	6	3.7	3.54					
Firewall	5	5.4	2.7	3.85										
<b>RIE</b>	<b>18.65</b>				<b>RIE</b>	<b>15.05</b>				<b>RIE</b>	<b>6.91</b>			

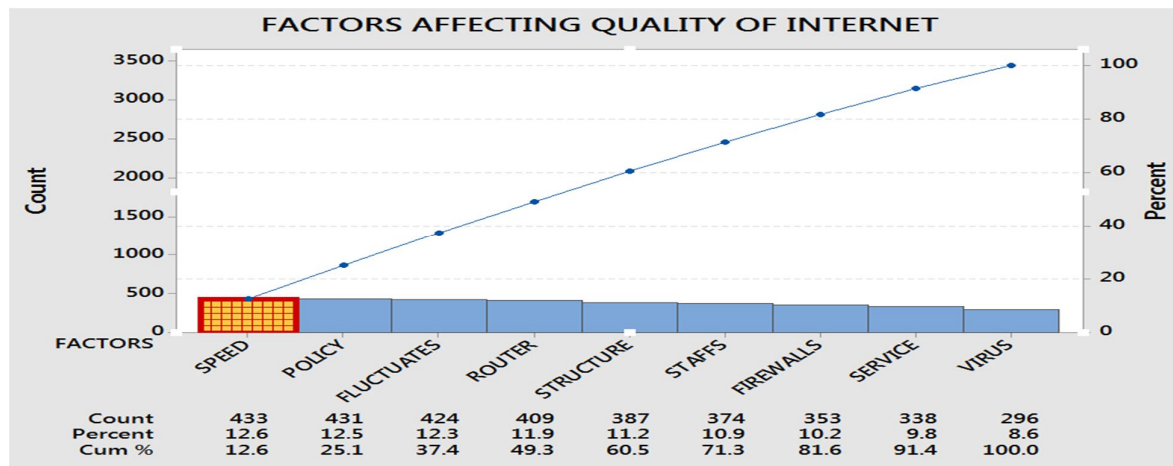


Figure 2 Factors Affecting Internet

### 10. Define Phase

This phase defines the goals and boundaries of an improvement study in terms of customer requirements or business requirements and the process delivering these requirements (Porter 2001).

The team which is assigned for Six Sigma in Table 1 has thoroughly studied those data which is obtained from the Questionnaire. The six sigma team has prepared a project charter which is shown in Table 1.11. Other main activities in this phase are SIPOC and Process Mapping.

**Table 9** Six Sigma Team Structure in Internet providing Educational Sector

<b>Champion</b>	<b>Vice Chancellor/Principal/Registrar</b> (Identify and scope the six sigma project)
Master Black Belt	<b>Director of Computer Technology Center</b> (Trains and coaches Black belts and Green belts)
Black Belt	<b>Network Engineers</b> (Apply Breakthrough strategy to specific projects)
Green Belt	<b>Technicians</b> (Supports Black belt by participating in the projects)
Team Members	<b>Student</b> (Carries out instructions for Data Collection)

Table 1.11 shows the objective of the project. Identifies the needs of the main stakeholders of this project. A clear description in terms of problem and the importance of solving the problem and the goals of the project.

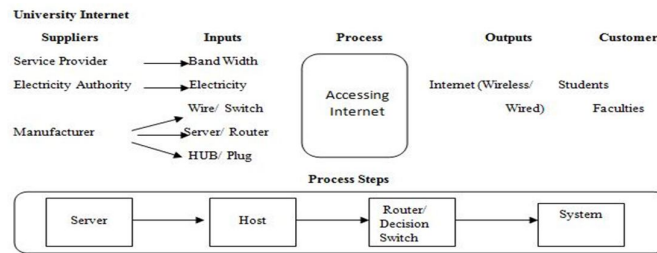
**Table 1.11** Project Charter

VOC	Customer Requirements	CTQ
Quality Internet	Good Service, Good Infrastructure,	Internet Speed
Good Student Performance	(Grading, Skill Improvement)	Delay, Jitter
<b>Process Importance</b>	<b>Process Problem</b>	<b>Project Goals</b>

Student Performance is controlled by Internet which is a facilitator for e-learning. It aims to increase the Quality of Internet.	The speed of Internet is not sufficient for the use of e-learning purpose and their by the student performance is decreasing.	To Increase Quality of University Internet From 1.33 sigma level to 2 sigma level and to increase student's performance.
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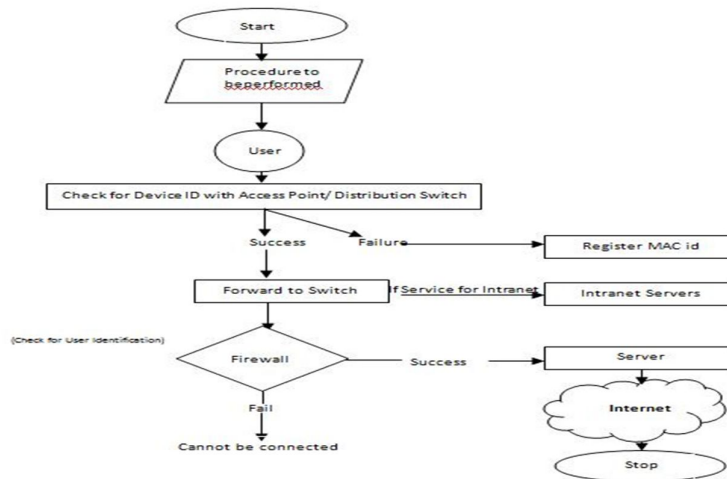
SIPOC Diagram which is used in Six Sigma Methodology. In this case, it is prepared by carefully observing the supplier, input, process, output and customer for attaining to increase Quality of Internet.

**SIPOC**



**Figure 3** SIPOC Diagram

**11. Process Map**



**Figure 4** Process Map

### 12. Measure Phase

The Internet speed data is subjected to normality test to check out whether the data collected from a normally distributed process or not. The Normality of data can be found out by Histogram.

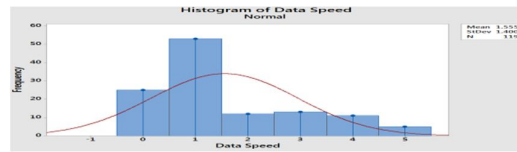


Figure 5 Normality

$$z = \frac{\bar{X} - \mu_0}{\sigma / \sqrt{n}} = 1.555 - 1.645 / .125 = 0.000$$

**Interpretation:** The z-test value is less than 1.645, so Ho is accepted, i.e, the data does not follow normal distribution.

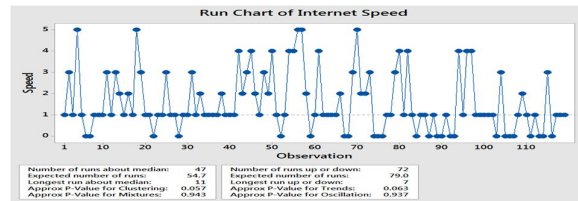


Figure 6 Stability

**Interpretation:** The stability of the data can be found out by Run Chart. Variation will exist in all process. These variation will be common variation or special variation. Special variation makes the problem for the customer. The common variation won't affect customers. The p-values shown in the chart i.e, Clustering (0.057), Mixtures (0.943), Trends (0.063), Oscillation (0.937) are more than significance level of 0.05, which indicates that there is no special causes of variation in data.

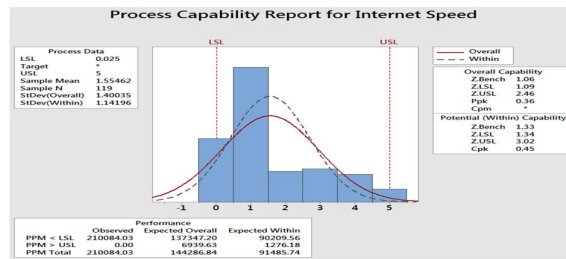


Figure 7 Process Capability

**Interpretation:** Process Capability is the ability of the process to meet the design specifications for a service or a product. Process Capability Index (Cpk), is an index that measures the potential for a process to generate defective outputs relative to either upper (USL) or lower specifications (LSL). From the result shown in figure 1.15, the Z-bench sigma value of the Internet Speed was found to be 1.33 and the DPMO level is found to be 90209.56.

### 13. Analysis Phase

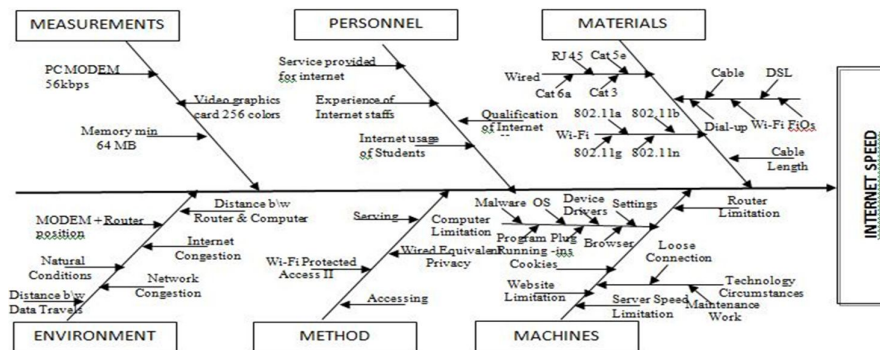


Figure 8 Fish Bone Diagram



**Interpretation:** From the figure 8, the main causes behind the problem of internet connectivity is showed. The problems are categorized according to their mode of occurrence.

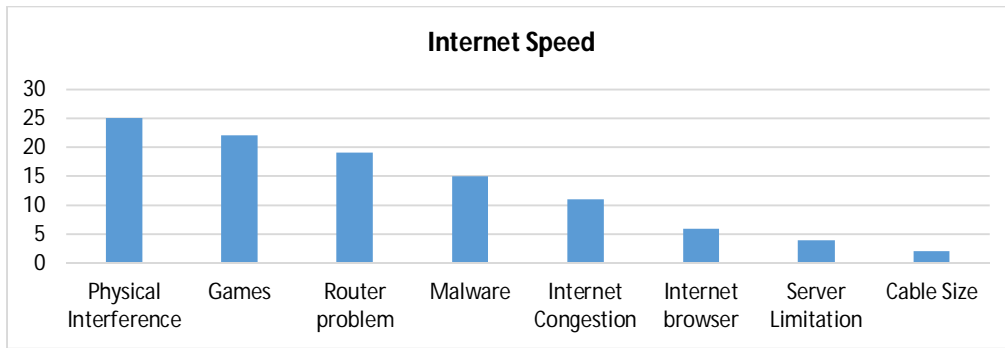


Figure 9 Problem in Internet Speed

**Interpretation:** From the figure 9, it is proved that the main problem behind the internet speed is physical interference. 80% of the problem can be reduced by 20 % of cause. By reducing physical interference, the problem of internet speed can be minimized to a great extent.

### 14. Improve and Control

Failure Mode and Effect Analysis (FMEA) is a methodology for analyzing the potential reliability problems in the process and to take necessary actions to overcome these issues. It is a bottom-up approach. It is used to identify the potential failure modes of the parts of components, determining their effect on the operation of manufacturing a product or service, and identify actions to mitigate these failures. This is mainly done by brainstorming.

The QS9000 standards put forward a new technique for FMEA based on **Risk Priority Number (RPN)**. This is a quantitative technique. It plays a major role in identifying the risk and action plan for reducing the risk. The risk priority number is the product of the **Severity (S)** of the effect, probability of **Occurrence (O)** and ease of **Detection (D)**.

Table 10 Failure Mode Effect Analysis for Provider

Mode of Failure	Components Details	Effect of Failure	S	Causes Of Failure	O	D	R	Recommended Action	Responsibility	
Student Performance lacks as the Quality of Internet fails	<b>Electrical</b>	Slow Internet Speed	8						University Management and Computer Center Staffs	
	Wired			Natural Condition	2	4	64	Shielding the Cables		
	Wi-Fi			Over Heat	1	5	40	Renew		
	ISP- Dial-up, DSL, Cable, FiOs			Shut downing for maintenance	1	1	8	Qualified Staff		
	Server Limitation			Overheating, Over computation, Natural temp, No of user	4	6	192	Coolers, No. of servers		
	Internet Congestion			Overheating, More no. of users	7	8	448	More coolers		
	Router Limitation			Range limitation, Bandwidth limitation	9	8	576	Band width increase, increase users acceptance in routers		
	Loose Connections of Cables			Damage of connecting pins	2	4	64	Rubberized		
	<b>Mechanical</b>									
	Cable Size			Excavation	2	5	80	Proper Shielding		
	Network Congestion			More no. of Users	7	8	448	More no. of Routers		
	Distance between computer & router			Limited coverage area	9	3	216	Boost signal strength		
	Limited range			Lack proper Infrastructure	7	9	504	Energy booster, ventilation, Blocking Rogue Access Points by sending traffic		

**Interpretation:** From the table 10, FMEA for provider is categorized into two namely mechanical and electrical. Details of the causes are mentioned such as Internet congestion, cable size, distance between computer and router, server limitation, limited range, loose connection etc. In the table 1.18, limited range (physical interference), network congestion, router limitation, internet connection and server problem are identified as some of major causes for the problem of internet speed in provider part.

Table 11 Failure Mode Effect Analysis for Accessing

Mode of Failure	Components Details	Effect of Failure	S	Causes Of Failure	O	D	R	Recommended	Responsibility
Student Performance lacks as the Quality of Internet fails	Electrical	Slow Internet Speed	8						
	OS			No Port	2	1	16	Upgrade	Students
	Internet browser			Time delay in Downloading data	7	6	336	Use suitable browser	
	Plug-ins			No videos can be played, compatibility	6	3	144	Install required software	
	Program running			Time delay	2	4	64	Close website not in use	
	Signal Receiver			Overheating	2	3	48	Use lap on well-ventilated area	
	Cookies			Automatic	6	5	240	Delete all unused cookies	
	Modem			Overheating, Physical damage	6	4	192	High Efficient Modem	
	Playing games			over heating	9	8	576	New firewall	
	Device Drivers			File corruption	4	5	160	Proper usage of drivers, Update	
	Malware			Files delete	8	4	256	Antivirus	

**Interpretation:** From the table 11, in FMEA for accessing, details of the causes are mentioned such as Internet browser, malware or virus, playing games, cookies, program running, device drivers, modem etc. In the table 1.19, playing games, internet browser, cookies, malware and modem are identified as some of major causes for the problem of internet speed in accessing part.

### 15. Conclusion

Now a days all the service or manufacturing sector are trying to implement Six Sigma in their concern. Internet is a facilitator of E- Learning (Blended Learning) and the student’s performance has a positive relation with Internet. Application of Six Sigma methodology in this study is to improve the medium of learning i.e. Internet Connectivity through a set of procedures in an effective way. The main root cause for the internet connectivity is found out in this study. The solutions to minimize the causes are suggested.

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# Need for Mentoring in Educational Institutions



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**Savita Shastri**

Bhandarkars' Arts and Science College, Kundapur  
(savitashastri@yahoo.co.in)

**Kavita Shastri**

Vijaya College (Jayanagar), Bangalore  
(kavitabsk@gmail.com)

*Mentoring is all about understanding the KSA (Knowledge, Skill and Attitude) of Mentee and guiding him / her to enrich his / her strengths and curb or eliminate the weaknesses. The concept of Mentoring has found a place in corporate world, however it still hasn't received due attention when it comes to Academic Institutions. Educational Institutions play an indispensable role in shaping the mind of future citizens of the country. They foster the process of Knowledge Creation and Knowledge Management. A new teacher or a lecturer needs to have a strategy to attract and retain students' attention. A certificate or a degree cannot equip teaching faculty with this skill, a mentor surely can teach this skill. Mentoring can prove to be an effective tool in improving the capabilities of the teaching faculty. This study aims at understanding the need for mentoring of new faculty in educational institutions. The need for mentoring will be studied through opinion survey of teaching faculty in Bhandarkars' Arts and Science College, Kundapura, Udupi, and Vijaya College (Jayanagar), Bangalore. The problems faced by new teaching staff in the discharge of their responsibilities will be collected through questionnaires and the need for mentoring would be assessed. Mentoring, through the use of an experienced person who need not be from the same department can be helpful in guiding the performance of young employees.*

**Keywords:** Mentoring, Educational Institutions, Teaching Faculty, Teaching Skills

## 1. Introduction

Mentoring as a concept has a pivotal role to play in improving individual performance alongside organizational growth and development. In the present competitive and stress laden work environment, a mentor can prove to be a saving grace for the new incumbents. A Mentor serves as a Guide, Coach, Motivator and an Emotional support system. Employees in any organization are constantly exposed to challenging situations, be it at an individual level, dyadic level, team level or at an organizational level. With years of experience, one learns how to ward off stress and pressures at work place. For the new employees, Work-Life Balance, Relationship Building and QWL (Quality of Work Life) are the major areas of concern. When a young person joins an organization, he / she needs help from a senior person to guide his / her efforts, correct the mistakes made and bring them back on track. The main objective of mentoring is to help an employee to develop psychological maturity and effectiveness in handling stressful situations and get integrated with the organization. Mentoring can prove to be an effective tool in bridging the gap between external constraints and internal ability. It can be of great help in channelizing the energy of young employees and steering them towards excellence. Stress management, Time management, Creativity, and Counseling are the areas where a mentor can be of potential help. A group of experienced and motivated faculty can be identified in every institution and they can be assigned as a mentor to a few new recruits.

## 2. Concept of Mentoring

The concept of Mentoring is as old as the human civilization. The culture of 'Mentoring' dates back to ancient Greece, when Odysseus entrusted his friend Mentor with the responsibility of his son Telamachu's education in his absence. The relationship between Telamachu and Mentor came to be known as 'Mentoring'. Indian history is also filled with examples of Mentoring in the form of Guru Dronacharya and Arjuna or Chanakya and King Chandragupta Maurya. According to Lewinson, "a mentor is a teacher, sponsor, counselor, developer of skills and intellect, host guide, exemplar and most importantly supporter and facilitator in the realization of the vision the young person has about the kind of life he wants as an adult". A Mentor is a person who systematically develops another person's abilities through intensive tutoring, coaching and guidance. Mentoring is a process whereby a senior employee acts as a friend, philosopher and guide to the new recruits. Mentoring performs both career related functions as well as psychological functions. Effective mentoring program first develops the positive mentoring relationship and then, focuses on guiding the desired behavioral changes. Mentoring process can be formal and informal, structured and unstructured.

Mentoring as a process involves three main stages, namely Communicating, Empowering and Helping. The stage of communicating involves listening, questioning and giving timely feedback to the mentee. The mentor should effectively communicate and share feedback with the mentee so as to reduce his / her blind areas and increase self-awareness. Empowering aims at increasing the mentee's autonomy and freedom of action. The mentor should encourage the mentee to take initiative and think differently. Being too critical about mentee's behavior could negatively impact his development. Helping implies showing genuine care, concern and empathy towards the mentee. A mentor needs to be sensitive towards his mentee and extend a helping hand whenever needed.

An advantage of mentoring is that it helps to acclimatize a new employee to the job and organization. By having a "go to" person to ask questions, discuss scenarios and generally learn the nuances of the organization, the mentee can become a productive member in a short period of time and never feel alienated to the work environment. The mentee can gain the sense of achievement that comes from the mentor's feedback and assessment of his / her progress. The mentee's quest to gain the mentor's approval can serve as a motivating force to improve his / her performance continually. The mentor can gain satisfaction from knowing that he / she is helping an individual and can take a measure of pride in his / her accomplishments. For a mentor who has already achieved a great deal of success, he / she can look at the process as a way of "giving back." Any concept introduced in the organization has its repercussions too. A possible disadvantage of Mentoring is that if the mentor-mentee relationship is forced, like when a supervisor assigns an experienced employee to tutor a new hire, it is possible that the two may not connect, or that the mentor may feel he / she doesn't have the time to fulfill the role while still carrying out his/ her professional duties. The strained relationship can be counterproductive and even make the mentee feel he / she is not a welcome addition to the company. Another possible limitation is that in some instances, the mentor may feel that the mentee is not progressing quickly enough or doesn't seem able or is unwilling to follow his / her direction, leading to frustration. The mentees may also become frustrated if they feel that they are not getting the guidance that they need. In either situation, it may be necessary for the mentee to find a new mentor if practically possible, before the situation erodes further.

In spite of a few limitations, mentoring in the workplace can have long-term benefits as employees become more self-directed and develop stronger communication and problem-solving skills. This allows for an institution to become more creative and focus its attention on growth, rather than training. Mentored employees value collaboration and sharing of information, which can lead to a stronger organization.

### 3. Mentoring Across Industry

Multi-national Companies like Wipro, Infosys, Intel, GE and Citigroup have successfully designed and implemented mentoring programs in their organizations. As a matter of fact these companies also have special mentoring programs for women employees. Women employees are encouraged to approach their mentors regularly for guidance, which can relate not only to purely professional matters but also personal ones that impinge upon their professional performance. This special focus on women employees is due to the fact that there is a dearth of women at the top and senior level positions. According to a WRC report, 36% of the labour force comprises of women employees, out of this 22.6% of employees are employed at lower and middle level, and only 5% of the women make it to the Board of Directors. In Japan, it is a common practice for all workers in a company to actively seek a senior employee's support and guidance. This person is called *Oyabun* which literally means the 'father status' and his protégé is called *Kabun*. The *Kabun* consults and takes guidance from *Oyabun* on important professional as well as personal issues. The senior employees consider it their privilege if they are considered to play the role of *Oyabun*. Since 1986, the training department of the Neyveli Lignite Corporation Ltd. has been working on a mentoring program for its employees as a part of its HRD activities. Under this program senior managers with 15 – 20 years experience are given the charge of nurturing the new generation of young managers and preparing them to take on future responsibilities. The mentors are entrusted with the task of designing a Career Development plan for their mentees and guiding them towards achieving their career goals. At Hewlett-Packard, mentoring is extended to all new managers at all levels, both new entrants and promotees. Here, mentoring which is a 9 – 12 month program is not only used to facilitate a mutual fit between the individual and the organization, but also to groom high-potential managers for future leadership.

### 4. Mentoring in Educational Institutions

Mentoring is defined as a developmental relationship in which a more experienced person helps a less experienced person. It is an ongoing process in which individuals in an organization provide support and guidance to others who can become effective contributors to the goals of the organization. Mentoring process is important for teaching profession where experience is important. In teaching profession low motivation, burn-out or quitting the profession or attrition are some of the problems that may occur if the novice teachers are not given guidance and support in their initial days. Since the 1980s many countries have seen a massive increase in the number of formal programs of school-based mentoring for newly appointed teachers. High expectations and a large amount of money are put into the mentoring programs. These Mentor Preparation programs are extremely variable in nature and quality and the focus is more on administrative aspects of the role than on developing mentors' ability to support and facilitate mentees' professional learning.

Mentoring as a concept has been implemented in Europe through European Union projects. One of them is TISSNTE (Teacher Induction: Supporting the Supporters of Novice Teachers in Europe) project. TISSNTE project, carried out between 2006 and 2009 with the support of European Commission, aimed at developing a Mentor Training program for European mentors. Twenty-two institutions from twelve different countries have developed five days mentor training program. The program includes six main themes related with mentoring which is: classroom observation, evaluation/feedback, communication, roles and reflection, planning, coaching process and learning environment (TISSNTE 2009). Junior faculty mentoring program is offered in several universities and colleges around the world. Programs are conducted to guide junior faculty in building long and productive careers in academic institutions. Mentoring is a well-structured program in the University of California and Stanford University. University of California has a mentoring team comprising of 3 members, one of them as the primary member the faculty has regular scheduled meetings and even ad-hoc one to one meetings to discuss any issues or problems that junior faculty confront. University of Wisconsin and Oregon have special women faculty program to increase the representation of women in several fields and branches. Emory University, USA issues a junior

faculty and senior faculty application form to become a mentor or a mentee. The mentor needs to fill his / her preference for a potential mentor. He / she needs to specify the gender, race, age and department of the mentor he / she prefers. Mentee needs to mention any three areas he / she would like to be mentored in. Mentors are also asked to review the performance of junior faculty on issues like how to prepare for a class, what to expect in a class and how to handle different situations. In the Indian Context, Mentoring in several Indian colleges and universities involves just a day long orientation program with a brief profile of the institution, the do's and don'ts, the culture and environment and lastly what is expected of them. In many academic institutions the Welfare Officer acts as the mentor, a junior faculty approaches him / her only when there is a dire need. A one day seminar is organized by several colleges and universities in India especially in the wake of NAAC accreditation as Faculty Development Program. These programs aim at addressing a host of issues that faculty members come across every day. Eminent academicians and educationists are invited to speak on issues like 'Work-life Balance', 'Creating the right work environment', 'How to be effective in the classroom scenario' etc. Such programs are highly effective but are held only once a year and do not help in handling day to day problems of the junior faculty. Refresher courses are organized by Government colleges, Central and State Universities for junior faculty members every year. This feature too takes place once a year or whenever there is recruitment or just after the induction of new faculty members. These courses which are a week long do not help the newly recruited faculty in times of need. Most of the private educational institutions have no definite plan with regards to Induction or Orientation Program. Mentoring as a concept has not found its due recognition in academic circles. It is indeed carried out at a mere informal level. Boice, R in his book "Quick Starters: New Faculty Who Succeeded", suggests incorporating effective practices to improve teaching. It is very essential to support and foster professional development of the junior faculty so that they can settle down and look forward to academic growth. The need of the hour is to have a regular Mentoring program in all academic institutions. Mentoring Program gives a new direction and new dimension to both teaching and learning.

### 5. Problem Statement

Mentoring is all about understanding the KSA (Knowledge, Skill and Ability) of Mentee and guiding him / her to enrich his / her strengths and curb or eliminate the weaknesses. The concept of Mentoring has found a place in corporate world, however it still hasn't received due attention when it comes to Academics. Educational Institutions play an indispensable role in shaping the mind of future citizens of the country. They foster the process of Knowledge Creation and Knowledge Management. The teachers are knowledge providers and they stand as Role Models for their students. The art of teaching cannot be learnt, it's a skill that you are born with. But the art of managing students, managing critical situations, managing time and managing emotions can be learnt from experienced hands. The concept of Induction or Orientation Training finds a mention in only a few Educational Institutions. Learning happens on the job and errors made whilst at work can have serious repercussions. The institution in question Bhandarkars' Arts & Science College, located in Kundapur Taluk of Udupi district in Karnataka was established in the year 1963 and offers Pre-university, Under Graduate and Post Graduate courses. Catering to over 2000 rural and semi urban students annually, Bhandarkars' College has created a brand name for itself. However, it does not have a formal Induction / Orientation program for its new faculty members. The senior faculty members do guide and support their junior colleagues when in need but the concept of Mentoring has not taken shape. The college management is keen on improving the quality of teaching imparted in the institution and has continually encouraged its staff to undertake research and learning programs.

Vijaya College (Jayanagar), Bangalore earlier named as BHS First Grade College was started by BHS Higher Education Society in the year 1989. With student strength of over 2,000, the college offers graduate courses in Arts, Science and Commerce. This institution unlike Bhandarkars' College caters to the urban students. Vijaya College has always strived to integrate academics with literary and cultural activities in a bid to promote all round development of students. The new faculty members at both the institutions who represent the rural, semi-urban and urban set up had expressed a need for a support system to encourage and guide their performance; hence, this study has taken its present form.

### 6. Research Objectives

This study aims at understanding the problems faced by new faculty at Bhandarkars' College and Vijaya College and whether the concept of Mentoring could help in improving the performance and effectiveness of new faculty. Improving the work culture, enhancing knowledge, research orientation could be some of the core areas where the concept of Mentoring can be applied. The objective of the research would be to assess and understand the following perspectives:

- To understand the nature and types of problems faced by faculties during the initial days of their career.
- To compare and analyze the problems faced by new faculty in semi-urban (Kundapura) and urban (Bangalore) work environment.
- To find out whether there is a need for induction / orientation training and mentoring in Educational Institutions.
- To highlight the areas where the concept of mentoring could be of use for new faculty.
- To suggest measures to apply the concept of mentoring for the benefit and growth of young faculty members.

### 7. Research Methodology

This study aims at understanding the need for a mentoring concept in educational institutions. The need for mentoring has been studied through opinion survey of teaching faculty in Bhandarkars' Arts and Science College, Kundapura, Udupi District and Vijaya College (Jayanagar), Bangalore, Karnataka. The problems faced by new teaching staff in the discharge of

their responsibilities have been collected through questionnaires and the need for mentoring has been analyzed. Mentoring, through the use of an experienced person who need not be from the same department can be helpful in guiding the performance of young employees. Technical, Interpersonal and Political Skills can be conveyed in such a relationship from the older and experienced to the newer and younger employee. Judgment and Convenience Sampling techniques have been applied to identify the faculty who were chosen to take the questionnaire. The sample selected for the research represents both male and female employees of both the colleges. A representative sample would consist of new faculties (within 2 yrs of service), Faculties with 5 – 10 yrs experience and senior faculty members (above 10 yrs experience). Structured – Undisguised Questionnaires have been used to collect information from the chosen sample. Closed ended questions have been designed to find out whether the employees feel that the concept of Mentoring could be introduced in the Institutions.

### 8. Data Analysis

Primary data has been collected at Bhandarkars’ Arts and Science College, Kundapura and at Vijaya College (Jayanagar), Bangalore in the month of Oct – Nov 2014. A sample of 30 and 20 faculty members has been collected at Bhandarkars’ Arts and Science College and Vijaya College (Jayanagar) respectively. The data collected through questionnaires has been analyzed and presented using various graphical tools.

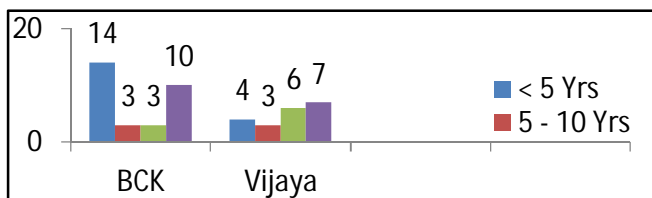
Name of the Institution	Total Faculty Strength	Arts	Science	Commerce	Sample Size
Bhandarkars’ Arts and Science College, Kundapura (BCK)	97	35	42	20	30
Vijaya College (Jayanagar), Bangalore	72	30	22	20	20

#### 1.1. Gender Ratio and Discipline Representation of Respondents

Institutions	Sample Size	Gender Ratio of respondents		Discipline Representation of respondents		
		Male	Female	Arts	Science	Commerce
BCK	30	16	14	11	12	7
Vijaya	20	06	14	8	5	7

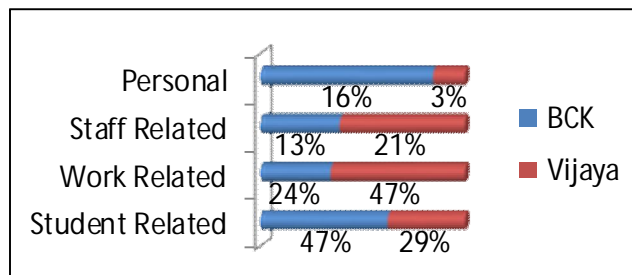
- In BCK the sample collected consisted of 47% female staff, whereas in Vijaya College 70% of the staff selected for study were female.
- At BCK out of a sample size of 30 respondents, 37%, 40% & 23% faculty represented Arts, Science & Commerce respectively. At Vijaya College, 40% represented Arts, 25% Science & 35% represented Commerce out of 20 chosen respondents.

#### 1.2. Teaching Experience of Respondents



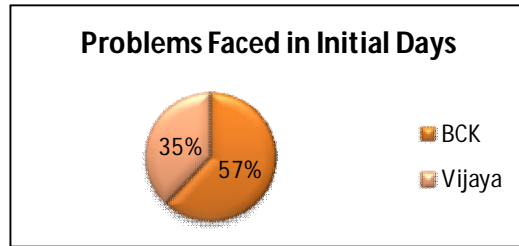
- Out of the chosen sample at BCK, 47% were within 5 years of teaching experience whereas 43% had over 10 years of teaching experience.
- At Vijaya College, 20% of the chosen respondents were under 5 years of teaching experience and 65% were over 10 years of teaching experience. Hence, it was ideal for identifying both probable Mentors and Mentees.
- The staff at both these institutions put in 16 – 20 hours of teaching per week and comprise of temporary as well as permanent staff

#### 1.3. Problems Faced By New Faculty



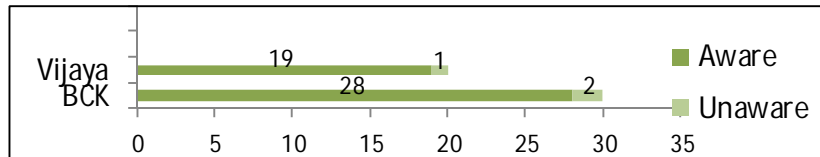
- On comparing both the institutions, we find that in BCK the major problem faced by new faculty is student related (47%), whereas in Vijaya College, work related issues (47%) seems to be the main concern for new faculty.
- Majority of the respondents mentioned Head of the Department or the Principal as the contact person when faced with any problem.

**1.4. Respondent’s Personal Experience**



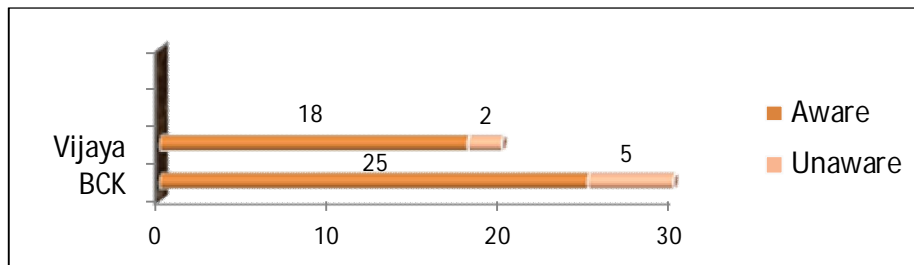
- In both the institutions the respondents faced problems in their initial days. The faculty at BCK had experienced more problems when compared to their counterparts in Vijaya College. The most common problems were student related and work related. 10% of the respondents had difficulty in adjusting with their senior faculty members.

**1.5. Awareness about concept of Induction / Orientation**



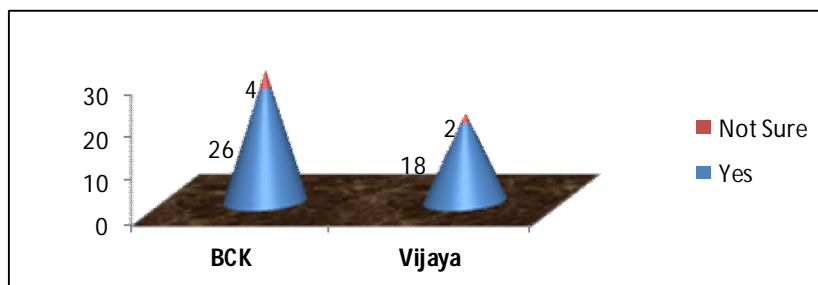
- Out of the total respondents, 93% at BCK and 95% at Vijaya College were aware about the concept of Induction/ Orientation.

**1.6. Awareness about the Concept of Mentoring**



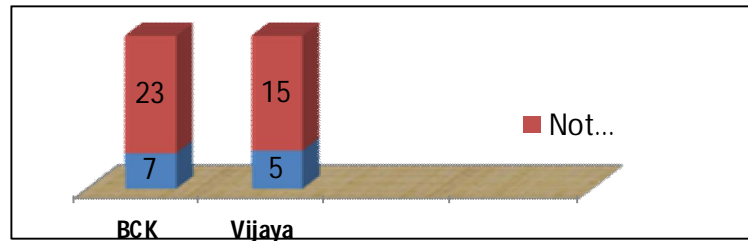
- At BCK 84% and at Vijaya College 90% of the respondents were aware about the concept of Mentoring.

**1.7. Need for Training in Educational Institutions**



- Out of the 30 respondents at BCK, 87% felt that there was a need for training in educational institutions. At Vijaya College, 90% of the respondents supported the idea of training for new faculty members. Less than 10% respondents were unsure about the need for training.

**1.8. Personal Experience with regards to Training**



- Out of 30 respondents at BCK 77% had not received any training in their initial days. At Vijaya College out of 20 respondents 75% were not provided with any form of training.

**1.9. Feedback on Concept of Mentoring in Educational Institutions**

Sl. No.	Areas	Yes		No		Not Sure		Total	
		BCK	Vijaya	BCK	Vijaya	BCK	Vijaya	BCK	Vijaya
1	Need for Mentoring in Educational Institutions	26	19	1	...	3	1	30	20
2	Need for a Mentor	12	7	1	...	1	...	14	7
3	Willingness to become Mentors	14	11	2	...	...	2	16	13

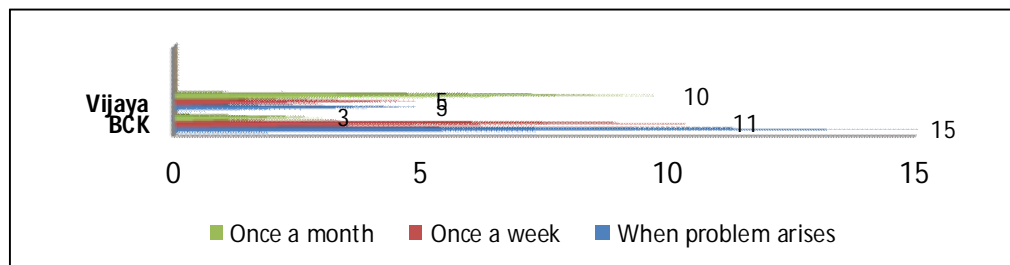
1. Out of the total respondents 87% (BCK) & 95% (Vijaya) felt that there was a need for Mentoring in Educational institutions. Less than 10% respondents were unsure about the need for mentoring.
2. At BCK, out of 30 respondents, 14 were eligible to be mentored, out of which 85% of respondents expressed a desire to have a mentor to guide them. At Vijaya College, out of 20 respondents, 7 were eligible to be mentored and all of them expressed their willingness to receive mentoring.
3. At BCK, out of 30 respondents, 16 were eligible to become Mentors, out of which 88% of respondents were willing to perform the role of a Mentor. At Vijaya College, out of 20 respondents, 13 were eligible to become Mentors and except of two respondents, all others were willing to act as Mentors.

**1.10. Areas where Mentoring can be of Help**

Areas	BCK	Vijaya
Time Management	17%	12.5%
Managing Emotions	14%	11%
Problem Solving	16%	19%
Performance Enhancement	21%	14%
Healthy Work Environment	16%	17%
Work-Life Balance	8%	14%
Research Orientation	8%	12.5%
Total	100%	100%

- Out of the seven areas where Mentoring could be help in an educational institution, the respondents at BCK ranked Performance Enhancement (21%) as the highest, followed by Time Management. At Vijaya College, Problem Solving (19%) came out as the most critical area of help followed by creation of a healthy work environment.

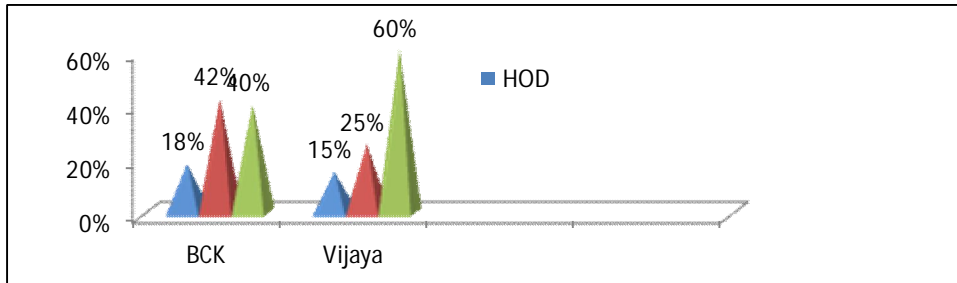
**1.11 Frequency of Mentoring**





- At BCK, 52% of the respondents remarked that they would meet their mentor only when there is a problem, 38% respondents wanted to meet their mentor on a weekly basis and only 10% respondents wanted to meet their mentor once a month.
- Unlike BCK, 50% of the respondents at Vijaya College wanted to meet their mentor only once a month and there was an equal response of 25% who chose weekly meeting and meeting the mentor in case of a problem.

### 1.12 Ideal Mentor



- The 42% respondents in BCK felt that faculty with 5 – 10 years of experience would be ideal for mentorship. In Vijaya College, 60% of the respondents recommended faculty with over 10 years of experience to be Ideal Mentors.
- Respondents in both the institutions placed Head of the Department as the third choice when it comes to being an Ideal Mentor.

## 9. Findings and Suggestions

The study conducted at both the institutions aimed at understanding the problems faced by new faculty in a rural, semi-urban and an urban set up. Teaching requires high amount of knowledge and skill and faculty members at both these institutions felt that there was a need to groom and train faculty members in the initial days of their career. In spite of a variation in the societal set up in these two towns, the problems faced by new faculty members remained the same. The awareness about the concept of mentoring among the teaching faculty at both these institutions was noteworthy. The support rendered by the faculty members at both the institutions in carrying out this study proves that there is a keen interest among them to bring a qualitative improvement in the knowledge delivery mechanism. Formal training programs could prove to be a costly affair; hence, college management could look at mentoring as a substitute to training. Mentoring Programs require commitment of the top management and a team of dedicated & motivated senior faculty members.

Introducing the concept of mentoring in the institution would be a Win-Win situation. For the new faculty, it would serve as an aid to improve their performance and acceptability in the institution. A mentorship may help a new faculty feel less isolated at work and encourage him / her to interact more with others. A mentor can provide a new faculty with tips on career growth and as the employee matures in his / her career, a mentor may remain a valued adviser to the faculty. For the senior faculty who choose to be mentors, it will help in developing their leadership skills and also create a cordial working relationship in the institution. The opportunity to teach or advise others can increase the mentor's confidence and his / her own job satisfaction. The mentor is required to listen to the concerns of the new faculty and develop a better understanding of employee issues and stronger communication skills. Even if a mentored employee leaves the institution, the mentor and mentee may maintain a professional connection. This may expand the mentor's reputation and connections.

From the management point of view, introducing Mentoring would give the institution an edge in terms of competent and unified workforce which in turn would result in building a brand par excellence. Employers will also be able to bring down the attrition rate of employees as they feel a greater sense of loyalty towards the institution. An educational institution can even use its mentoring program to attract new employees.

## 10. Conclusion

Majority of the faculty face numerous problems in their initial days as a lecturer, however due to certain inhibitions they fail to share these problems with others. With time, they learn how to cope with these problems. When the new faculty members were asked whether they would have liked to have a mentor to guide them in their initial career, the answer has been in the affirmative. Hence, the concept of Mentoring in educational institutions if introduced would be well received by all the faculty members. Mentoring is very crucial in the overall performance of the junior faculty. Mentors can facilitate by co-authoring and offering positive feedback in research projects, paper presentations, conferences and seminars. Mentoring helps in the retention of faculty by resolving conflicts at the infancy stage. The mentee can also add value by coming up with new ideas and approaches that can improvise teaching practices. Mentoring can also help the junior faculty in prioritizing his responsibilities like teaching, research, invigilation, valuation, paper setting etc. Mentoring would not only help in achieving professional milestones but also help in accomplishing a sense of camaraderie across departments.

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# Student Employability Skills: Perspectives of Faculty and Employers



ISBN: 978-1-943295-01-2

**Remadevi O.T**  
*Bharathiar University*  
(otkrishnan@gmail.com)

**V. Ravi Kumar**  
*CMS Institute of Management Studies*  
(rav\_ash@yahoo.com)

Advancements in information technology, fast changing structures of organisations and management styles, and emerging decisive roles of service sector in the world economy, are demanding diverse employability skills. Being aware of these market forces, understanding the changing requirements and having a willingness to learn new skills, all these are very essential to progress in one's career. This paper furnishes important global employability skills and presents a set of these skills/attributes, rated in terms of their importance, by the two domain partners in the employability skills spectrum—the faculty and the prospective employers. Collected as part of an on-going research study in India, during July–November 2014, these ratings are compared with an employer satisfaction study in India conducted by the World Bank, in 2011.

**Keywords:** Employability Skills, Engineering Students, Faculty, Employers

## 1. Introduction

Any student pursuing higher studies aspires to obtain an employment, which matches his/her qualification and abilities. While, in many situations, it may not be very difficult to gain a certificate of qualification, it seems not so easy to acquire the required abilities, skills and competencies, especially in a labour market, where the demands for these are subject to rapid changes. These skills/attributes are collectively termed as employability skills and need modifications and sharpening as per the context and requirements of the employment sector. The present paper forms part of an intensive ongoing study by the authors to find out the key employability skills which employers are interested in, to understand the global scenario of employability skills and attributes and also to assess the skill/attributes possessed by engineering students.

The employers and teachers being the major contributors in the realm of employability skills, an attempt has been made to find out the perspectives of these two groups. Faculty members from six engineering colleges and prospective employers were contacted to elicit their perception regarding the importance of different employability skills/attributes in the selection process of final year engineering students. The primary data for the study were collected during July– November 2014.

Employability skills reflect one's aptitudes, capabilities and personal qualities. Early childhood education, primary, secondary and tertiary education –all these have key roles to play in shaping one's employability. Outdated syllabus, rote-memory based learning, theory dominated pedagogy, lack of opportunities for developing creativity/innovativeness, absence of rigorous assessment and evaluation mechanism - these are but a few of the scenario we witness across our educational system. Realizing the urgency of reforms, with a view to enhance the overall employability of its workforce, many countries are geared for a turnaround and a total restructuring in the educational system from the kindergarten onwards. They plan these in close collaboration with parents, employers, faculty members, researchers and the civil society leaders. Those who hesitate and procrastinate to take the right decisions in this race for survival are brushed aside, making it extremely difficult for them to cope up with the front-runners.

Government of India, through its highly ambitious National Skill Development Initiative, has set a target of skills development which is expected to benefit around 500 million people by 2022. Its document notes... "To stimulate and support reforms in skills development and to facilitate nationally standardised and acceptable, international comparability of qualifications, a National Vocational Qualification Framework will be established" (National Policy on Skill Development, 2009, page 25. [www.skilldevelopment.gov.in](http://www.skilldevelopment.gov.in)). Through its various plans and programmes, it aims to impart quality skill training for self employment as well as for potential job-seekers. Formulation of Labour Market Information System (LMIS), the National Skills Qualification Framework (NSQF), Curriculum Development and Occupational Standards Development are among the key action points. The present Government has formed a New Ministry, the Ministry of Skill Development and Entrepreneurship and is in the process of revising the policy with additional inputs. In tune with the central government plan, different State governments have also set their programmes in motion.

The National Board of Accreditation (NBA), India, promotes internal quality standards for technical education in India. India is presently (2014) a signatory to the Washington Accord, the membership of which is an international recognition of the quality of undergraduate engineering education offered by the member country and is an avenue to bring it into the world-class category. This, in turn would facilitate the mobility of engineering graduates and professionals at international level ([www.nbaind.org](http://www.nbaind.org)).

The NBA (2012) has set parameters for undergraduate engineering programmes, called 'Graduate Attributes for UG Engineering Programme'. The key areas of this include:

- Engineering knowledge

- Problem Analysis *Twelfth AIMS International Conference on Management*
- Conduct investigations of complex problems
- Modern Tool Usage
- The Engineer and Society
- Ethics
- Individual and Teamwork
- Communication
- Project Management and Finance and
- Life-long Learning

Blom and Saeki (2011) of the World Bank, as part of the Second Phase of Technical Education Quality Improvement Programme (TEQIP-II), and in close collaboration with the Ministry of Human Resource Development (MHRD), Government of India and the Federation of Indian Chamber of Commerce and Industry (FICCI), investigated the employability and skill set of newly graduated engineers in India. They had used the 'expected learning outcomes' by the National Board of Accreditation (NBA), as one of the main sources for developing their questionnaire. The data collected through survey with 157 employers, revealed that qualities such as integrity, reliability, teamwork, willingness to learn, entrepreneurship, self discipline, self- motivation and communication skills, were 'very high' in the level of importance.

## 2. Global Employability Skills

Employability frameworks and policies formulated by developed countries and relevant literature on the topic, lead us to take cognizance of the prominence they attribute for personal qualities in the employability skill spectrum. Equal importance seems to have been given for teamwork/interpersonal skills, which includes customer service skill, managing workforce diversity, emotional and social skills, conflict management and negotiating skills. The growing global demand for service sector jobs explains this need. Problem-solving skills, analytical skills, reasoning and critical thinking skills, once considered as the skill for the top management, are expected now, at the entry level itself, as an essential element to decentralised governance. In this knowledge-driven economic world, communication skills and the use of information technology for effective communication, form another area demanded and valued, not only for the present day functioning, but for future strategic interventions too.

Commercial/Business awareness, life-long learning, work safety, political, environmental, legal and social awareness, foreign language and work experience (during the course of studies) are other areas that gain focus.

Policy makers with vision and wisdom understand that these skills/attributes could not be pumped into the students during their final year at school/college, to make them job-ready. They set the foundation from primary education onwards, continuing over to secondary and tertiary education. They give thrust to learning by doing and experiential learning. They update and modify the curriculum periodically. They motivate the children to be self -learners. The children thus grow to be self- motivated and self confident to face the challenges in the employability field.

## 3. Perspectives of Faculty and Employers

Considering the global scenario on employability skills, replete with employer perspectives, it would be interesting to probe how the group that is responsible to instil these skills in their students, view them.

Relatively few studies that capture the perspectives of faculty in this sphere have been published. Among those published, many have restricted the use of those for their in-house purpose only. The following give a brief account of the perspectives of engineering faculty and prospective employers of engineering students, collected as part of an ongoing study on the employability skills of engineering students.

### 3.1 Research Methodology

#### 3.1.a. Data Collection from Faculty

The authors have collected responses from sixty eight faculty members from six engineering colleges from the southern part of India. The faculty were approached through proper channel after discussions with the concerned authorities on the purpose of the study. The skills- set, developed by Blom and Saeki (2011), with slight modifications, was used for the study. Three – point Likert-type scale was used to collect their perspectives on the importance of the skills presented in the skill-set. They were requested to mark the skills/attributes they considered 'very important', 'important', or 'less important', with regard to the employability of their students. The responses were given scores as 'Very Important'-3, 'Important'-2 and 'Less Important'-1. Academic heads and teachers with more than five years teaching experience, and who volunteered to give their true and honest responses, formed the sample. The faculty were also requested to write three key suggestions to improve the employability skills of their students.

#### 3.1.b. Data Collection from Employers

Forty one employers constituted the employer sample, consisting of thirty one from within India and ten from employers of Indian origin, employed in different countries abroad – including the U.S, Canada, Australia and Singapore. Employer, for the purpose of this study, is defined as a senior officer, involved in the selection and recruitment/training of newly recruited engineers or has managerial role that involves supervision/assessment of the newly recruited engineers. Snowball sampling

was used for the selection of employers. The sectors in which these employers are engaged include manufacturing, telecom, information technology (IT), IT-enabled services, consulting firms and public sector service firms. The skills set provided for the employers contained the same skills/attributes as those given to the faculty. Among other things, the employers were also requested to give three very important areas to be focused upon to improve the overall employability of engineering students.

#### 4. Results and Findings

Results and findings of the study are given in four sub sections. Sub section 4.1 explains the perspectives of faculty and employers on the importance of different skills. The total score, mean score and standard deviation for each of the top ten skills as per the ratings of these two groups are given in table 1. Sub section 4.2 differentiates the skills which the employers considered important, but differed from the faculty perspective. The next sub section 4.3 compares these ratings of importance with that of the Blom and Saeki (2011). These are tabulated in Table 2. Last sub section, 4.4, furnishes qualitative suggestions from the faculty and the employers to improve the overall employability of engineering students.

##### 4.1 Perspectives of Faculty and Employers on the Importance of Employability skills/attributes

Let us have a comparison of the importance of skills/attributes, expressed by these two groups. Table 1 gives the skills that found place among the top ten positions, with their total score, mean and standard deviation.

**Table 1** Skills/Attributes under the 'Top Ten' Category, in the Order of Importance

			Faculty Perspective N=68		Rank	Employer Perspective N=41				
Total Score	Mean Score*	S.D.	Skill/Attribute			Skill/Attribute		Mean Score	S.D.	Total Score
188	2.76	0.43	Problem Solving Skill		1	Honesty, Integrity and Dependableness		2.88	0.33	118
185	2.72 2.72	0.45 0.45	1.Honesty, Integrity and Dependableness 2. Teamwork		2	Teamwork		2.85	0.36	117
181	2.66	0.48	Data analysis and Interpretation		3	1. Reliability 2. Problem Solving Skill		2.78 2.78	0.42 0.42	114
180	2.65	0.63	Self Discipline		4	Understands and takes direction for work assignments		2.73	0.45	112
179	2.63	0.49	Self Motivation		5	Basic Computer		2.71	0.51	111
178	2.62	0.49	Willingness to Learn		6	Self Discipline		2.68	0.52	110
177	2.6	0.49	Verbal Communication in English		7	Willingness to Learn		2.63	0.49	108
173	2.5	0.56	Apply Knowledge of Mathematics, Science and Engineering		8	Data Analysis and Interpretation		2.61	0.54	107
170	2.5	0.56	Basic Computer		9	Self Motivation		2.58	0.50	106
169	2.48	0.53	Self Awareness		10	Flexibility and Adaptability		2.56	0.50	105

Source: Authors' Primary Data

\* Maximum Possible Score for One Attribute: 3. Minimum Score: 1.

The comparative ratings of faculty and employers, give us more similarities than differences, among the top ten ranks. Out of these, eight skills found their places in both lists. 'Team work' is the only skill which received the same rating by both groups. 'Problem-solving' topped the list from the faculty perspective. 'Integrity' topped the list from the employers' views. 'Integrity' was ranked second in the list of importance by the faculty. 'Data analysis and interpretation', was considered as the third important skill, by the faculty. This was only the eighth, as per the employers' rating. 'Self discipline' is a quality that faculty considered more important (with fourth position) compared to that of the employers' (sixth position). 'Self motivation' is ranked fifth by the faculty, and ninth by the employer. 'Willingness to learn' is another important quality, with sixth position given by the faculty. The employers too felt it important and gave it the seventh position in their order of importance. While the faculty considered, 'verbal communication in English', among the top ten with seventh position, it did not appear among the employers' top ten skills. From the faculty's perspective, the ability to 'apply knowledge of mathematics, science and engineering', was one of the top skills required by an engineering graduate to be considered for entry level engineering employment. The employers did not consider it so. Their ranking for this ability did not occupy a place among their top ten. For 'basic computer proficiency', while the faculty gave the ninth rank, the employers felt it more important and assigned the fifth position among their priorities. 'Self awareness' is another attribute that was rated higher by the faculty compared to that of employers. The employers did not rate it so high as to include it among their ranking of top ten skills.

#### 4.2 Skills Employers Considered among the Top Ten, but not Considered by the Faculty among the Top Ten

Compared to the employers' 'very important skills' expected from newly graduated engineers, three skills/attributes considered not of that much importance by the faculty are: 1. Reliability, 2. Understands and takes direction for work assignments, and 3. Flexibility and adaptability. The employers ranked reliability as the third important skill. They considered the attribute related to 'understands and takes direction for work assignments', the fourth in importance. Flexibility and adaptability was rated tenth among the employers' list of importance. These choices, in general, reflect the practical work place requirements perceived by the employers as against the more academic environment related choice of the faculty.

#### 4.3 Skills by Importance, Compared with the World Bank Study

A quick comparison of these findings with that of the World Bank study by Blom and Saeki (2011) would be worth at this juncture. These are presented in Table 2.

**Table 2** Level of Importance of Skills/Attributes: Comparison of Top Ten Skills by Importance in the World Bank study (2011) findings with the Student Employability Skills Study, 2014.

Skill/Attribute*	Level of Importance		
	World Bank Study, 2011(study I)	Student Employability study, 2014 authors (study II)	
		Employer responses	Faculty responses
Honesty, Integrity and Dependableness	1	1	2
Reliability	2	3	16
Teamwork	3	2	2
Willingness to Learn	4	7	6
Entrepreneurship	5	23	17
Self-Discipline	6	6	4
Self-Motivation	7	9	5
Flexibility and adaptability	8	10	14
Understands and takes direction for work assignments	9	4	13
Use Appropriate Modern Tools, Equipment, Technologies	10	17	11

(\* The ratings of study I, calculated by the authors based on the mean scores given in the Blom and Saeki, 2011 report)

Comparing the top ten in the World Bank study with the ranks these were assigned by the employers in the present study, we could observe that the first three skills/attributes, i.e., honesty related attribute, reliability and teamwork, have occupied their places in both 2011 study and 2014 study, with slight difference in their ranks of importance. 'Entrepreneurship skills' (difference of 18), 'use of appropriate modern tools, equipment and technologies' (difference of 7), 'understands and takes directions for work assignments' (difference of 5) and 'willingness to learn' (difference of 3) - these are the ones which had noticeable differences.

The skills by importance, given in table 2, also picture the significance of personal qualities in the gamut of employability skills. The value given by employers for honesty related attribute has remained the same, despite the sample and year of study being different. Personal qualities such as honesty, reliability, flexibility and adaptability, need to be developed from childhood onwards. While the employers may be able to develop organisation-specific technical skills, it may not be easy for them to develop personal attributes. A lower rank given by the employers in the 2014 study for the 'use of appropriate modern tools, equipment and technologies' demonstrates their confidence to develop this skill through their own training. Entrepreneurship skill is given only 23<sup>rd</sup> position in the present study. May be there are other skills more important than this, for an entry level engineer; entrepreneurship skill may be more important only after one or two years of their employment.

As years passed by, employers appear to be more and more concerned about the way in which an entry level engineer responds to directions from his/her superior. When asked to rank the importance of 'understands and takes directions for work assignment', the employers in the 2014 study, considered this as the fourth important skill, while it was only ninth in importance in the World Bank study. The employers in the present study might have experienced the difficulties on account of carelessness from the part of newly recruited engineers. Clarity of what to be done and how to do them, is basic to the achievement of competencies-professional as well as personal.

Comparing the faculty responses with the World Bank study, except the rank number two (reliability) in 2011 study, skills ranked one, three, four and six-honesty, , teamwork, willingness to learn, and self-discipline respectively, - have found places among the top seven. This tells us that faculty responses are in unison with that of the employers. The major differences observed were for the following skills.

- Reliability (16<sup>th</sup> rank by faculty)
- Entrepreneurship (17<sup>th</sup> rank by faculty)
- Flexibility and adaptability and (14<sup>th</sup> rank by faculty)
- Understands and takes direction for work assignments (13<sup>th</sup> rank by faculty)

The skills and attributes may vary in importance from sector to sector and from organisation to organisation, sometimes, even from one department to another. Going through these different skills, what one has to remember is the value of the appropriate combination of skills. Excellence in one or two skills will not lead to employability. One should have the capacity to acquire, develop and market these skills, as per the contextual requirements, to succeed in the employability corridors.

#### **4.4 Suggestions from the Faculty and Employers to Improve the Overall Employability of Engineering Students**

Through an open-ended question, the two groups, employers and the faculty were requested to offer their suggestions for the overall enhancement of the employability skills of the engineering students. Most of the respondents were generous in recording their suggestions in the questionnaire. Among these, enthusiasm, self-confidence, self-motivation, the need to receive training from home to acquire the quality of responsibility, willingness to learn, attitude to learn, other interpersonal and problem-solving skills were listed by the faculty. The employers' suggestions included, the need for - in-depth subject knowledge, practical application, the right skill and aptitude for work, learning with minimal guidance, understanding the tasks to do, not to wait for step-by step direction, social commitment and dedication.

The qualitative inputs contributed to this study by the faculty and employers give much food for thought. Industry-oriented curriculum, application focused teaching methodology, project orientation with qualitative and innovative approach, setting rigorous and on-going assessment and evaluation system, internship during the academic course itself, provision of adequate facilities, team based co-curricular and extra-curricular activities, exposure to modern technology, research and industries, developing entrepreneurial mind, and above all, developing an enabling environment for self development-these are but a handful of base level solutions only. The road to international standards, is too far, but reachable, too.

### **5. Conclusion**

Student Employability Skill development, is a process, requiring utmost diligence and vision. Raising the standard of these skills in a qualitative manner, to reach global levels, and to sustain and refine those, calls for strategic intervention, efforts and collaboration with various partners at various levels. With a strong political and social will to achieve, the impossible becomes possible.

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#### **Note to the Editor**

Please note that the research paper by Blom and Saeki (2011), (.). Employability and Skill Set of Newly Graduated Engineers in India. Policy Research Working Paper 5640, The World Bank. From [www.worldbank.org](http://www.worldbank.org) has authorized public disclosure in their document itself. Rest of the references are government /govt. authorised organisations with public access.

# Organizational Culture as a Moderator of the Human Capital Creation- Effectiveness: The Indian Companies Perspectives



ISBN: 978-1-943295-01-2

**Geeta Rana**

Roorkee Institute of Technology, Roorkee  
(geetaphd@rediffmail.com)

*Due to maximizing organizational benefits for achieving competitive advantage, organizations gradually shift their views from human resources to human capital and constantly strive to implement strategies related to human capital creation. In this context, Indian organizations are making more investment into human capital creation so that their employees symbolize his/her potential to contribute to organizational financial performance and productivity. The purpose of this paper is to analyze how knowledge based employees, perceive their human capital creation through organizational investment. The data from a survey of 170 employees in India were used empirically to test the proposed research model. Moreover, hierarchical regression analyses, and correlation analysis techniques were used to analyze the data. The results show that factors of human capital creation (human resource management measures and leadership measures) are the antecedents of organizational effectiveness. Human capital creation practices empowering employees to be creative and innovative in order to create a greater organizational knowledge at workplace which lead to effectiveness. This paper suggests that human capital practices influence employees skills, attitudes, and behavior to do their work and they will be more able to create more value and achieve superior competitive advantage for employees.*

**Keywords:** Human Capital Creation, Leadership, Effectiveness, Career Management, Reward

## 1. Introduction

Organizations today have an entirely new way to compete by maximizing their existing capabilities within the organization; and the abilities to do so may be the key source of competitive advantage in the current times. Organizations typically create capabilities through human capital creation practices. These practices are about ensuring effective and efficient deployment of existing human resources for capability maximization. Human capital creation practices are the key element in creating an overall effectiveness. Human capital as a core competence is described as one of the main indicators of organizational effectiveness (Shimizu, and Kochhar, 2001). In the changing economic scenario, organizations should understand that right set of human capital, at the right time, at the right cost and at the right place which only reap the benefits for organization. The effectiveness or success of an organization is generally viewed from human capital capability and organizational culture as infrastructure capability. Organizational culture weaves all the said elements into a uniform thread, hence strengthening the element.

Until recently, researchers had made few systematic attempts to explore the influences of an organization's culture on the behavior of employees. It is often suggested that culture operates as a unitary "main effect" on all people. On the other hand organizational effectiveness literature has also been increasingly emphasizing the importance of culture in motivating and maximizing the value of its intellectual assets, particularly its human capital (Melero, 2004). Today's organization significantly nurturing the culture for recognizing human capital capabilities that are aligned to the business effectiveness. Therefore, organizations invest greatly in firm-specific human capital development than generic human capital because of its value and uniqueness (Snell & Dean, 1992). The importance of organizational culture, and therefore the importance of managing it in order to balance global and local effects appropriately, rests in the fact that organizational culture has been linked with leadership and employee effectiveness (Kooij et al. 2008), productivity (Dolan & Garcia, 2002), and satisfaction (Fry, 2003) which subsequently lead to overall effectiveness. More recently, the moderating effect on the relationship between human capital creation and organizational effectiveness has drawn substantial attention (Motley, 2007, Birasnav and Rangnekar, 2009). Cultural factors, such as tradition, are argued to act as a moderator in the relationship between human capital creation and organizational effectiveness (Pareek, 2007). The present study builds upon and extends previous research on organizational effectiveness in two ways. First it expands prior research by concurrently examining the effects of human capital creation and its factors human resource management and leadership on organizational effectiveness. In addition, the present research also identifies the specific dimensions of human capital creation which are important predictors of organizational effectiveness.

Second, we test the moderating effects of the organizational culture on the relationships between human capital creation and organizational effectiveness. The development of sustainable competitive advantage is a vital management function and an important requirement is the nurturing of a human capital to enable the organization to develop resources better than competitors and create sufficient knowledge to address the industry's future success factors. In knowledge intensive Indian



organizations culture plays a critical role in the strategic management of its human capital and to leverage its knowledge for business performance improvement.

## 2. Literature Review

Tiwari and Thakkar (2005) in their book has conceptualized following practices as main practices of human capital creation: Performance management, compensation design, training & development, organizational effectiveness, change management and recruiting & retention. Mayo (2000) focuses on a definition of human capital and defines it as: capability, knowledge, skill, experience and networking with the ability to achieve results and the potential for growth. The definition of human capital encompasses in itself individual motivation in the form of aspirations, ambitions, drives, work motivations and productivity which lead to organizational effectiveness. Human capital can also be described as work group effectiveness in the form of supportiveness, mutual respect sharing and values; leadership in the form of clarity of vision and ability to communicate that vision; organizational climate in the form of culture particularly the freedom to innovate, openness, flexibility and respect for the individual make organization effective. Such human capital benefits are high individual return on investment, increase of compensation being a future leader, opportunity to participate in high profile project and increase in status and authority (Ulrich, 1999; Biraasnav and Rangnekar, 2009). Ingham (2007) has defined that human capital exists as a resource and a capability at individual and organizational levels. Individual human capital can be acquired by attracting and selecting staff with the right skills and experience. It can be developed through learning. Human capital can be converted into an organizational resource by aligning people with the organization, engaging its owners and investors so that they will choose to make it available to the organization. This can then be leveraged by applying it to meet business requirements. Weatherly (2003) explains that human capital can be developed and cultivated but it can also decide to leave the organization, become sick, disheartened and even influence others to behave in a way that may not be to the advantage of an employer, thus usurping or siphoning off resources intended for use elsewhere in the organization which lead to organizational effectiveness. According to CIC (2003) organizational culture is the set of values, norms and behaviors shared and by most members of the organization which influence firm performance and returns. Berthon (1993) views culture as the results of the human actions and shows the link between the ideas of mental programming and the consequence of behavior derived from this. Maznevski (1994) opines that cultural awareness facilitates to perform a set task successfully. Knowledge is a crucial factor behind sustainable competitive advantage and overall success of companies, and knowledge issues are closely interlinked with organizational culture (Davenport and Prusak, 1998). As culture has no fixed or broadly agreed meaning, many authors have explained their view about organizational culture. In addition, culture prevails in the organization through artifacts, language in the form of jokes and metaphors, behavior patterns in the form of rituals and ceremonies, norms of behavior, heroes, symbols, and symbolic actions, and history (Brown and Heywood, 1995). On relating to human capital, a knowledge-enriching culture in the organization is characterized by empowered individuals, active learning from customers, results of individual's own actions, a constant search for improvement and innovation, boundary crossing individuals spend much time on interacting with non-team members, encouragement of experimentation rather than blindly following rules, and willingness to share knowledge widely among colleagues, who may be in different groups (Skyrme, 2001) finally, make organization competence in competitive environment. Yukl (2006) defined leadership as "the process of influencing others to understand and agree about what needs to be done and how to do it, and the process of facilitating individual and collective efforts to accomplish shared objectives. Interim leadership is described as an engagement of executive on a temporarily vacant position for a limited period of time (Birasnav and Rangnekar, 2008). There are two kinds of interim leadership ubiquitously exercised in any organization: external employee's interim leadership on occupying a management role for a short period of time not more than nine months (Spitze *et al.*, 2004); and internal employee's interim leadership on filling a vacant position for a specific period (Weingart, 2003). This study assumes that interim leadership is temporarily performed by a homegrown employee on behalf of immediate superior, who is temporarily or permanently absent due to resignation or off-site duties or illness or vacation. Thus, interim leader significantly contributes to achieve organizational goals, and simultaneously avails opportunities to gain executive experience, career advancement, and salary bonus (Goler, 2003). Kanungo and Medonca (1994) suggested that HRM policies and practices, which are used to control and direct behavior and performance, are largely the result of managerial beliefs. That reflects the combination of different managerial beliefs via culture to business practices. Organizational culture has been defined as relatively stable beliefs, attitudes and values that are held in common among organizational members shared normative beliefs and shared behavioral expectations (Cooke & Szumal, 1993). The environment has long been recognized as a source of influence on the individual's behavior. Whilst there are a variety of opinions as to what constitutes 'culture', this paper adopts a definition which synthesizes the views of a number of widely cited researchers including Schein (1992). Thus, culture is defined in this paper as the dynamic set of assumptions, values and artifacts whose meanings are collectively shared in a given social unit at a particular point in time. Hofstede (1991) developed four dimensions of culture based on an extensive survey conducted among IBM managers in over 50 countries for work values and subsequently developed those dimensions of culture compatible in a sense to the business practices. Work Culture is now seen as increasingly more important by managers, management scholars and consultants. Key attributes of any functional work culture include: establishing a clear and well documented work process, treating employees fairly and consistently, participating in training and continuing education (Pool, 1997). Bryson (2008) addressed the issues of time and perspectives which underlie the contested nature of culture by explaining the dynamics of organizational change through dominant, residual and emergent culture which make organization effective..

**Hypothesis 1:** To study the significant relationship between human capital creation (recruitment strategy, training, reward strategy, performance appraisal, and career management) and organizational effectiveness as well as prediction of organizational effectiveness with human capital creation, as the criterion variable.

**Hypothesis 2:** To study the significant relationship between leadership measures (interim and transformational leadership) and organizational effectiveness as well as prediction of organizational effectiveness with leadership measures, as the criterion variable.

**Hypothesis 3:** Organizational culture moderates the relationship between human capital creation and organizational effectiveness.

### 3. Research Methodology

#### Sample and Procedure

The study was conducted on a sample of 170 executives working in Indian organizations. The convenient purposive sampling procedure is used to collect the data. Data was collected on the basis of a questionnaire related to human capital creation practices (HCC), organizational culture (OC) and organizational effectiveness (OE). Apart from this, personal information was also collected on the basis of certain factors as: age, gender, educational qualifications, designation and work experience. The descriptive statistics of the demographic variables as: gender, age, educational qualifications and work experience have been shown in Table 1.

**Table 1** Mean, Standard Deviation, and Inter-Correlation between Human Capital Creation and Organizational Effectiveness (N = 170)

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	β	R <sup>2</sup>	ΔR <sup>2</sup>	F-value	
<b>Control Variables</b>										
Age	.13*	.06	-.04	-.01	-.02	.16	.03	.01	16.45	
Gender	.15*	.09	-.02	-.03	-.06	.19	.06	.04	3.49	
Education	.05	-.03	-.07	-.01	-.01	.10	.02	-.05	6.72	
Rank	.17*	.11*	.10**	.03	-.02	.18	.06	.02	19.12	
Tenure	.07	.04	.09	.02	.01	.09	.05	.01	5.62	
<b>Direct Effect</b>										
<b>HCC</b>										
<b>HRM Factors</b>										
Recruitment Strategy		.11*	.09	-.01	-.03	.45	.29	.24	78.12	
Training		.19*	.12*	-.11	-.13	.59	.31	.43	65.17	
Performance Appraisal		.16*	.07	-.01	-.21	.43	.34	.29	35.67	
Reward Strategy		.13*	.05	-.02	.03	.41	.28	.41	49.34	
Career Management		.17*	.10*	-.06	-.04	.60	.45	.56	51.54	
<b>Leadership Factors</b>										
Interim Leadership			.09	.03	-.04	.15	.59	.34	57.34	
Transformational Leadership			.29*	.19*	.07	.56	.57	.22	65.11	
<b>Organizational Culture</b>										
<b>Interaction Effect</b>										
RS*OC					.05	.02	.36	.12	48.12	
T*OC					.30*	.29	.49	.23	55.17	
PA*OC					.36*	.23	.34	.45	35.61	
RS*OC					.49*	.27	.13	.67	49.34	
CM*OC					.38*	.45	.29	.32	41.44	
IL*OC					.09	.10	.12	.11	34.13	
TL*OC					.47*	.34	.47	.34	45.12	
R <sup>2</sup>	.21	0.49	.45	.49						.33
Adjusted R <sup>2</sup>	.19	.22	.23	.19						.18
F	21.96*	45.23*	23.45*	34.12*						56.27*

**Table2** Hierarchal Regression

	Variable	Mean	S.D	1	2	3	4	5	6	7	8	9	10	11	12	13
1	Age	23.45	10.91													
2	Gender	13.09	4.29	-.08	1											
3	Tenure	19.22	4.89	.03	.01	1										
4	Education	21.21	5.47	.07	-.04	.00	1									
5	RS	23.45	5.27	.22	.02	.02	.13	1								
6	Tran	13.24	3.58	.08	.04	.07	.03	.18*	1							
7	PA	29.23	3.60	.09	.05	.05	.05	.21*	.07	1						

8.	RS	17.45	3.58	-.35	-.01	.03	-.04	.32*	.09	.15*	1						
9.	CM	30.23	3.56	.34*	.19*	.11	.10	.21*	.21*	.23*	.16*	1					
10.	IL	27.78	4.34	.19*	.11	.10	.08	.19*	.32*	.28*	.34*	.17*	1				
11.	TL	31.46	4.34	.34*	.04	.09	.01	.12	.12	.33*	.41*	.23*	.19*	1			
12.	OC	45.89	3.25	.12	.09	.03	.07	.33*	-.24	.23*	.31*	.19*	.32*	.11*	1		
13.	OE	42.45	3.45	.21*	.02	.01	.01	.49*	.39*	.47*	.40*	.64*	.47*	.50*	.51*	1	

Note: Coefficients are Standardized Beta Values; \* $p < 0.01$ ; \*\* $p < 0.05$ ;

#### 4. Measurement

##### Independent Variable

Human Capital Creation was measured by Birasnav and Rangnekar (2009), which tests the firms human capital creation practices in multi-faceted environment to achieve competitive advantage. The scale yields the measure of human capital creation into eight factors. These are *as recruitment strategy, training, performance appraisal, career management, reward strategy, transformational leadership and interim leadership* which constitute the concept of human capital creation. Participants were asked to respond on a five point Likert-scale ranging from 1= Strongly Disagree to 5 = Strongly Agree. The reliability coefficients for *recruitment strategy, training, performance appraisal, career management, reward strategy, transformational leadership and interim leadership* are: .78, .70, .71, .68, .60, .82, and .68 respectively.

**Organizational Culture** was measured by the competing value framework (CVF) as a conceptual framework to integrate criteria of organizational "effectiveness" of Kalliath et al. 1996. The scale consist of 14 items an four dimensions as hierarchical, entrepreneurial, team, and rational. Each item was rated on a 5-point scale. In the CVF, labeled *hierarchical cultures* (also sometimes referred to as "bureaucratic" cultures), adopt centralized authority over organizational processes; respect formal hierarchy; and adhere to rules. They place a premium on stability and predictability. Organizations with an internal focus and emphasis on flexibility, labeled *team cultures*, encourage broad participation by employees, emphasize teamwork and empowerment, and make human resource development a priority. Organizations with an external focus and emphasis on flexibility, labeled *entrepreneurial cultures*, exhibit creativity and innovativeness; they place a premium on growth and expanding resources. Finally, organizations with an external focus and an emphasis on control, labeled *rational cultures*, are characterized by clarity of tasks and goals. They place a premium on efficiency and measurable outcomes. The reliability coefficients for hierarchical, entrepreneurial, team, and rational are: .69, .85, .82, .68, and .80 respectively.

##### Dependent Variable

**Organizational Effectiveness** ((Cronbach's alpha= .76) was measured by the eight-item scale of Mott, 1972 to tap the perceived organizational effectiveness. The scale consisted of such dimensions as quality, quantity, efficiency, adaptability, and flexibility. Each item was rated on a 5-point scale.

**Control Variables:** Control variables of gender, age, rank, educational qualifications, designation and work experience were controlled for the potential effects on HCC through independent variables OC. In the hierarchical regression analyses OE were regressed by biographical variables (step1), HCC and OC (step 2) and moderating interaction of HCC and OC (step3).

#### 5. Results

The means, standard deviations and Pearson correlations for demographic variables, Human capital creation, organizational culture and organizational effectiveness are presented in Table 1. It can be observed that our hypotheses is generally supported by the strong correlations between each of the independent variables and the dependent variables, the strength of this relationship varies widely between .45 (lowest) and .91 (highest). Prior to hypothesis testing, the degree of multicollinearity between independent variables was examined using variable inflation factor (VIF). The degree of multicollinearity between all the constructs in this study (VIF ranged from 1.99 for age, 1.5 for gender and 2.1 for tenure in the organization-all control variables) was found to be well below the allowable maximum (10; Nester, Wasserman and Kunter, 1989). The variable of focus (recruitment strategy, training, performance appraisal, career management, reward strategy, transformational leadership and interim leadership, organizational culture and organizational effectiveness) has consistent VIFs of 2.9 to 5.3, well below the cutoff of 10. Therefore, we can conclude that distinct interpretations of the associations between the variables are allowed in our study.

We next conducted a series of hierarchical multiple regression analyses to assess the incremental-explanatory power of variables in each block and to control statistically for demographic variables (Aiken and West, 1991). Moderated regressions were used to test the hypothesized relationship (Cohen and Cohen, 1983). As seen in the table 2, when five demographic variables were entered into the regression equation in the first step, the co-efficient of determination  $R^2$  was found to be .21, indicating that 21 percent of organizational effectiveness is explained by demographic variables. When HCC factors was entered in the second step, R-square was .49 percent, indicating that 49 percent of OE is explained by HRM factors. On the whole, we can say that career management is the strongest predictor of organizational effectiveness with the calculated Beta value as .45. Thus hypothesis 1 was supported. In the third step leadership measures (interim leadership and transformational leadership) were entered, only transformational leadership emerged as a significant predictor, partially supported hypothesis 2. When organizational culture was entered in the fourth step, the R-square value changed to .33 at significant level, indicating

that additional 33 percent of OE is explained by organizational culture. Thus hypothesis 3 was supported. To fully test for the two-way interaction effects, we followed the guidelines suggested by Aiken and West (1991) for moderated regression. We plotted the slopes at one standard deviation above and below the mean of the focal-moderator variable. Seven interaction terms were added into the equation. The results of the moderated regression analysis indicate that organization culture buffers the positive relation between human capital creation and organizational effectiveness. In terms of the moderation hypothesis, out of the seven, only five were significant. Thus hypothesis 3 was partially supported. This Performing HRA needs a step by step procedure to enter independent variables the HRA blocks of SPSS 18. To eliminate the variance explained by control variables, these variables should be entered in the first block. HRM factors (recruitment strategy, training, performance appraisal, career management and reward strategy) and leadership factors such as interim leadership and transformational leadership are entered in the second and third block. Organizational culture and organizational effectiveness are entered in the fourth and fifth block. Finally, HRM factors such as recruitment strategy, training, performance appraisal, reward strategy, and career management are entered in the fourth block. Significant increment in R2 and standardized beta value ( $\beta$ ) will support the each hypothesis ( $\Delta R^2 = 0.45$ ;  $F = 51.14$ ,  $p < 0.01$ ).

## 6. Discussion

On the basis of the obtained results, it can be suggested that factors of Human capital creation (human resource management measures and leadership measures) are the antecedents of organizational effectiveness. Human capital creation practices empowering employees to be creative and innovative in order to create a greater organizational knowledge at workplace which lead to organizational effectiveness. From the findings, it is showed that HRM factors play a crucial role in developing human capital creation which lead to organizational effectiveness. Particularly, performance appraisal, career management, reward strategy and training play an important role to develop human capital creation which leads to organizational effectiveness. This study showed that presence of HRM factors in the organization make employees competent and effective and improve employees' perception on human capital creation which lead to organizational effectiveness. Organizational leadership (transformational and interim leadership) plays an important role in supporting sustainability through the development of various styles and capabilities which enable organizations to ensure those ideas about ecology, sustainability and social justice which provide conducive platform for organizational effectiveness. In this regard, it should be noted that transformational leaders are more focused on development of employees or followers, and are stimulating their intelligence to contribute on firm's innovation (Aragon-Correa *et al.*, 2007). This is achieved from following a path that motivate and inspire their employees by providing meaningful and challenging work creating a vision. Training augments return on investment from employees, their wage or salary, and even increases opportunities to participate in high level projects. Due to these reasons, employees' highly perceive their human capital creation in their firms (Bass and Riggio, 2006). Interim leadership is positively related to employee's ability to and they get more opportunities to perform interim role. When employees find that career advancement in the present organization is more beneficial, they start to feel strong commitment to their organization (Bass and Riggio, 2006). Therefore, committed employees perceive high human capital creation. This study found that organizational culture, play a moderate role for human capital creation and organizational effectiveness. Researchers showed that innovation-supportive culture fosters employees' creativity, willingness to experiment, and risk-taking skills (Jassawalla and Sashittal, 2002). These skills are specifically considered as the components of human capital. Therefore, it is obvious that employees perceive more about human capital creation when they work under this kind of culture. Employees are provided with more autonomy under employee-supportive culture, which encourages employees to get involved in the decision making process. Thus, firms encourage 'freedom to innovate' concept among employees.

## 7. Conclusions

Human capital is the source of competitive advantage, and immensely supports firms for their sustainability in the global turbulent and dynamic market environment. Due to the importance of human capital, managers and researchers involving in the field of HRM and constantly try to identify the developmental or creational process of human capital for organizational effectiveness.

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# Employee Benefits from Training and Organisational Commitment - A Review



ISBN: 978-1-943295-01-2

**Geethu Anna Mathew**  
**Siby Zacharias**

Mahatma Gandhi University, Kottayam  
(annamathew123@gmail.com)  
(sibyzac@gmail.com)

*Organizational commitment has clearly emerged as the most recognized and researched construct of the employee's attachment or loyalty to the organization. Training makes a very important contribution to the development of the organizations human resources. The objective of this study is to investigate the relationship between employee benefits from training and organizational commitment. To meet this purpose, extensive literature review was done to find the relationship between training benefits and organizational commitment. The variables identified in the study are Employee benefits from training (personal, career, job-related benefits) and Organisational commitment (affective commitment, normative commitment, continuance commitment).*

**Keywords:** Organizational Commitment, Training Benefits, Career Development

## 1. Introduction

Employee training has become increasingly important for hotels to improve service quality, decrease labor costs, increase productivity and profitability, and effectively manage workforce diversity (Kim, 2006). The knowledge and skills of an organization's workforce have become increasingly important to its performance, competitiveness, and innovation (Lawler, Mohrman, & Ledford, 1998; Martocchio & Baldwin, 1997). Training can be viewed as a management practice that can be controlled or managed to elicit a desired set of unwritten, reciprocal attitudes and behaviors, including job involvement, motivation, and organizational commitment (Sparrow 1998). Trained employees are more likely to take pride in organizational achievements; believe in the goals; committed to their organizations and values of the organization and, therefore, exhibit higher levels of performance. Organizational commitment is the employee's acceptance, involvement and dedication towards achieving organizational goals. Organizational commitment is commonly conceptualized as a multidimensional construct consisting of three components (Allen & Meyer, 1997). An employee with high level of organizational commitment is an asset for the organization because reduced labour turnover and increased performance can be ensured from them. Highly trained, satisfied and committed employees in the hotel industry, delivering high service quality levels to the tourists, is of paramount importance, whereby the employees are often seen as an integral part of the service experience (Kyriakidou et. al.; 2010; Chand, 2010; Vinten, 2000). Moreover, training has a positive effect on productivity and makes it important for firms to invest in training (Jennifer, et. al.; 2013). This study explores a different way to assess the outcome of training in organizations, that is, by examining the relationship between employee benefits from training and organizational commitment based on the literature reviews done.

## 2. Significance of the Study

Emphasizing and implementing dominant training and development programs are becoming more critical in order to accomplish organizational objectives and goals. An organisation to survive in this competitive world must have a committed work force. Organisational commitment of employees can be enhanced through different ways. Training can be viewed as a management practice that can be controlled or managed to elicit a desired set of unwritten, reciprocal attitudes and behaviours, including job involvement, motivation, and organizational commitment. The significance of the study was to develop a conceptual framework on the relationship between employee benefits from training and organizational commitment. The purpose of the study was accomplished through the review of previous studies in the particular area.

## 3. Methodology of the Study

The present study is conceptual in nature. Data has been collected from various sources including books, research papers, newspapers, magazines and websites for the purpose of study.

## 4. Summary of Theoretical Framework

### Organizational Commitment

Organizational commitment refers to the strength of attachment of a person to his or her organization (Arnold, 1998). (Meyer and Allen, 1997) suggested that a 'committed employee is one who will stay with the organization through thick and thin, attends work regularly, puts in a full day, protects company assets, and who shares company goals. Organizational commitment is a concept that is increasingly being considered an important variable in explaining work-related behavior because of its assumed impact on performance (Benkhoff, 1997). Organizational commitment is recognized as one of the

major determinants of organizational effectiveness (Steers, 1975). (Meyer and Allen, 1997) suggest that it is not financial rewards that develop organizational commitment; rather, employee commitment to the organization is based on the opportunity the organization offers its employees to conduct important and challenging work, the interaction with interesting people, and the environment that facilitates developing and building new skills.

### **Employee Benefits from Training**

Noe and Wilk (1993) grouped employee training benefits into three categories: personal benefits, career benefits and job-related benefits. Personal benefits represent the extent to which employees believe that participation in training activities help them network, improve their job performance and make progress towards their personal development. Career benefits result from participation in training activities that lead to identifying career objectives, reaching career objectives and creating opportunity to pursue new career paths. Job-related benefits lead to better relationships between peers and managers, and provide a necessary break from the job (Noe & Wilk, 1993).

## **5. Literature Review**

**Phillips (1997)** investigated from his study that organizational commitment is one of the benefits of employee training.

**Bartlett (2001)** studied the relationship between employee attitudes toward training and feelings of organizational commitment among a sample of 337 registered nurses from five hospitals. The study revealed that perceived access to training, social support for training, motivation to learn, and perceived benefits of training are positively related to organizational commitment.

**Ahmad & Bakar (2003)** conducted a study on the relationship between training and organisational commitment. The major findings of this study suggested that individual perception on training plays an important role in affecting organizational commitment. It was found that availability of training, support for training, and motivation to learn were significantly and positively associated with affective, normative, and overall organizational commitment but not continuance commitment. On the other hand, training environment and benefits of training seemed to correlate with all three types of commitment as well as overall commitment.

**Bartlett & Kang (2004)** examined the relationship between employee attitudes related to training and organizational commitment among a sample of nurses in New Zealand and the United States. Results show that perceived access to training, supervisory support for training, motivation to learn from training and perceived benefits of training were positively related to the affective and normative components of organizational commitment.

**Azad & Michael (2007)** examined the relationship between the beliefs of senior staff Qatari national employees regarding training benefits as measured by the benefits of employee training, and employees' organizational commitment. The key finding of their study was there is a positive relationship between employees' beliefs regarding training benefits and employees' organizational commitment. Additionally, the findings revealed that personal benefits of employee training and age are significantly related to affective and normative commitment, and career benefits of employee training and years of service are significantly related to continuance commitment.

**Tharenou & Saks (2007)** conducted a study on training and organizational-level outcomes. The study identified that training is related independently to organizational outcomes in support of the universalistic perspective of strategic human resource management rather than a configurationally perspective.

**Bulut & Culha (2010)** study investigated the impact of organizational training on employee commitment focusing on employees emotional and affective responses towards their organization. The results revealed that all dimensions of training positively affected employee commitment. Also organizational training should be considered as an antecedent to enhance employee's commitment to their organization in order to use organizational training as a motivator of organizational commitment.

**Newman & Thanacoody (2011)** investigated the impact of employee perceptions of training on organizational commitment, and its relationship with turnover intentions. The findings differ from that of previous studies in non-Chinese settings. No evidence was found to indicate that motivation to learn and the perceived benefits of training impact on the organizational commitment of employees. This may be explained by three factors: the involuntary nature of employee training, the limited career development opportunities on offer to local employees of multinational enterprises and the difficulty employees face in applying learnt skills given cultural differences.

**Sudhakar & Rao (2011)** evaluated the perception of employees on their training and development programme. The findings of this study show that there are various possibilities to increase the effectiveness of the training programme. Organization should identify the needs of the employee and encourage them to participate in training and development programme.

**Yang & Sanders (2012)** analyzed the connections between employee's perceptions of training, in terms of perceived training related benefits, perceived supervisor support for training, and perceived access to training and their three types of organizational commitment continuance, affective, and normative. The results showed that employee's perceptions of training were related to their commitment to the organization.

**Riaz & Idrees (2013)** studied about the relationship between Employees belief about training benefits including personal, job and career related benefits and their impact on organizational commitment in banking sector of Pakistan. The results include that there is significant positive relationship between employee perception of training benefits and organizational commitment. Furthermore, results revealed that the employees who are having positive attitude towards training as they perceive that they will get different benefits from training and who expect that they will get benefits by participating in training programs, they are likely to be more committed with their employers than those who perceive training a leisure activity.

Rollah & Hussain (2014) studied the employee perception regarding training and development programs in the health sector of Pakistan. It has been observed that employees neither motivated nor they perceive training very important in the current situations as they see no benefits other than just a formality in the routine job.

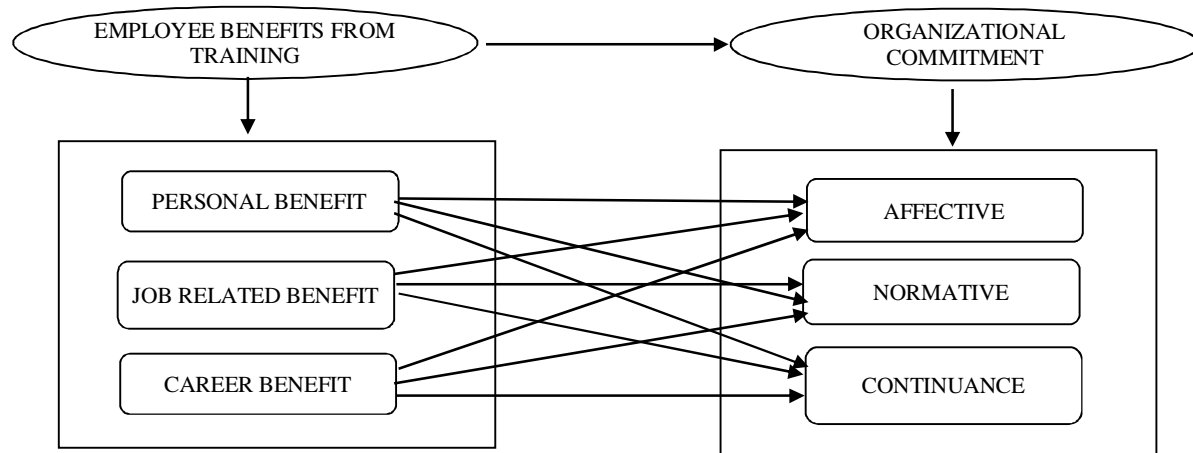
### 6. Variables Identified

Title of the paper	Authors	Journal	Variables identified
Relationship between employees' beliefs regarding training benefits and employees' organizational commitment in a petroleum company in the State of Qatar	Mohammed AsadShareef Al-Emadi& Michael J. Marquardt (2007)	International Journal of Training and Development Vol: 11:1	<ul style="list-style-type: none"> <li>• Personal benefits</li> <li>• Career benefits</li> <li>• Job-related benefits</li> <li>• Affective commitment</li> <li>• Continuance commitment</li> <li>• Normative commitment</li> </ul>
The association between training and organizational commitment among white-collar workers in Malaysia	Kamarul Zaman Ahmad &Raida Abu Bakar (2003)	International Journal of Training and Development Vol: 7:3	<ul style="list-style-type: none"> <li>• Availability of training</li> <li>• Support for training</li> <li>• Motivation to learn</li> <li>• Training environment</li> <li>• Perceived benefits of training</li> <li>• Affective commitment</li> <li>• Normative commitment</li> <li>• Continuance commitment</li> </ul>
The Relationship Between Training and Organizational Commitment: A Study inthe Health Care Field	Kenneth R. Bartlett (2001)	Human Resource Development Quarterly vol. 12, no. 4	<ul style="list-style-type: none"> <li>• Perceived access to training</li> <li>• Perceived support for training</li> <li>• Training Motivation</li> <li>• Perceived benefits of training</li> <li>• Job satisfaction</li> <li>• Job involvement</li> <li>• Affective commitment</li> </ul>
Training and organizational commitment among nurses following industry and organizational change in New Zealand and the United States	Kenneth Bartlett &DaeSeok Kang (2004)	Human Resource Development International Vol7:4 pp. 423-440	<ul style="list-style-type: none"> <li>• perceived access to training</li> <li>• training frequency</li> <li>• motivation to learn</li> <li>• benefits of training</li> <li>• supervisory support for training</li> <li>• Organizational Commitment</li> </ul>
Employees' Belief Regarding Training Benefits and Organizational Commitment: A Case in Banking Sector of Pakistan	Amir Riaz&Rana Nadir Idrees (2013)	Middle-East Journal of Scientific Research 16 (3): 310-318	<ul style="list-style-type: none"> <li>• Personal training Benefits</li> <li>• Career Related training Benefits</li> <li>• Job Related training Benefits</li> <li>• Organizational Commitment</li> </ul>
The impact of employee perceptions of training on organizational commitment and turnover intentions: a study of multinationals in the Chinese service sector	Alexander Newman & Rani Thanacoody (2011)	The International Journal of Human Resource Management, Vol. 22, No. 8, 1765-1787	<ul style="list-style-type: none"> <li>• Perceived availability of training</li> <li>• Motivation to learn</li> <li>• Perceived supervisor support for training</li> <li>• Perceived co-worker support for training</li> <li>• Perceived benefits of training</li> <li>• Turnover intentions</li> </ul>
The effects of organizational training on organizational commitment	CagriBulut& Osman Culha (2010)	International Journal of Training and Development Vol: 14:41	<ul style="list-style-type: none"> <li>• Motivation for training</li> <li>• Access to training</li> <li>• Benefits from training</li> <li>• Support for training</li> <li>• Affective Organizational Commitment</li> </ul>



Literature reviews of employee training and organizational commitment suggests that there is a relationship between employee training and organizational commitment. A conceptual framework of employee benefits from training and organisational commitment was developed.

## 7. Conceptual Framework



Source: Literature Review by the Author

**Employee Benefits from Training** refer to employees' perceptions of positive results they can obtain by participating in training and development activities (Yang Huadong 2012)

**Personal Training Benefits** explain as the extent to which employees think that by attending and participating in training activities their job performance will improve, it help then in networking and facilitate them in personal development (Noe, R.A. and S.L. Wilk, 1993)

**Career-Related Benefits** include leading to determine and attaining career objectives and creating opportunities to identify and select new career options (Noe, R.A. and S.L. Wilk, 1993)

**Job-Related Benefits** are those benefits that provide necessary skills and abilities required to perform job and leads towards better relationship with peers and with managers (Noe, R.A. and S.L. Wilk, 1993)

**Organizational Commitment** refers to the relative emotional strength of employees' identification with and involvement in a particular organization (Porter, Steers, Mowday and Boulian, 1974)

**Affective commitment** refers to employees' emotional attachment to, identification with and involvement in the organization (Allen and Meyer 1997)

**Normative commitment** refers to employees' feelings of obligation to their superiors, peers, subordinates and other third parties to remain within the organization (Allen and Meyer 1997)

**Continuance Commitment** is a form of psychological attachment to an employing organization that reflects the employees' perception of the loss he/she would suffer if they were to leave the organization (Allen and Meyer 1997)

## 8. Findings from the Literature

The present study is a conceptual framework of employee benefits from training and organisational commitment. Based on the previous research studies the researcher proposes a relationship model for benefits from training and commitment of employees in an organisation. Variables identified from the literature review forms part of the conceptual model. Several studies investigated the relationship between benefits of training and organisational commitment. The results differed based on the industry, the employee profile, their demographic features etc. According to the study by Azad & Michael (2007) demographic factors along with career benefits and personal benefits from training are related to affective, normative and continuance commitment. According to Ahmad & Bakar (2003) benefits of training were the second most important predictor of affective and normative commitment; the most important training factors in determining overall organizational commitment were support for training followed by the benefits of training. Bartlett (2001) suggests that employees who expect benefits from their participation in training are likely to be more committed should encourage a more strategic approach to linking outcomes of training to both individual and organizational benefits. Riaz & Idrees (2013) found that all three types of training benefits (personal, career-related and job-related) have positive and direct effect on employees' organizational commitment in banking sector of Pakistan. The underlying theme is that employees who receive training might think that the organization values them as individuals and therefore develop a stronger commitment with the organization. Study done by Yang & Sanders (2012) highlighted the association between perceived training-related benefits and continuance commitment and also pointed out that out that different types of perceptions of training have distinct connections with employee work-related attitudes.

## 9. Conclusion

The purpose of this study is to investigate the relationship between employee benefits from training and dimensions of organizational commitment based on the existing studies in the specific area. Employees are the asset of every successful organization. Training is one of the most important investments of an organization because it enhances the knowledge, skills, attitudes and behavior of employees. Thus training within organizations creates various work related attitudes among employees. One of the most important work related attitude among them is organizational commitment. An employee with high level of organizational commitment is an asset for the organization because reduced labour turnover and increased performance can be ensured from them. This particular study suggests a conceptual framework for the relationship between employee benefits from training and organizational commitment.

## 10. Scope for Future Research

The present study is a conceptual framework for the relationship between employee benefits from training and organizational commitment. Every organization differ in its activities and employee policies, hence the relationship is different for different types of organizations. The conceptual framework should be empirically tested to validate the relationship and to analyze which variable is more significant. Other work related attitudes like job satisfaction; job involvement etc. can also be included in the framework for future study.

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# Creating Peoples' Brand for Inclusive Growth in India: Case of Vindhya Valley



ISBN: 978-1-943295-01-2

**Manmohan Yadav**  
Indian Institute of Forest Management  
(manmohan@iifm.ac.in)

*Creating Brand Equity is major core business strength of profit making organizations, corporate, for commercial products. However, the concept of brand building can be effectively implemented for products made by small, medium and even traditional household scale operations. Though there are examples of such brand building efforts like – Tribes India, Vindhya Valley, Chhattisgarh herbals etc, however these People's Brands – the term used to depict the profit making objective along with social objective of enhancing income generating opportunities to the rural poor, have not been able to grow beyond the threshold level to really make a mark in the consumers' minds.*

## 1. Introduction

### 1.1 Genesis of the Concept of Brand

The word brand is derived from 'brandr' meaning "to burn" – recalling the practice of producers burning their mark (or brand) onto products.

The oldest generic brand that is still in use in India since the Vedic period (ca. 1100 B.C.E to 500 B.C.E), is the herbal paste known as Chyawanprash. It is consumed for its claimed health benefits and attributed to the revered rishi named Chyawan. This product was developed at Dhosi Hill, an extinct volcano in northern India some 10,000 years ago.

In the known modern history, the Italians used brands in the form of watermarks on paper in the 13th century. Blind Stamps, hallmarks and silver-makers' marks are all types of brand. Brands in the field of mass-marketing and as we know them today, originated in the 19th century with the advent of packaged goods. Industrialization moved the production of many household items, such as soap, from local communities to centralized factories. When shipping their goods, the manufacturers would literally brand their logo or insignia on the barrels used, in a way extending the meaning of "brand" to that of a trademark.

Factories established during the Industrial Revolution introduced mass-produced goods that necessitated selling of their products to a wider market - to customers previously familiar only with locally-produced goods. It became apparent to these factories that a generic package of soap had difficulty competing with familiar, local products. The packaged-goods manufacturers needed to convince the consumers that they could place just as much trust in the non-local product. Pears Soap, Campbell soup, Coca-Cola, Juicy Fruit gum, Aunt Jemima, and Quaker Oats were among the first products to be "branded" in an effort to increase the consumer's familiarity with their products.

Bass & Company, the British brewery, claims that their red-triangle brand is the world's first trademark. However, Tate & Lyle of Lyle's Golden Syrup also makes a similar claim, having been recognized by Guinness World Records as Britain's oldest brand, with its green-and-gold packaging having remained almost unchanged since 1885. Antiche Fornaci Giorgi in Italy, which has stamped or carved its bricks (as found in Saint Peter's Basilica in the Vatican City) with the same proto-logo since 1731, is another example of earliest uses of trademarks.

### 1.2 The Art and Craft of Branding

Branding is the process of creating and disseminating the brand name. Branding can be applied to the entire corporate identity as well as to individual product and service names.

James Walter Thompson for the first time published a house ad explaining trademark advertising around 1900. This early commercial explanation of what we now know as branding was soon adopted by companies in the form of slogans, mascots, and jingles that began to appear on radio and early television. The way in which consumers were developing relationships with their brands in a social / psychological / anthropological sense was recognized by the Manufacturers quickly learned to build their brands' identity and personality such as youthfulness, fun or luxury in 1940s. This was another turning point towards the practice we now know today as "branding", where the consumers buy "the brand" instead of the product. This trend continued till the 1980s, and is now quantified in concepts such as brand value and brand equity.

The American Marketing Association defines the term 'Brand' as "A name, term, symbol or design, or a combination of them, which is intended to signify the goods or services of one seller or group of sellers and to differentiate them from those of competitors" (Keller, 2003). A brand is a product, service, or concept that is publicly distinguished from other products, services, or concepts so that it can be easily communicated and usually marketed.

The process involved in creating a unique name and image for a product in the consumers' mind, mainly through advertising campaigns with a consistent theme. Branding aims to establish a significant and differentiated presence in the market that attracts and retains loyal customers.

The brand elements are used to express or represent and identify or differentiate a brand from that of the competition. The consistency in use of the brand elements in all marketing programmes in an integrated way help create the brand character in the marketplace. The brand elements include the brand name, logo, slogan, jingle, font/typography, and packaging. The brand elements should be meaningful, memorable, appealing, protectable, adaptable, and transferable to the extent possible. A brand name is the name of the distinctive product, service, or concept. Simple & small, without any meaning in any language, easy to spell brand names go a long way in making a strong connect with the target audience across countries, cultures and product categories. Tata, Amul, Nokia, Sony, Dabur, Apple, Mahindra, Google, are the examples of simple, memorable and of course well known brands.

A good logo can be a synthesizer of a brand that is readily used by customers for identification, differentiation and positive associations. Recent research finds that effective corporate logos can have a significant positive effect on customer commitment to a brand — and even on company performance.

Brand aspects such as brand association, brand identity, brand personality, brand trust, brand equity, and brand valuation have gained importance during the last few decades.

## 2. Power of Brand in Modern Businesses – Commercial Brands

Branding is seen as the process of adding value to the product (Farquhar, 1989). A brand is a cluster of functional and emotional benefits that extend a unique and welcomed promise (de Chernatony & McDonald, 2003). Branding is essentially used to convey a set of values to potential buyers which may be considered at various stages of the purchasing decision making process.

The importance of brand as a mean to gain competitive advantage has been extensively discussed in literature. With strong brands, companies can enjoy customer loyalty, potential to charge premium prices, and considerable power to support new product and service launches (Keller 2008).

Powerful brands can be considered as a source of long-term security and growth, higher sustainable profits, and increased asset value, as they enable companies to achieve competitive differentiation, premium prices, higher sales volumes, economies of scale and reduced costs, and greater security of demand (Temporal, 2000).

From the customer's point of view, strong brands are able to reduce search costs and perceived risk of purchase (de Chernatony & O'Riley 1998). A successful brand is an identifiable product, service, person or place, augmented in such a way that the buyer or user perceives relevant, unique added values which match their needs most closely (Chernatony and McDonald, 1998). A brand thus signals to the customer about the source of the product, and protects both the customer and the producer from competitors who would attempt to provide products that appear to be identical (Aaker, 1991). Brands provide the basis upon which consumers can identify products and services (Weilbacher, 1995). However for building strong brands, firms need to have thorough understanding of customer beliefs, behaviors, product or service attributes, and competitors.

Brands are one of the most valuable assets for the businesses today. Coca cola has retained the number one position as world's most valuable brand for more than a decade except for the current year. In 2014 both Apple and Google have surpassed Coca cola in brand valuation with brand value of \$119 and \$107 billion respectively (table 2). The brand Tata continues to be most valuable Indian brand for the third consecutive year, since the brand valuation started for Indian brands (table 2).

**Table 1** List of Best Indian Brands 2014 (The ET Bureau)

Brand	Brand Value (\$ Million)
Tata	10,907
Reliance Industries	6,247
Airtel	6,220
State Bank of India	3,838
Infosys	3,797
HDFC Bank	3,277
Mahindra	2,576
ICICI	2,571
Godrej	2,456
Larsen & Toubro (L&T)	2,320

**Table 2** Best Global Brands 2014 (Interbrand)

Brand	Brand Value (\$ Million)
Apple	118,863
Google	107,439
Coca-cola	81,563
IBM	72,244
Microsoft	61,154
General Electric (GE)	45,480
Samsung	45,462
Toyota	42,392
McDonald's	42,254
Mercedes-Benz	34,338
BMW	34,212
Intel	34,153

Can and should 'Yoga' be branded? "Branding Yoga" is one of five branding cases Harvard Business School Professor Rohit Deshpandé uses in his classes to explore how companies create brands that are differentiated and worthy of a price premium. It's all about creating value for a large audience. By using marketing and branding one can be more effective and bring its product to a larger audience as was done by manufacturers of soaps in the beginning of the industrialization era. This ancient Indian spiritual wealth has been in the public domain from centuries but branding efforts in the likes of some more than 5000 'Bikram Yoga Studios' across the globe has created \$6 billion business for Yoga in the US itself.

The Nobel Prize's brand core identity, as identified by Mats Urde and Stephen Greyser in the HBS paper 'The Nobel Prize: A Heritage-based Brand-oriented Network, —"for the benefit of mankind"—is rooted in its past (the will of Alfred Nobel), informs and guides its present, and strengthens its relevance for the future "as the world's most prestigious award", according to Professor Stephen of Harvard University. "All brands have a history, many brands have a heritage, but only a few brands use their heritage as the heart of the value proposition that they put forth", says Professor Stephen. The Nobel Prize is the hub in a network of independent organizations that choose laureates and other reputation stakeholders including the laureates themselves, the scientific communities that covet the Prizes, the general public, and, finally, the media.

### 3. Role of Peoples' Brand for Inclusive Growth

#### 3.1 The Concept of Peoples' Brand

Building a strong brand requires careful planning and a great deal of long-term investment. At the heart of a successful brand is a great product or service, backed by creatively designed and executed marketing. When a brand has accumulated a mass of positive sentiment among consumers, the company is said to have acquired brand equity. Brands are one of the most important assets of modern business firms. And thus, creating Brands has been one of the major core business strength of profit making organizations - corporate, for commercial products. However, not-for-profit as well as government organizations with a profit motive do practice or give a chance to building brands. One such attempt of creating brand equity for People's Brands such as Vindhya Valley (and Vindhya Herbal) has been made by the state of Madhya Pradesh (see the Exhibit I). The term *People's Brand* (the term coined by the author) is used to depict the profit making objective along with a broader social objective of providing income generating opportunities to the rural poor. Also such brands do not belong to one single entity rather are the collective property of all the stakeholders, including consumers, who are involved in the business chain of making and marketing of products / services under the common (umbrella) brand name (such as Vindhya Valley).

The key differentiators between a commercial brand and the peoples' brand can be understood by analyzing the way in which the two types of business models and their supply chains are designed. The complete supply chain of the two types of brands in this case study is depicted in the Figure 1 & 2. The two business models and the supply chains can be differentiated from in three ways. Firstly, the procurement of materials for the commercial brand is done by professional purchase teams which are competent in making highly informed decisions with respect to price, quality, quantity and timing of purchases. Secondly, a commercial brand has modern manufacturing that ensures uniform and quality production across batches and manufacturing units. Thirdly, a commercial brand has wherewithal to create market demand, command channel cooperation and create brand awareness among various stakeholders. All these enable such a brand to sell large volumes of the products, charge premium prices, and thus generate huge revenues. Peoples' brands on the other hand lack professional management, consistency and financial strengths to enjoy scale-of-economies and become large. These initiatives start in a project mode and either they end-up with the closure of the projects or loose energy as the project funding dries.

#### 3.2 Examples of Peoples' Brands

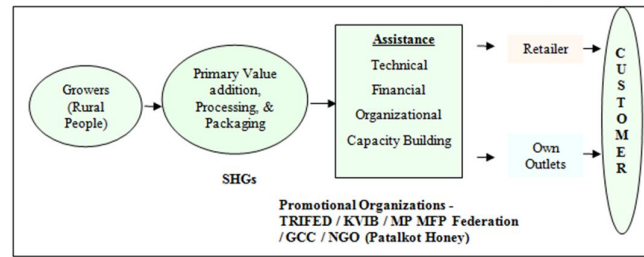
There are numerous other examples across the country where products primarily manufactured by small groups or even individuals in the rural areas are linked to the urban consumers through a network of government and /or non-government supported value-chains. In almost every state there are handloom and handicraft development corporations that bare set up primarily to help marketing outlets to the products made by rural artisans /craftsman / weavers / self-help groups. These products are sold either with an umbrella brand name or through network of retail outlets with an umbrella brand name – such as *Rajasthali* in Rajasthan, *Mrignayayni* in Madhya Pradesh.

Though a similar but for different kinds of products, various states initiated organized marketing of products made by the rural people under a common brand name. One such example is that of *Mojari* – a brand of traditional style shoes used by male and females in the state of Rajasthan.

There are couples of examples of promoting forest based products marketing, initiated primarily to help enhance the income of forest dependent communities - mostly tribal people in many states. These include Madhya Pradesh Minor Forest Produce (MFP) Marketing & Development Federation (MP MFP Federation) – the promoter of *Vindhya Herbal* brand, Girijan Co-operative Corporation of Andhra Pradesh – promoter of *Girijan* brand and Chhattisgarh MFP Marketing & Development Federation – promoter of *Chhattisgarh Herbals*. These are all state government bodies established with social benefit objective and not for making profits per se. The business model for these enterprises comprise of procurement of raw material mostly collected from the forests (called as Non-timber forest products) by the people living inside or at the fringe of the forest areas, processing, packaging and branding and then marketing to the consumers in urban areas.

There are examples of non-government organization (NGO) initiatives like Madhya Pradesh Vigyan Sabha – promoter of *Patakot* brand of products. The level of operations of the NGO initiated enterprises efforts are still at the smaller scale with little or no branding included.

Figure 2: Supply Chain for Peoples' Brand (Vindhya Valley)



At the national level there is one initiative that needs some mention. This is the TRIFED (Tribal Cooperative Marketing and Development Federation under the Ministry of Tribal Affairs, government of India) initiative for linking the tribal products with the urban consumers. Launched under the umbrella brand name 'Tribes India', the various product types made by the tribal people in different corners of the country are sourced by TRIFED and marketed through exclusive retail outlets also named as 'Tribes India' retail outlets. There are about 50 such outlets throughout the countries but mostly in the metro cities and the state capitals. However, this effort also lacks the professional marketing and brand building capabilities needed to scale up and make it a big business.

### 3.3 Vindhya Valley: Brand Development Initiative of Madhya Pradesh

#### 3.3.1 Vindhya Valley Brand Introduction

Vindhya Valley is an innovative approach towards progressive development initiated by the Khadi and Village Industries Board (KVIB), Madhya Pradesh with financial assistance from Madhya Pradesh State Mandi Board and the central government schemes. The specific objectives of the initiative include –

1. providing employment to the rural people through rural enterprise development;
2. making them self-reliant with strengthening of the SHG bodies;
3. providing alternate marketing channel for rural produce (from the existing system of middlemen) under the umbrella brand Vindhya Valley; and
4. Developing market preference for Vindhya Valley brand products.

To achieve these objectives, KVIB and Madhya Pradesh State Government entered into an alliance with HLL (now Hindustan Unilever Limited) for assistance in technical, marketing and brand building initiative for the two brands namely Vindhya Valley and Vindhya Herbal. The brand Vindhya Valley was created as an umbrella brand for the diverse product range to be made by the small agri-producer groups of the state and to include Spices, Papad, Honey, Pickles, Mustered Oil, Tomato ketchup, Jam & Jelly and other Herbal products like Tea, Shampoo. This Umbrella brand is operated and managed by MP Khadi and Village Industries Board with professional (technical and managerial) inputs from Hindustan Lever Limited during the early years of the initiative. HLL was not to gain any direct commercial benefit from this alliance but got associated with it to enhance its understanding of rural economy and the market response for rural food products. However, the company thought of gaining long term benefit as project Vindhya Valley would help empower rural people through improved incomes, and thus create a positive image of HLL company & its product while its executives working closely with the people along the backward supply chain. The company might consider, at later stage, to offer similar products from its own stable.

The brand Vindhya Herbal was created for the product range - Herbal Medicinal and Food Supplements (Over The Counter products) produced by the MP Minor Forest Produce Marketing (and Trade Development) Federation. However, the management of MFP Federation decided to develop this brand at its own and not under the Umbrella brand Vindhya Valley. Therefore this paper has not included the performance of this brand.

#### 3.3.2 Vindhya Valley Product Range

The project further envisaged to launch different categories of products of interest to the rural producer groups. The products to be launched in the four stages are given in the figure 4. As per the product launch plan under the Vindhya Valley portfolio a large number of products of importance to the local people in terms of raw material availability, local employment opportunities and ease of manufacturing were thought to be considered. Similarly the market potential for each product was also considered for the viability of the whole initiative. The consistency in these two important considerations was the hallmark of this initiative and thus an assurance to its long-term sustainability.

Table 3 Product Launch Plan for Vindhya Valley Brand

Stage of product launch	Product Types
Stage I	Straight Spices (Masaala) - Mirchi (Chili powder), Haladi (Turmeric Powder) and Dhania (Coriander Powder)
Stage II	Other Spices – Paobhaji Masaala, Sambhar Masaala, Chana Masaala, Kasturimethi, Kashmiri mirch, Papad and Honey
Stage III	Pickles, Soyabadi and Aomla Murabba; Agarbatti; Herbal Shampoo; Herbal tea
Stage IV	Mustered Oil; Tomato ketchup; Jam & Jelly, Chyawanprash; Herbal Mehndi; Pain balm; Aomla Shampoo

However the main driver of sales volume was thought to be the Masaala category. As per AC Neilson data on market availability of spices in 2000, showed that the state of Madhya Pradesh has huge potential for branded 'Masaala' (spices) like Paobhaji Masaala, Chana Masaala, Chili Powder, Haldi powder etc as almost 95% people bought unbranded loose 'Masaala' or local brands with little or no brand equity. Only 5% of the consumers purchased branded Masaala like MDH and Everest (national brands). Thus there was ample opportunity for introducing branded Masaala products in the state. The branded products were positioned on the quality plank and were priced almost at 50% or even more premium over the local products. Though consumers were found to be conscious about the adulteration in Masaala product category particularly the local Masaala products but the price was main driving force for preferences for the local / loose masaala in the state, reported the market studies.

### 3.3.3 Vindhya Valley Supply Chain

Having understood the market need and the business & social objectives of KVIB, HLL managers were in a position to craft the brand positioning strategy; design the production operations; design the channel strategy and the communication strategy for KVIB products under the umbrella brand name 'Vindhya Valley'.

HLL helped KVIB in developing the whole business model for achieving the stated objectives including creating brand strategy for Vindhya Valley, designing distribution channel, and the backward supply chain for manufacturing of products by the rural SHG (Self Help Group) bodies. Building brands is always at the heart of every HLL manager and thus this was not a major problem area for the HLL executives. But the real challenge was to integrate the numerous small production operations primarily by the small SHG bodies with limited technical knowledge and skills. The help from HLL executives came in handy on this account (HLL has its strengths in understanding the agribusiness sector because of its own products offerings in similar product categories) that made it possible for the initiative in product, process, and packaging standardization as well as quality assurance at each level given the diversity of manufacturing by the SHG bodies and the skill up-gradation of its members – both technical and commercial. The emphasis was given on packaging, standardization, and quality of product - the attributes to be used in differentiating and positioning the products from Vindhya Valley stable). The supply chain for Vindhya Valley products as depicted in figure 2 as discussed in the preceding pages. A total of about 35 SHG s were made part of the Vindhya Valley project providing direct employment to more than 550 persons (mostly women) at the end of year 2005-06.

### 3.3.4 Vindhya Valley Brand Positioning and Promotions

The philosophy of the Vindhya Valley Project is to achieve the dual objective of providing quality products at reasonable price with a promise of 100% purity to consumers and ensuring better value realization for small agri-producer groups in rural areas of the state.

The unique selling proposition (USP) for the products were purity, international packaging and 10-15% less price than immediate branded competitors like MDH and Everest. The brand positioning for different products under 'Vindhya Valley' was based on the Points-of-parity (POP) of the product category and Points-of-differentiation (POD) in line with the existing image of KVIB as a producer of genuine products from an organization under the state government. Accordingly the Punch line for all the food products under the Vindhya Valley umbrella brand was decided as '100% Purity (Shuddhata), 0 % Adulteration (Milawat)'. As mentioned earlier, adulteration was a major concern among all the Masaala consumers and thus the need for a trusted product with purity. The price was also decided on competitive parity basis. Thus the ad campaign with the jingle "Swaad Kamaal – Shuddhata Bemiasal" (Astonishing taste – and unmatched Purity) was focused on these two key brand attributes.

The promotional budget of RS 2 crore per year was planned (and approved by the board) for the first two years. The major media types identified to carry the brand communication were based on the target audience media habits. For promotion of the brand, HLL managers suggested KVIB to invest 25% of the sales value on brand promotions every year at least during the initial years. However due to financial crunch and lack of funds from the State Government, the expenditure on promotions got reduced significantly after two years of initiation of the project. The total amount spent on promotions and its distribution among the different elements of promotion tools is shown in the table 4.

**Table 4** Expenditure on Promotion-Mix Elements during Initial Years (Rs Lakh)

Promotion Element	2002-03	2003-04	2004-05	2005-06	Total Expenditure
Packaging & Designing	2.7	4.2	1.9	0	8.8
Agency Commission	15.1	4.3	0	0	19.4
Film Production and Artwork	0.1	6.2	8.7	0	15
POP Materials & Posters	0.5	1.1	0.2	1.4	3.2
Training & lab Development	0.4	3.6	9.7	1.2	14.9
Communication	6.3	73	52.1	7.3	138.7
Total Promotional Expenditure	25.1	92.4	72.6	9.9	200



**Table 5** Total Sales Revenue and Promotional Budget for Brand Vindhya Valley

Year	Total Sales (Rs. Lakh)	Total Promotional Expenditure (Rs. Lakh)
2002-03	20.2	25.1
2003-04	140.6	92.4
2004-05	175	72.6
2005-06	70	9.9
2006-2007	97.3	46.9
2007-2008	142.5	49.1
2008-2009	52.3	36.8
2009-2010	60.3	29.7
2010-2011	14.7	194
2011-2012	230	199.3
2012-2013	437	238.5
2013-2014	590	249.2

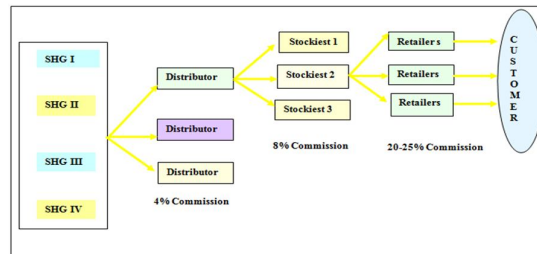
While the promotional effort increased from RS 25 Lakh in 2002-03 to Rs 92.4 Lakh in 2003-04 but then declined to RS 72.6 Lakh in 2004-05 and to just RS 9.9 in 2005-06. In fact the promotional budget provision of RS 200 Lakh for initial two years got spread to four years and reached to almost negligible in the year 2005-06. There was marginal increase in promotions during the subsequent years but again it declined to Rs 29.7 lakh in the year 2009-10. However there has been a steady growth in sales revenue with corresponding increase in the promotions budget from the year 2011-12 onwards.

The advertising agency, Linta’s India was commissioned for providing professional support for the brand building efforts through advertising.

**3.3.5 Distribution Channel Developed for Vindhya Valley**

The distribution channel designed for the Vindhya Valley products was a three level channel as shown in the figure 3 in the Exhibit 2. At the first level there were 4 distributors appointed in four major cities of Madhya Pradesh Namely - Bhopal, Indore, Gwalior and Jabalpur. These distributors were linked with 3-4 stockiest who in turn would supply the Vindhya Range of products to the retailers. To attract the channel members’ interest and maintain the same over long-term, the channel margins were kept at par with the existing products (Unbranded and branded ones) and included 4% margin to the distributors, 8% to the stockiest and 20-25-% to the retailers. As a result the channel members supported the products push in the market.

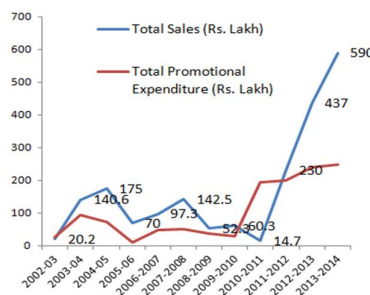
Figure 3: Distribution Channel Designed for Vindhya Valley Brand



**3.3.6 The Brand Performance Score Card**

The initiative of building brands for the peoples’ products has been successful with the sales of RS 175 Lakh at the end of year 2004-05 and a market share of 14% in the spice product category. An achievement of this kind for a new brand in such a short span of time, that too from a government organization got appreciation from all the quarters. While the sales grew fast during the first three years of the product launch but then suddenly dropped in the year 2005-06 to RS 70 Lakh (Table 5).

**Figure 4: Sales Revenue and Promotions Expenditure (Rs Lakh)**



The pace of brand growth got a jolt with almost little funds to take the project efforts further. The decline in the sales was attributed directly to the drop in promotions, non-availability of product, poor quality and over & above withdrawal of the sales force in the year 2005-06. The relationship between drop in promotional expenditure and the sales is very much evident from the figure 4. It is evident from the graph that there seems to be a direct correlation between the promotional budget and the sales revenue.

The study result of Vindhya Valley brand reveals that the level of promotional effort of these brands has been much less, given the immense potential the brands have. The brand - Vindhya valley has lost its upward moving growth and the total sales in 2005-06 dropped to Rs. 70 lakh from a high of Rs 175 lakh sales in the year 2004-05. The discontinuity in promotions and poor availability of product severely affected the otherwise fast growing sales. The market share in 2005 dropped almost to 4% to 5%. The Self –help-groups had no working capital to manufacture the products, the field sales force was practically withdrawn and promotions got drastically reduced. The distribution channel responded negatively and lost interest in brand and products under it. The problem was further accentuated with poor quality products getting into the distribution channel resulting into loss of consumer faith. While interacting with the top officials of the organization it was revealed that the major problem with the organization was non-availability of funds to continue the Vindhya Valley project efforts. This situation was narrated to the author by the brand managers of Vindhya Valley with a heavy heart. The brand that they created and build with a meticulous strategy lost customer faith and trade interest in a matter of just few years. The *Vindhya Valley* brand was still in its nascent stage when it received a big jolt to the brand building effort on account of drying budgetary support.

However with the infusion of funds and thus renewed efforts through promotions since 2011-12 the brand seems to be recovering fast but the fact remains that once a brand building momentum is lost in early years of its growth, it takes much longer time and efforts to come back on the growth track. Such things probably do not happen in case of commercial brands.

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# Gen Y Women in the IT Sector in India: A Review and Research Agenda



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**Shivani Inamdar**  
Symbiosis International University  
(sraserkar@gmail.com)

*India is today considered as one of the youngest nations in the world. The number of Gen Y/millennials ready to enter the workforce is abundant and the IT sector provides plethora of employment opportunities for the young Indians. While researchers in the past have done a significant study on the millennial generation, there is limited investigation related to the female employees of Gen Y who constitute a major part of the workforce. The following research study intends to develop a conceptual framework to understand the expectation and experience of the Gen Y women at their workplace and provide further research directions.*

## 1. Introduction

Today India has become one of the youngest nations in the world, with 65% of the population below the age of 35 years. This indicates that the average age of an Indian by the year 2020, will be 29 years creating one of the youngest and largest available labour markets of the world (Confederation of Indian Industry, Press release, 2015). With a large number of young population entering the workforce, IT sector which is a major contributor to the Indian Economy has the potential to create enormous employment opportunities for the young Indians.

The young workforce is typically called as the Gen Y. Born in an era of globalization and information technology, the millennials are well qualified, independent and assertive (Krywulak & Roberts, 2009). They are also much technology proficient than the prior generations and feel very comfortable to operate in a digital environment. The young tech savvy generation with high expectation of immediate promotion, flexible work arrangements, healthy work life balance (Zemke, 2001) are different from their predecessors.

Also the female employees of Gen Y are believed to be highly career oriented and financially independent. They are equally comfortable in using the digital technology like their male counterparts and make optimum utilization of internet and social media to maintain relations both personally and professionally (Ganesh, 2014). With the overall change in the role of women from being a home-maker to a career oriented women professional creates some unique challenges to HR in engaging and retaining the young female talent.

While many of the researchers in the past have focused their study on the Gen Y (Bolton et al, 2013; Hewlett et al, 2009) or on the Multi-generation workforce context (Rajput et al, 2013; Jenkins, 2008). There is an extensive scope to study the issues related to the female employees of Gen Y in the IT sector.

The main objective of this study is to undertake a systematic literature review and understand some of the unique attributes of the female employees belonging to the millennial generation from an HR perspective. The further research objectives of this paper are derived as:

1. To provide an overview of the change in attitude, beliefs, values and perception of women towards their personal and professional life.
2. To develop a conceptual framework to understand the expectation and experience of the Gen Y women at their workplace and the impact of support from organisation, family, society and the HR initiatives to bridge the gap between these components.
3. To provide further research directions so that contributions can be made in this field in the future.

## 2. Understanding the Gen Y

### 2.1 Who are Generation Y Employees?

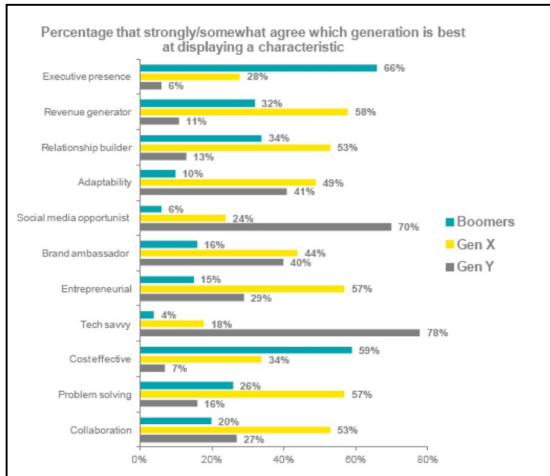
The young population which has recently begun to enter the workforce is typically called as the Gen Y, millennials, Next Generation, Generation Me (Murphy, 2007). They are considered to be born in the year from 1982-2000. However, as there is no widespread agreement regarding the exact birth years of this generation (Bolton et al, 2013). Hence, for the purpose of the research study, the researcher will consider them within the age limit of 21-29 years.

The term "Gen Y" which defines the youth population is gaining a lot of attraction these days. Their open-mindedness, frankness, creativity and multi-tasking approach (Erickson et al, 2009) contrasts them from the other generations. They are technology savvy and operate in the digital environment with ease. They do not believe in the rigid hierarchical structure and rather prefer a casual and friendly approach in their professional life.

This outlook of the GenYers towards the work culture contrasts them from the traditionalists and the diversity occurs not only in terms of demographics but also of the thoughts and approach. Managers today are facing a major challenge in identifying the differences and similarities of the young tech savvy generation and their attitudes, beliefs and perception with the prior generations.

The Gen Y population is increasing at a tremendous rate all over the world. Today, out of the total world population the Gen Y composition captures almost 25% (Gibson, 2013) of which a significant number is present in India. More than half of the population in our country belongs to the young generation which creates both challenges and opportunities for growth. The following table represents some set of characteristics commonly possessed by the Gen Y.

**Table 1** Some Survey Reports on Gen Y Members of Each Generation that “best” Display the Following Characteristics



Members of Gen Y were viewed as the “best” at being “tech savvy” (78%) and being social media opportunists, or leveraging social media beyond marketing (70%) – the two largest endorsements any generation received. Gen Y also scored higher than boomers for being the “best” at “collaboration” (27% vs. 20%), “adaptability” (41% vs. 10%) and being “entrepreneurial” (29% vs. 15%).

Source: Ernst & Young (2013). *Younger Managers Rise in the Ranks*

**2.2 Definition of Gen Y**

The following section captures some of the definitions of Gen Y on the basis of the available literature of the past few years.

**Table 2** Definitions of Generation Y

Reference	Definitions
Armour, 2005	Gen Yers have high expectation of self and employers. They are risk averse, ready for new challenges and like to show creativity at work.
Chen & Choi, 2008	Millennials are brought up in an era of globalization. They are good academically, financially independent, tech savvy and goal oriented
Tapscott, 2008	The Gen Y has been brought up in the digital environment and is much technology adept than the prior generations. They make the utmost use of social media or internet to stay connected with the world. Hence, they are also called as the Net Generation.
Schweitzer et al, 2010	The Gen Y employees are highly professionals, focused, work oriented and expect rapid growth in their career path. At the same time, they also prefer to maintain a healthy work life balance and give time for their personal life.

**2.3 Comparing and Contrasting the Gen Y Women Employees from the Previous Generation**

Although the status of women in India has improved a lot over the years, there still exist hidden practices and beliefs in the Society Which Hampers the Growth and Progress of Women. Earlier, The Work Division For Men And Women Was Very Clearly Defined. Where On One Hand, Men Had To Go Outside For Work, Women Had To Stay Back At Home And Take Care Of Their Household And Children (Seth, 2001)

The 20<sup>th</sup> Century Came As A Ray Of Hope Especially For The Women. The Work Area Which Was Restricted To Household And Kitchen For Women Was Extended To Offices And Board Rooms. The Corporate World Accepted Women Presence Whole Heartedly And Gave Equal Treatment To Its Female Recruits. The Millennial Generation Is Today Redefining Feminism Which Represents Strength, Independence, Confidence And Optimism. However, Corporate Still Struggle With The Problem Of Gender Discrimination And Insensitivity At The Workplace (Henderson, 2014).

Women Of 21<sup>st</sup> Century Are Constantly Fighting This Battle And Proving Themselves To Be On Par With Men. They Have Proved Themselves As Independent Earners And Not Supplementary Breadwinners Of The Family. Women Go For Job Not Only To Earn Money But As It Give Them An Internal Satisfaction. Today Many Of Them Have Also Reached The Top Notch Positions In The Corporate Sector And Earned Respectable Position Breaking The Traditional Barriers. While Comparing The Gen Y Women From The Previous Generations, A Clear Distinction Not Only Exists Of Demographics But Also Of Values, Beliefs, Perception And Overall Lifestyle.

In The Following Table, An Attempt Has Been Made To Systematically Differentiate Between Women Of Gen X And Gen Y.

**Table 3** *Difference between Women of Gen X and Gen Y*

Gen X Women	Gen Y Women
Prioritise family over career.	Career oriented, focused and may prioritise career over personal/family engagement.
Struggle in using the latest technology.	Feel comfortable in the digital environment, tech savvy.
Consider themselves as the secondary earner in the family.	Financially independent and expect to be treated equally with the opposite gender.
Follow the path set by their predecessors.	Ready to modify the traditional approach and set their own norms.
Gen X women are risk averse and do not make huge investment.	Gen Y women make better investment in equities and do not hesitate to take risk.
Gen X women consider to maintain a formal relation with colleagues, seniors, managers etc.	They like to maintain an informal relation with their peers, managers and want their workplace to be fun.

### 3. Expectation of Gen Y Women Employees

Today, the population of India stands close to 1.2 billion, of which 48.5% are females (Catalyst, 2013). The modern Indian society is witnessing a lot of women presence in the corporate sector wherein they step up at the workplace with lot of confidence, zeal and determination. The Gen Y females with their optimistic attitude have entered the society and are creating a unique definition of feminism.

The young women employees have not only entered the professional world gracefully but have also proved their talent and convinced everyone that they are critical for the success of their companies. Many corporate have explicitly accepted that the women presence has created a positive impact in the company. The presence of women in the corporate board has improved the operating profits and return on investment of the company by almost 56% (Ganesh, 2014).

Few years ago, the expectation of a woman from her workplace was limited to work life balance, safety, compensation etc. However, as the role of women in the society has changed, so have the expectations. Today women are much more specific about what they exactly expect in terms of support from organization, employers and also negotiate for their demands.

With the evolution of the new generation, the expectations from the employer in terms of career advancement, salary, equal opportunities etc have raised. Today the Gen Y women consider themselves to be equally capable and efficient than their male counterparts and hence expect equal treatment in the workplace. They try to do their work with full dedication and sincerity and expect prompt feedback, word of appreciation in return. These “super-women” believe to achieve everything including fast growth, career advancement, and financial independence as well as sparing time for their personal and family life (Emerick, 2010).

The following table which represents some of the key expectations of Gen Y women:

**Table 4** *Expectations of Gen Y Female Employees*

S No.	Expectations
1.	To be treated equally in the workplace especially in cases of promotions, hikes, higher responsibility.
2.	To get enough time for maintaining a healthy work life balance even when they are single.
3.	To get support, encouragement for working especially after marriage, maternity and be given equal chances of growth and career advancement.
4.	Flexible work options after maternity not only in terms of working hours but also in terms of place of work. Ex: facility of work from home.
5.	Greater self-control, autonomy or decision making power.
6.	Not to be considered as incapable of doing a particular work only on basis of their gender.
7.	Employer should give proper justification and should be answerable in case of any concerns/queries raised.
8.	The Gen Y women are tech savvy and expect to stay digitally connected with their superiors, peers.
9.	They believe in a flat structure and an open, interactive environment.
10.	Clear definition of roles and responsibilities.
11.	To get a safe, hygienic and flexible work environment.
12.	Facilities like: medical room, doctors/counselor, crèches, transportation etc should be provided by the employer.

Apart from the expectations mentioned above, there are many other challenges which the HR department faces in managing the Gen Y women. HR tries in meeting up the expectation of the young women by putting best efforts as it is ultimately beneficial for both the employee and the organisation.

#### 4. Experience of Gen Y Women at the Workplace

India is believed to be one of the major upcoming economies in the world. It has one of the largest and youngest workforces available. The growth which India has witnessed in the last few years is admirable. However, the Indian society is still at the cross ends and there is a wide scope for improvement.

The beginning years in the technology sector are very promising for young women professionals and give the young folks a big scope for growth and career advancement. However, after certain years women suddenly feel stagnancy in their career path due to the gender, pay and opportunities gap existing at all the levels (Saraswathy, 2014). A slowdown in the job opportunities, pay packages, career growth is experienced by many of them. Due to which very few women secure leadership or senior positions in the company (Lannon, 2013).

Many a times, females also complain about feeling differentiated in the workplace because of their gender. Cases of gender discrimination, male domination, glass ceiling etc are common issues of concern (Bhattacharyya & Ghosh, 2012). Following are some of the experiences of the Gen Y women:

- Many times women have to leave their jobs to take care of their parents or their children as they are being considered to take the primary responsibilities of their family (Ullas, 2013).
- Women may have to leave the work because of the relocation of the spouse. Job leaving in such cases is sometimes taken for granted by the family members.
- Work pressure, late working hours, project deadlines etc may cause difficulty in coping with work life balance issues.
- Women face issues regarding the inability to take decisions in choosing their own career path. In many cases, roles are predefined by the organisations without asking about their opinion. Ex: in case of maternity or post maternity.
- Stringent policies of the organisation sometimes restrict the women from rejoining the organisation after a career break.
- Many times women are not taken seriously in the organisation because of their gender, age. They are not considered for the senior positions as the companies fear about their capability to handle the work pressure.
- Cases of gender discrimination, gender insensitivity and harassment still stand out as one of the major causes of concern for working women.

A woman who plays multiple roles in the society also encounters multiple challenges in her life whether personal or professional. She faces challenges not only in terms of career advancement or growth but sometimes lack of family or social support also act as a barrier for her. Hence, a collective support from her organization, family and society can help her in career path and life journey. It can also ultimately help in bridging the gap between her expectation and overall experience in the workplace and in reducing the attrition.

#### 5. Support to the Gen Y Females from Organisation, Family And Society

In order to bridge the gap between the expectations and experiences, support of the organisation, family and society can prove to be very helpful.

##### (a) Organisational Support

IT sector is considered as one of the most women friendly sectors in India. Women like to work in this sector due to the safe, healthy and hygienic work environment it provides. Compared to the other sectors, the IT sector is believed to have one of the most free, flexible and women friendly culture. Women in this sector have advanced very well in their career and some of them have also entered the top notch positions or have got placed in the executive board (Valk & Srinivasan, 2011).

However, as women advance in their life, the roles and responsibilities not only enhance but they also become divergent. This creates a major challenge to maintain a balance between the organization demands versus the commitments at home. Earlier, this created a major attrition of the female staff as the women preferred their personal commitments over their careers. But today situation has somewhat changed. Women of Gen Y do not prefer to make any compromises in their career. They want to achieve a perfect balance between their personal and professional life.

The following sub-section majorly focuses on some of the HR initiatives that are taken by the company to support its female staff and some of the suggestions that can be implemented for further improvement.

##### HR Initiatives

The role of HR in ensuring a correct balance between their personal and professional life or between the expectations and experiences is quite crucial. The HR needs to make sure that some of the best practices are being implemented in order to keep the women employees motivated and satisfied.

Today the HR Dept is focusing constantly on giving a supportive hand to its female employees. Various initiatives are being taken in order to ensure that the female employees feel connected at their workplace and continue their journey with the organisation while managing the different commitments of their life. The following table represents some of the HR initiatives that can be taken in order to ensure support to the female staff.

**Table 5** HR Initiatives to Support Female Staff in the Organisation

S No.	HR Initiatives
1.	Ensuring a just work life balance for both married as well as unmarried females as this generation appreciates it anyways.
2.	Creating a modified engagement plan as per the generational, gender difference rather than “one fit for all” approach.
3.	Rewards and recognition do play an important role. As, women appreciate being recognized for their work.
4.	Managers to be trained properly in handling cases of women hygiene, safety, health or maternity especially male managers.
5.	Constant feedback, determining areas of improvement, doing meaningful work etc are all considered as strong motivating factors.
6.	Ensuring safety, hygiene in the workplace especially the safety of women to be taken care of.
7.	Conducting sessions, seminars related to women empowerment, career management etc.
8.	Flexible career options to women especially after maternity. Ex: work from home, job sharing etc.
9.	To educate women employees about policies related to maternity, time off etc in advance so that they do not feel insecure of losing job.
10.	To ensure that the female employees stay connected using the digital technology and do not feel disconnected in case of career breaks/leaves.
11.	No gender discrimination in case of career advancement, promotions.
12.	To support employees with family or caring responsibilities like aged parents, in laws etc.

In many of the IT companies, some of the above mentioned policies are being practiced. However, gaps still exists and there is scope of improvement. HR is doing a rigorous job in providing training to the managers, conducting counseling sessions and ensuring that cases of gender insensitivity, discrimination do not occur. Apart from that, feedback can be used as one of the most important tool to determine whether the policies and practices are actually useful and to determine the grey areas to be looked upon. Following is the example regarding some of the HR initiatives taken by the IT companies to engage its women employees and the areas that needs to be worked upon.

- **Words of Priti Kataria (HR Head) from Wipro (an IT firm) in India:** “Hiring staff are trained not to ask women candidates any personal questions. They are the ultimate decision makers of their career and questions like this can put them off.”
- **From Archana Bisht, Founder of a counseling organisation:** A male boss ignored the women subordinate who filled a complaint against him. The act was not deliberate but sometimes male bosses lack interpersonal skills and hence needs to be trained.
- Women like men want to be recognised for their work rather than their gender. Companies have set up committees for grievance redressal mechanisms where in women can share their problems or grievances which might adversely impact their careers.

Source: *The Times of India* (2014). ‘Gender Sensitivity a Hot-Button Issue’

### (b) Family Support

The division of work in the family was clearly defined earlier. While women were responsible to take care of the household and children, men had to go out for work and earn money. The involvement of women apart from the household activities was unacceptable.

However with the changing times and increasing expenses, it became very difficult to depend on only one member of the family for the financial resources. Hence, women started working and tried to reduce the financial burden. That time it was more of a compulsion rather than a choice. But as the time progressed, women not only proved to be good at work but also started giving a tough competition to the males. In today’s time, a working woman has become a common phenomenon.

On one hand, as the women are progressing well in the professional world, the challenges are also increasing. With dual career couples, nuclear families, extensive work pressure it becomes all together more difficult to maintain adequate balance between family and career (Aryee et al, 2005).

IT sector which is considered as one of the most women friendly sectors struggles to provide an adequate work life balance to the women professionals. Long working hours, late night shifts, project deadlines etc has a strong impact on the family life. In such situations, the biggest support for a woman is her family. If she is single then the encouragement from parents, siblings, relatives can be a great motivating factor. Support from spouse, children, parents, in laws can prove to be a great help for a married working women (Marcinkus et al, 2007). The role of husband in such situation is very crucial. He can

provide his support by sharing the household responsibilities with his wife. Domestic help or sometimes the support of parents/in laws can also prove to be of great help (Valk & Srinivasan, 2011).

If the family is supportive, women can achieve a great high in her career path. She can not only make her family proud but also share a great hand of support to her spouse, parents in case of need.

### (c) Social Support

The progress of a society/nation is not only measured by its financial status or economic progress but by the respect shown by the male citizens towards the women of the country. The development of a women helps in the development of the nation. If the women of a country is not educated, qualified or independent then the growth of society remains stagnant. As the society is incomplete without females, so is a woman incomplete without the support of her society. She cannot achieve success if the society around her is not supportive.

In ancient India, the status of women was miserable. Problems like illiteracy, child marriage, dowry etc predominantly existed in the society. Girls were not allowed to step out of the house and walk around freely. They were married at a very early age and were considered only a source to take care of the family and bear children. (Jain, 2012).

During the pre-independence era, a lot many initiatives were taken by the social and religious reformers in order to educate the females and for the upliftment in the status of women (Mishra, 1994). Apart from that some of the welfare measure schemes were also introduced like Mahila Samridhhi Yojana (1993), Indira Mahila Yojana (1995) etc for improving the overall condition of women in the society (Dash, 2004).

In later years, the term “women empowerment” gained a lot of focus in the Indian society. It majorly focused on self-empowerment i.e. the right to make choices, take decisions etc (Pujari, 2012; Dubey, 2013). Various social reforms, legislations were initiated to help in improving the condition of women over the years.

Even though, our country has progressed a lot in the past few years, problems like gender differentiation, discrimination still exists. Women still experience discrimination in the society and at the workplace. They are restricted from doing certain work even if they desire to. They are still looked upon as a weaker section in the society and hence restrictions are imposed upon them especially after marriage or having children.

The modern Indian society should not only support the women who are already working but also encourage and motivate others who wish to get education and make a good career. Instead of presuming or restricting the work of women, the choice or decision should be left on them. This will not only motivate them but also give a sense of freedom and accomplishment.

## 6. Final Outcome

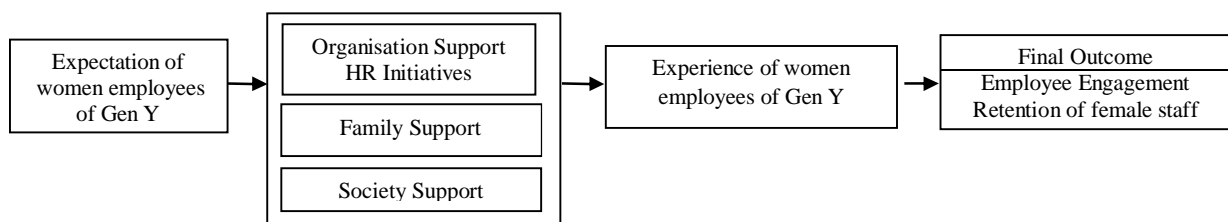
When we say that women of the current generation have become more independent the reality says that the dependency has actually increased like ever before. Today women have become capable enough to take multi-tasking challenges but it becomes very difficult to achieve all this without the support of everyone which includes family members, colleagues, managers and most importantly the society. All the three supporting factors are equally important and help in bridging the gap between the expectations and experiences of women. If the gap between the expectations and experiences are narrowed down, it will ultimately help in keeping the women employees much engaged, motivated and satisfied. This will help the organisation in achieving the objective of engaging the women employees and at the same time ensuring their retention in the company.

Engaging the employees and especially the youth generation has always been a difficult task for the company. If the goal of keeping the employees engaged is achieved it will ultimately keep the employees motivated and control the attrition.

## 7. Conceptual Framework: Linkage between Expectation and Experience of Gen Y Women Employees

In an attempt to address the above mentioned concepts, a conceptual framework has been developed which includes the following components:

- Expectation of Gen Y women employees
- Experience of Gen Y women employees
- Factors supporting: Organisation, Family and Society
- Final Outcome: Employee Engagement, Retention of Female Staff



**Figure 1** Conceptual Framework to understand the Expectation and Experience and how to Bridge the Gap between them



With the help of the conceptual framework model and by understanding the concepts/components in detail, it can be interpreted that many a times the expectation and experience of a person in real doesn't match and a gap does exist between the two. However, with a hand of support from the organisation, family and the society can help in bridging the gap between these two components. The HR initiatives which are shown as a sub-component of the organisation can help in ensuring that some of the best practices are followed in the organisation to support the women employees. Ultimately once the experiences starts meeting the expectation can prove to be a great motivating factor. This may help in ensuring the employee engagement and the retention of the female staff.

## 8. Conclusion

With an increasing number of the young female talent available in the labour market, organisations need to take a pause for a while and understand difference between the basic attitude, thinking and perception of the Gen Y with the previous ones. With the changing times, there is a huge change in the overall perception and attitude and so in the demands. Women of today are not ready to make compromises in their career so easily. They do not want to take the responsibility of managing the family alone and expect the support, co-operation from everyone. In the organisation as well, they have their own expectations and are ready to work only on their own conditions. With the increasing expectation, the job of HR has also increased. They should try to understand in detail the expectations of the young generation women and the reason for that. Some revision in the policies, programs, initiatives should also be made as per the need of time. Things like social media, digital networking etc can be used as a strong engagement tool. Further improvements can be made so that the cases of discrimination or differentiation can be avoided.

The researcher expects that the literature presented will help in getting a better understanding of the Gen Y female population which has not been explored in detail till now especially in India. It will also help in determining whether the current policies in the organisation are helpful or needs to be further improved. However, the research is limited to being an eye opener in understanding the female employees of Gen Y. It has further scope of understanding the youth female generations in different context and the overall impact not only on the organisation but also on the family and society in particular. Further research can be conducted both in the local or global context to understand the expectation of young females around the globe. And the way organisations can prepare themselves in a better manner in order to engage the young and coming generations.

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# A Case Study on Employee Attrition at Amara Raja Batteries Limited, Tirupathi



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**Syamala Devi Bhoganadam**  
**Dasaraju Srinivasa Rao**  
K L University, Vaddeshwaram  
(syamaladevi\_b@kluniversity)  
(Srinivasa\_mba@kluniversity.in)

Organizations at present are facing many issues with the employees from starting to the exit of the employee. Normally organizations keep employees in probation period to know the employee's related information and to learn the organization environment. Employee attrition was the serious problem in the present scenario. The manufacturing companies like ARBL were facing the situation. Employees of Amara Raja Batteries Limited (ARBL) were kept under probation for two years to evaluate their performance but unfortunately employees are leaving the organization without any intimation within the probation period. This has turned in to a challenge and burning issue for HR personnel at Amara Raja Batteries Limited. Hence a study has been conducted on employee attrition in Amara Raja Batteries Ltd to find out the reasons why the employees are leaving the organization without any intimation Primary data was collected from both personal interview method and by distributing structured questionnaire to the automotive battery division of Amara raja batteries limited employee's with a sample size of 100. The study uses the Karl Pearson's correlation method and weighted average method for data analysis. The findings of the study reveal that an Amara raja battery limited is facing an attrition rate.

## 1. Introduction

Organizations success in the 21<sup>st</sup> century can be majorly attributed to the employee's concern. Organizations are realizing that employees are the valuable assets. So HR manager's role in the present era was prominent (Tandon, April 2006). Employees in this era are more often eager to jump from one to another because of some many reasons. Hence employee attrition has become a major factor in estimating the organization efficiency. Attrition is a major concern for organizations because functioning of the organization is entirely depends on the pool of employees. Attrition rate defines the organization's image. Higher the attrition rate the organization's has to face some incurred costs to recruit, induct, placement and train the employee. This study was undertaken to identify the employee dissatisfaction factors and the reasons for leaving the organization. Employee attrition rate can be defined with mathematical expression as shown in below formulae. Employee attrition and employee retention were considered to be joint words because one's impact is inversely proportional to the others. Hence lower the attrition rate says that the organization's retention strategies were good. Hence an identical organization has to maintain the low attrition rate and higher retention of the employees. There are many reasons for employees to leave to the organizations. These factors differ from one organization to another, one department to another, one country to another, considered sample to other and from employee to employee. Hence some of the previous researcher's say that salary was the dominant factor for employee attrition but there are many others. Based on many factors like organization size, location, policies, procedures also have an impact on the employee attrition but its indirect form. The below flowchart explains the employee attrition factors and the employee retention (Harries, Vol 3; Iss 2 Feb 2003).

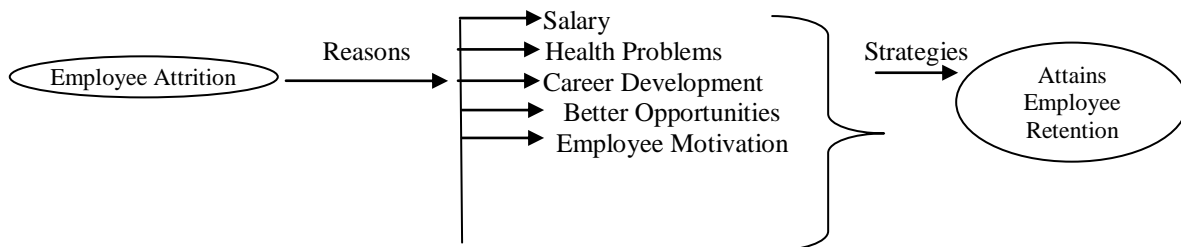


Figure 1.1 Framework of Employee Attrition Factors at ARBL

## 2. Review of Literature

The meaning of employee attrition in a work environment refers to a reduction or decrease of employees or a gradual reduction of labour cuttings other than the firing of the employees. For a human resource management people these attrition rates increases the HR department budgets. Employee attrition can be affected by many factors based on the organization size and type. The study conducted by Indian IT industries says that 23% in 2011. According to the study by Indian Inc 33% was identified the attrition rate which is 10% increase compared to the earlier. The reasons for employee turnover may vary from external environmental factors such as economy that influence the business that in turn affects the employment levels (Pettman 1975; Mobley, 1982, Schervish, 1983; Terborg and Lee, 1984) to Organizational variables such as type of industry, occupational category, Organization size, payment, supervisory level, location, selection process, work environment, work

assignments, benefits, promotions and (Mobley, 1982; Arthur, 2001). The other factors that influence employee turnover in Organizations include the individual work variables like demographic variables, integrative variables like job satisfaction, pay, promotion and working condition (Pettman, 1975; Mobley 1982; Arthur 2001) and the individual nonworking variables such as family related variables (Pettman, 1975; Mobley, 1982;). High rates of voluntary turnover of such employees are often found to be harmful or disruptive to firm's performance (Glebbeck & Bax, 2004). When poor performers, choose to leave the Organization, it is good for the Organization (Abelson & Baysinger, 1984), thus it is important to differentiate between functional and dysfunctional turnover and accordingly encourage or discourage employee turnover. Demographic factors cannot be ignored as age, tenure, level of education, level of income, job category, gender have influenced employee retention and have been found to have stable relationship with turnover intention. Of the above demographic factors, age, tenure and income level was found to be negatively related to turnover intention (Arnold & Feldman, 1982; Cotton & Tuttle, 1986; Gerhart, 1990; Mobley et. Al, 1979; Price & Mueller, 1986; Wai & Robinson, 1998; Weil & Kimball, 1995); level of education is positively associated with turnover, the more educated the employees there is a tendency to quit (Berg, 1991; Cotton & Tuttle, 1986); With respect to job category, Wai & Robinson, 1998 and Price and Mueller, 1986 found that non-managerial employees are more likely to quit than managerial employees. The top reason for traditional organizations is the higher salaries. Dr. Parker says that there many others as supervisor, job satisfaction, career growth and others. Hiltrop, Jean Marie and John showed that the impact of organization culture on the employee retention. These researchers have also explained the strategies for employee retention in the organizations. In a article by Gagan Deep Sharma that the experience, age and education qualifications play an important role of employee attrition (Gagan Deep Sharma). Rossano (1985) defined that in his article as salary as a basic component for employee attrition (Panchanatham, Vol 1 Issue 1 May 2010). In her article 80% of the respondents in the Chennai based call centre say that salary as a prominent role in defining the employee attrition (Panchanatham, Vol 1 Issue 1 May 2010). In an article salary, career development and other as identified as prominent factors in employee attrition (Saner, Vol. 2, Issue 1 January, 2014). According to the Investopedia attrition means that number of employees that were left within a specific period of time. Attrition rate is also called as churn rate which means that the rate of number of employees that were left the organization within in a specific period of time and is follows below.

$$\text{Attrition Rate} = \left( \frac{\text{Number of Attritions} * 100}{\text{Actual employees} + \text{New Joined}} \right) 100$$

### 3. Objectives

- To study the organization culture at Automotive Battery Division (ARBL).
- To calculate employee attrition rate at ARBL.
- To analyze the reason for attrition at ARBL.
- To bring out appropriate retention strategies that can be applied at ARBL.

### 4. Hypothesis Testing

$H_0$ : There is no relation between induction classes and satisfaction with training period.

$H_1$ : There is a relation between induction classes and satisfaction with training period.

$H_0$ : There is no significance relationship between experience and employee satisfaction.

$H_1$ : There is significance relationship between experience and employee satisfaction.

### 5. Organization Profile

A first generation entrepreneur, Dr. Ramachandra Naidu Galla is the founder of Amara Raja Group Of Companies in 1985. The Amara Raja Group is an Indian Conglomerate Company with its corporate office at Anna Salai, Chennai. The group has presence in packaged foods and beverages, electronics products manufacturing, infrastructure sector, power system production and fabrication of sheet metal products and fasteners. The Amara Raja Group is better known for its automotive battery brand "Amaron" which is the second largest selling automotive battery brand in India today. Amara Raja Group employs a work force of over 7000 employees. Amara Raja Batteries made it to Asia's 'Best under a Billion' 2010 list of companies compiled by Forbes magazine. Amara Raja Batteries Limited was incorporated as a private limited Company on 13th February & converted into a public limited Company on 6th September 1990. The Comp. manufacture sealed maintenance free lead acid batteries. The organization structure of ARBL was given below in Fig 1.1

ARBL has inaugurated its Automotive Strategic Business Unit (ASBU) plant at Karakambadi in Tirupati on September 24<sup>th</sup> 2001 this plant is part of the most completely integrated battery manufacturing facility in India with all critical components, including plastics sourced in house from existing facilities in site. In this project Amara Raja strategic alliance partners Johnson controls, USA have closely worked with their Indian components required for automotive batteries. The production capacity is 750000 units of automotive batteries. This is the first phase in the enhancement of Amara Raja production which the company has invested Rs.75 Crores in Green field project. In the next phase at an additional cost of Rs.25 Crores. Production capacity will increase to 5 million units estimated to complete around 1 year. After that ARBL will become the single largest facility for battery manufacture in Asia. The organization has divides the employees into 3 grades depending on their education qualification, experience, performance and their behavior.

1. Management Grade - (M01- M09)
2. Staff Grade - (S01- S05)
3. Workmen Grade - (W1 – W5)

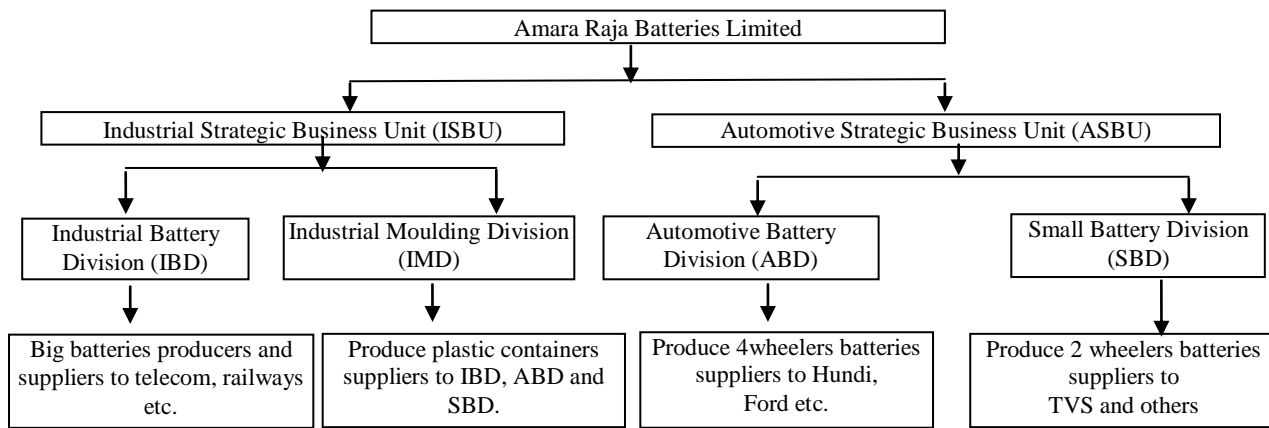


Figure 5.1 ARBL Organization Structure

### 6. Research Methodology

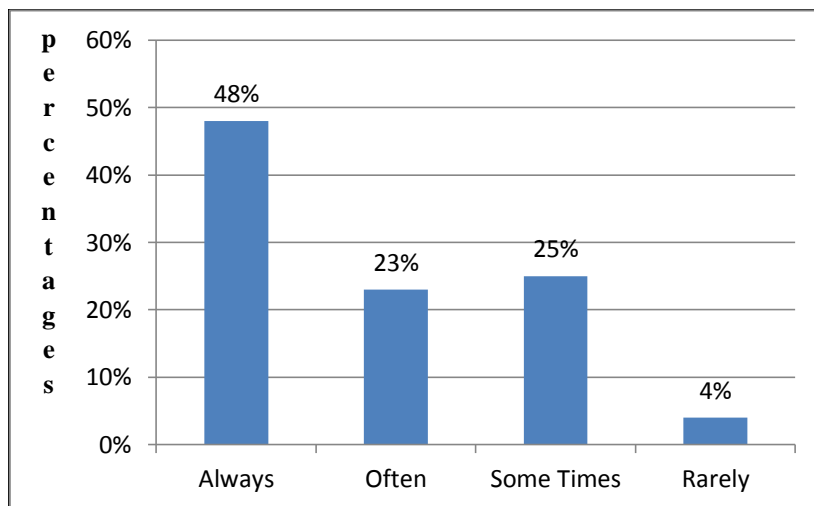
This paper takes empirical type of data from the ABD employees with simple random sampling method by using interview and structured questionnaire method. The sample size was 100 employees. The research was carried for limited period of time and the due to the busy schedule of the employees the sample size was confined to 100 employees.

### 7. Analysis

#### 7.1 Analysis based on Support from Superiors

##### 7.1

Category	No of respondents	Percentage
Always	48	48%
Often	23	23%
Some Times	25	25%
Rarely	4	04%
TOTAL	100	100%

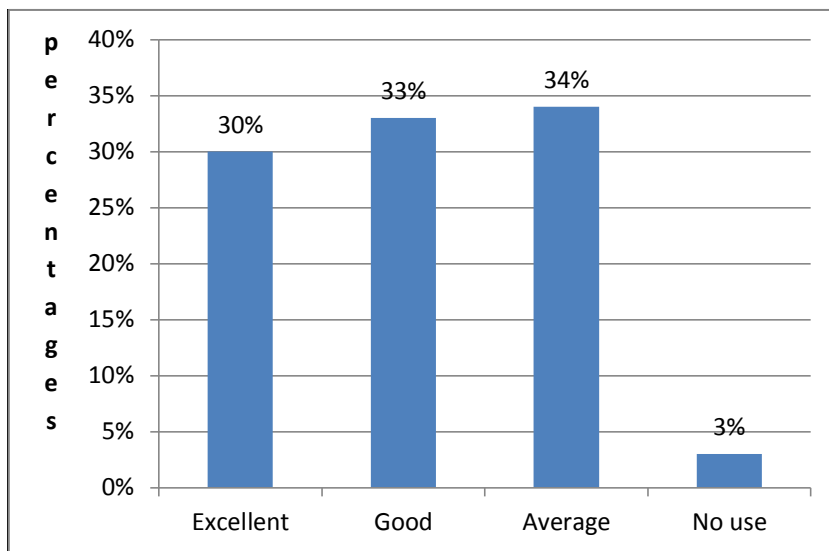


**Interpretation:** From the above chart, 48% of employees believe that they get support always from the superiors, 25% of employees are said that sometimes, 23% are said that often, and only 4% are said that rarely.

#### 7.2 Analysis based on Opinion on Medical Facilities

Table 7.2

Category	No of respondents	Percentage
Excellent	30	30%
Good	33	33%
Average	34	34%
No use	03	03%
Total	100	100%



**Interpretation:** From the above chart, 34% of employees stated that medical facilities are satisfactory at ARBL, 33% of employee stated that good, 30% are said that excellent, and 3% are said that no use.

**7.3 Analysis based on Safety Measures Provided at ARBL**

**Table 7.3**

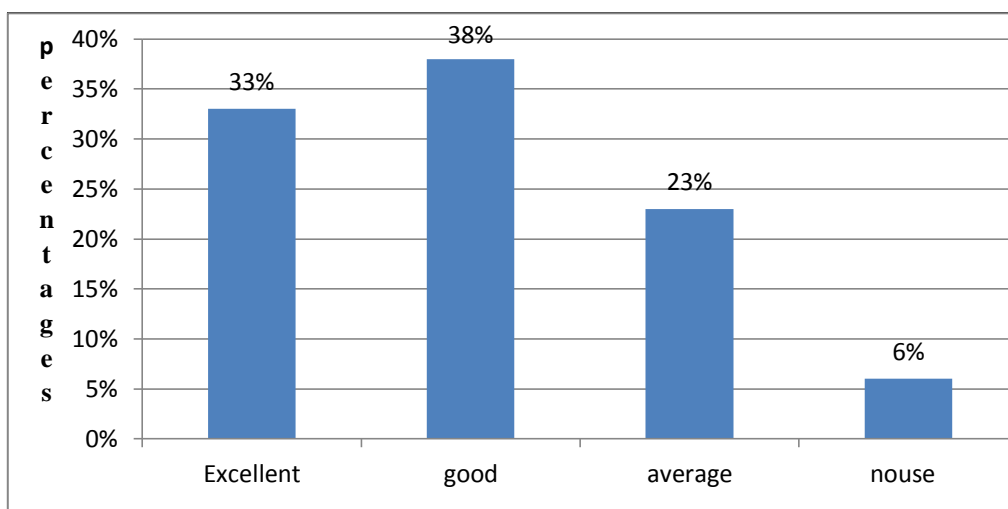
Category	No of respondents	Percentage
YES	87	87%
NO	13%	13%
Total	100	100%

**Interpretation:** From the above chart, 87% of employees are stated that safety measures are provided at ARBL, only 13% are said that not provided.

**7.4 Analysis based on Environmental Facilities at ARBL**

**Table 7.4**

Category	No of respondents	Percentage
Excellent	33	33%
Good	38	38%
Average	23	23%
No use	06	06%
Total	100	100%

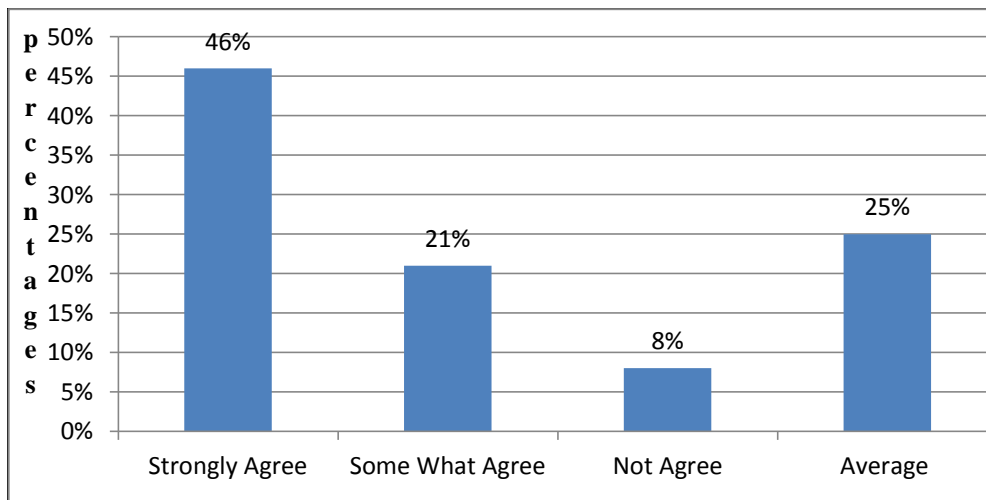


**Interpretation:** From the above chart, 38% of employees stated as environmental facilities are good at ARBL, 33% of employees stated as excellent, 23% are said that average, and 6% are said that no use.

7.5 Analysis based on Communication among Staff is Effective

Table 7.5

Category	No of respondents	Percentage
Strongly Agree	46	46%
Some What Agree	21	21%
Not Agree	08	08%
Average	25	25%
Total	100	100%

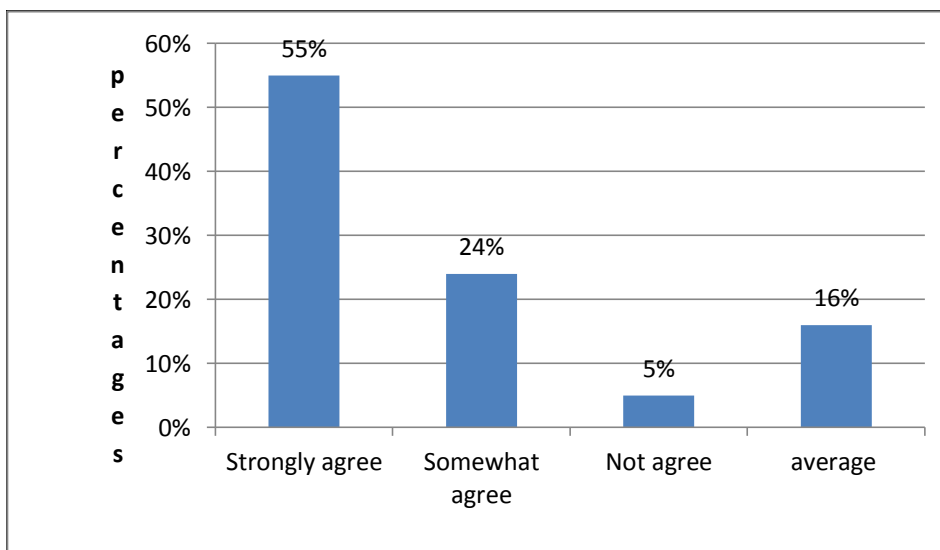


**Interpretation:** From the above chart, 46% of employees are strongly agreed that there is effective communication among staff, 25% of employees stated as average, 21% are said that somewhat agree, 8% are said that not agree.

7.6 Analysis based on Spirit of Cooperation among Staff

Table 7.6

Category	No of respondents	Percentage
Strongly agree	55	55%
Somewhat agree	24	24%
Not agree	05	05%
Average	16	16%
Total	100	100%

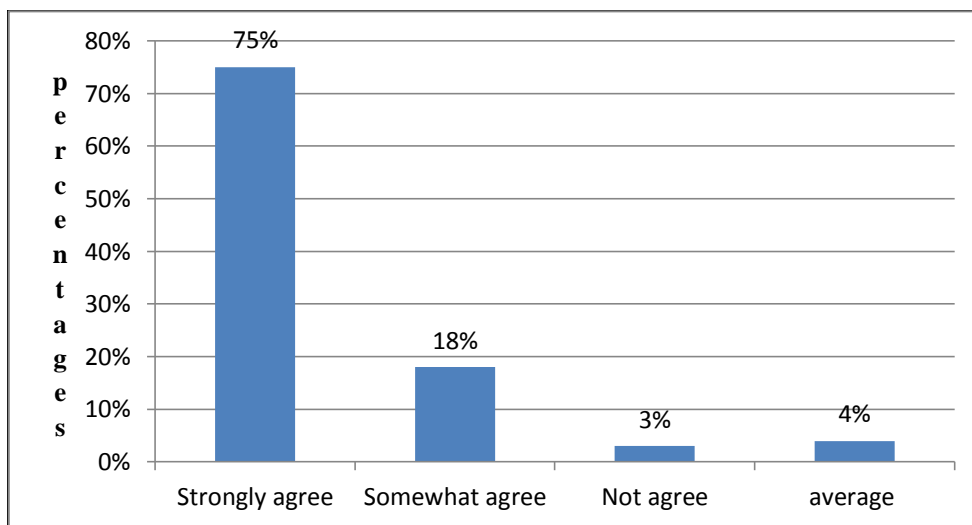


**Interpretation:** From the above chart, 55% of employees strongly agree that there is cooperation among staff. 24% of employees said somewhat agreed 16% are said that average, 5% are said that not agree.

7.7 Analysis based on Awareness of Policy Standards of the Company

Table 7.7

Category	No of respondents	Percentage
Strongly agree	75	75%
Somewhat agree	18	18%
Not agree	03	03%
average	04	04%
Total	100	100%

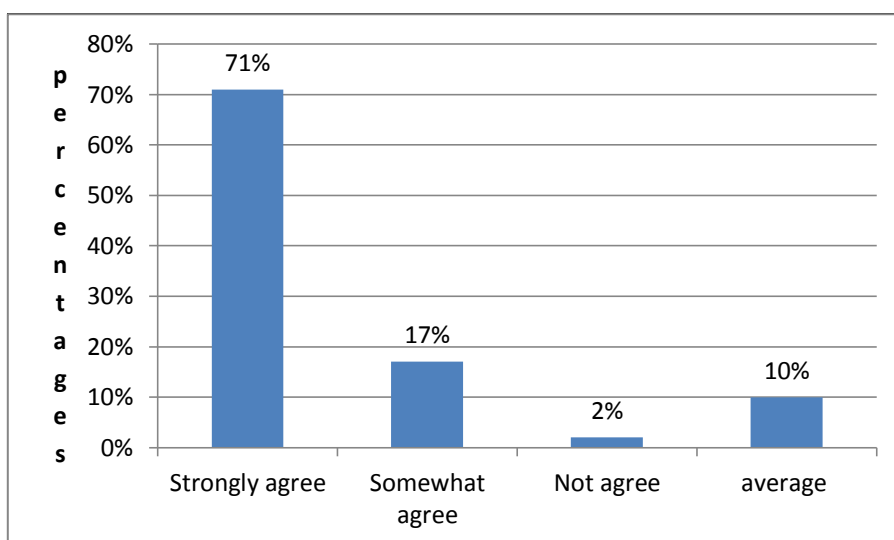


**Interpretation:** From the above chart, 75% of employees are aware of policy standards of the company, 18% are said that somewhat agree, 4% are said average, 3% are said that not agree.

7.8 Analysis based on Regular Staff Meetings at Work Place

Table 7.8

Category	No of respondents	Percentage
Strongly agree	71	71%
Somewhat agree	17	17%
Not agree	02	02%
average	10	10%
Total	100	100%



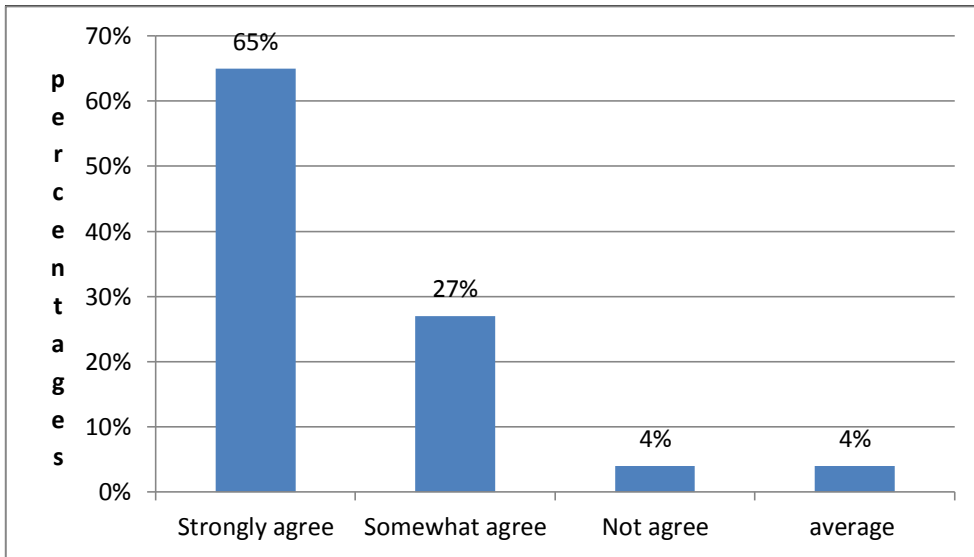
**Interpretation:** From the above chart, 71% of employees are strongly agreed that the staff meetings are happening regularly, 17% are said that somewhat agree, 10% are said that average, 2% are said that not agree.



7.9 Analysis based on Induction Classes at the Time of Joining

Table 7.9

Category	No of respondents	Percentage
Strongly agree	65	65%
Somewhat agree	27	27%
Not agree	04	04%
average	04	04%
Total	100	100%

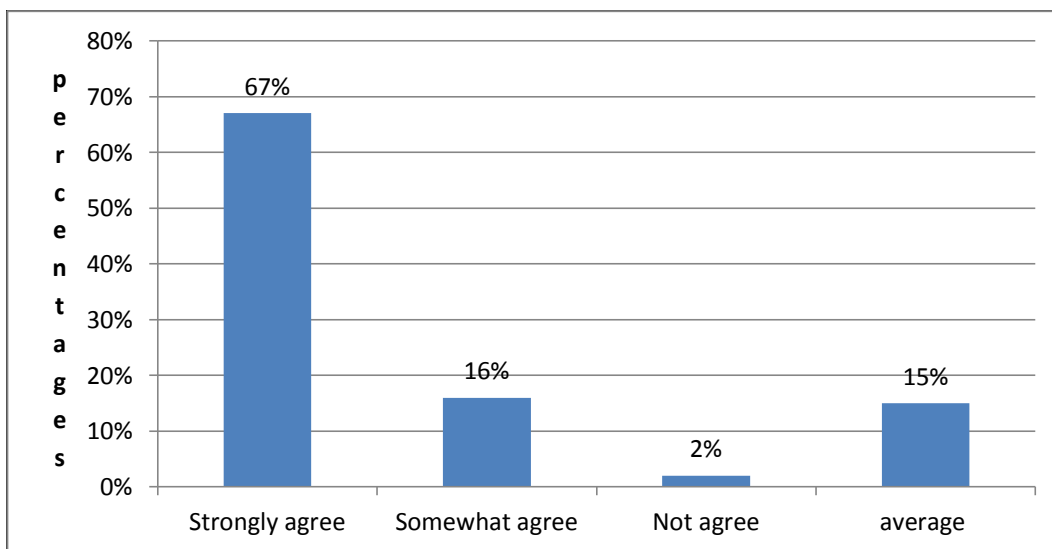


**Interpretation:** From the above chart, 65% of employees strongly agreed that induction classes provided thoroughly, 27% are said that somewhat agree, 4% are said that not agree, and 4% are said that average.

7.10 Analysis based on Satisfaction with the Job

Table 7.10

Category	No of respondents	Percentage
Strongly agree	67	67%
Somewhat agree	16	16%
Not agree	02	02%
average	15	15%
Total	100	100%

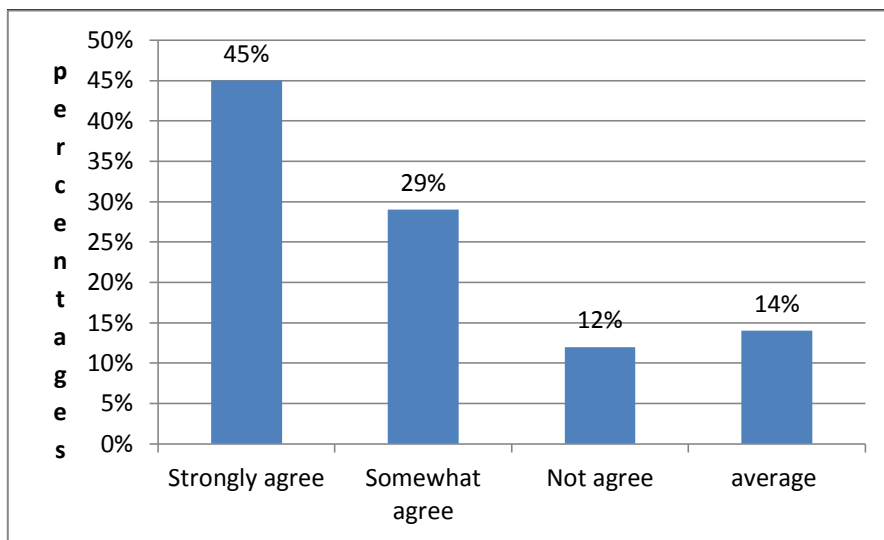


**Interpretation:** From the above chart, 67% of employees are strongly agreed about satisfaction about their job, 16% are said that somewhat agree, 15% are said that average, 2% are said that not agree.

7.11 Analysis based on Awareness of how the Job Performance is Measured

Table 7.11

Category	No of respondents	Percentage
Strongly agree	45	45%
Somewhat agree	29	29%
Not agree	12	12%
average	14	14%
Total	100	100%

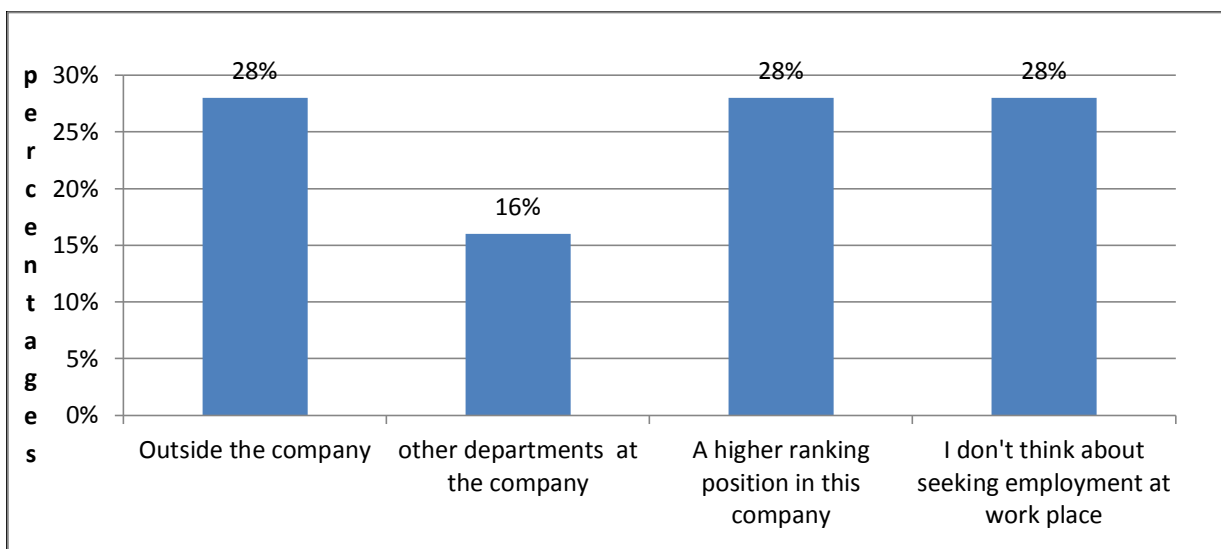


**Interpretation:** From the above chart, 45% of the employees are strongly agreed that they are aware of how the job performance is measured, 29% are said that somewhat agree, 14% are said that average, 12% are said that not agree.

7.12 Analysis based on Seeking Employment Else Where

Table 7.12

Category	No of respondents	Percentage
Outside the company	28	28%
other departments at the company	16	16%
A higher ranking position in this company	28	28%
I don't think about seeking employment at work place	28	28%
Total	100	100%

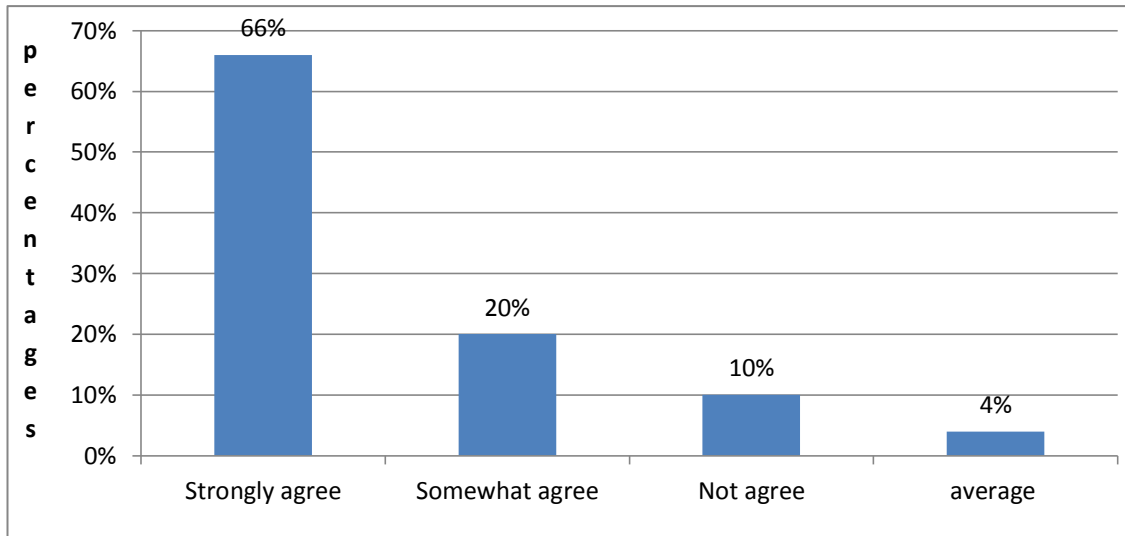


**Interpretation:** From the above chart, 28% of the employees stated that seeking employment to outside the company, 28% are stated a higher ranking position in this company, 28% are said that I don't think about seeking employment at work place, 16% are said that other department at the company.

7.13 Analysis based on Work Load and Expected Completion times are Reasonable

Table 7.13

Category	No of respondents	Percentage
Strongly agree	66	66%
Somewhat agree	20	20%
Not agree	10	10%
average	04	04%
Total	100	100%



**Interpretation:** From the above chart, 66% of employees are strongly agreed that the workload and expected completion times are reasonable, 20% are said that somewhat agree, 10% said that not agree, and 4% are said that average.

8. Testing of Hypothesis

**Karl Pearson Correlation Method:** The correlation between induction classes and satisfaction with training period. X = Induction classes, Y = Satisfaction with training period.

**H<sub>0</sub>:** There is no relation between Induction classes and satisfaction with training period.

**H<sub>1</sub>:** There is relation between Induction classes and satisfaction with training period.

Table 8.1

X	Y	XY	X <sup>2</sup>	Y <sup>2</sup>
65	52	3380	4225	2704
27	24	648	729	576
04	06	24	16	36
04	17	68	16	289
<b>ΣX = 100</b>	<b>ΣY = 100</b>	<b>ΣXY = 4120</b>	<b>ΣX<sup>2</sup> = 4986</b>	<b>ΣY<sup>2</sup> = 3605</b>

$$r = \frac{N\sum xy - (\sum x)(\sum y)}{\sqrt{[N\sum x^2 - (\sum x)^2][N\sum y^2 - (\sum y)^2]}}$$

$$r = \frac{4\sum 4120 - (100)(100)}{\sqrt{[4*4986 - (100)^2][4*3605 - (100)^2]}}$$

$$r = \frac{6480}{\sqrt{43952480}}$$

$$r = 0.97$$

**Interpretation:** it is inferred that the correlation is highly positive as the value (x, y) lies between 0 & 1. from the result, there is a strong positive correlation between induction classes and satisfaction with training period. So H0 is rejected.

**T-Test:**

For testing the significance of Karl Pearson rank coefficient we have to do t-test. If the resulted value is greater than 2 then the value of ‘r’ is significant. If not then there is no significance of rank correlation.

$$t = \frac{r \sqrt{N-1}}{\sqrt{(1-r^2)}}$$

Where, r = Karl Pearson Rank Coefficient      N = Sample size

$$t = \frac{0.97 \sqrt{100-1}}{\sqrt{(1-(0.97 * 0.97))}}$$

$$t = \frac{9.6514}{0.2431}$$

t = 39.70

**Interpretation:** Here ‘t’ value is greater than 2 hence there is significant between the variables induction classes and satisfaction with training period.

**Weighted Average:** Employees’ Feedback on the Various Aspects of the Training Program

**Table 8.2**

Description	Strongly Agree	Somewhat Agree	Not agree	average
satisfaction with training period	52	24	06	18
Communication Among Staff Is Effective	46	21	08	25
Spirit Of Cooperation Among Staff	55	24	05	16
Induction Classes At The Time Of Joining	65	27	04	04
Awareness Of Job Performance	45	29	12	14

- Strongly Agree = 4
- Somewhat Agree = 3
- Not agree = 2
- Average = 1

**Calculation**

- 1 Satisfaction with training period = [(52\*4) + (24\*3) + (06\*2) + (18\*1)]/ 10 = 31
- 2 Communication Among Staff Is Effective = [(46\*4) + (21\*3) + (08\*2) + (25\*1)]/ 10 = 28.8
- 3 Spirit Of Cooperation Among Staff = [(55\*4) + (24\*3) + (05\*2) + (16\*1)]/ 10 = 31.8
- 4 Induction Classes At The Time Of Joining = [(65\*4) + (27\*3) + (04\*2) + (04\*1)]/ 10 = 34.4
- 5 Awareness of Job Performance = [(45\*4) + (29\*3) + (12\*2) + (14\*1)]/ 10 = 30.5

**Table 8.3**

Description	Weighted Average	Rank
Satisfaction with training period	31	3
Communication Among Staff Is Effective	28.8	5
Spirit Of Cooperation Among Staff	31.8	2
Induction Classes At The Time Of Joining	34.4	1
Awareness Of Job Performance	30.5	4

**Interpretation:** From the above weighted averaged table it has been inferred that the majority of the respondents have given first preference to the Induction Classes at the Time of Joining, the second preference is given to Spirit of Cooperation among Staff, whereas the third preference is given to Satisfaction with training period.

**Chi Square Test**

**H<sub>0</sub>**: There is no significant relationship between experience and employees satisfaction.

**H<sub>1</sub>**: There is significant relationship between experience and employees satisfaction.

**Table 8.4**

Experience/Job satisfaction	Highly satisfied	Satisfied	Dissatisfied	Total
Below5months	5	7	3	15
5-12 months	11	50	10	71
13-24 months	7	4	3	14
Total	23	61	16	100

**9. Calculation**

The formula for calculating the  $\chi^2$  value is

$$\chi^2 = \sum((O-E)^2/E)$$

Where, O is the observed value. E is the expected value.

**Table 8.5**

Oij	Eij	Oij-Eij	(Oij-Eij) <sup>2</sup> /Eij
5	3.45 (23*15/100)	1.55	0.69
11	9.15 (23*71/100)	1.85	0.37
7	2.4 (23*14/100)	4.6	8.816
7	16.33 (61*15/100)	9.33	5.33
50	43.31 (61*71/100)	6.69	1.033
4	11.36 (61*14/100)	7.36	4.767
3	3.22 (16*15/100)	0.22	0.0149
10	8.54 (16*71/100)	1.46	0.249
3	2.24 (16*14/100)	0.76	0.257
Total =21.5269			

**Degrees of Freedom:** Degree of freedom in distribution is number of observation or values that are independent of each other and cannot be detected from each other.

At 5% level of significance

Tabular Value = 9.49

**Degrees of Freedom=(r-1) (c-1)**

$$= (3-1) (3-1)$$

$$= 4$$

**Result:** Since the calculated value is greater than tabulated value we accept alternative hypothesis. We reject H<sub>0</sub>. i.e. H<sub>1</sub>so there is significant relationship between the experience and satisfaction level of training program conducted in ARBL.

**Attrition Rate of ARBL**

**Attrition Rate = (Number of Attritions \* 100/Actual employees + New Joined|100)**

Percentage of Attrition Rate of ARBL = ((48\*100)/(750+26))

$$= (4800/776)$$

$$= 6.1\%$$

**Result:** It is observed that the attrition rate of ARBL is 6.1%, which is high.

**10. Findings**

- Most of the employees are satisfied with the training that provided by the company. Training is not the cause for employee attrition.
- 48% of employees stated as they are getting support from their superiors always.
- 38% of the employees are stated as the medical facilities provided at ARBL are Excellent.
- 87% of employees are stated that safety measures are provided at ARBL.

- The environmental facilities that provided in ARBL are excellent which was stated by 92% of employees.
- 48% of employees strongly agreed that there is a effective communication among staff.
- 75% of employees are aware of policy standards of the company.
- 71% of employees are strongly agreed that the staff meetings are happening regularly.
- 65% of employees strongly agreed that induction classes provided thoroughly.
- 67% of employees are strongly agreed about satisfaction about their job.
- 45% of the employees are strongly agreed that they are aware of how the job performance is measured.
- 28% of employees are seeking employment on the following three categories
- Outside the company,
- A higher ranking position in this company,
- No idea about seeking employment else anywhere.
- 66% of employees are strongly agreed that the workload and expected completion times are reasonable.

### 11. Scope for Future Research

The study was done for the specific sample of data so it can be further prolong to the entire employees of ARBL. We can also find the employee attrition rate particularly to specific industry of manufacturing or service. We can also compare the employee attrition rates between the companies. We can also calculate the employee attrition rate of Indian manufacturing and service industries.

### 12. Conclusion

Organizations can reduce the employee attrition rate to some extent only but can't eradicate completely due to the employee individual needs. Employees of ARBL responses these identified factors for their attrition as a dissatisfaction with the salary packages, employee benefits, employee motivation, family reasons and some health issues. The company has to reduce the rate by reducing the dissatisfaction faced by the employees. The company has to modify the salary packages majorly because it was the major reason for employee attrition.

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# Empirical investigation of Intrinsic Attributes in IT Company in uncertain Times



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**Timira Shukla**  
JIMS, Kalkaji  
(timirashukla@gmail.com)  
**Anita Singh**  
Institute of Management Studies  
(anita.singhims@yahoo.com)

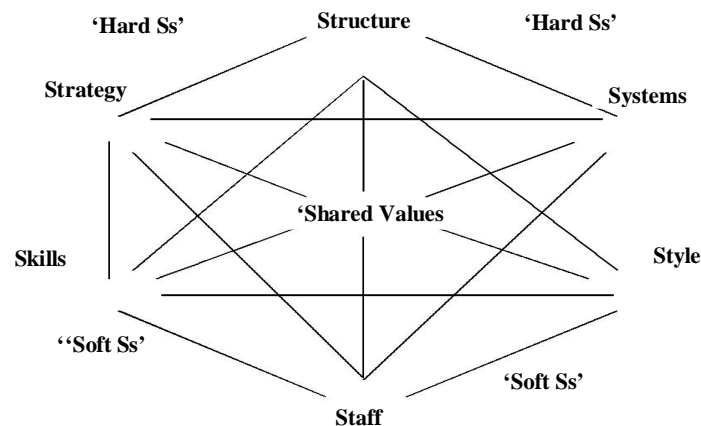
*The role of intrinsic attributes becomes manifold as these are important building blocks for skill development for performing organizations. To focus on attributes such as the feedback mechanism, career and development, communication systems becomes significant as the management is undergoing change. Measuring employees' pulse wherein the management has invested substantial resources in recruiting educated professionals from the campus and groomed them assumes strategic importance. The study is exploratory in nature; the data has been collected from IT organizations and analyzed to obtain an insight into the factors that are important for skill development in the coming future*

**Keywords:** Intrinsic attributes, Growth, Skill Development, Young professionals, Shared values

## 1. Introduction

It has been well documented that intrinsic motivation is time and context-dependent. Therefore, in times of uncertainty, when collectivistic norms in an organization are interlinked with future it can inspire employees. Doing a job because one loves it is intrinsic; the motivation comes from within. The technical manpower may or may not possess hard skills relevant for the domain for which they are hired; they often need to be trained for soft skills to understand the ways organizations function. Employees need purpose especially at work; when their growth is linked with organization values it leads to creativity and innovation which are precursors for growth in this economy.

In the 7S McKinsey framework shared values are at the core; they are the norms and standards which acts as a guiding principle for employee behaviour and organisation actions. The model shown above represents the connection between 'Soft Ss' and 'Hard Ss'.



**Figure1** McKinsey 7S Framework

Source: Robert H. Waterman, JR., Thomas J. Peters and Julien R. Phillips (1980), *Structure is not Organization, Business Horizon*.

The above model which clearly depicts the inter-relationships between hard skills and soft skills has been successfully used to identify the areas that need to evolve and change. The basic premise in the study is to identify the issues that are relevant for identifying these skills so that the organization can focus on them to build a strong organizational identity. The main hypothesis is that better knowledge related to the job and interpersonal relations (intrinsic) lead to skill development and therefore growth. For millennial employees, the opportunity to use skills and abilities can prove to be boon especially in times of uncertainty. It can provide employers an opportunity to partner with employees in a way that can build organization's future while developing employees.

## 2. Literature Review

Bainbridge (2011) asserts that intrinsic motivation alludes to motivation that originates from within a person rather than from external merits such as remuneration. Herzberg (1959) posits that motivated people are stimulated by inner values as compared to other values that are peripheral to the working environment. Evidently, motivation is aroused internally by

factors native to the work that Herzberg referred to as “motivators”. Factors which intrinsically motivate employees are the work itself, advancement, achievement, responsibility, recognition, and growth. Motivation would thus only be in effect an outcome to these intrinsic variables being utilized. Herzberg (1959) conducted a research in private and public organizations and presented intrinsic motivational factors which had a momentous influence on individuals.. These motivational factors were: job security, freedom for innovative thinking, training and development, challenging/interesting work, and sense of belonging to the organisation

Research suggest that the organisations strategy to enhance manpower productivity drastically and boost retention is to request the optimization of their manpower through ample training and development programmes. Wan (2007) posits that for training and development organizations need to invest enormous resources in order to ensure that workers have the skills, competencies and information necessary to work successfully in a fast changing and complicated work environment. Research supports that it is essential for companies to invest on human resource development, which ultimately forms part of the course of assisting employees improve their knowledge, skills, experiences, and IT add value to their working lives. It is evident that the key technique of achieving this is through education, training, and development.

Choo and Bowley (2007) cited in Samuel (2008) point out according to the opinion of employees training and development is one of the highest retention factors. Opportunities for training and development, as confirmed by research, improve employee skills and enable them to be up-to-date with technologies.

The other critical factor which plays an important role is work environment that endear the organization to employees. Factors such as job opportunities which exist outside the organization make it essential to influence employees’ decisions to be engaged and stay with the company. When extrinsic motivators such as higher pay in other organisations arise, leaders have the obligation to create a work environment for employees that will motivate them to resist such factors and stay in the organisation. This will enable employees to meet their performance (earning potential) due to open communication and requisite levels of training and support given by the organisation (Samuel & Chipunza, 2009).

Therefore, it is crucial that the organisation as a whole facilitates employee attachment to their leaders. Hao *et al.*, (2009) posits that autonomy given to employees can also be one retention strategy that involves management attention. Amar (2004) discerns that in modern organisational leaders are not concerned about the creativity of employees on the job and the organisational policies are such designed that create hurdles. the researchers further contend that leaders’ management must ensure to what degree controls are required ,too much of control stifles creativity.

An organisation’s retention practices can be helped by removing structures and strict formalities which restricts employee autonomy. This will reduce the high turnover rate caused by the rigid organisational policies. as a result of the satisfying social atmosphere that exists in the organisation which include i.e. happy and friendly environment reminiscent of a family environment, employees’ intention to quit is eliminated (Samuel, 2008).

Research posits this approach by stating that professions should be structured so as to cultivate experiences of an employee of responsibility, meaningfulness, and knowledge of the outcome of one’s effort (Ramlall, 2004). Particularly, three specific core factors are desirable for making work feel meaningful. Skill variety, task significance and task identity comprise these three factors. “The degree to which a job requires a variety of different activities in carrying out the work, involving the use of a number of different skills and talents of the person is defined as the skills variety” (Hackman & Oldham, 1980).

Therefore it is evident that unlike jobs that require the use of only one or two types of skills, jobs which require the use of multiple talents are experienced as more meaningful, and therefore more intrinsically motivating. Ramlall (2004) contends that consistent with the concept of growth need satisfaction, the inclusion of task variety as an element of job design is a good factor, as well as with a more psychological approach advocated by activation theory. Tippet & Kluvers(2009) have also posited that these factors contribute to learning and growth. However, it does not imply that the employees will not seek merits. But in uncertain times employees consider a good mentor in the organisation as one of the factors that will keep them from leaving the organization (Gupta-Sunderji; 2004).

It can be concluded that intrinsic factors when coupled with growth and an opportunity to learn new skills can enhance employees’ sense of belongingness in the organization.

### 3. Purpose of the Study

It can be seen that the association between intrinsic attributes and opportunities for growth can lead to collaboration; in the sense that the employees’ energies are aligned with the organisation’s interest. The problem statement in this study is to discover this hidden link between intrinsic attributes, growth and shared values, especially for employees who have been with the organization for 5 years or less. The primary data has been collected through a pre-tested structured questionnaire administered to the employees of purposely selected IT companies in the National Capital Region.

### 4. Research Methodology

The study is exploratory and analytical in nature. The IT organizations were selected using purposive sampling; the questionnaire was administered to the employees in the organization by co-ordination with the HR department of the organization. To achieve a possible high response rate, it was agreed that the data collection period be a maximum of two months the primary data was collected from different functional areas of the organization to ensure representativeness. The total sample size is 200 respondents from 12 organisations. The profile of respondents is given below in Table 1. The



responses were scored on a 5-point Likert scale with 1 being 'strongly agree' and 5 being 'strongly disagree' on 34 statements developed and adapted from job satisfaction surveys.

**Table 1 Profile of Respondents**

Variable	Description	Frequency
Gender	Male	132
	Female	86
Tenure of work	Less than one year	18
	Between 1-2 years	58
	Between 2-5 years	124
Education	Graduation	162
	Post graduation	38
Department	Customer service	38
	Product development	84
	Marketing	26
	Operations	15
	Quality assurance	17
	Research	20

**Table 2 Cross Tabulation of Sex and Tenure in the Organization**

Sex	Less than 1 year	1-2 years	2-5 years
Male	10	36	86
Female	8	22	38
<b>Total</b>	<b>18</b>	<b>58</b>	<b>124</b>

### 5. Analysis and Findings

The method of factor analysis was used to extract the factors that provide an insight into the role of intrinsic attributes in the organization. The calculated Cronbach alpha is 0.968 which shows that the data are reliable. The table 3,4 and 5 shows the output of exploratory factor analysis. It can be seen from table 4 that EFA was able to explain 72.3% of the total variation. The initial extraction was rotated and 6 factors were extracted from 34 statements which imply inter-correlations between the different areas and skill sets that impact growth. The table 6 shows the factor matrix with factor loadings.

**Table 3 KMO and Bartlett's Test**

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	.926
Approx. Chi-Square	5.278E3
Bartlett's Test of Sphericity	df
	561
	Sig.
	.000

**Table 4 Total Variance Explained**

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	16.758	49.287	49.287	16.758	49.287	49.287	5.025	14.780	14.780
2	2.348	6.907	56.194	2.348	6.907	56.194	4.316	12.695	27.475
3	1.649	4.851	61.045	1.649	4.851	61.045	4.048	11.906	39.381
4	1.364	4.011	65.056	1.364	4.011	65.056	3.917	11.522	50.903
5	1.249	3.674	68.730	1.249	3.674	68.730	3.650	10.734	61.637
6	1.231	3.621	72.351	1.231	3.621	72.351	3.643	10.714	72.351
7	.837	2.462	74.813						
8	.725	2.133	76.946						
9	.692	2.034	78.980						
10	.615	1.810	80.790						
11	.554	1.630	82.420						
12	.515	1.515	83.935						
13	.479	1.409	85.344						
14	.443	1.304	86.648						
15	.435	1.278	87.926						
16	.419	1.233	89.159						

17	.383	1.127	90.286						
18	.371	1.091	91.377						
19	.305	.897	92.274						
20	.281	.827	93.101						
21	.257	.757	93.858						
22	.246	.724	94.582						
23	.230	.677	95.260						
24	.218	.640	95.900						
25	.198	.583	96.483						
26	.196	.578	97.060						
27	.167	.492	97.552						
28	.162	.475	98.028						
29	.139	.410	98.438						
30	.138	.405	98.843						
31	.121	.357	99.199						
32	.109	.321	99.520						
33	.090	.263	99.783						
34	.074	.217	100.000						

Extraction Method: Principal Component Analysis

Table 5 Rotated Component Matrix<sup>a</sup>

	Component					
	1	2	3	4	5	6
My company is one of the best. Companies to work in	.180	.151	.132	-.075	.784	.276
My company treats me well	.215	.139	.234	.242	.734	.197
I am proud to tell people I work for this company	.223	.283	.209	.399	.621	.068
I am happy working here	.123	.182	.178	.336	.621	.390
I like the kind of work I do	.262	.374	.015	.304	.296	.549
My job is interesting	.249	.107	.128	.149	.269	.785
I am getting relevant job training	.272	.072	.104	.261	.219	.676
I understand what is expected of me	.056	-.076	-.049	.709	.088	.367
I have the resources required to do the job	.155	.228	.128	.723	.277	.125
I am satisfied with my work condition	.457	.215	.223	.340	.329	.413
My manager recognizes and acknowledges my performance	.473	.461	.156	.307	.172	.298
I am happy with my current job	.195	.356	.334	.398	.028	.505
The company fills vacancies from within	.109	.678	.272	.260	.044	.342
I am satisfied with the exposure I get	.135	.611	.253	.013	.211	.480
Promotion is given to those who deserve it	.212	.587	.311	.194	.284	.345
My manager gives feedback on my performance	.312	.491	.338	.212	.356	.333
There are opportunities for training	.304	.295	.294	.219	.372	.405
My manager trusts me	.599	.100	.069	.381	.166	.391
My manager helps me to improve	.718	.135	.186	.302	.223	.245
My manager takes fair corrective action on employees who fail to perform	.671	.244	.149	.103	.247	.359
My manager establishes work plan	.710	.219	.097	.204	.341	.172
My manager gives clear instructions	.542	.222	.044	.350	.460	.067
My manager is available when I need advice	.403	.201	.273	.596	.315	.130
I feel free to talk to my manager	.276	.219	.212	.691	.089	.175
My manager praises me when I do good job	.376	.390	.164	.643	.024	.040
My manager conducts regular meetings	.342	.784	.141	.145	.188	-.131
My manger regular gives information	.220	.718	.248	.167	.214	.101
My manger is effective in decision-making	.660	.252	.437	.154	.041	.067
My manager knows about work groups/work	.610	.303	.484	.053	.067	.213
My manger is doing a good job	.515	.258	.570	.159	.032	.200
Work is fairly distributed in the group	.231	.404	.631	.062	.333	.066
My group helps to solve work problem	.063	.296	.799	.077	.278	.095
My work group co-ordinates well	.057	.164	.838	.118	.224	.049
I feel free to talk openly with members of my work group	.336	.039	.666	.162	-.024	.176

*Extraction Method: Principal Component Analysis*  
*Rotation Method: Varimax with Kaiser Normalization. a.*  
*Rotation converged in 8 iterations*

**Table 6** Factor Matrix

Factor Name	Variables	Factor Loading	%Variance
Factor1 Work environment	manager trusts me	.599	14.760
	manager helps me to improve	.718	
	fair corrective action on employees who fail to perform	.671	
	manager establishes work plan	.710	
	manager gives clear instructions	.542	
Factor 2 Career development	company fills vacancies from within	.678	12.695
	satisfied with the exposure I get	.611	
	Promotion is given to those who deserve it	.587	
	Regular. Meetings	.784	
Factor 3 Work group	manager.info	.718	11.906
	Manager freely	.570	
	workfare	.631	
	work Problem	.799	
	work Well	.838	
Factor 4 Support and Recognition	open group	.666	11.522
	understand what is expected of me	.709	
	have the resources required to do the job	.723	
	manager advice	.596	
	manager freely	.691	
Factor 5 Motivated Employee	manager praise	.643	10.734
	Best companies to work in	.784	
	company treats me well	.734	
	proud to tell people I work for this company	.621	
Factor 6 Challenging and interesting work	happy working here	.621	10.174
	like the kind of work I do	.549	
	job is interesting	.785	
	getting relevant job training	.676	
	happy with my current job	.505	

## 6. Discussion

### Factor 1: Work Environment

The most important factor 1 with 14.760% Variance is Work environment which is very much required for skill development among employees. Employees are motivated to perform in congenial work environment. Employees contribute their best when there is a proper plan of action and clarity in instructions. Employees are comfortable to work in an environment of trust and support. This factor is also supported by Herzberg studies. The studies suggest that motivated individuals are aroused by inner values relative to other values that are peripheral to the working environment. Organizations need to devote enormous resources in order to ensure that workers have the skills, competencies and information necessary to work successfully in a hastily changing and complex work environment (Wan (2007).

### Factor 2: Career Development

Factor 2, Career development with 12.695 % Variance suggests that employees are motivated to perform when they get opportunity to grow within the organization. The employees of IT organization are satisfied with the exposure they get and information shared by the managers to achieve their objectives. Further they are satisfied with the promotion given to those who deserve it.

### Factor 3: Work Group

This factor with 11.906% Variance depicts that employees are motivated to perform when there is open communication among the workgroup and members are involved in solving the problems with team spirit. The employees when they work in team they acquire team skills.

### Factor 4: Support and Recognition

This factor with 11.522% Variance suggests that employees of this organization understand what is expected from them. They have the resources required to do the job. They are free to discuss with the manager. In this organization employees are appreciated for their good job performance which leads to motivated workforce. Managers in IT Company have participative style of functioning. Employees get proper guidelines and support to perform the task.

**Factor 5: Motivated Employee**

One of the important attribute is Motivated employee with 10.734% Variance demonstrates that employees feel proud and think that this is the best company to work in. Company treats their employees very well and employees are motivated and happy to contribute and learn the skills. Company believes in happy employees are productive employees.

**Factor 6: Challenging and Interesting Work**

This factor with 10.174 % Variance shows that employees are motivated to contribute when the job is interesting and full of challenges. They get relevant job training when required and are happy about their current job. Challenging task leads to acquiring different kinds of skills and employees can handle the task with enthusiasm.

**7. Conclusion**

It can be summarized from the above empirical study that employees (Staff) have positive orientation and are eager to collaborate when skills, style (of managing, leading and supervision) are aligned with shared values (as exemplified in the organization goal charter). These four 'Soft S' areas overlap with 'HARD S' areas and has various avenues for improving collaboration between people whose skills are assets for the organization. This is especially true in cases wherein organization have invested time and energies to recruit and develop young minds into future potential workforce. This is an important insight as IT industry is in midst of change. The large sample size (n=200) shows that this hold true irrespective of the work domain.

It proves that when managers commit every single individual in the in affecting the organization onward, it builds a combined effort at all levels. It shows what an organization needs to do in antagonistic condition to retain employees. We can conclude that assigning individual's well-defined task is an enabler for employees as it aligns with their individual goals.

**8. Limitations**

The study is exploratory in nature and cannot be generalized across other sectors of the industry as primary data has been collected only from IT companies. It provides direction for further studies; the study can be undertaken at pan-India to reveal whether there are differences among different parts of the country.

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# Cloud Computing Adoption in SMEs: A Literature Review



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**Pragati Priyadarshinee**

**M.K. Jha**

**Rakesh Raut**

*National Institute of Industrial Engineering (NITIE)*

(priyadarshinee.pragati@gmail.com)

*This paper presents a detailed literature review with detailed classification for Cloud Computing research. This includes 296 referred journal articles published between 2010 and 2014. The articles are classified into 4 main categories: Technology Adoption, Small and Medium Scale Enterprises, Risk Analysis, and conceptualizing Cloud Computing. The critical findings show that Risk Analysis in adoption of Cloud Computing among Small and Medium scale Enterprises needs more attention. This review provides a reference to guide future research and facilitates knowledge accumulation and creation concerning the adoption of Cloud Computing in Indian Small and Medium scale Enterprises.*

## 1. Introduction

Cloud computing has become a universal topic in recent years. Due to size; resources, IT expertise and other constraints Cloud Computing could be of specific advantage to SMEs. However, migrating internal Information Technology data and applications to the cloud is associated with a wide range of risks and challenges [1]. Security, confidentiality, auditability, regulatory compliance and a host of other risks must be verified before adopting any new technology. Migrating data, applications or services to the cloud exposes a business to a number of new threats and vulnerabilities, which need to be properly assessed. The migration of data and applications to cloud may also have some compatibility problems [2]. In addition, SME increases a number of issues: Protection of Critical Infrastructures; Information Assurance and Trusted Computing; Privacy and Freedom of Information; and Laws and Regulation of IT Security. Hardware, software, operations, help desk, and back up are conducted by cloud vendors. Also software as a service, software development and platform control are managed by the vendors [3]. Addressing these issues can develop a way forward for more and more SMEs to adopt Cloud computing. Current market is characterized as being very competitive. Therefore, for companies who want to survive, it is essential to adopt innovations. As it has been mentioned previously, one of the most state-of-the-art technology that assist companies gain competitive advantage is Cloud Computing. It allows companies to access the most advanced technology over a network (e.g. Internet). If companies switch to Cloud Computing, they can save time, energy and money. These resources can then be spent in other value-adding areas of their business. It makes a company more efficient and productive which is particularly true for SMEs. If several companies switch to Cloud Computing the payback for companies and the economy is much higher. In that case Cloud Computing brings efficiency to the economy and environment. Cloud providers are specialized in offering IT services; therefore they can accomplish IT related tasks more quickly by spending fewer resources [4].

Moreover, offering any service in large scale brings in economies of scale which results in more efficient operations. Economies consisting of more efficient and innovative companies are certainly better than those which are comprised of inefficient companies. Widespread usage of Cloud computing will reduce the number of data centers; because individual companies do not need to have their own data centers. Data centers that are operating by cloud providers consume resources in a more efficient manner than small data centers. Cloud Computing is based on virtualization, which results in consumption of less power. It is one way to achieve environmental sustainability. It also saves energy cost for the company.

This research is an exhaustive review of Cloud Computing Adoption in SMEs published in academic journals during the period of 2010 to 2014. The main outlines of the paper consists of review process of the literature, the classification criteria of Cloud Computing adoption articles in SMEs, Cloud Computing adoption in SMEs are analyzed and the outcomes of the review, conclusion, and research gaps. We have developed a classification framework for this literature review process.

## 2. Review Process

As the related matters are covered in different research papers, Adoption of Cloud Computing in SMEs is very hard to restrict to a particular direction. Technology adoption is the general academic subject for researcher in Cloud Computing. The online databases searched for the Cloud Computing Adoption are:

- (1) Science Direct
- (2) EBSCO Open Access Journals
- (3) ACM Digital Library.
- (4) Emerald Management.
- (5) IEEE Electronic Library.
- (6) Pro Quest Science Journals.

There are some other famous areas in IT like “Adoption of Technology”. But, we found lots of ongoing research work in the area of TOE/TAM Model. As per the Survey in EBSCO combining all three (Adoption+ Cloud Computing + SMEs), the total number of academic journals published are 462 where as in current area (RM +Cloud Computing + SMEs), the total number of academic journals till date is only 291. So, it’s clear from this literature review that a lot of study still required in the field of “Risk Associated for Adoption of Cloud Computing in SMEs”.

### 3. Classification Method

The papers were reviewed and classified with three ways (Risk, SMEs and Cloud Computing Adoption) of combination. The classification method consisted of four phases:

- (1) Database search through internet,
- (2) Basic grouping through “Cloud Computing Adoption”,
- (3) Analyzing the grouping outcomes through “Risk Analysis in Cloud adoption in SMEs”, and
- (4) Final verification of critical findings through the consistent result from the previous three ways (Risk, SMEs and Cloud Computing Adoption).

#### 3.1 Classification Process

The classification of articles is filtered by different combination of Risk Management, Cloud Computing, Technology adoption and SMEs.

- (1) Cloud Computing (CC)
- (2) Adoption of Cloud Computing (ACC)
- (3) Adoption of Cloud Computing in SMEs (ACC + SME)
- (4) Risk Analysis in Adoption of Cloud Computing in SMEs (RA+ACC+SME)

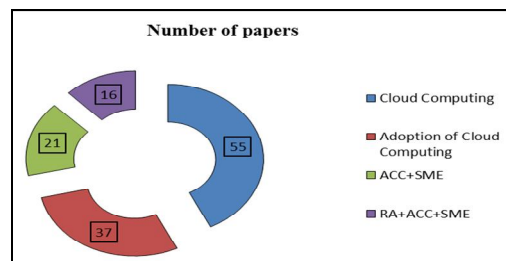


Figure 1 Research Papers Classified

Fig.1. shows the classification of research papers from the six online databases. Among the four combinations of academic journals, (55 out of 296 articles, 43%) 55 papers support technology adoption concept in cloud computing. There were 37 papers in technology adoption covering various aspects of cloud computing. Cloud computing and technology adoption also rank first (55 articles, 43%), and second (37 articles, 29%) respectively with respect of subject matter in the area of adoption of Cloud Computing in SMEs. It was observed that very few research papers cover “Cloud Computing adoption in SMEs” (21 articles, 16%) and “risk analysis in adoption of cloud computing in SMEs” (16 articles, 12%). With respect to technology adoption, 12% (16 from 55 academic journal papers) gave risk models to support the adoption of cloud computing in SMEs.

#### 3.2 Classification Framework

This is a comprehensive classification process. If there was an inconsistency in categorization of these academic journals, then it was discussed how the journals should be grouped as given in the grouping framework. The final paper selection process and framework is given in Fig. 2. The grouped papers were verified with respect to cloud computing adoption in SMEs and risk analysis. The papers were categorized based on the year of publication and the online database in which the paper was present.

Initially the papers were searched from online Database based on two search criteria.

1. Cloud Computing Adoption.
2. Papers published between 2010 to 2014.

Only research articles related to Cloud computing adoption were taken into consideration in the first phase. Then articles related to Risk associated with Cloud computing adoption in SMEs were taken in the next step. The final classification outcome of journals is obtained from the previous three ways of classification of research articles.

Fig.2. Explains the papers searched from the online database which gives the reputed journal articles. If research articles were related to Cloud computing adoption, then only it is included otherwise excluded from the next step. This type of most relevant Cloud computing adoption articles published between 2010 to 2014 were 296 in number. Again these 296 research papers were refined to our current research area of adoption of Cloud computing in SMEs and risk associated with it. The numbers of core academic papers sorted out were 55 in number and remaining 241 research papers were excluded in the next step of classification. Finally the consistent classified results of academic journals were considered for our study of literature.

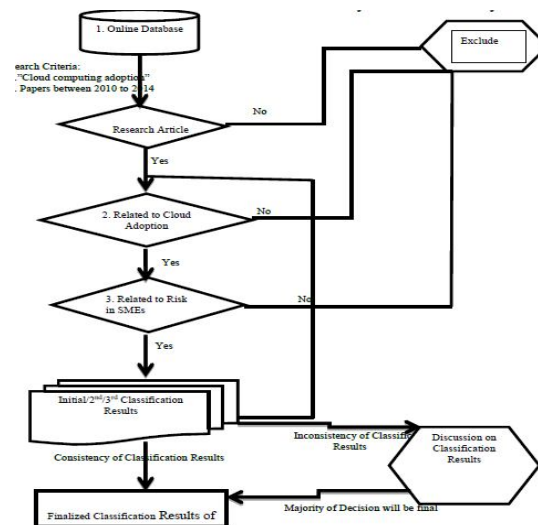


Figure 2 Selection Criteria Framework

#### 4. Classification of Journals

The findings of Cloud computing discussed by different authors in several research papers are given as follows. There could be a better way to understand the design challenges of Cloud computing which could result in identification of important research directions[5].The current developments could be in relation to Cloud computing and it may hold promises for solving some of the pressing needs of construction IT[6].The study criticized that when the cloud vendor faces intense competition, the cost-center organizational model preferred over the profit-center model[7].A clear linkage among Cloud computing areas, threats within the areas and security and privacy properties were provided[8].The study of literature verified some of the important resource management schemes such as resource mapping, resource provisioning, resource allocation, and resource adaptation[9].

The findings of Cloud computing Adoption in SMEs are discussed as follows. The study explained the role of social influence and the moderating effect of a product's public/private status on consumers' intended adoption of innovations in industries [10].The literature highlighted that cloud computing technology could be closely related to the Virtualization and the Virtual Machines [11]. It was argued that Cloud computing could be available for many small and medium enterprises (SMEs) due to its flexibility and pay-as-you-go in the current climate of economic difficulties[12].The various independent variables (factors influencing dependent variable)were identified as; Cost reduction , Convenience, Reliability, Sharing and collaboration, and Security and privacy[13]. This study found that almost half of the respondents had not migrated any services to the cloud environment. It suggested that many of these SMEs did not assess their willingness to adopt cloud computing technology [14].

The findings of Risk analysis associated with the cloud computing adoption are discussed as follows. The literature found the involvement of the risk management discipline into the cloud computing which could assist in business present in the internal decision-making processes [15]. The study emphasized that as a result of changes in the business environment, globalization, and technological advancements, companies have adopted innovative business models by relying on IT outsourcing [16].A formal mathematical decision model was developed which supports the selection of Cloud computing services in a multi-sourcing scenario [17].It analyzed the newest technologies in accounting software for small to medium sized enterprises [18]. This study verified privacy risk assessment for Cloud computing, and identified threats, vulnerabilities and counter measures that clients and providers could implement in order to achieve privacy compliance and accountability [19]. The literature presented a comprehensive survey which is to focus on the trust management of services in Cloud computing environments [20].

##### 4.1 Grouping of Papers through Cloud Computing, Cloud Computing Adoption in SMEs, and Risk in Cloud Computing Adoption

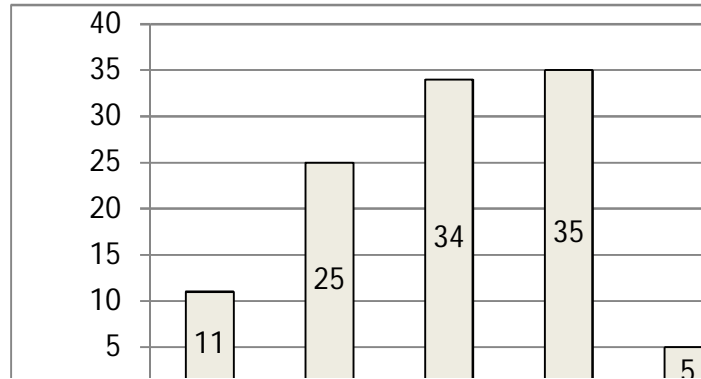
The findings of Cloud computing are summarized in different ways. It includes business issues, research directions, current developments, status of supporting tools, major trends like IT efficiency and business agility, some models like cost and profit center models, linkages, one systematic Literature review and important resources.

The findings of Cloud Computing adoption in SMEs are also synthesized in various patterns. It includes models with four constructs, adoption of innovation, virtualization and Inter-organizational Information Systems (IOIS).

The findings of Risk in Cloud computing adoption can be summarized as risk management approach led by business-level objectives(BLOs),innovative business models, formal mathematical decision model, risks in cloud industries in China, trust management services in Cloud, audit and risk management system in the information technology environment.

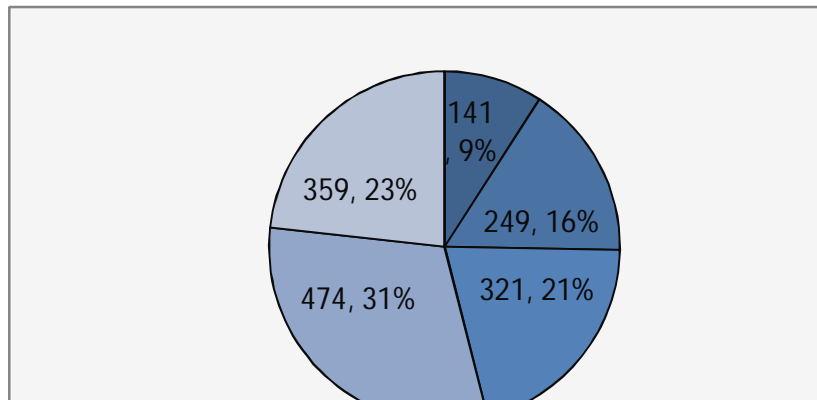
**4.2 Grouping of Papers through Year of Publication**

According to IEEE Conference publication the following articles have been found in the last 5 years (2010-2014) associated with the current research area. It shows maximum number of research papers (35) were found in 2013. The publications are in ascending order. The fig.3 highlights that the publications in the year 2014 have reduced to 5 as compared to that of previous year 2013.



**Figure 3 IEEE Conference Papers**

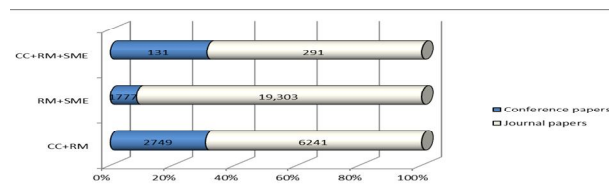
According to Science Direct, the total number of Journal paper publication in this area in last five years is given in the following chart diagram (fig.4). Maximum numbers of articles (474, 31%) were there in 2013, but few publications (141, 9%) were there in 2010.



**Figure 4 Science Direct Research Papers**

The grouping of academic journal papers through year of publication is shown in Fig. 3. and Fig.4. It is clear from the figures that relevant publications to Cloud Computing adoption in SMEs have sufficiently increased between 2010 to 2013 compared to 2014.

**4.3 Grouping of Papers through Conference vs. Journal Publications**



**Figure 5 EBSCO Conference vs. Journal Publications**

Fig. 5 explains the distribution of articles in Cloud Computing adoption in SMEs from EBSCO Conference vs. Journal Publication till 2014. Based on our classification process three types of combinations of articles were taken.

Cloud Computing adoption, Risk Management, and SMEs (CC+RM+SME): In this combination the total number of Journal publications (291) is more than the Conference publications (131). Risk Management and SMEs (RM+SMEs): In this also the total number of Journal publications (19,303) is more than the Conference publications (1777). Cloud Computing adoption and



Risk Management (CC+RM): In this combination also the total number of Journal publications (6241) is more than the Conference publications (2749). So, it is clear that, in EBSCO, Journal publications are more than the Conference publications in the current area of “Risk associated for Cloud Computing Adoption in SMEs”.

## 5. Conclusion and Research Gaps

Risk associated with Cloud Computing adoption is very rare in case of Small and Medium scale Enterprises. It is noticed that the academicians and practitioners are very interested to explore this area. The paper has distinguished academic journal papers relevant to Cloud Computing adoption in SMEs which are published between 2010 and 2014. The objective is to give an overview of Cloud Computing adoption in SMEs and risk analysis. Despite the literature review cannot be defined as comprehensive, still it provides adequate awareness and allows the occurrence of research in the adoption of Cloud computing in SMEs.

## 6. Research Gaps

This literature review has certain limitations. This review only analyzed journal papers published during the period of 2010 to 2014 in last five years which were generated based on a keyword search of “Adoption of Cloud Computing” and “SMEs”. Hence it is limited only in keyword search method of the articles which mentioned the adoption of Cloud Computing in SMEs. The literature only found the journals from 6 databases in internet. There may be other online databases containing more number of academic journal papers in this subject which might be able to give a bigger exhaustive review of the journals associated to the adoption of Cloud computing in SMEs. The publications in English language were only considered for the present study. There may be publications in other foreign languages which provide scope for further study.

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# ERP in Cloud for Small and Medium Enterprises



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**D.Sangeetha**  
**S. Prem Chandar**

*Sri Ramakrishna Institute of Technology*

(sangeethad.mba@srit.org)

(premchandar.mba@srit.org)

*Cloud computing is an emerging paradigm that dominates the attention of Industries for Business Enterprises application. MS Office, ERP, CRM, SCM, Infrastructure like Server and Platform are offered as a service through cloud. Small and Medium Enterprises (SME) need to catch up with the technology adoption for a viable solution to increase the profit by increasing the efficiency of Business. This Paper deals with the factors influencing selection of ERP in cloud and its benefits in comparison to proprietary ERP packages as a business solution. The adoption of ERP in cloud for SME is discussed considering case studies relevant to them. The Cost effectiveness of cloud based online office suites versus MS Office is presented. Further, certain issues on security related to implementation of ERP in cloud for SME are also discussed.*

## 1. Introduction

Cloud computing has offered computing from desktop or portable devices to remote computing to its users. It delivers hosted services over the internet which can be accessed by its patrons. Cloud has features like elasticity, dynamic massive scalability, measured service and self-provisioning of resources which attracts many industries for its adoption. The profit making was the primary goal of any business that in turn can be achieved through increasing the efficacy of business by adopting cloud. Three Level of Services and Deployment models are offered by Cloud computing providers and these services are customized based on its consumers need and demand.

The growth of Indian economy can be rendered stable by improving the performance of Small and Medium Enterprises (SME) as they are the main sources of growth of economy. The country's GDP can be improved by improving the efficiency of SME business models that can deliver stable growth. The SME faces challenge in technology adoption and it is because of their financial distress towards investing in hardware and software, Cloud could provide a practicable solution for adoption of technology. Service providers are providing a customized way through new nascent technology which is faster and easier to put into operation by all business. The technology up-gradation provides the competitive edge to the companies justified by cost effectiveness of the business solution. The acceptance and adoption of technology by SME can improve business efficacy.

This paper deals with the adoption of cloud by SME offering a wide range of advantages to their company which can differentiate them from their competitors in business. The factors influencing the SME towards the selection of "ERP in Cloud" as a business solution are presented in this paper. "ERP in Cloud" is compared to 'Simple ERP' by portraying its customized usage with reduced cost. The cloud platform used by SME with desired advantages listed by service providers will be a solution by taking into account cloud adoption problem with cost effectiveness. This paper deals with the implementation of ERP in cloud by considering the aspects of technology and cost by considering the case studies which are not related to each other. Further, Case studies relevant to the vendors and end users are also presented.

## 2. Services of Cloud and Deployment Models

The level of services provided under cloud is shown in Fig.01 and Fig.02. The Cloud deployment models in public, private, community and hybrid domain are illustrated in Fig03, Fig04, Fig 05 and Fig 06 respectively.

The use of technology in business benefits industry in the large number of aspects that delivers competitive gain to companies. The companies can reach more potential customers through technology as it was the primary target that drives profits in the present competitive environment and will help companies to develop business relationship with the potential customers. The technology can streamline operations that bring improved efficiency in the business and can reduce cost thereby maximizing profit. The technology can curtail waste and devote talent to core business instead of overhead. It can provide better service to customers and support better relationship with key allies.

Cloud offers many advantages to companies that can deliver numerous ways that provides companies a competitive edge over their competitors. The Business solution in cloud renders faster Implementation time ensuing in rapid start of the services. It offers "pay as you Use" model that result in greater advantage for SMEs in cost aspects. Cloud computing comes as a cost effective solution to key business demands that in turn offers companies with the advantage of competitive pricing of their products in the aggressive market environment. Cloud offers anywhere anytime access with high level of security so that the companies can have transparent and hassle free working methodologies towards faster decision making and companies betterment. Real-time backup to offer maximum up time & availability are possible in cloud. The advantages of cloud are well illustrated in Table 01.

### 3. Offline Suites of Cloud Vs Desktop Based Microsoft Office

The software are available for desktop devices and on online markets for the users in a customized way based on their need towards the software. Office 365 of Microsoft was used by most of the desktop devices and it was challenged by established adversaries like Google Apps and Zoho Docs. Table 02 depicts the comparison of these services based on its advantages, data security and cost effectiveness.

SME are facing a huge cost capital towards Microsoft Office (Desktop Based) and it results in the notion of technological bane in the cost aspect of the company. In this connection, the Cloud providers are offering their packages in a customized way added with more security aspects. The clients are ensured with the freedom of selecting their own ERP packages with the functions that relate to their company through Cloud when compared with Microsoft Office (Desktop Based). The clients can also switch their packages based upon the changing needs of the market.

The users are concerned about the privacy and security issues of ERP in Cloud and it can be addressed by IAM Model (Identity and Access Management – IAM). It can ensure the right access by the right people at right time. IAM model offers various functional elements namely Identity Provisioning and DE-Provisioning, Authentication & User Management, Identity Federation Management, Authorization & Compliance Management.

The user gains enough security credentials to gain the access to the system or a particular service and it is ensured by Authentication & User Management. The Identity provisioning and DE-Provisioning of IAM model ensures the Procedure of on boarding of user (Provisioning) when they join and off-boarding (DE-Provisioning) the user when they leave the enterprise.

The Authentication & User Management deals with the process by which the user gets enough credentials to gain the access to the system or a particular service. The Identity Federation Management is a Method of establishing the trust relationship between different enterprises. Authorization model supports complex access control policies comprising user roles, user groups and its attributes. Compliance Management is used to clearly track and monitor the access rights and privileges of the users are not violated auditors to validate compliance. (Sudha,S., ViswanathamV.Mathu (2013), "Addressing Security and Privacy Issues in Cloud Computing", *Journal of theoretical and applied Information Technology*)

SLA (Service-level agreement) is another way of security addressing process where it provides a contract between a network service provider and a customer that specifies the list of services offered by network service provider. The Internet service providers (ISP) are providing SLA for their customers to ensure security and privacy.

### 4. Factors Influencing Selection of ERP in Cloud

SME has to analyze three perspectives in the ERP software on cloud that will ensure better and hassle free usage. The first perspective is focused on **Economical** view which deals with financial issues as cost play the major role in decision making. The second perspective is **Technological** which deals with technical evaluation of the software towards adoption of the software in the company. The third perspective alerts on **People concerned** with the effect that selection and adoption of ERP will have on the people within the organization and their adoptability towards the software.

The Factors Affecting Selection of ERP in Cloud (Hofmann, 2010; Clarke, 2010; Tripti Negi Mahara, 2013) are as follows:

- **Flexible Payment:** The charges are determined by actual use of the ERP software rather than by fixed license fees as charged by the traditional ERP vendors. Prices are very competitive. This is one of the major advantages of moving to the cloud.
- **Reduced IT Infrastructure Cost:** There is no need to invest upfront in hardware, software or any other IT infrastructure as the virtual services are on a remote server and only a login through internet is needed to access the ERP software.
- **Low Operational Cost:** The cost to maintain and run the ERP software reduces.
- **Data backup and Recovery:** Assured backup of data and in case of data loss or tampering, efficient recovery should be possible.
- **Ubiquitous access:** can access the ERP software on the cloud without any delay and technical difficulties.
- **Scalability on demand:** The number of modules and users for the ERP software on the cloud can be scaled depending upon the organizations usage.
- **Low IT Manpower:** The IT manpower needed to maintain the ERP software goes down as it is the task of the vendor to manage the required infrastructure.
- **Availability (24X7):** Readiness and accessibility. The services available on demand and 24X7 on the Internet.
- **Platform Independence:** The ERP software can be accessed at any location and compatible to the digital devices.
- **Data Security:** The data can not be accessed by unauthorized persons on the network and within an organization.

### 5. Cloud For SME as Business Solution

Micro, Small and Medium Enterprises (MSME) contribute nearly 8 percent of the country's GDP, 45 percent of the manufacturing output and 40 percent of the exports [<http://msme.gov.in/Web/Portal/New-Default.aspx>]. The financial and security aspects are hindering the SME to hire technology that in turn obstructs them towards the path of continuous development in spite of their innovative business ideas.

SME tend to use pirated software in order to meet the competitive environment by reducing their cost burden. The original software was not affordable to SME and instead they try to use semi functional pirated software that gives an unsafe

environment of data theft or loss. MIS of Indian Government are tracking pirated software use as it is a crime. TALLY/ERP software is used by most of the SME to meet their accounting needs and these are offered through cloud by improvised security at reduced cost that can stimulate SME to use ERP in Cloud in a genuine manner.

Science & Technology which positively intrude SMEs on a cluster basis is today well appreciated internationally. SME can group themselves as a community and they can adopt community cloud or private cloud, where they can be able to access original software at a reduced cost and improved security in the cloud. The payment is designed to pay as per the usage of the company and maintenance of the software is done by the vendors and thus the clients have ease of maintenance towards usage of service.

The cloud ERP is compared with simple ERP and the following conclusions drawn justifying the choice of cloud ERP as a Business Solution for SME.

- Enterprise resource planning (ERP) is the latest buzz in the industry and has helped many organizations to boost their productivity.
- Clients can decide on the type of ERP based on their organization's requirements, it could be either Cloud ERP or On-Premise ERP (simple ERP).
- A cloud ERP is an online subscription-based solution and a third party vendor would manage the software and related data using a robust database centrally.
- On-premise ERP would be installed locally at the enterprise place.
- Low initial Investment for Cloud.
- Clients can have quick Return On Investment.
- Clients have better performance delivery.

## 6. Case Studies

The case studies are discussed with respect to end user and vendor point of view towards ERP in Cloud. The end users view towards adopting ERP in Cloud can be clearly visualized as discussed in sections 6.1 and 6.2. The case of ERP in Cloud from the point of view of vendor is depicted in the section 6.3.

### 6.1 A Japan Based Conglomerate

A Japan based conglomerate manufactures Umami seasoning which does its operations in 26 countries. In India it markets from its Chennai-based headquarters with employees in various functions spread among various branches. This organisation maintains all its transactions manually, which it results in lack of integration among various functional departments and its branches leading to poor efficiency of business.

This organisation approached RAMCO for enhancing their business through cloud based ERP. RAMCO provided them comprehensive end-end functionality with local statutory compliance, affordable subscription model through cloud. It allowed the client to pay for an employee per month and more importantly RAMCO provided exhaustive training to help familiarize the users with the systems.

The implementation of Cloud based ERP for the Japan based conglomerate tasted success by integrating among all departments and its geographical locations by providing error free, low cost, updated and timely data of all the functionalities. [<http://www.ramco.com>]

### 6.2 IT Services: UST Global

UST Global is a leading provider of end-to-end IT services and solutions. They use a client-centric Global Engagement Model that combines local, senior, on-site resources with the cost, scale, and quality advantages of off-shore operations. UST Global chose SAP Cloud for Travel and Expense for various advantages like reduced costs and improvised decision making. With SAP Cloud for Travel and Expense, companies can manage their business travel, from planning to expense reimbursements. It is designed for enabling companies to travel smarter, spend better, get reimbursed faster – all while staying in compliance with corporate policies and delivering on their business goals.

SAP Cloud for Travel and Expense helped UST Global to reduce corporate travel expense costs by 11.6% and with the addition of the SAP integrated GetThere Online booking tool they recognized an additional 15% savings in total travel cost without reducing actual travel. [<http://www.sap.com/pc/tech/cloud/software/cloud-for-travel/customer-reviews.html>]

### 6.3 A Case Study for Tracking Solution

The case study of J-Tech tracking solution is highlighted to spot the cost benefits that are offered through cloud as Software as a Service (SaaS).

J-Technologies India Ltd (J-Tech) is a part of the Euro €60 million IndoShell Group. J-Tech provides an integrated solution through the brand "VCare" to maintain the vehicles in an effective manner, incorporating all the latest industry standards with GPS Tracking. "Vcare" is a time-tested application and comes on a "Pay-as-you-go" model reducing the need for a high initial investment on either hardware or software. The model provides the clients with the flexibility to pay for the product based on usage and the freedom to exit. 80+ clients are using this application without hassles.

The cost effectiveness of in-house developed GPS tracking solution and cloud based GPS tracking solution provided by J-Technologies has been analysed by the authors.

The cost involved in developing the in-house GPS tracking solution is categorized under the following captions and the related costs are specified below.

• Application Development Cost	: Rs. 10,00,000 (approx.)
• Web Server Cost for Hosting	: Rs. 2,00,000 (approx.)
• Bandwidth Cost	: Rs. 1,00,000 (approx.)
• Google Map Cost	: Rs. 1,00,000 (approx.)
• Maintenance cost	: Rs. 5,00,000 (approx.)

The total accountable cost for development of the application is Rs.19,00,000 per year(approx.).

Whereas the cloud based GPS tracking solution provided by J-Tech through (Software as a Service) SaaS Model in Cloud is charged only Rs. 550 per month for a vehicle, Rs.55000/- for a fleet of 100 vehicles monthly and Rs. 6,60,000 yearly.(approx.)

From the above working model, it is possible to save up to Rs.12, 40,000 per year (Rs.19, 00,000-Rs.6, 60,000) when a client adopts cloud based solution offered through SaaS in cloud provided by J-Tech.

## 7. Data Security in Cloud ERP for SME

Cloud secures customer's business data stored in its data center by using various security measures that are needed for a person to access and thus it can provide data security to SME. If RAMCO cloud is considered, it has more than 430 servers in its data center. These servers hold the worldwide business data of customer projects being executed by Ramco Systems. These servers are also connected to the global offices of Ramco Systems and their customers through high-speed networks and telecommunication systems. To protect the data, Ramco has put in place a comprehensive Information Security System as mandated by ISO27001 standards. The various security aspects handled by Ramco Systems are Internal theft, Physical Access Control, Physical Access Monitoring, Login Access Control, Audit Trail, Data Transport over Internet, Firewall, Privacy and Fire & Natural Calamities [<http://scn.sap.com/docs/DOC-54865>]. If J-Tech service is considered, the basic security is User credentials with user name and password for login purpose and encrypted to validate the security of users. This prevents phishing of sensitive information. They also provide retina security scanning and digital signatures on demand by customers to protect their sensitive data. This can provide confidence to SME towards adopting ERP in cloud by addressing the security issues in cloud. SME can protect the data in cloud through various kinds of security measures that are provided by the vendors and they also have option towards selecting their security measure based upon the sensitivity of information and their budget allocation.

## 8. Conclusion

Cloud computing is attractive for SME customers because it offers significant potential for players of all sizes and it is one of the large and fast growing market. Companies must focus on managing the top and bottom line to hold its competency and it can be done through "Cloud Computing". The SME can adopt ERP in cloud as a concrete business solution compared to simple ERP tool. SLA (Service Level Agreements) and IAM (Identity and Access Management) offer data security through user authorization. The cost effectiveness of Microsoft using Google Docs as a service provider are revealed through case studies. Based on the case studies presented from the point of view of end users, RAMCO cloud ERP demonstrates the improvement of efficiency in business and SAP offering its ERP through cloud in a customized cost effective manner to its clients provides an end to end solution. J-Tech-GPS, as presented by the vendor, is found to be a specific cloud service for cost effective tracking solution. Thus, ERP in cloud can provide a Business solution for SME and also improve the business prospects of service providers working in cloud platform.

## 9. Acknowledgment

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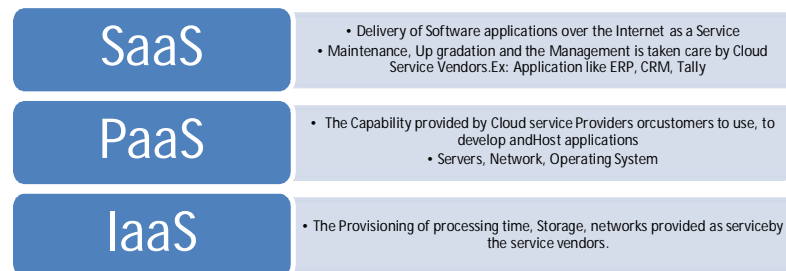
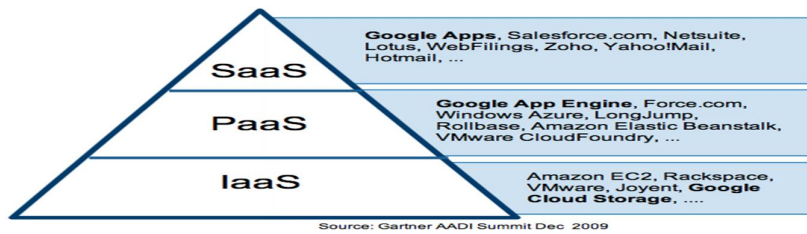
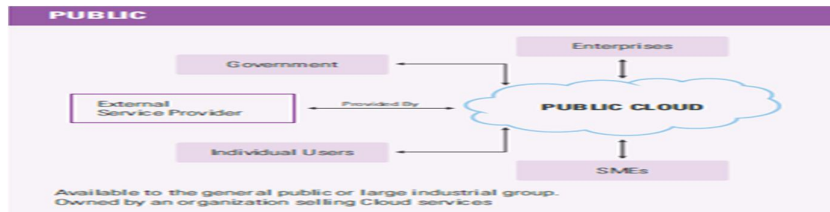


Figure 1 Levels of Services



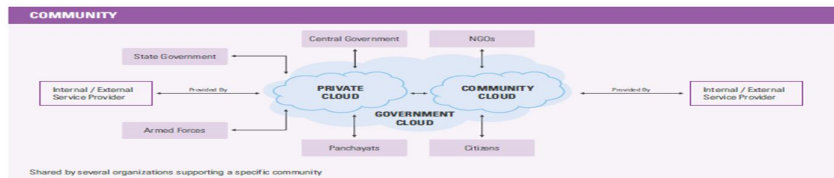
Source: Gartner AADI Summit Dec 2009  
**Figure 2 Levels of Services**



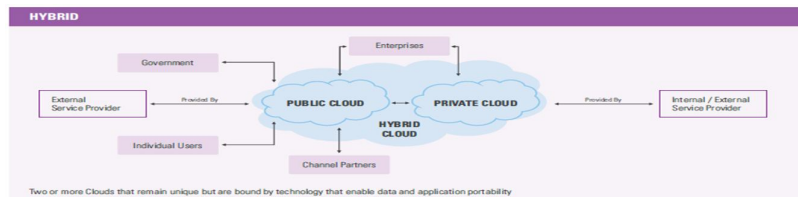
**Figure 3 Public Cloud Deployment Model**



**Figure 4 Private Cloud Deployment Model**



**Figure 5 Community Cloud Deployment Model**



**Figure 6 Hybrid Cloud Deployment Model**

Source: KPMG's *The Cloud: Changing the Business Ecosystem*, 2011

**Table 1 Advantages of Cloud**

	<b>Advantages</b>
<b>Administrative</b>	Availability of / ease of access to hardware and software
	Easier to recover after disaster
	Reduced system administration
	Rapid acquisition and deployment
<b>Partnership</b>	Improved Information Sharing and Collaboration
	Easier to partner with other organizations
<b>Cost-Based</b>	Little or no capital investment
	Need for less IT staff to support system
<b>Data-Based</b>	Transforms high fixed –capital costs to lower variable and operating expenses
	Better data Security
	Data is being organized
	Data is more under control

Table 2 Cloud Based Offline Suites Vs Microsoft Office (Desktop Based)

	Office 365	Google Docs	Zoho Docs	Microsoft Office
URL	<a href="http://office.microsoft.com/en-in">http://office.microsoft.com/en-in</a>	<a href="https://docs.google.com">https://docs.google.com</a>	<a href="https://www.zoho.com/docs/">https://www.zoho.com/docs/</a>	<a href="http://www.microsoft.com">www.microsoft.com</a>
Cost	Rs.420.00 per user/month.	Rs.150/- per user / per month for the Business Users	Rs.250 per user/per month	18,500/- per user / per system (Enterprise Edition)
Total Cost per year	12 Months & Rs.420 =5040/- Per year	12 months & Rs.150 = 1800/- per year.	12 months * Rs250/per month. =3000/- per year	
Advantages	No big initial investment/cost. <i>Ease of deployment.</i> No Hardware Required <b>Reduce your IT overhead and headaches</b> <b>Collaboration made easy</b> The single most important feature is the feasibility of true scalability, allowing businesses to acquire and release hardware resources on demand. Process efficiencies also shoot up as more and more employees are able to access applications remotely and update data in real time.			Initial Investment high
Is data Secure	Your/User data is very secure. Cloud Service providers take utmost care in ensuring that your/user data is safe. These include physical security practices (24 x 7 x 365 security, video monitoring, biometric access, bullet-resistant walls etc.) Example : With nearly 10 million users worldwide accessing Zoho services, individuals, small, medium and large organizations count on Zoho security and data protection to meet their needs. Zoho take security very seriously and have developed a comprehensive set of practices, technologies and policies to help ensure your/user data is secure.			
Uptime	Reputable SaaS providers generally offer far better uptime and protection than individual businesses can hope to match.			

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# System Dynamics Modeling for Recuperating Software Quality



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**Sini V. Pillai**  
**Vinu P. Nair**  
**D. Bijulal**

*Software projects endure frequent problems of cost overrun, schedule overrun and inferior quality. Different move towards addressing the software quality issue have been projected with the purpose to prevent software failure by detecting and removing faults in the early hours of software development lifecycle. A system dynamics modelling for managing software development and quality of software product has to be planned to overcome the quality issues. This paper presents the system dynamics modelling and analysis to enhance the quality of software. The project managers and developers from IT companies in Technopark, Trivandrum were interviewed for the study.*

**Keywords:** Software development project, software quality, system dynamics modelling

## **Problem Definition**

Software development projects face languish quality resulting in time, resource and cost over-runs from initial estimates due to defects in the final product.

### **Objective**

To enhance software development quality in projects by reducing errors, thereby minimizing time, resource and cost overruns using system dynamics modelling approach.

### **Scope**

To guide software development process from the initial phase by system dynamics simulation study of scenarios perceived to improve software quality.

## **1. Introduction**

In point of fact every software companies have a common theory named “40-60 theory” affirming 40% of the total time allotted to be utilized for development processes and the rest 60% of the time to be exclusively allotted for testing processes. That means more priority is given for quality processes just like any other development/ production process. But in a general scenario, if there is a delay in the development process, it is usually adjusted against crashing the testing phase, thereby meeting the delivery timeline. Hence this type of practice highly hinders the quality of deployed software. In each stage of development process also unit testing is done by the developing team members. But it may fail while integrating process. As the software industry is now heading a major share towards mobility apps, more variables is appending according to the trend. Project delays occur when the quality team finds some bugs or errors while their testing phase, residual errors found while their testing phase, residual errors found while the deployment or when customer/client changes the requirements or when the specifications are not well defined. In modern software projects the concept of defect removal is central. The ability to identify and remove errors during production and prevent errors, determine the factor of success or failure.

## **2. Software Process and Software Project Management**

Software specification, software development, software validation and software evolution are the four basic process activities common to all software processes and these process activities are incorporated in four general models [1]. Among the models the waterfall model approach is commonly used in the software development processes at many software development companies operating from Techno Park, Trivandrum.

Project Management Institute (PMI) requires a project manager has to select project members and determine the schedule to finish the development of the software and generally the accomplished date is decided under the consideration of the past experience of several projects. Even though the target date is carefully determined, the delivered date is overrun the target date in general [2]

Brooks (1995) claimed that assigning more programmers to a project running behind schedule will make it even later, due to the time required for the new programmers to learn about the project, as well as the increased communication overhead [3]. The methods employed in the factory production are unfit to resolve the problem of software quality because software is developed by non-manual labour such as intellectual work. Abdel-Hamid and Madnick [4] developed a System Dynamics model to analyse Brooks’ law by applying different staffing policies on cost and schedule in a specific project, the NASA DE-A project. They conclude that adding more people to a late project always causes it to become more costly but does not always cause it to finish later.

Several reasons exist to realize the target date which includes unclear specification, revisions of the original software specification, bugs/errors included in the program (logical mistakes and careless mistakes), human relationship in the



organization, project and so on. The change of customer requirements and the addition of functions on the way of the software development also lead to similar problem [5].

### 3. System Dynamics

Systems thinking are the base of all system dynamics simulations. It is a way of thinking about, and describing the forces and inter-relationships that shape the behaviour of systems. This discipline helps to see how to change systems more effectively [6]. System dynamics simulations are based on the principle of cause and effect, feedback, and delay. Cause and effect is a simple idea, that actions and decisions have consequences. Feedback is the process in which an action taken by a person or thing will eventually affect that person or thing. A feedback loop is a closed sequence of causes and effects, a closed path of action and information. An interconnected set of feedback loops is a feedback system [7].

Causal-loop diagrams can be created and are often used in system dynamics to illustrate cause and effect relationships, consisting of variables connected by arrows denoting the causal influences among variables. The important feedback loops are also identified in such a diagram, and variables are related by causal links. Understanding the concepts of cause and effect, feedback loops, and delays provides a good foundation to uncover the complexity of a system's nature. Casual loop diagrams are useful in many situations but have some limitation to capture stock and flow. Stocks are accumulations, and they characterize the state of the system. Stocks generate information that decisions and actions are based upon and provide a system with both memory and inertia, and are the source for delay. Stocks provide this delay by accumulating the difference between inflow and outflow to a process. Through decoupling rates of flow, stocks are a source of disequilibrium in a system. The flow changes the amount in the stock. The flow is determined by a statement that tells how the flow is controlled by the value of the stock. The increasing and decreasing levels of flows are called rates [8].

A system dynamics model will organize, clarify, and unify knowledge [6]. System dynamics builds two-way communication between mental models and simulation models. Mental models are the basis for everyday decisions. Computer simulation meshes nicely with mental models by taking the mentally stored information and then displaying the dynamic consequences [9].

### 4. Methodology

A detailed discussion was conducted among the software managers in five different major companies operating from Technopark and an expert review was done systematically among the top testing managers. As the initial step of research an extensive literature survey was conducted. The survey widens in different stages like Software Testing and Quality Analysis in Software development projects, Estimation in Software development projects, Drivers/attributes influencing the testing sector, System dynamics, modeling and simulation etc.

For this study, only the quality testing sector of software development projects was considered. Medium sized projects of 64-128 KSLOC with duration of 30-36 months, and 60% average productivity were taken as representative projects of software produced in 5 companies of Techno Park depending on size, complexity and scope. An enhanced model was developed using the VENSIM software.

**Table 1** Representative Project Details

Items/Company Representative Project	UST	Nest	Allianz	IBS	Infosys
Development effort	960	520	790	820	700
Testing effort	372	218	308	345	282
Lines of Code(KLOC)	128	64	96	110	82
Function Points/KLOC	59	31	43	51	36
Total function points	1161	972	1094	1126	998
Defects detected during in house testing	1172	965	1121	1143	984
Defects detected by client during beta testing	162	109	154	160	104
Defects detected by client after full release	62	54	58	42	38

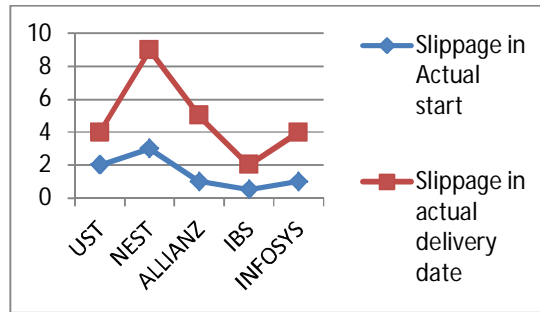
(Source: Secondary Data)

**Table 2** Slippage in Actual Start and Delivery

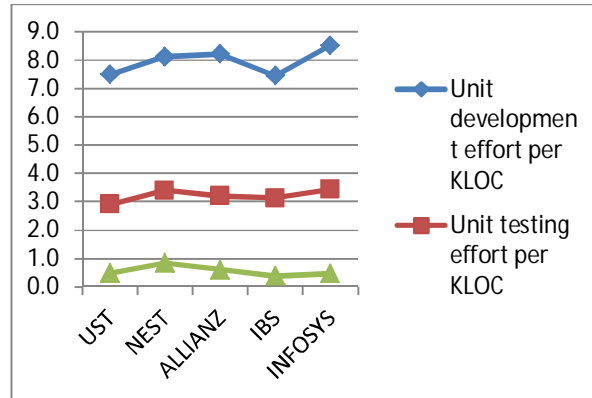
Company	Slippage in Actual start (months)	Slippage in actual delivery date (months)
UST	2	4
NEST	3	9
ALLIANZ	1	5
IBS	0.5	2
INFOSYS	1	4

**Table 3** Unit Development and Testing Efforts

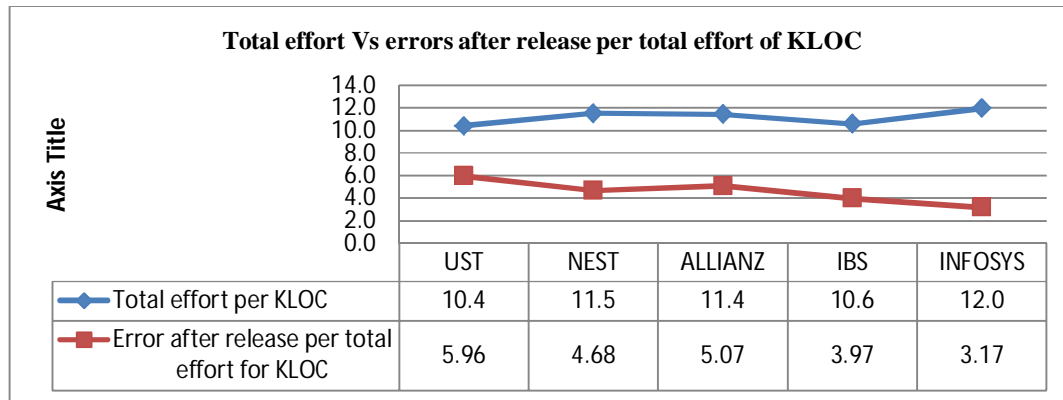
Company	Unit development effort per KLOC	Unit testing effort per KLOC	Defects after release per KLOC
UST	7.5	2.9	0.48
NEST	8.1	3.4	0.84
ALLIANZ	8.2	3.2	0.60
IBS	7.5	3.1	0.38
INFOSYS	8.5	3.4	0.46



**Figure 1** Slippage in Actual Start and Delivery



**Figure 2** Unit Development and Testing Efforts



**Figure 3** Errors After Release per Total Effort of KLOC

A new and important factor found through the research is Error Density. Error density was not accounted in any other previously developed model. More density of errors means more typographical, small errors and less density of errors means logical, big technical errors. The in house errors will be reduced if the development effort and testing effort is high. Of the five software development companies the error after release per total effort per KLOC, which can be stated as the error density, Infosys has the least, since their total development and testing effort are on the higher side. Changing customer requirements also affect the error density. Concentrating more on software development and crashing the software testing

time also increases the error density. As the error density increases, the distribution of errors among the system's modules generally also increase; errors become less localized, and more expensive to detect and correct. This means increase in costs.

### 5. Modelling of Software Development

The prime reason for software failure is due to poor quality. Software failure produces two kind of serious problem. One is obviously the cost of fixing the problem and other one, and the most perennial of problems would be the leakage of classified information as well as customer data to the public. Thus the question of quality in software goes beyond that of just costs [9]. Building system dynamic models, with both stock and flow diagrams and causal loop diagrams allows identifying the non-linear relationships over time. The ability to simulate decisions/policies and their effects on the software testing process will provide valuable insight for top managers. It will allow them to understand the true relationship between effects over time, and when to adjust their approach due to non-linearity. This is the strength for the system dynamics method [10].

Before starting modeling the prime step is to identify the boundary of the system. Model boundaries provide the scope and applicability of models within the phenomena they are created to represent [11]. The first boundary to the base-model is size of project. The model is based on a medium ranged software project. The second boundary of the base-model is a clarification of processes that are included and excluded in the process.



Figure 4 Causal Loop Diagram of Software Development Project Management

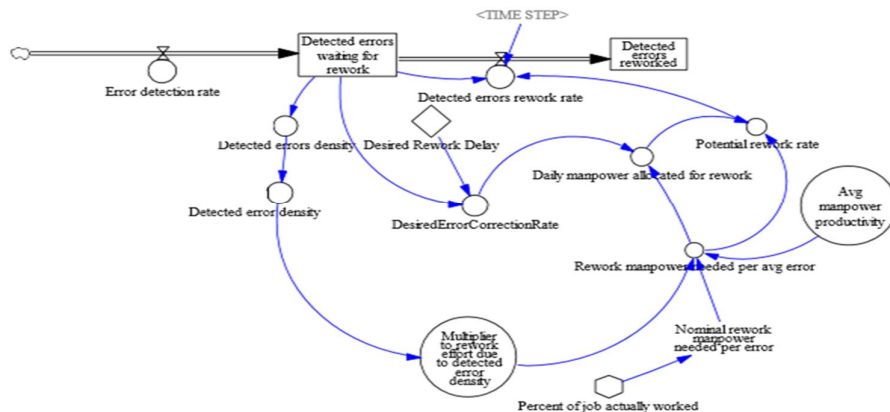


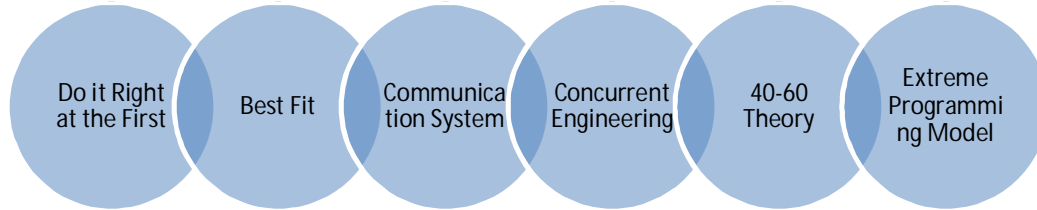
Figure 5 System Dynamic Modeling of Software Quality using Vensim Software

### 6. Findings and Discussions

The computer simulation model offers an invaluable tool to experiment with different settings and options in a very short period of time. In previous works it was noted that errors are described as either design or coding errors. A new and important factor found through the system dynamic modelling is Error Density-errors after release per total effort of KLOC. Error density was not accounted in any other previously developed model. Error density will be higher if the total effort of development and testing is lower. Errors and continuous rework leads to more delays and schedule pressures. The continuous need to reallocate manpower for different project efforts to bring a crashed project back on track shows the sign of poor quality of process.

Another pertinent finding came out of the study is that concurrent engineering to be used inside the water fall model to improve the quality process and thereby decreasing the rework process time. That is from the first stage itself both developers and testers should work concurrently so that the errors can be minimized and also the time and expenses due to rework is also minimized. The first set of factors includes organizational factors such as structured techniques, quality of staff and project factors. Even though these factors may differ from project to project they remain invariant during a single project. Typically design errors are found at the earlier stages of software development, while coding errors are most prominent when the project progress towards completion. Design errors are costly and require more effort to detect than coding errors.

## Software Quality Drivers



**Do it Right at the First Time (DRIFT):** The management concept that defect prevention is more advantageous and cost effective than defect detection and associated rework. The idea behind DRIFT is that management wants all of the processes that make up the JIT philosophy to be done correctly and efficiently so there are no delays in the production process.

**Best Fit:** There should be a best fit or bond between software designing, software developing and the software testing team. The ideas and communications should be easily accessible and understandable to both team.

**Communication System:** The communication system between the team and team members should be systematic and effective. Even the intergroup communications should be documented and should be easily available for future teams also. If not it will arise an unwanted delay between the schedule.

**Concurrent Engineering:** From the first stage itself both developers and testers should work concurrently so that the errors can be minimized and also the time and expenses due to rework is also minimized.

**40-60 Theory:** Developing teams should take 40% of total time of production while testing sectors should take 60% of the total production time. But in real time scenario this turns out to 80-20. Here the testing sectors or the testing works are crashed to a very lesser time period. Adding resources to final stage will not facilitate to finish the project but it will be acting opposite to that.

**Extreme Programming Model:** Elements of extreme programming include programming in pairs or doing extensive code review, unit testing of all code, avoiding programming of features until they are actually needed, a flat management structure, simplicity and clarity in code, expecting changes in the customer's requirements as time passes and the problem is better understood, and frequent communication with the customer and among programmers. Extreme programming's approach is that if a little testing can eliminate a few flaws, a lot of testing can eliminate many more flaws. As a type of agile software development it advocates frequent releases in short development cycles, which is intended to improve productivity and introduce checkpoints at which new customer requirements can be adopted. This model at length aids in reducing the error density due to customer requirement changes

## 7. Conclusion and Future Research

A study on system dynamics model on software quality enhancement has been conducted and the model was found to be relevant even now as it provides a system dynamic model highlighting some variables which was newly introduced. Concentrating more on development and testing efforts (40:60) with emphasis on extreme programming from the early phases of software production results in lower error density, enhancing the software quality being delivered to the customer on time within the cost. Discussions were held with project managers and developers from software product companies in Technopark, to understand the current trends in software development and to identify attributes that improve software quality. Researchers could use the model to investigate the effects of different testing tools and techniques on the overall software development process. Future work can be done by incorporating enhanced testing process which includes several testing phases based on testing strategies implemented in the software industries.

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# Critical Success Factors for ERP Implementation: A Classification



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**Boby Chaitanya Villari**

Indian Institute of Management Kozhikode  
(boby cv06fpm@iimk.ac.in)

**Sanjay Jharkharia**

Indian Institute of Management Rohtak  
(sanjay.jharkharia@iimrohtak.ac.in)

*In recent years research on ERP implementation has gained prominence because ERP, in most cases, has resulted in improving the efficiency and productivity of the user company. However, the decision to implement ERP alone is not a recipe of success, a lot depends on the planning and quality of implementation. Several factors are found to have an important role in the success of ERP implementation. In the ERP literature these factors are commonly described as Critical Success Factors (CSF). Several researchers have contributed to the body of literature pertaining to these CSF. However, the research in this area is still fragmented and unorganized. Hence, there is a need to identify and classify the relevant success factors, which is paramount for the success of ERP implementation. In this work we have classified various CSFs identified from literature in seven broad categories. This may help the practitioners and researchers in getting a quick understanding of these CSFs.*

## 1. Introduction

In recent years research on ERP implementation has gained prominence because ERP, in most cases, has resulted in improving the efficiency and productivity of the user company. However, the decision to implement ERP alone is not a recipe of success, a lot depends on the planning and quality of implementation. Several factors are found to have an important role in the success of ERP implementation. In the ERP literature these factors are commonly described as Critical Success Factors (CSF). Several researchers have contributed to the body of literature pertaining to these CSF. However, the research in this area is still fragmented and unorganized. Cologero, in his article named “Who is to blame for ERP Failure?” [1] States that though ERP software implementations reduce the costs of the firm and can contribute to the company’s sustainability, an ERP implementation failure can even lead to bankruptcy of the company. Thus this is natural that the researchers, from time to time, seem to have taken special interest in the Critical Success Factors (CSFs) that contribute to the success of an ERP implementation. There are large number of publications on the CSFs for ERP implementation in various Academic Journals, Conference proceedings, Doctoral and Masters Theses dissertations that were published in recent years.

ERP implementation is tricky and complex phenomenon and many firms had to encounter failure [2]. There are many reasons for the failure of an ERP implementation and the most prominent among them could be the disparity between the estimated budget and the cost overrun that occurred during the software implementation process [3]. Cologero also spoke about the schedule overrun that has been a prominent reason that denied the successful implementation of ERPs by many firms. It is to be noted that ERP implementation requires a strong support from the Strategic management support which will ensure the timely allocation of financial and human resources for changing requirements of ERP implementation projects.

According to Freund [4] (1988), a Critical Success Factors as those things that must be done for a company to be successful. CSFs for ERP implementation success would then be those important steps and measures that must be identified and executed. The identification of CSFs for ERP implementation success has not been an unexplored arena. Prior studies have been reporting different sets of CSFs for the same. There have been efforts to develop Taxonomies of CSFs and that developed by Al-Mashari et al. [5] is an example of the same. We have identified efforts to segregate the CSFs into Strategic and Tactical factors [6] as well. Our attempt in this paper is to extend the research to a more comprehensive way which is inclusive of all such factors that can be logically categorized into a conclusive classification. We propose a classification in this paper while including the relevant research work reported till date i.e., 2014. We organized this paper by allocating an individual section for the Research methodology, Data presentation and results, Discussion & conclusion, Limitations & Implications.

## 2. Methodology of Research

We conducted an in depth and all-inclusive search with each of the keywords ‘Critical Success factors’, ‘Success factors’, ‘Critical Factors for Success’ searched along with ‘Enterprise Resource Planning’. The search is done on Google Scholar, an academic publication database. Relevant literature published in Journals between 1995 and 2014 was taken in to consideration for the analysis. ERP is quite an established topic of research and we focused only on CSFs as our research questions concentrated on the identification of most relevant CSFs for successful implementation of ERP software in firms and the corresponding implications to Indian scenario. The scope of this research is wide as it spanned relatively a very long duration of time (about 19 years) in which the articles published in various journals were taken into account. We observed that Information technology management and Information Systems Research are the themes of the journals in which ERP research articles were published in a large number.

We scrutinized the large number of articles we could obtain from the academic journals and excluded many of them. The inclusion criteria are that the articles should have been published in English and the methodology should consist of either a quantitative or qualitative approach to the research. The articles should also mention the geographical regions where the ERP software implementation was done. We did not take into consideration the conference proceedings as certain conference proceedings were later developed into journal publications. Moreover due to the large number of journal publications that we could obtain, we were satisfied with the quantity and quality of the data we had in hand. Nevertheless we have considered a couple of PhD theses and a few conference publications for referring to the then trends during the initial stages of data collection.

**Table 1** Distribution of Articles by Regions/Countries

USA	Europe & UK	Australia & Denmark	China & South Asia	Middle East
Amoako & Salam( 2004)	Akkermans & Helden (2002)	Ho & Lin (2004)	Davison (2002)	Davison (2002)
Ehie & Medsen( 2005)	Allen et.al (2002)	Kraemmerand et al (2003)	Hong & Kim (2002)	Al-Mashari & Al-Mudimigh (2003)
Gattiker & Goodhue (2002)	Botta et.al (2006)	Parr& Shanks( 2000)	Law & Ngai (2001)	Park & Hwang (2013)
Mabert et al. (2000)	Holland & Light (1999)	Xu et.al (2002)	Reimers (2003)	
Motwani et al (2005)	Skok & Legge (2002)	Zhao et.al (2002)	Xue et.al (2005)	
Nah et.al.(2001)	Van Everdingen et.al (2000)		Zhang et.al (2003)	
Sarkar & Lee (2003)	Ward et.al (2005)			
Somers & Nelson ( 2000)				
Somers & Nelson ( 2004)				
Sumner (1993)				
Sun & Yazdani (2005)				
Trimmer et.al (2002)				
Umble et al (2003)				
Verville & Halingten (2002)				

A total of 38 journal articles are considered for this work and the researchers have worked on ERP software implemented in various geographical regions (Table 1) and published their work in many journals in various years. Nah et.al [13] have identified and classified the factors affecting the successful implementation of ERP software in firms. The information in the following table is extracted from Nah et.al's work and we understood that even though the researchers considered publications spanning the period before 2003, we could identify similar factors and features in ERP implementations that were studied even recently. Hence we decided to use and categorize our finding based on the 11 CSFs identified by Nah et.al [13].

### 3. Data Presentation & Results

We reviewed 38 articles across various journals. Again the researchers have worked on ERP software implemented in various geographical regions (Table 1) and published their work in many journals .The cases studied were the firms from the USA, Europe & UK, Australia & Denmark, South Asian countries including China & India, Countries from the Middle East and Gulf. A few articles discussing cases from India are discussed very recently [7].

We summarized the list of CSFs identified in various publications (see References section) .Nah et al. (2003) have identified major part of these CSFs which were observed repeatedly in many of the research works published even later to 2003.The broad category of the factors are 'Appropriate business and information technology legacy systems, Business plan and vision, Business process reengineering (BPR),Change management culture and program, Communication related, ERP teamwork and composition, Monitoring and evaluation of performance, Project champion, Project management, Software development, testing, and troubleshooting, Top management support. In addition to these 11 factors which we took as a guidance to classify the CSFs, we could also identify a few more factors and the classification is given along with the details of the articles in which these CSFs were mentioned. Top Management Support or Strategic Management Support, Change Management, Training and Education were the most commonly observed CSFs in most of the studies. The details of each of these success factors are given below. The most commonly observed CSFs are given preference and the ordering is based on the most commonly observed CSFs.

#### CSF 1: Strategic or Top Management Support (TMS)

Top Management Support (TMS henceforth) is one of the most commonly observed CSF in ERP implementation literature.

The senior management should have an understanding of their role in driving the ERP project to success and hence they have a wider role spanning over the longest period of time during the ERP implementation. The top management has the authority to support the project with the required resources and planning. They are also expected to provide cushion for the disruptions that the project team may encounter if any. In general the mechanisms that are encountered for dealing with unexpected difficulties during any critical project implementation are to be followed by the senior management personnel. According to Holland and Light [8], the Top management's disposition and inclination for the success of the project will play a key role in the overall success of ERP for the firm and hence these become a top priority CSF. Table 2 gives details of the academic research which consider ERP success factors related to CSF1.

**Table 2** ERP Success Factors Categorized as CSF1 (TMS) and the Respective Articles in which they were Identified.

		USA	Europe & UK	Australia & Denmark	China & South Asia	MiddleEast
CSF1: Strategic or Top management support (TMS)	Business plan	[Motwani et al (2005), Nah et.al.(2001)]	[Holland & Light (1999)] [Ward et.al (2005)]	Kraemmerand et al (2003)]	[Reimers (2003)] [Law & Ngai (2001)]	
	Total commitment				[Zhang et.al (2003)] [Law & Ngai (2001)]	
	Top management support	[Ehie & Medsen( 2005),Mabert et al. (2000),Motwani et al (2005), Nah et.al.(2001),,Sarkar & Lee (2003), Somers & Nelson ( 2004),Sumner (1993),Trimmer et.al (2002),Umble et al (2003)]	[Akkermans & Helden (2002),Holland & Light (1999).] [Allen et.al (2002),Ward et.al (2005)]	[Parr & Shanks( 2000),, Xu et.al (2002)] [Kraemmerand et al (2003)]	[,Reimers (2003),, Zhang et.al (2003), [Law & Ngai (2001)]	[Al-Mashari & Al-Mudimigh (2003)]

### CSF 2: Communication and Change Management (C&CM)

In our opinion Communication and Change Management stands on par with TMS in terms of importance and the frequency of occurrence in research publications. A detailed curriculum for implementing ERP and the necessary training programs to educate the same are to be formulated. This involves choosing a Project Champion from each department & team. The details of resources for training i.e., data sheets, presentations, demonstration videos and computer based training modules are to be communicated to the concerned employees at the earliest. As on-site training i.e, training in real time had been gaining momentum, the web based training modules should also be explained to employees in advance. As per Robey [9] the planning for such efficient change management and communication involves incorporation of business practices of the company it to the content of the training programs.

**Table 3** ERP Success Factors Categorized as CSF2 (C&CM) and the Respective Articles in which they were Identified

		USA	Europe & UK	Australia & Denmark	China & South Asia	MiddleEast
CSF2: Communication and Change Management (C&CM)	Change management culture & Programme	[Nah et.al.(2001)]				
	Change management	Motwani et al (2005),Somers & Nelson (2004), Umble et al (2003)]	[Botta et.al (2006),Skok & Legge (2002)] [Ward et.al (2005)]	[,Xu et.al (2002)]		[Al-Mashari & Al-Mudimigh (2003)]
	User participation& involvement		[Ward et.al (2005)]	[Kraemmerand et al (2003)]	[Zhang et.al (2003),Zhao et.al (2002),] Law & Ngai (2001)]	[Davison (2002)]
	User Commitment to change			[Parr & Shanks ( 2000),]		
	Training IT work force in new skills	[Sumner (2013)]				
	Training & education	[Mabert et al. (2000), Motwani et al (2005), Somers	[Botta et.al (2006),Holland &	[Ho & Lin (2004),Xu et.al	[,Reimers (2003),Xue et.al	[Davison (2002),Al-

		& Nelson ( 2000),Somers & Nelson ( 2004), Sumner ( ),Trimmer et.al (2002),Umble et al (2003)]	Light (1),] [Allen et.al (2002),Ward et.al (2005)]	(2002)] Kraemmerand et al (2003)]	(2005), Zhang et.al (2003),Zhao et.al (2002),]	Mashari & Al-Mudimigh (2003)]
	Clarity in training & educationstrategy	[Mabert et al. (2000)]				
	Training on BPR	[Somers & Nelson ( 2004)]			[Davison (2002)]	
	Communication	[7,Nah et.al.(2001),Somers & Nelson ( 2000)]	[Botta et.al (2006),Holland & Light (1)] [Ward et.al (2005)]	[Kraemmerand et al (2003)]	[Law & Ngai (2001)]	[Al-Mashari & Al-Mudimigh (2003)]
	Quality of communication across departments	[Somers & Nelson (2000),Somers & Nelson (2004)]	[Akkermans & Helden (2002)]		[,Reimers (2003)]	
	Effective and regular communication to concerned employees	[Mabert et al.2000),Somers & Nelson (2000)]			[Law & Ngai (2001)]	
	Honest communication	[Motwani etal(2005),Sarkar & Lee (2003)]				

**CSF 3: Project Management (PM)**

The CSF Project Management has been cited very frequently in studies and this has been cited with emphasis on the fact that the ERP implementation processes are complex and exhaustive. This require a careful project management module to be in place when ERP implementation is required. Effective planning and project management will allow the firms to manage the resources efficiently and with purpose. Goals, Objectives and timelines are essential for success in ERP implementation and hence this CSF is also studied by researchers across various regions. This CSF is prominently observed across various academic studies and we could identify more than 20 different factors which could be put into this category (see Table 4).

**Table 4** ERP Success Factors Categorized as CSF3 (PM) and the Respective Articles in which they were Identified

		USA	Europe & UK	Australia & Denmark	China & South Asia	MiddleEast
CSF 3: Project management (PM)	ERP implementation methodology		[Holland & Light (2001)]			
	Phased vs. Big Bang mode of implementation		[Ward et.al (2005)]		[Reimers (2003)]	
	Implementing accelerated strategy	[Mabert et al. (2000)]				
	In depth understanding of the importantissues relating to ERP implementations					
	Careful selection of appropriatepackage	[,Somers & Nelson ( 2004),]	[Akkermans & Helden (2002),Botta et.al (2006).Van		[Law & Ngai (2001)]	[Davison (2002)]
	ERP teamwork and composition(Personnel)	[Nah et.al.(2001),Umble et al(2003)]	[Holland & Light (1)][Ward et.al (2005)]		[Law & Ngai (2001)]	[Davison (2002)]
	Directing committee	[Mabert et al. (2000),Somers & Nelson ( 2000),Somers & Nelson ( 2004)]			[Reimers (2003)][Law & Ngai (2001)]	
	Project team capability	[Somers & Nelson ( 2004),Umble et al(2003)]	[Akkermans & Helden (2002),]		[Reimers (2003),Xue et.al (2005)][Law & Ngai (2001)]	
	Endowed decision makers			[Parr & Shanks( 2000),][Kraemmerand et al (2003)]		
	Choosing the right employees	[Trimmer et.al (2002)]				



Employee confidence	[Trimmer et.al (2002)]			[Reimers (2003)]	
Business and technical knowledge of consultants	[Somers & Nelson (2004), Sumner (), Trimmer et.al (2002)]	[Allen et.al (2002)]	[Kraemmerand et al (2003)]	[Law & Ngai (2001)]	
Balanced implementation team	[Sarkar & Lee (2003)]		[Parr & Shanks(2000),][Kraemmerand et al (2003)]		
Handling consultants		[Skok & Legge (2002)]		[Reimers (2003)]	
Staff retaining		[Skok & Legge (2002)]			
Employee/personnel relations		[Allen et.al (2002)]	[Xu et.al (2002)]		
Monitoring and evaluation of performance	[Ehie & Medsen(2005), Nah et.al.(2001), Somers & Nelson (2000)]				
clear milestones	[Mabert et al. (2000)]				
Focused performance measures	[Motwani et al (2005), Umble et al(2003)]		[Kraemmerand et al (2003)]		[Al-Mashari & Al-Mudimigh (2003)]
Client approval		[Holland & Light (1)][Allen et.al (2002)]		[Reimers (2003)]	
Monitoring and feedback		[Holland & Light (1)][Allen et.al (2002)]		[Reimers (2003)]	
Project champion	[Nah et.al.(2001), Motwani et al (2005), Somers & Nelson (2000), Somers & Nelson (2004)]	[Akkermans & Helden (2002)]	[Parr & Shanks(2000),]	[Reimers (2003)]	
Project management	[Motwani et al (2005), Nah et.al.(2001), Somers & Nelson (2000), Somers & Nelson (2004), Umble et	[Akkermans & Helden (2002),][Ward et.al (2005)]		[Reimers (2003), Zhang et.al (2003),]	[Davison (2002)]
Clear and defined project plan	[6, 16, Mabert et al. (2000), Somers & Nelson (2000), Somers & Nelson (2004), Umble et al(2003)]	[Akkermans & Helden (2002), Holland & Light (1),][Allen	[Ho & Lin (2004), Parr & Shanks(2000),][Kraemmerand et al (2003)]	[Reimers (2003),]	[Davison (2002)]
Lesser scope			[Parr & Shanks(2000),]		
Evade scope creep					[Al-Mashari & Al-Mudimigh (2003)]
Implementation expenses	[Trimmer et.al (2002)]				
Accurate deadlines for implementation are set	[Somers & Nelson (2000)]				
Convincing expectations on ROI					

	Management of expectations	[Somers & Nelson ( 2004)]	[Akkermans & Helden (2002)]			
	Cooperation across departments	[Somers & Nelson ( 2004)]	[Akkermans & Helden (2002)]			
	Dedicated resources	[Somers & Nelson ( 2004)]				
	Knowledge management	[Sun & Yazdani (2005)]	[Allen et.al (2002)]			[Al-Mashari & Al-Mudimigh (2003)]
	Handling conflicts in ERP projects		[Skok & Legge (2002)][Ward et.al (2005)]			
	Clear and simple project organization					

**CSF 4: ERP Vendor Selection (VS)**

ERP Vendor selection has been a very critical factor for the success of ERP in a firm. In fact vendor selection will form one of the very important primary steps in the process of ERP implementation. The factors to be considered include the Vendor’s reputation, Core business area, financial strength, support offered, technical strength and capabilities, mission and vision etc. Bingi et al [10], Zhang et.al [11] emphasize on the same. Table 5 puts forward the details of the academic research which consider ERP success factors related to CSF4.

**Table 5** ERP Success Factors Categorized as CSF4 (VS) and the Respective Articles in which they were Identified

		USA	Europe & UK	Australia & Denmark	China & South Asia	MiddleEast
CSF4: ERP Vendor Selection (VS)	ERP vendor	[Somers & Nelson (2000), Trimmer et.al (2002)]				
	Vendor-customer cooperation	[Somers & Nelson ( 2004)]				[Davison (2002)]
	Vendor support	[Somers & Nelson (2000), Somers & Nelson ( 2004), Trimmer et.al (2002)]	[Akkermans & Helden (2002)]		[Zhang et.al (2003), Zhao et.al (2002)]	

**CSF 5: ERP Fitness to Business processes (FIT)**

According to Davenport [12], the fitness between the firm’s business processes and the way the ERP is designed will play a critical role in the success of ERP implementations. The match between the practices followed in the firm and the processes adopted by the ERP will determine how quickly the ERP can be assimilated in to the system. Greater the fitness the easier for the organization and people to adopt to the system as there would be lesser requirement for any further business process reengineering. Factors which check if business process/rules are well understood, Business Process Reengineering, Negligible customization, Alignment between business strategy & IT strategy, fit between software and hardware ,use of vendors’ customization tools, Fit between ERP and business process etc. were put in this category(see Table 6).

**Table 6** ERP Success Factors Categorized as CSF5 (FIT) and the Respective Articles in which they were Identified

		USA	Europe & UK	Australia & Denmark	China & South Asia	MiddleEast
CSF 5: ERP Fitness to Business processes (FIT)	Justification upon factors of cost	[Sumner (2013)]	[Ward et.al (2005)]			
	Business process/rules are well understood		[Ward et.al (2005)]	[Ho & Lin (2004)]		
	Business Process Reengineering	[Ehie & Medsen( 2005), Motwani et al (2005), Nah et.al.(2001), Somers &	[Botta et.al (2006), Holland & Light (1), Skok & Legge	[Kraemmerand et al (2003)]	[Xue et.al (2005), Zhang et.al (2003),] [Davison	[Davison (2002)]

		Nelson ( 2000),Somers & Nelson ( 2004),Sumner ( ),Trimmer et.al (2002)]	(2002),] [Allen et.al (2002),Ward et.al (2005)]		(2002),Hong & Kim (2002),Law & Ngai (2001), 66]	
	Negligible customization	[36] [Mabert et al. (2000),4,, Somers & Nelson ( 2004)]		[Parr & Shanks( 2000),]	[Hong & Kim (2002)]	
	Alignment between business strategy & IT strategy	[Somers & Nelson ( 2000)]		[Ho & Lin (2004)]		[Al-Mashari & Al-Mudimigh (2003)]
	Fit between software and hardware				[Zhang et.al (2003)] [Law & Ngai (2001)]	
	Use of vendors' customization tools	[Somers & Nelson ( 2004)]				
	Fit between ERP and business process	[Somers & Nelson ( 2000)]	[, Van Everdingen et.al (2000)]		[Hong & Kim (2002)] [Hong & Kim (2002),Law & Ngai (2001),66]	[Davison (2002)]

### CSF 6: Culture and Country specific factors (CUL)

The National culture affects organizational culture and hence will affect the way in which the ERP is implemented. Also organizational procedures are also determined by the country and the law of the land. The data output requirements, reporting procedures vary across countries and the ERP should match these norms and rules. From our literature review, we identified factors (see Table 7) like Organizational culture and political arrangements, Understanding corporate culture, Decision-making process or styles, National culture, Country-related or Region specific functional requirements toning into this category.

**Table 7** ERP Success Factors Categorized as CSF6 (CUL) and the Respective Articles in which they were Identified

		USA	Europe & UK	Australia & Denmark	China & South Asia	MiddleEast
CSF 6: Culture and Country specific factors (CUL)	Organizational culture and political arrangements		[Allen et.al (2002)]	[Ho & Lin (2004)]Kraemmerand et al (2003)]		
	Understanding corporate culture				[Davison (2002)]	
	Decision-making process or style s				[Reimers (2003)]	
	National culture		[,Van Everdingen et.al (2000)]		[Xue et.al (2005),Zhang et.al (2003),] [Davison (2002)]	
	Country-related functional requirements				[Hong & Kim (2002),,Xue et.al (2005)] [Davison (2002),66]	

### CSF 7: Technological Factors (TF)

Technical factors include data management [13], legacy systems compatibility, data validation etc. Zhang et al. mentioned that the data accuracy if achieved quickly can positively affect the success of the ERP implementation process. It is reasonable to understand without contradictions that the data output and input are to be validated and verified regularly. The data model followed by the ERP software should be compatible with the legacy system and if not the necessary adjustments are to be done to make it certain that valid data is given as output. The Technological Factors (TF) include Data management, Data analysis and conversion, Data accuracy, Data quality control, Organizational characteristics, technology/infrastructure already existing, Prior Organizational experience of IT or change management projects of a similar scale, Software development, testing and troubleshooting, Defining the choices of architecture, Integration, Software configuration, Troubleshooting.(See Table 8)

**Table 8** ERP Success Factors Categorized as CSF7 (TF) and the Respective Articles in which they were Identified.

	USA	Europe & UK	Australia & Denmark	China & South Asia	MiddleEast
Data management	[Sun & Yazdani (2005)]				
Data analysis and conversion	[Somers & Nelson ( 2004)]				[Davison (2002)]
Data accuracy	[Umble et al (2003)]			[,Zhang et.al (2003),]	
Data quality control			[Xu et.al (2002)]		
Organizational characteristics		[Botta et.al (2006)]			

technology/infrastructure already existing	[Ehie & Medsen (2005)]	[Botta et.al (2006),Mabert et al. (2000)] [Allen et.al (2002)]	[Ho & Lin (2004)]		[Davison (2002)]
Prior Organizational experience of IT or change management projects of a similar scale		[Allen et.al (2002)]			
Software development, testing, and troubleshooting	[Nah et.al.(2001)]				
Defining the choices of architecture	[Somers & Nelson (2004)]				
Integration	[Trimmer et.al (2002)]	[Botta et.al (2006)]		[Reimers (2003),Zhao et.al (2002)]	
Software configuration		[Holland & Light (1),][Allen et.al (2002)]			
Troubleshooting		[Holland & Light (2001)][Allen et.al (2002)]			

#### 4. Business Implications & Limitations in the Indian Scenario

These factors can be identified in the case studies which were done very recently in 2013 and hence this study takes a prominent role in identification of the critical success factors which if achieved and observed successfully would improve the chances of obtaining success in ERP implementation processes. Shashank Saini et.al [14] studied Indian SMEs to identify the CSFs affecting the success of ERP implementations. They have segregated these factors in to Technological, Organizational and People factors. Nevertheless the factors which appeared relevant in our study were bearing importance in their empirical study as well. Thus this study we conducted can safely be extended to Indian SMEs with higher confidence.

We identified many CSFs for successful implementation of ERP. Some of these factors are fundamental for ERP implementation and hence could be found in most of the journal publications we reviewed for this work. The identification and understanding of these CSFs is a result of the amount financial and human resources spent and risk encountered by the firms in developed countries while they tried to succeed in ERP implementation. This will ease the learning of firms in developing countries while these provide a checklist and caution the firms against the most common pitfalls which may prove fatal not only for the ERP success but also for the organization. This work will also caution the firms which are newly implementing ERP by indicating that the software implementation is a comprehensive, complex and a time consuming task. Hence necessary top management support is to be provided right from the start of the ERP planning process and that support should continue till the implementation is complete. This work will also emphasize that appropriate planning and decision making will play a key role in ERP implementation success. These CSFs are linked to each other and in fact one can find that some CSFs have a stronger relationship between them than the others. This implies that firms should observe necessary caution while putting efforts to satisfy these CSFs.

The limitations of a study based on identification of CSF for ERP implementation is that the theory is evolving from the cases under consideration and the existence of the same factors (influencing these companies) cannot be guaranteed in every company. Also this work is comprehensive but not exhaustive. Hence generalization of the CSFs has been a problem in studies like this. We caution the readers to keep note that this research pertains to literature published till 2014 and to keep track of other future researches published in ways similar to the methodology adopted in this paper. Since many of the cases are from the USA and Europe, which are the developed Nations, the applicability of the same to developing countries like India is a reasonable question. But we do not have enough literature support of the ERP cases from India and we look forward to identifying the cases and comprehensively validating the results for Indian scenario.

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# Examining the Patients' Perception Regarding Responsiveness of Staff Members at Government Hospitals in Kerala



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**Rehin K.R**  
**Raveendran P. T**  
Kannur University, Thalassery Campus  
(rehinkr@gmail.com)  
(ravindranpt@gmail.com)

*The promptness in willingly providing a service, i.e., the degree of responsiveness shown by the staff members is an important parameter used by a customer to judge the quality of services offered by a hospital. We often hear the patients complaining about the doctors, nurses and support staff at government hospitals being hesitant to provide timely care thus making them unhappy with the same. An examination of the patients' perception using factor analysis and regression analysis showed that majority of the patients were happy with the responsiveness of staff members at government hospitals across Kerala.*

**Key terms:** intangibility, promptness, responsiveness, service quality

## 1. Introduction

Employees in service industries have a significant role in determining customer satisfaction. Employees have an increasingly important role in driving organizational performance. One of the most important ways that employees affect performance is in their interactions with customers. In the globalized and liberalized business environment, service sector is encountering stiff competition to meet the requirements of the profitable ways of business. It appears that the driving force towards success in service business is the delivery of high quality service (Thompson et.al. 1985). In the era of increased competition, enhancement of service quality and its measurement is one of the significant issues for developing efficiency and the growth of business (Anderson & Zeithamal 1984, Babakus & Boller, 1992 and Garvin, 1983).

In the service sector, the health care industry, one of India's largest sectors in terms of revenue and employment which is growing at a rapid pace. In India, the service quality of health care is miserable and in general, the health outcome is far from satisfactory (Bajpai & Goyel, 2004). As in the case of other industries, in the health care sector also, customer satisfaction is an important issue (Shabbir et.al. 2010). A health care organization can achieve patient satisfaction by providing quality services keeping in view patients' expectation and continuous improvement in the health care service (Zineldin, 2006). The extent of responsive behaviour showcased by the hospital staff is a prominent factor determining the satisfaction level of patients with the kind of services offered by hospitals. In the present study, an attempt is made to assess the perception of patients about the responsiveness of staff members at government hospitals in Kerala with the help of SERVQUAL model.

## 2. Review of Literature

Newman et.al. (2001) opined that customer service is a prerequisite for customer satisfaction. The value of service consists of eight dimensions viz. reliability, assurance, access, communication, responsiveness, courtesy, empathy, and tangibles (Brown, 1997; Caruana & Pitt, 1997; Homburg and Garbe, 1999; Clemes et al., 2001; Sower et al., 2001; Yang et al., 2003).

Patients, in general, receive various services of medical care and judge the quality of services delivered to them (Choi et al., 2004). During 2004 and 2005, a focus group interview was conducted by the Agency of Health Care Research and Quality and Centers for Medicare and Medicaid Services (CMS) to find out how patients perceive the quality of health care. In this study it was observed that patients, usually, preferred four qualities of health care services viz. doctor communication skill, responsiveness of hospital staff, comfort and cleanliness of the hospital environment and communication of nursing staff (Safavi, 2006).

Babakus and Mangold (1992) identified SERVQUAL as a reliable and valid model in the hospital environment.

O'Conner et.al. (2001) found SERVQUAL instruments suitable to analyze the perceptual gap in understanding patient expectation among health care stakeholders. SERVQUAL was found to be a useful model to measure the differences between patients' preferences and their actual experiences. Qin and Prybutok (2009) mentioned all the five dimensions of the service quality in SERVQUAL instrument are significant and reliable in a health care setting.

The above literature clearly indicates the significance of responsiveness of staff members in enhancing patient satisfaction as well as the use of SERVQUAL in measuring the same.

## 3. Significance of the Study

Every organization, irrespective of whether it is in manufacturing or service sector, has to ensure that their customers are satisfied to the fullest to be successful in the long run. While the quality of the end product is a major determinant of customer satisfaction with products, the excellence in provision of services by the staff members is the primary determinant of customer satisfaction in case of services. Along with other dimensions of service quality, the speed and efficiency with which

the staff members respond to the needs and requirements of patients or in short their responsiveness is a key aspect that influences their satisfaction with service quality. Being a service organization, all this applies to hospitals. So, it is very important for hospitals to have a clear picture of the patients' perception regarding the responsiveness of staff members. Hence, the present paper is an attempt to take a deeper look at the patients' perception regarding the responsiveness of staff members at government hospitals in Kerala.

#### 4. Methodology

The researcher followed a descriptive approach in conducting the study. Data were collected from inpatients at various districts and general hospitals across Kerala. A structured questionnaire was administered among a sample of 330 patients identified at the convenience of the researcher from various government district hospitals across Kerala. The questionnaire was designed in such a way that the opinion of respondents on various aspects relating to tangible elements were sought.

The collected data was then analyzed using factor analysis. Factor analysis tries to bring inter-correlated variables together under more general, underlying variables. More specifically, the goal of factor analysis is to reduce "the dimensionality of the original space and to give an interpretation to the new space, spanned by a lower number of new dimensions which are supposed to underlie the old ones" or to explain the variance in the observed variables in terms of underlying latent factors (Rietveld & Van Hout, 1993). In the present paper, factor analysis was done to identify the key variables impacting the satisfaction of patients with physical environment or tangible elements at government hospitals and to group them into certain factors based on common properties.

The factor scores thus obtained were then subjected to multiple regression analysis. Multiple regression is a statistical technique that allows us to predict the value of one variable on the basis of values of several other variables. There will be two set of variables – predictor variables which are helpful in predicting the values of other variables and the criterion variables for which the values are predicted based on the values of predictor variables. This statistical technique can be used while exploring linear relationships between the predictor and criterion variables. Multiple regression analysis helps us to understand the significance level of different dependent variables in relation to one or more independent variables and also to identify the most significant factor(s) (Brace et al, 2006). In this paper regression analysis was performed to find out whether there existed significant difference in the perception of male and female patients regarding responsiveness of staff members at government hospitals in Kerala.

#### 5. Results and Discussion

**Table 1** Patients: Responsiveness of Staff Members: KMO and Bartlett's Test

<b>Kaiser-Meyer-Olkin Measure of Sampling Adequacy.</b>		<b>.662</b>
Bartlett's Test of Sphericity	Approx. Chi-Square	147.289
	Df	21
	Sig.	.000

Source: Survey Data

The KMO test is conducted to assess the adequacy of a given sample. KMO value varies between 0 and 1. A value of 0 indicates that factor analysis is inappropriate for the data and a value of 1 indicates that factor analysis will yield distinct and reliable results. A value of 0.5 or above means that the sample is adequate and we can proceed with factor analysis whereas if it is below 0.5 we have to collect more data (Field, 2000). As seen in Table 1 the KMO value for this set of data is 0.662 which is acceptable.

For factor analysis to work there has to be some kind of relationship between the variables and this is tested using the Bartlett's Test of sphericity. This test indicates whether factor analysis is appropriate for a given set of data. Factor analysis can be considered appropriate for a data only if the significance value is less than 0.05 (Field, 2000). As the significance value for the present data as shown in Table 1 is 0.000, factor analysis is appropriate for this data.

As the present data set satisfies both KMO test and Bartlett's test, factor analysis is appropriate.

**Table 2** Patients: Responsiveness of Staff Members: Communalities

Variables	Initial	Extraction
Service of doctors was available without having to wait for long.	1.000	.524
Doctors responded to my queries positively.	1.000	.419
Doctors clearly explained the medical care to be taken after discharge.	1.000	.589
The service of nurses was available whenever required.	1.000	.396
Nurses helped me follow the instructions given by doctors.	1.000	.417
Attendants were always helpful in this hospital.	1.000	.377
Attendants and nurses were always willing to help while moving around in this hospital.	1.000	.305

Extraction Method: Principal Component Analysis.

Source: Survey Data



Table 2 showed the communalities before and after extraction. Principal component analysis works on the assumption that all variance is common. So before extraction all communalities are 1. Column two, i.e., the extraction column indicates the percent of common variance associated with each variable. Hence from Table 2, we can say that 52.4 percent of variance associated with the variable 'Service of doctors was available without having to wait for long' is common, 41.9 percent of variance associated with the variable 'Doctors responded to my queries positively' is common and so on. The table clearly shows the percent of common variance associated with each variable. While the highest degree of common variance is with respect to 'Doctors clearly explained the medical care to be taken after discharge', the lowest common variance is in case of 'Attendants and nurses were always willing to help while moving around in this hospital'.

**Table 3 Patients: Responsiveness of Staff Members: Total Variance Explained**

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.911	27.304	27.304	1.911	27.304	27.304	1.560	22.282	22.282
2	1.116	15.947	43.251	1.116	15.947	43.251	1.468	20.969	43.251
3	.959	13.701	56.951						
4	.876	12.513	69.464						
5	.820	11.710	81.174						
6	.691	9.866	91.040						
7	.627	8.960	100.000						

Extraction Method: Principal Component Analysis  
Source: Survey Data

Table 3 lists out the eigenvalues with respect to each factor before extraction, after extraction and after rotation. Before extraction there were seven eigenvalues as there were seven variables included in the analysis. The eigenvalues associated with each factor shows the variance associated with each factor. It also shows eigenvalues in terms of percent of variance. For e.g. the first factor, i.e., 'Service of doctors was available without having to wait for long' explains 27.3 percent of variance. It is clear from Table 3 that the first few factors explains relatively larger amount of variations in comparison to the later ones. SPSS then takes out those factors with eigenvalues greater than 1, which leaves us with 2 factors which are shown in the second part of Table 3 labeled as 'Extraction Sums of Squared Loadings.' The values in this part of the table are same as the values before extraction except that the values for factors other than those with eigenvalues greater than 1 are ignored. The last part of the table, i.e., 'Rotation Sums of Squared Loadings', displays the eigenvalues of factors after rotation. Rotation more or less optimises the factor structure leading to equalization of importance of all factors. Before rotation the first factor accounted for 27.3 percent of variance while the remaining factors contributed to lesser proportion of variance whereas after rotation all the factors contributed more or less equally thereby optimizing the importance of all factors.

**Table 4 Patients: Responsiveness of Staff Members: Rotated Component Matrix**

Variables	Component	
	1	2
Service of doctors was available without having to wait for long.	.721	
The service of nurses was available whenever required.	.629	
Nurses helped me follow the instructions given by doctors.	.624	
Doctors clearly explained the medical care to be taken after discharge.		.756
Attendants were always helpful in this hospital.		.598
Attendants and nurses were always willing to help while moving around in this hospital.		.538
Doctors responded to my queries positively.	.450	.464

Extraction Method: Principal Component Analysis.  
Rotation Method: Varimax with Kaiser Normalization  
Rotations converged in 3 iterations  
Source: Survey Data

Table 4 showed the rotated component matrix which is the matrix of factor loadings for each factor into each variable. 0.4 was used as the cut-off for factor loading. The factors converged at 3 iterations. The variables were listed in the descending order of size of their factor. As evident from Table 4, factor rotation resulted in the extraction of 2 factors as significant determinants of patients' perception regarding responsiveness of staff members at government hospital. Factor 1 loaded across three variables, i.e., 'Service of doctors were available without having to wait for long', 'The service of nurses was available whenever required' and 'Nurses helped me follow the instructions given by doctors' which will jointly be termed as 'Availability of doctors' and nurses' services whenever required'. Second factor loaded across four variables namely 'Doctors clearly explained the medical care to be taken after discharge', 'Attendants were always helpful in this hospital',

'Attendants and nurses were always willing to help while moving around in this hospital' and 'Doctors responded to my queries positively' which will hereafter be referred to as '**Willingness of doctors, nurses and attendants to help patients and to clear their doubts**'.

Hence the seven variables included in the analysis converged to two factors namely '**Availability of doctors' and nurses' services whenever required**' and '**Willingness of doctors, nurses and attendants to help patients and to clear their doubts**'.

The factor scores were subjected to regression analysis at 5 percent significance level by taking gender of the respondents as dependent factor to test the following hypotheses.

**H1:** There is no significant difference in the perception of male and female patients regarding the availability of service of doctors and nurses at the hospital whenever required.

**H2:** There is no significant difference in the perception of male and female patients regarding the willingness of doctors, nurses and attendants to help patients and to clear their doubts.

**Table 5** Patients: Responsiveness of Staff Members: Regression Coefficients

Model	Unstandardised Coefficients		Standardised Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	1.476	.028		53.630	.000
1 Availability of doctors' and nurses' services whenever required.	-.042	.028	-.085	-1.540	.125
1 Willingness of doctors, nurses and attendants to help patients and to clear their doubts.	-.003	.028	-.007	-.126	.900

From regression results Table 5 it was concluded that both the factors that emerged after factor analysis were found to be insignificant as far as gender of respondents was considered. Hence, it was concluded that there was no significant difference in the opinion of male and female respondents regarding availability of doctors' and nurses' services whenever required and the willingness of doctors, nurses and attendants to help patients and to clear their doubts.

## 6. Conclusions and Limitations of the Study

The above results clearly indicates that among the numerous factors impacting the satisfaction level of patients with the responsiveness of staff members at government hospitals, the most prominent ones among them are availability of doctors' and nurses' services whenever required and willingness of doctors, nurses and attendants to help patients and to clear their doubts. As such, the authorities concerned should ensure that service of doctors and nurses whenever necessary and also that the doctors, nurses and support staff are always ready to clarify the doubts of patients in order to maximize their satisfaction with responsiveness of staff members. However, as the findings of the study are purely based on the inputs received from the surveyed patients, proper care should be taken before generalizing the same.

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# “It Looks So Good! So Might Taste Good Too...” Chocolate Package and Baby Boomers



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**Suraj Kushe Shekhar**  
VIT University  
(Surajkushe@gmail.Com)

**P. T. Raveendran**  
Kannur University  
(Ravindranpt@gmail.Com)

*Packaging, which is often debated as the fifth ‘P’, is an important component of marketing. This study was conducted to examine the effects of two important packaging cues namely: ‘Visual Cues’ and ‘Informational Cues’ and how senior citizens subjectively evaluated the chocolates based on packages. The results proposed a model where two packaging cues (Visual and Informational) showed direct positive influence on consumers purchase decisions. However there were no significant differences in the opinion of the senior citizens across these cues. The results of the study emphasise the importance of chocolate package designs on consumers purchase behaviour.*

**Keywords:** Consumer, Chocolate, Package, Product, Purchase

## 1. Introduction

Packaging is the science, art, and technology of enclosing or protecting products for distribution, storage, sale, and use. Packaging also refers to the process of design, evaluation, and production of packages. Packaging can be described as a coordinated system of preparing goods for transport, warehousing, logistics, sale, and end use. Packaging contains, protects, preserves, transports, informs, and sells (Soroka, 2002). Packaging is any container or wrapping in which the product is offered for sale and can consist of variety of materials such as glass, paper, metal or plastic, depending upon what is to be contained (Brassington & Petit, 2002). Packaging is defined as an extrinsic element of the product (Olson & Jacoby, 1972) - an attribute that is related to the product but does not form part of the physical product itself. Packaging is a structure prepared to contain a commercial food product, i.e. enabling it easier and safer to transport, protecting the product against contamination or loss, degradation or damage and maintaining a convenient way to dispose the product (Sacharow & Griffin, 1980).

As per Hine (1995), in a modern retail environment, a package is not just a container but a tool for delivering goods in a best condition for use. Keller (1993) identified packages as non-product-related but brand-related elements. But according to Richardson et al. (1994), packages are product-related but with extrinsic attributes. Similar to the statement by Richardson et al. (1994), Underwood (2003) explained packages as product-related attributes, but different from the previous two explanations. Underwood (2003) stated package as intrinsic or extrinsic attributes based on their features. He suggested that they are intrinsic when they are physical part of the content (e.g. toothpaste tube), and they are extrinsic when the information on the package (e.g., logo, picture) is taken into account. He further added that packaging is posited to influence the brand and self-identity via mediated (through exposure to mass-communication culture and mass media products) and lived in experience (interaction with the brand, typically resulting from purchase and usage). To summarize, a package can be identified as a designed-product served for use, which has to meet many requirements to satisfy the demands of the many stakeholders (e.g., manufacturer, distributor, retailer) and especially those of consumers/users.

Today product package is often debated as the fifth ‘P’ of marketing mix. Although advertising is a major sales promotion tool, packaging is even more critical. This is because, for other promotional tools, there is always the need for communication to persuade and attract the consumer. However, when packaging is properly done, the products can sell by themselves. Proper packaging is an easier, cheaper means of advertising and hence the huge amount of money spent on advertisement and promotional techniques can be redirected by ensuring that the right things are done during the product packaging itself. In order to perform the role effectively and to reap the right results and benefits to the manufacturer (increase in profit margins), a product’s packaging must be attractive, informative, and clearly identify with the product. Packaging must also continuously communicate its real benefits and create awareness to ensure image and brand preference.

According to Doherty & Tranchell (2007), the world loves chocolates. They opined that nine out of ten people like chocolates and the tenth person always lies. In a bit of humour they even added that chocolate could make everyone smile even bankers. Packaging in chocolate industry is therefore critical. Today packages are designed to go with different occasions, demand to different social classes and differentiate between different brands. Based on the results from relevant previous research studies, it was found that there existed a relationship between food products packaging and consumer purchase behaviour.

## 2. Statement of Purpose

Marketing environment has become increasingly complex and competitive. Advertising is a highly effective means of communication. But reaching the entire target market with advertising for most products is generally not a feasible prospect.

Fragmentation of the media has shown that it has become extremely difficult as well as expensive to reach and communicate with the potential customers forcing marketers to adopt more innovative means of reaching their target market. In contrast to advertising, which has limited reach, a product's packaging is something which every consumer's experience and which has strong potential to engage the majority of the target market. This makes packaging an extremely powerful and unique tool in the modern marketing environment. Apart from its benefits in terms of reach, some marketers believe that packaging is actually more influential than advertising in influencing consumers, as it has a direct impact on how they perceive and experience the product. For products with low advertising support, packaging takes on even more prominent role as the key vehicle for communicating the brand positioning. But despite the importance of packaging, there is limited marketing research currently available to the public in the area of packaging research. Most of the textbooks and literatures agree packaging playing a vital role in marketing, but there is little empirical research available investigating its impact on the marketing function and how best to leverage packaging in a marketing context particularly with regard to various low involvement and high impulse purchase product categories; where companies cannot invest too much in advertising. The present study examined the influence of packaging cues on senior citizens purchase behaviour for one such high impulse and hedonic product category namely: The Chocolates.

### 3. Statement of Importance and Implication for Practice

Although earlier studies have shown an increase in the managerial focus towards packaging, a review of the marketing literature shows that only few theoretical contributions has been taken in the area of packaging and relatively fewer efforts to its impact on the marketing function such as consumer behaviour (Rettie & Brewer, 2000). Marketers often measure consumer brand perceptions and ignore the pack. But we see that consumers react to unbranded products were in packaging plays a vital role in reinforcing consumer perceptions (Underwood, 2003). Packaging helps to drive the way consumers' experience a product and this is believed to be true for chocolate packaging as well. Though earlier studies have been undertaken in chocolate consumption behaviour, there is hardly any marketing literature understanding chocolate packaging and its direct effect on purchase and final consumption. For chocolate consumers, the product is the package and its contents combined (Suraj & Raveendran, 2012). Today there are different categories of chocolate packages like ordinary packs, family packs, gift packs, festival packs etc. A layman who wishes to buy a chocolate from the market would always choose to buy a chocolate which has an eye catching package. Chocolate packaging thus has a hypnotizing effect on the customers mind (Patwardhan et al., 2010). Today researchers spend very little time and money researching the connections between packaging and the direct experience of the product. The situation is even grave when it comes to low involvement purchase categories like chocolates where researchers can't afford to spend too much money on packaging research (Giyahi, 2012).

The results of this study substantially contribute to the theoretical and practical understanding of consumer purchase decisions towards chocolates based on its package. A model which was developed based on the study indicated that when consumers decide to purchase a chocolate, he/she may retrieve the constructs (factors) and directly relate it to purchase intentions. From a practical standpoint the results of the study would provide managers with greater insights concerning the potential benefits and limitations associated with consumers purchase strategies. The research clarifies the confusing role of dual influence of 'Informational Cues' (Ampuero & Vila, 2006; Silayoi & Speece, 2007) and 'Visual Cues' (Ampuero & Vila, 2006).

### 4. Literature Review and Related Constructs of the Study

#### Visual Cues (VC)

**Colour** is the most important tool for emotional expression of a package (Hine, 1995) as it reflects an image for the product (Sauvage, 1996). Underwood (2003) opined that consumers associate meaning to the package colours in three different ways: "the physiological, the cultural, and the associational". The first one is described as universal and involuntary (e.g. the colour red speeding the pulse). The second one, cultural meaning for colours, occurs over long periods of time in different societies (e.g. the colour black relates to elegance in Europe. The third one, associational meaning, is developed through marketing efforts (e.g. the colour pink relates to the product with low calories). In addition, colour is considered as a tool for brand identification and visual distinction (Underwood, 2003). It is also considered as an important factor for legibility of the texts and comprehension of the images placed on the package.

**Picture:** MacInnis & Price (1987) stated that a consumer viewing a product picture on a package was more likely to spontaneously imagine aspects of how a product looked, tasted, felt, smelt, or sounded like than they would with a picture less package. The imaging of the individual brand, according to them, then lead to fewer brands being evaluated, improving the brand's likelihood of purchase (MacInnis & Price, 1987). Underwood et al. (2001), on the other side, stated that the positive impact of package pictures is primarily to increase attention to a brand, rather than increase the likelihood of the brand to be chosen. According to them, pictures were extremely vivid stimuli and incorporating visual imagery on a package enhanced the product's accessibility to consumers (Underwood et al., 2001), which did not seem to be synonymous to brand choice. Alternatively, Fitzgerald & Russo (2001) opined that a picture's capacity to serve as a framework for interpreting a package's informational components, since pictures, according to them, were likely to be processed prior to other components of a package (Fitzgerald & Russo, 2001). Therefore, on one side, a picture could reinforce the informational, for example verbal, stimuli. On the other side, if a package was carelessly designed, the two components could contradict and in that case,

Fitzgerald & Russo's (2001) statement implied that the intended informational stimuli would be hampered. According to Underwood et al. (2001) the picture could also be a source of information to a consumer. Pictorial content conveyed a concrete information that directed to be more influential in the decision making process than more abstract verbal information (Underwood et al., 2001). A picture could actually show how the product looked like or how it could be served, while verbal information could only describe it (Underwood et al., 2001). Moreover, in categories where product knowledge was low, the product picture proved to be highly diagnostic (Underwood et al., 2001), as it revealed the unknown product in a way that stimulated consumers imagination. Also if little variance existed in price and perceived quality among brands, a product picture was exceedingly important (Underwood et al., 2001).

### **Informational Cues (IC)**

The second type of packaging elements, are the nutritional informational elements: information provided by the package and technologies used in the package. One of packages' functions is to communicate product information, which can assist consumers in making their decisions carefully (Silayoi & Speece, 2007), and it seems evident that written, verbal information has a great capacity to do this. However, written information on a package can also create confusion by conveying either too much information or mislead through inaccurate information (Silayoi & Speece, 2007) in some cases. Further, in a study by Silayoi and Speece (2007), consumers were found to use explicit product information to assess healthiness, and also many other aspects of quality. Yet, consumers were more likely to read the label to check that the product information was consistent with their needs if the package made it seem that the product was worth investigating (Silayoi & Speece, 2007). This suggested that informational elements were relevant only if the graphical elements had performed well.

Nutritional Information, nutritional claims and ingredients form part of most packages. Keller et al. (1997) examined the effects of nutrition claims (e.g., "99% fat free;" "low in calories") on the front of packages, nutrition value information presented in the nutrition facts panel, and consumers motivation to process nutrition information on consumers product-related judgments in a between-subjects experiment. A frozen dinner with a chicken-based product was chosen as the package. Results showed that: nutritional claims that were not consistent with nutrition value information (supplied in a nutrition facts panel) had a stronger negative effect on consumer evaluations of manufacturers' credibility than claims that were consistent, or when no claims were made. Higher level of nutrition value (suggested in a nutrition facts panel of the context of total package information) resulted in a more favorable attitude towards the product, purchase intentions and product nutrition attitude. Consumers levels of motivation to process moderated the effect of nutrition value on nutrition and product evaluations. For consumers with higher level of motivation, nutrition and product evaluations were more favorable for a product that was higher in nutrition value and less favorable for a product that was lower in nutrition value than for consumers with lower levels of motivation.

Compared to packages on which no claims were made, packaging with nutritional claims resulted in less favorable nutrition and product evaluations for consumers with lower motivation than for those with higher motivation. Prathiraja & Ariyawardana (2003) identified the market (objects, objectives, occasions and occupants) for nutritional labeling in Sri Lanka and the factors that influenced the consumer willingness-to-pay for nutritional labeling. Results projected that nutritional label played an important role in providing the relevant nutrition information to Sri Lankan consumers. Inclusion of a nutritional label on food items was believed to be an important packaging decision for the Sri Lankan food processors as well. Singla (2010) examined the usage and understanding of food and nutritional labels among Indian consumers. The results portrayed that food labels were read by the consumers for brand comparisons and not for consulting nutritional information. Difficult terminology, small font size and inability to understand nutritional labels were the major problems encountered by the consumers. Television, friends, magazines are commonly used for assessing nutritional information. Labels were considered more consumers friendly when benchmarks regarding serving size were provided. Income level, size of household, number of children and age did not play a role in the usage of nutritional labels by the consumers. Consumers with special dietary needs used nutritional labels regularly.

### **Packaging and Buying Influence (PBI)**

As the package is a critical factor in the decision making process in communicating to the customers, the package standing on the shelf affects the consumer decision process and package design ensures that consumer response are favourable (Silayoi & Speece, 2004). Consumer intention to purchase depends on the degree to which consumers expect that the product can satisfy their expectations about its use (Kupiec & Revell, 2001). But when they have not thought about the product before entering the store, this intention to purchase is determined by what is communicated at the point of purchase. How they perceive the subjective entity of products, as presented through communication elements in the package, influences choice and is the key to success for many food products marketing strategies. Thus the package becomes a critical factor in the consumer decision making process because it communicates to consumers at the time they are actually deciding in store and finally trigger purchase decisions.

## **5. Hypotheses of the Study**

### **Influence of Visual Cues**

Aesthetic response can be defined as an experience (i.e., visual, emotional) that occurs in reaction to a specific stimulus (Berlyne, 1974; Veryzer, 1998). This sensory stimulation can encourage viewers to imagine how a product looks or feels when in use. Visual attributes such as colour, style and shape can arouse consumer emotion, communicate values and convey

meaning to both users and viewers. If consumers perceive positive aesthetic experience from a product, they are more likely to further examine and potentially purchase that product (Eckman, Damhorst & Kadolph, 1990; Morganosky, 1984). Hence it is hypothesized that:

**H<sub>1</sub>**: Visual Cues of Chocolate Packages have Direct Positive Effect on Purchase Decisions of Chocolates.

### Influence of Informational Cues

It is assumed that when consumers initially encounter a newly launched product, important information is communicated by the Information given on product packages. In this case, consumers may even infer about the missing information by drawing a connection between available pieces of information, one of which is 'Informational Cues'. Upon facing a newly launched chocolate brand, consumer's cognitive responses will incline towards informational contents. These positive responses will develop in favourable evaluations towards the brand. Thus 'Informational Cues' which is relevant to consumers' ability to produce output is one likely source of consumers' influence on purchase decisions. Hence it is hypothesized that:

**H<sub>2</sub>**: Informational Cues of Chocolate Packages have Direct Positive Effect on Purchase Decisions of Chocolates.

## 6. Research Methodology

Descriptive research (Malhotra, 2004) was used in the study. The researcher elicited responses senior citizens of Kannur district, Kerala, India. A total of 100 responses were collected. 58% of the respondents were females. Respondents were at an average age of 62 years. Prior to final data collection, a pre-test was conducted amidst 20 respondents to refine and validate the questions included. Final data collection was done in public libraries, households, clubs etc. The questionnaire captured consumers behaviour with respect to chocolate packages on first purchase. Respondents were asked to imagine as if they were purchasing a chocolate for the first time, a chocolate which they hadn't tasted before, sighted before but probably may have heard before. It could even had been a new brand pitched in the market. Respondents were even asked to imagine as if they were purchasing a chocolate bar or chocolate boxes (family packs, special packs, festival packs) but not single toffees (e.g. 50 paise éclairs), assorted chocolates, candies and chewing gums. 4 communicative components (independent variables) of chocolate packages were used in the study and arranged on a 5 point Likert's scale. Respondents were asked to mark their responses with regard to the influence of all the communicative components of chocolate packages in a typical situation/scenario as mentioned Multi item measures were used to get the data on the constructs considered. The variables used in the section were borrowed from the works of (Underwood et al.,2001; MacInnis & Price,1987; Sehrawet & Kundu,2007; Imram,1995; Keller et al.,1997; Hill & Tilley ,2002; Sonsino,1990; Rokka & Uusitalo,2008; Suraj & Raveendran ,2012;Ampeoro & Vila,2006 and Silayoi & Speece,2004). Exploratory Factor Analysis (EFA) which was initially performed (to understand the nature of the facets) on four independent variables revealed that the original variables were clustered around two subscales (factors): Visual Cues (VC) and Informational Cues (IC).The convergent validity of the evolved constructs after EFA were confirmed using Confirmatory Factor Analysis (CFA) using SPSS AMOS 20 software. The convergent validity was assessed by checking the loading of each observed indicators on their underlying latent construct. Loadings greater than 0.2 were retained as given by the specifications of (Anderson et al., 1987). Later, full structural model testing was performed to test two specific hypotheses as described earlier using Structural Equation Modelling (using SPSS AMOS 20 software).Here, Packaging and Buying Influence (PBI) was designated as the dependent variable and the two factors (evolved after EFA) were designated as the independent variables.

Overall reliability statistics which was tested using Cronbach's alpha coefficient for 6 variables were found to be 0.94 which was considered to be 'very strong' (Malhotra, 2004). Reliability/internal consistency of the multi-item scales of each of the constructs were also tested using Cronbach's alpha coefficient measures. The minimum acceptable reliability for primary research should be in the range of 0.50 to 0.60 (Nunnally, 1967).The details of the reliability statistics for the dependant and independent constructs are as shown in Table 1:

**Table 1** Summary of Reliability Measurement

Sr.No	Dimensions*	Variables*	Nature	Number of items	Alpha values
1.	Visual Cues (VC)	Colour (Co) & Picture (Pi)	Independent	2	0.80
2.	Informational Cues (IC)	Nutritional Info. (NI) & Nutritional Claim (NC)	Independent	2	0.84
3.	Packaging and Buying Influence(PBI)	Chocolate packaging is important (1) & Chocolate packaging influence buying (2)	Dependent	2	0.87

*Source Survey Data*

*\*The full Structural Modelling that Follows in Figure 1 used the Codes Given Under 'Dimensions' and 'Variables' of Table 1*

## 7. Results

The two independent factors followed two hypotheses formulated in the study. Figure 1 shows the overall result and Table 2 shows the structural results needed for testing the hypotheses.





It was observed (Table 3) that 'Visual Cues' had direct positive effect ( $\beta=.189$ ) in buying influence of chocolates i.e. when senior citizens associations with 'Visual Cues' were high, the tendency to buy chocolates was also high. This supported the first hypothesis. However the result was insignificant ( $p>.05$ ) i.e. there was no much significant difference in opinion of the respondents as far as the first hypothesis was considered. Similarly it was seen that 'Informational Cues' had direct positive effect ( $\beta=.217$ ) in buying influence of chocolates i.e. when senior citizens associations with 'Informational Cues' were high, the tendency to buy chocolates was also high. This supported the second hypothesis. However it was seen that the result was insignificant ( $p >.05$ ) here too i.e. there was no much significant difference in opinion of the respondents as far as second hypothesis was considered. The interpretation concerning the size of effect of the standardized path coefficients for the present study was based on Kline's (2005) recommendations. Accordingly, standardized path coefficients with absolute values less than .10 indicated a small effect; value around .30 indicated a medium effect; and those values greater than .50 indicated a large effect (Kline 2005). The details of the hypotheses testing indicated that 'Informational Cues' ( $\beta=.217$ ) had larger influence as compared to 'Visual Cues' ( $\beta=.187$ ) on respondents purchase decision of chocolates based on packages.

## 8. Conclusion and Implication for Further Research

This study was conducted to examine the effects of two important packaging cues namely: 'Visual Cues' and 'Informational Cues' and how students subjectively evaluated the chocolates based on packages. In general this study allowed analysis of direct influence of the packaging cues on purchase decisions. Therefore the direct effects of these cue, i.e. Visual and Informational were tested. The results proposed a model where two packaging cues (Visual and Informational) showed direct positive and significant influence on senior citizens purchase decisions. Further it was observed that there was no much significant difference in opinion of the respondents as far as the two hypotheses were considered. Results supported the findings of (Silayoi & Speece, 2004; Silayoi & Speece, 2007, Ampuero & Vila, 2006; Rundh, 2005) mentioning the influence of visual and informational elements of product packages.

Like any research, there were some limitations in this study too. Future research should continue to test and refine the relationships of the present study and the variables that moderate them. Firstly, it is clear that future research is required to yield a more complete understanding of the phenomenon surrounding purchase influence for the purpose of reaffirmation of the findings of the present study. This study was attempted to outline major variables that logically and theoretically impacted the linkages in purchase decisions scenarios in Kerala. However data should be collected from the nation as a whole and even from third world countries and determine if the same result of purchase decisions could be observed. Secondly, the two cues studies here (i.e. Visual Cues & Informational Cues) are themselves a simplified abstraction. Other potentially important cues were excluded from the present study. Notable is the product attributes which could play a very important role in forming consumer perceptions and purchase decisions. Further, as chocolate is a type of product which is consumed irrespective of age groups, the study could even be extended to all age groups. Such an extended study would throw more light in understanding the significant differences across several demographic variables. The study can also be raveled in understanding the purchase mechanisms across young consumers of urban and rural areas. The study could even be extended to diverse products/brands and even on unbranded chocolates and the consumer behavior patterns can be interpreted with different methods of analysis such as discriminant analysis, cluster analysis and so on.

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# Power of E-WoM as the Next “P” in Marketing



ISBN: 978-1-943295-01-2

**Mithra Manmadhan**  
**Suresh Subramoniam**  
CET School of Management  
(mithramohan18@gmail.com)  
(sureshsubramoniam@gmail.com)

*Word of mouth influence has a heavy impact in marketing. This in the pre-internet era is slow and hence did not catch much attention. But today, SMAC and speedy processes available for lower prices, has given added power to the consumer in the form of e-WoM. This study is aimed at analysing how digital media accentuates a shift in consumer power. It also analyses emerging technologies which reduces the cost of information spreading in the internet era, its implications on consumers, marketers and other stakeholders and discusses drivers responsible for e-WoM.*

**Keywords:** Internet, consumer power, e-WoM, SMAC, social media, marketer

## 1. Introduction

With the advent of the World Wide Web, usual customers got access to huge quantities of information and built up prospects to control their own living in the market and beyond. Further, the social media platform of everywhere connectivity, facilitated through mobile devices, consecutively has not only improved access to information, but also facilitated customers to produce content and intensify their voices, across the world. Consumers now have unrivalled access to information which is endowed by the wise blend of new media and mobile devices.

In this era of internet, three factors dictate the power of consumers, namely, simpler transactions, wider options and more information available globally. Consumers are empowered due to the digital revolution by giving access to information and other customers regardless of time and place. The scripted unidirectional flow of information that existed at the time when only a few channels were available has been annihilated by the digital age. With the emergence of the Internet, researchers started anticipating a transformation in influence from the marketer to the customer, proposing a new type of customer–firm association (Maheswaran and Sternthal, 1991; Richins and Shaffer, 1988; Bronner and Hoog, 2010; Sen and Lerman, 2007; Park and Han, 2010).

The discussion on consumer power can be divided into four waves. The first wave of consumer power started with President Kennedy’s conceptualisation on consumerism (Aaker and Day, 1970). The second wave of discussion on consumer power can be traced in the distribution channel literature (Stern and El-Ansary, 1972; Nevin and Gaski, 1985; Dwyer et al., 1987; Heide, 1994; Brown and Lusch, 1996; Betancourt and Gautschi, 1998; Ping, 1993; Hibbard, Stern and Kumar, 2001), wherein consumers are described as the most powerful among the distribution channel members. Put differently, in the second wave, consumer enjoyed the role of a buyer or ultimate decision maker in the purchase process and hence enjoy greater bargaining power. The third wave of discussion on consumer power can be spotted in the literature regarding consumer complaints (Hirshman, 1970). Consumer word of mouth can be considered more dangerous due to its speed and reach in the internet era. The most recent wave on consumer power attained momentum with the emergence of internet (Gilly and Wolfinbarger 2001; Pitt et al. 2002; Urban 2004; Rezabakhsh et al. 2006; Denegri-Knott et al. 2006; Kucuk and Krishnamurthy 2007; Gregoire, Legoux and Tripp 2009; Gregoire, Laufer and Tripp 2010). The internet undoubtedly has endowed consumers with power in many ways. It is seen that this wave of consumer power is indisputable and has radical impacts in digital markets than ever before (Kucuk and Krishnamurthy 2007). Thus, digital age is characterised by the emergence of a new medium of communication in the marketplace which is faster than light. In other words, consumer power has transcended from passive and symbolic stage to an active and multifold powerful level.

The digitalisation of consumer markets is increasing which has enabled consumers to establish many communications and relationships in the marketplace. Preceding the internet era, it was presumed by marketers that it is easy to control consumers or refused that consumer behaviour. But the digital revolution has brought about a challenge to the above situation. Obviously, in order to have a thorough understanding of the correct and future market scenario, the primary role is played by the changing dynamics of consumer power. This demands a thorough and continuous investigation of consumer power due to the change in technology and resulting change in the market scenario.

Vast changes can be observed in the entire business environment, companies and even in the lives of consumers due to the emerging role, application and possibilities of IT. Competition which has intensified due to the new technologies has played a major role in the empowerment of consumers, necessitating them to be treated as individuals rather than as a mass. There is a wide impact of technology on bargaining power of buyers and suppliers. This increases the rivalry among existing firms which can be termed as the next “P” in marketing called “power of consumers due to technology” or simply stated as “Power”.

In the context of digital revolution, this study traces how the power in the marketplace is shifting from marketers to consumers and how internet acts as a medium actuate this power shift. The paper also explores the challenges and

implications that this shift provides for marketers. The earlier marketing literature on the internet enabled empowerment substitutes the claim of inclusion of “power due to e-WoM” as the next P in the marketing mix.

### 2. Consumer Power in the Pre- Internet Era

The condition in the elderly business system has conventionally been categorized by a fragile power point for the customer. In the older business system, the professional power is principally comprised of organizations. In the market practice with houses on one side and companies on the other, each market side provides and, simultaneously, collects necessary information for the reason of setting up assessments and dealings. In financial side of information supposition these events are known as screening and signalling (Liu, 2006). Signalling signifies that the well-versed party tries to convey information to the less well-versed party, while screening signifies the less well-versed party’s attempts to decrease his/her lack of information by information collection.

In B-C dealings, both market sides carry out both screening and signalling operations. Businesses signal information about their products, prices, services and conditions of business to households, whereas, simultaneously, attempting to extract information on customers’ requirements. Companies’ signalling is intended at controlling buying behaviour of consumer and thus making sure the organization’s market accomplishment. They are attracted to communicate only those parts of information that will make them and their products emerge in a positive radiance. Hence, influenced information about the organization is corresponded to the market.

Since customers require an extensive system for information exchange, they are mainly not capable of sharing their product or service experience with one another. Consequently, the understanding of knowledgeable purchasers scarcely contact less knowledgeable consumers. Moreover, information collection incurs substantial expenditure in the pre-internet era that frequently beat the advantages of acquiring comprehensive pre-purchase information. The non-consistent information a customer has, the lesser his/her market power. According to Dellarocas (2007), when one identifies a little, he/she has the capability to create an improved selection.

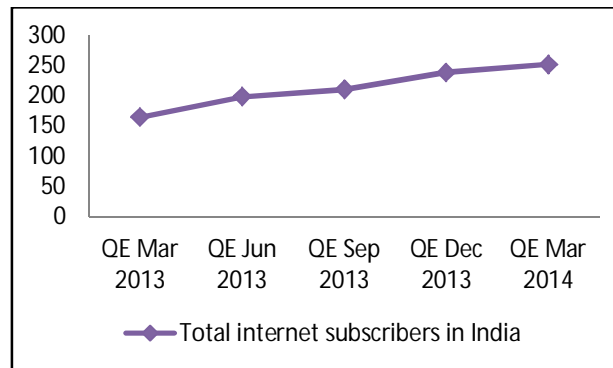
### 3. The Advent of Internet & Social Media

Internet is the brain child of a few visionaries in the early 1960s. They identified that it would be advantageous if computers in the military and defence areas are permitted to share information regarding research and development. The predecessor of internet named as ARPANET, was brought online in 1969. Tim Lee, the discoverer of the World Wide Web, stated that he wished scientists and physicists to be linked with each other and there should be no monarchs (Park and Han, 2007). The internet has brought about radical changes in the lifestyle of people across the globe. It has become a new means of communication and knowledge sharing. The internet penetration has been tremendous across the globe ever since it came into being (Table 1).

**Table 1** Internet Penetration Rate across the Globe

	(% of total population)									
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014*
Developed	50.9	53.5	59.0	61.3	62.9	67.1	70.5	73.1	75.7	78.3
Developing	7.8	9.4	11.9	14.6	17.4	21.2	24.3	27.4	29.9	32.4
World	15.8	17.6	20.6	23.1	25.6	29.4	32.5	35.5	37.9	40.4

(Source: ITU World Telecommunication/ICT Indicators Database)

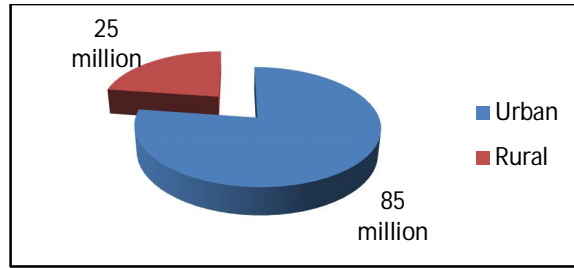


**Figure 1** Total Internet Subscribers in India

(Source: TRAI Performance Indicator Report January- March 2014)

The story is not different in India too (Figure 1). The Indian online population registered a steady growth of 31% from 56.32 million in March 2012 to 73.9 million in March 2013 (McKinsey Digital Consumer Research 2012, Comscore 2013). The increased penetration of internet has been driven primarily by the use of mobile phones as an important medium for internet access (Figure 2). It is estimated that the total internet connections may reach 1463 million by the end of 2018, thanks

to the increased access of internet via mobile phones (Comscore- India Digital Future in Focus- 2013). According to IMRB-IAMAI report 2013, the total number of active internet users in India is 243 million which constitute 19 % of the total population.



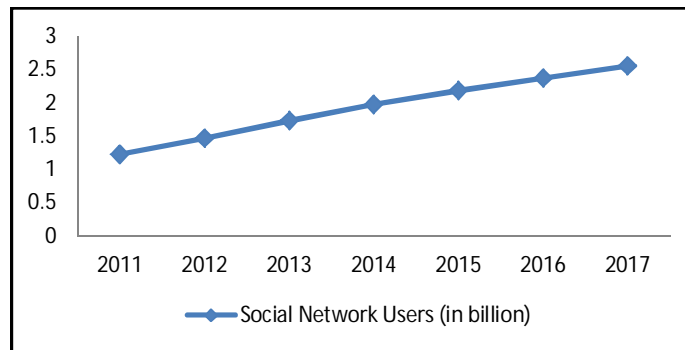
**Figure 2** Mobile Internet users in India  
(Source: Nielson Report 2013)

The social media began in Rome. Nowadays a person posts on the ‘wall on the Twitter or Facebook page’. Romans began this before with a graffiti wall. On the graffiti wall, a person can inscribe what he/she desired. That was the initial conception of wall, where normal people can inscribe something regarding the subject of that time. That was considered as the newspaper of the Roman age. So the Roman Graffiti wall was considered as the social media at that time. Then came the leaflets. In the era when printing did not exist, people wrote leaflets, which was a lengthy course. But one could say this as a kind of social media. Social media user penetration in India rose from 7.7% in 2012 to 10.5% in 2013, and is estimated to reach 17.2 % by the end of 2017 (Figure 3, Table 2) (E-marketer Newsletter -2013).

**Table 2** World Internet and Social Media usage Statistics

Average time that internet users spent each day using the internet	4 hours 58 minutes
Average time that mobile internet users internet users spend each day using mobile internet	2 hours 50 minutes
Average time that social media users spend each day using social media	2 hours 05 minutes

(Source: Global Web Index)



**Figure 3** Social Network users Worldwide (2011-2017)  
(Source: E-marketer newsletter -2013)

The primary reason for the widespread usage of social media arises due to the fact that it facilitates its users to express their views freely and the ease with which their opinions can be voiced to the rest of the world. The major advantages of social media for consumers include higher reachability of content circulated through social media, higher frequency of generation and access to content and instantaneous exchange of thoughts. There is a limit to the number and type of people which can access one’s opinions and number of people being impacted by the opinion in traditional media which is overcome in social media.

The social networking sites have emanated as significant channels of communication which individual consumers use for content creation, idea sharing, distributing materials, expressing opinions and using knowledge and information. This emerging channel is contributing to a power shift from traditional producers of messages and information to consumers (Denegri-Knott, 2006).

Consumers have been using word of mouth recommendation and published reviews that gauge the product or service quality in the past also. But with internet facilitating sharing of real time information with millions of other consumers, the consumer feedback has become more timely and potent. For example, in websites like opentable.com, users can post

feedback on every meal booked via the website which in turn allows other users to read those real time reviews from customers. Finally, social media can be used as a medium to obtain consumer insights during product development in a rather inexpensive way which further contributes to the increasing power that consumers gain in the market place. An informational power shift has occurred from marketers to consumers which can be attributed to the colossal proliferation in online user generated content. This phenomenon can be greatly attributed to the emanation of social media. As a result of this, marketers are faced with several challenges since they have less control and authority over the type of information produced and consumed over the internet.

Presently, the messages are sent by brands through social media platforms. From that point onwards, consumers have the full freedom to choose the brand messages to share, edit and include in their discussions and conversation happening online. Consequently, consumer preferences and recommendations are driving the market. This has an effect on the decision making process since consumers inspect all purchase options up to the last minute detail.

#### 4. Electronic Word of Mouth (e-WoM)

According to Xue and Zhou (2010), e-WoM is any type of constructive or unconstructive comment of any prospective, genuine or former customer regarding any brand or product that can be accessed by various individuals and organizations. Furthermore, Xue and Zhou (2010) also stated that e-WoM is a communication amongst consumers regarding products, brands and companies and their experiences about them. Even though these descriptions are related with e-WoM, word of mouth (WoM) has been understood for numerous decades as a critical influencing element of marketing (Bronner and Hoog, 2010). With the growth of technology and communications shifting increasingly to the internet, the conventional WoM to a huge extent converted into electronic WoM and the features of communication sources have been altered as well (Bronner and Hoog, 2010).

To begin with, WoM communications were confined to local social networking, while e-WoM messages can be accessed by any individual everywhere and at any instant of time, if internet connectivity is present. Secondly, the medium of WoM was by means of directly communicating amongst the consumers and companies which could not control the spreading of messages (Bronner and Hoog, 2010). Nevertheless, with e-WoM messages, companies can have some degree of control over how and where to find the messages and also to review the messages before spreading among other customers so as to get maximum attention (Liu, 2006). Furthermore, information spread by means of WoM is acquired by individuals like relatives or peers. Comparatively, information spread by means of e-WoM messages are generally acquired from customers who are not familiar with one another (Chevalier and Mayzlin, 2006)

Assessing the influence of e-WoM messages on product sales is huge as consumers spread their experiences of the product and their experiences and reviews about the product influences other customers in an effective manner (Chevalier and Mayzlin, 2006). Hence, e-WoM messages are crucial aspects from consumption actions. Specifically, the features of e-WoM messages like quality, volume and sender of messages, in addition to consumer aspects like experience of the customer effectively influence buying decisions as a reaction towards e-WoM messages. They also suggested that there are positive relationships between the number of messages posted online about the product and purchase intentions.

Xue and Zhou (2010) explained that originating location of e-WoM messages are important factors for decision making action of customers. In a study conducted by Bronner and Hoog (2010), it is found that consumers visited only a few company promoted websites while majority of consumers visited consumer based sites. Apart from studying the effect of origin of e-WoM messages, it is also vital to comprehend consumer buying pattern and their perception of reliability of any website for reviewing product features. Hence, it was purported by Xue and Zhou (2010), that information posts by any customer were considered to be more reliable and truthful than information supplied by marketers. Moreover, Bronner and Hoog (2010) stated that consumer created messages are more effective in influencing customer purchase decisions as people tend to trust their fellow customer more than the company selling the products.

#### 5. Measuring e-WoM

The influence of word of mouth is substantial for high involvement products and during first time purchases which need more information gathering and evaluation. This has magnified with the digital revolution and has become a one to many basis of communication wherein online posting and dissemination of product reviews takes place.

There has been a phenomenal shift in the balance of power between marketers and consumers due to the abundance of information available over the web. This fundamental shift in power towards consumer is manifested in the purchase decision making process. Right messages have the capacity to reverberate and spread within interested online communities, which in turn can influence consumers' perception of the brand, purchase rate and market share.

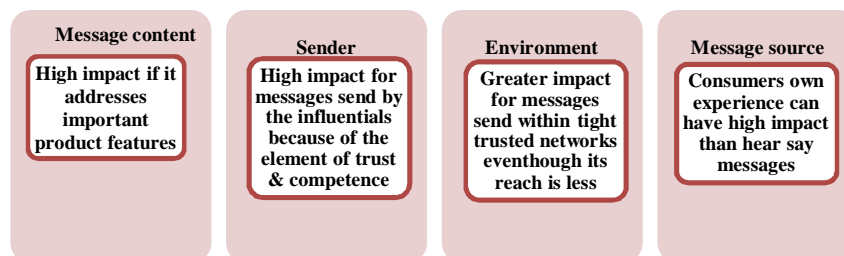


Figure 4 Drivers of E-WoM Impact

Bughin et al., (2010) has developed a method to measure the impact of different forms of word of mouth called WoM equity. The different drivers of word of mouth impact are the content of the message that deals with the important features of the product or service, identity of the sender of the message, and the community where word of mouth disseminates (Figure 4). Word of mouth equity can be arrived at by multiplying the average sales impact of a message by the number of WoM messages (Figure 5). Word of mouth equity permits marketers to appreciate the relative impact of word of mouth on the performance of the product and brand. This empowers the marketers to harness the power of electronic word of mouth and achieve sustainable and considerable competitive edge by adopting appropriate marketing strategies.

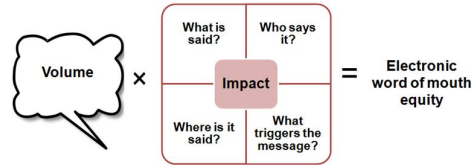


Figure 5 Metrics to Measure E-Wom

## 6. Implications for Marketers

The connected consumer era challenges marketers to provide tailored, impeccable experiences highly pertinent to individual consumers. Marketing implications is for taking advantage of the population of users of the internet and those present on social networks as a prospective market. As discussed in previous sections, these networks are enormous. Such a scenario creates a great set of opportunity for conducting business on the basis of prospective advantage that can be achieved by any company from these networks for promoting their brands and offerings. Studies on leading databases of internet users, had shown that aspects associated with marketing like behaviour change, alteration in perception and the attitude of an individual for any brand, consumer power and segmentation are examples of such aspects (Bronner and Hoog, 2010). Hence these aspects stress on employing internet for marketing.

The profiles can be created for the company as well as brands and products. Important information about the brand can be supplied to this profile. For instance, corporations have to create a page as if it is created for an individual profile by a corporation and is not in accordance with the Facebook's terms and conditions as it differentiates between a company and an individual. Moreover, social networking sites like twitter do not differentiate, although it does provide security features for verification of users so that it can be ensured that messages are being received from a genuine sender (Liu, 2006). Moreover, these social networks also provide for distinguished URL for corporations. Another key feature is the exchange of free messages among the users connected to the companies by these profiles. Procedures for achievement of these associations may differ among the networks. However, they generally necessitate that the individual who creates the profile connects with the profile of the company and there is a high probability that the users may link other people to the profile (Liu, 2006). Furthermore, social networks provide payment services for creation of advertisements and promotional campaigns that target specific groups of users who pertain to specific conditions like their location, age, sex, education, language, interests and other factors. Internet and social media can create huge influences of viral marketing. Viral marketing, a form of word to mouth marketing is attained when user promote or suggest others in their network to try or purchase some product or service. It is a popularly known fact that suggestions from friends and peers strongly influence buying decisions. The "like" and "comment" features of Facebook and "re-tweets" actually illustrate whether the viewer has attained value out of the information or not (Chevalier and Mayzlin, 2006).

Even though viral marketing has been extremely helpful in internet, the successes of suggestions differ based on category of products and pricing. Moreover, viral marketing at the first instance may be viewed as an outcome of attitude of the network due to its connectivity, the pattern and the interest in the website. Finally, internet and social media can be utilized in the form of focus groups. Individuals present in social media may be using discussion associated to brands or about the organization as well. By paying attention to these discussions, termed as conversational marketing, companies can gain essential feedback about the products and the ways through which a company conducts dealing with its clientele. Since people are not conscious about their being monitored, there is conception of being anonymous on the internet, and hence feelings are expressed more openly about any brand or organization when compared to surveys or face to face interviews. Methods like Google alerts provide for listening to customer discussions and acquire supporting or non-supporting perceptions that might be taken for prospective marketing needs. According to Chevalier and Mayzlin (2006), it is essential for analyzing the feelings expressed in these conversations. For instance negative and positive emoticons can be searched on twitters as well as comments on Facebook and likes can indicate the overall feelings towards any specific information. The growth of business by means of internet on the basis of market, specifically targeted towards sales by other companies can be deemed to be highly important by the social networking companies as well for generating revenue and hence companies also need to be cautious so that they do not become victims of e-commerce companies or e-WOM.

## 7. Impact of SMAC on Consumer Power

The post digital era has led to sweeping changes in the consumer behaviour. This trend is leading to contagion effect across the global business environment. This is an era where multiple digital sources provide consumers with information in

abundance that equips them to take intelligent buying decisions. Now the upsurge in social media accessibility through mobile devices like smart phones and tablets provide consumers with information across the globe at their fingertips. Mobile phones and tablets are increasingly used by consumers now a days to access internet in the different steps in the purchasing process. With global mobile broadband subscription reaching 2.3 billion in 2014 and a predicted 80% increase in mobile broadband subscription by the end of 2019, the mobility aspect is gaining momentum and posing challenges to marketers (Ericsson Mobility Report, 2014).

To add to this, two other technology enablers, namely, analytics and cloud, also play a crucial role to help businesses to understand the consumers and their buying behaviour and exploit the opportunities available. Analytics provide immense opportunities for marketers due to the exponential increase in the access of internet via smart phones, seismic acceptance of social media and capture of large volume of consumer data across various touch points. Analytics help business to create customer focussed options thereby increasing firm revenue and culminating in firm delight.

Digital consumers now dictate how products and services are to be consumed and delivered. This power of digital consumers has led to the emergence of cloud computing which fosters innovation and improves productivity. Cloud computing has enabled companies to employ mobility and analytics in a cost effective manner in the market place (KPMG Report 2014).

The convergence of these four technology trends- social, mobility, analytics and cloud- synchronously termed as SMAC will lead the business in the next decade. The proliferation of these technology enablers, provide consumers greater opportunities for information acquisition, communication and collaboration. This has resulted in the replication of physical world in the digital world via online communities and online transactions thereby radically shifting the consumer engagement. Consumers are equipped with real time access to data about brands and competitive prices by scanning barcode with their mobile devices. This has led to the transparency in price, since consumers resort to price comparisons.

SMAC has led to the transformation of consumers to prosumers who are willing to commit their time and energy to share their views, comments and technical knowhow about a brand with other consumers online. Marketers can tap into this emerging phenomenon of prosumerism to survive the competition and emerge as leaders. Companies need to be agile, aware of consumer insights and connected with stake holders. Embracing SMAC will enable enterprises in this race to win the market.

## 8. Conclusion

This article attempted to study the empowerment of customers due to internet and SMAC and its implications for marketers through literature review. The astounding proliferation of digital touch points comprising of mobiles and social media signals a compelling need for consumers to stay connected with the product or service provider. There has been a shift in the balance of power in the market place from the business to the consumer.

The emergence of the internet boosted the predictions of the consumer power that evolved in the digital age. Now it is reignited by the blooming social media. A major instrument, which has enabled the effective participation of consumers for bargaining in the market place, is the internet which undoubtedly has the potential to do so.

One of the key sources of internet based power of customer is the social media. Social media is synonymous with “word of mouth” marketing or e-WoM. Consumers created messages are more effective in influencing customer purchase decisions as people tend to trust their fellow customer more than the company selling the products.

All these aspects have huge implications as marketers can take advantage of the population of users of internet and those present on social networks as a prospective market. As discussed in previous sections, the number of users on these networks are enormous. Such a scenario creates a great set of opportunity for conducting business on the basis of prospective advantage that can be achieved by any company from these networks for promoting their brands and offerings.

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# Go-To-Market Strategies for Emerging Business Opportunities in E-Tailing Industry



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**Susnato Lahiri**  
**Keshav Kumar**  
**Joffi Thomas**  
*IIM Kozhikode*  
(susnato.lahiri@gmail.com)  
(keshavk1324@gmail.com)  
(joffithomas@iimk.ac.in)

*The objective of the paper is to examine the challenges faced in formulating and implementing innovative go-to market strategies in e-commerce space. Emerging e-retailing companies have to address several challenges namely product differentiation, door-step delivery, trust of consumers, competing with offline stores, generating leads and converting them, customer engagement strategies and revenue models including pricing. A descriptive case based on in depth interviews of top management executives is used to examine the challenges faced by a leading online jewelry retailer and the solutions it has adopted. The contribution of the paper is to develop an understanding of these issues in practice.*

**Keywords:** - Go-to-market, e-tail, venture capitalist, start-up, value proposition, factors (best practices), CaratLane

## 1. Introduction

Ecommerce industry and especially e-tail has witnessed exponential growth both in global markets as well as in the Indian market in the recent years. Although there are many studies examining factors affecting technology there is a paucity of studies which examines the factors to be considered in formulating go- to-market strategies especially in emerging markets like India. Designing and implementing effective go to market strategies is a very critical link behind the success of e- retail firms.

## 2. Purpose/Method

The objective of the paper is to examine the factors to be considered in formulating and implementing innovative go-to market strategies in e-commerce space. A literature review of studies on go-to market strategies of e-retailing companies revealed the following factors - (i) formulating appropriate value proposition to compete with offline and online stores (ii) developing consumer trust on e-tail format as well as the e tailing firm (iii) designing innovative programs to attract online customers to the website and converting them (iv) dynamically adapting prices to design attractive offers and (v) implementing strategies to enhance customer engagement and loyalty. These factors were further examined in the case of a leading online jewelry retailer.

## 3. Organization of the Paper

The paper is organized in four sections. The state of electronic commerce industry and the need to examine the factors affecting effective go to market strategies is discussed in the first section. In the next section, the factors to be considered in formulating and implementing innovative go-to market strategies are identified through a literature review. These factors are further examined in the context of an online jewelry retailer. Directions for future research are addressed in the concluding section.

## 4. State of Electronic Commerce Industry in India

Ecommerce became possible in 1991 when the Internet was opened to commercial use. Although the dot-com collapse in 2000 led to unfortunate results and many of ecommerce companies disappearing, the "brick and mortar" retailers recognized the advantages of electronic commerce and began to add such capabilities to their web sites. By the end of 2001, the largest form of ecommerce, Business-to-Business (B2B) model, had around \$700 billion in transactions. History of ecommerce is unthinkable without Amazon and E-bay which were among the first Internet companies to allow electronic transactions. At the outset Amazon.com was considered as an online bookstore, but in time it extended a variety of goods by adding electronics, software, DVDs, video games, music CDs, MP3s, apparel, footwear, health products.

E-Commerce in India was kick-started in 2004 when eBay started its operations in India by acquiring Avnish Bajaj's Baazee.com, which was India's largest online auction portal. This was followed by two IIT-Delhi and ex-Amazon employees Sachin Bansal and Binny Bansal starting Flipkart in 2007 by investing 2 lakh rupees each as an online book retailer. In the same year, Mukesh Bansal, Ashutosh Lawania and Vineet Saxena started an online portal to customize goodies called Myntra. With perseverance, these e-commerce portals started winning the trust and confidence of Indian population and people gradually started shopping online. But the game changer that provided the much needed growth steroid was Cash on Delivery, which made online shopping very accessible in a country like India where the credit and debit card penetration is

extremely low. In 2010, Snapdeal an online platform started providing daily deals but pivoted into an e-commerce company via the marketplace model.<sup>i</sup>

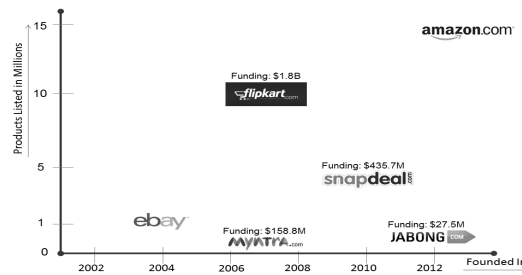


Figure 1(above) –Source: - Yourstory.Com, End-Note (I)

Estimated size of India e-commerce in 2013 is 400 Billion Rupees. Out of this online ticketing is the largest with 65 % share and online retail has around 17% share. Online Retail is expected to grow at a CAGR of 40 % to reach 180 Billion Rupees by 2016.<sup>ii</sup>

### 5. Need to Examine Go-To-Market Strategies (Demand and Supply Side)

In the current \$500 billion retail sector, the online segment's contribution is less than 0.50%, which signals a further huge growth in this segment. Leading Indian online retailers, including Snapdeal and fashion portal Myntra, expect to turn profitable in the next two years, signaling a seismic shift in an industry where so far growth has been pursued at the expense of the bottom-line. Jabong.com, an online e-tailer, gets around 14,000 orders daily, which is reported to be the third largest player in the Indian market. In terms of the scope for future growth of the sector, more than 60% of India's 73.9 million Internet users visit online retail websites, spending an average of 28.4 minutes, less than what people spend in countries such as China, Russia, Brazil and even the worldwide average of 84.3 minutes. Hence there is a tremendous potential to exploit in years to come.

India's retail market is expected to increase from the current ~USD 500 billion to USD 810 billion, by 2021 from the **demand** side. There are three types of destinations that address retail sales in any market<sup>iii</sup> (with share of market in brackets):

- Traditional Retail: Brick & Mortar (93 %)
- Corporatized Retail: Brick & Mortar (6.5 %)
- Corporatized Retail: E-tailing (0.5 %)

Taking a cue of e-tail growth from other countries

- US – size of e-tail is \$ 304 billion in 2014 growing at a CAGR of 13 %
- UK – Only e-tail has seen a growth of 8% CAGR, not the brick and mortar
- China – e-tail growing stupendously at 83 %, out of a 20% organized retail market
- Following factors have also let to a surging growth of e-tail in India from the **demand** side(see table 1)
  - Evolving Internet Users – reach, accessibility and usage – Convenience seekers
  - Active internet users – 120 million, Facebook users – 71 million, number of railway tickets booked online yearly – 116 million
  - Proliferation of Internet transactions and usage across tier-2 and tier 3 towns
  - Proliferation of devices that use internet – mobile, smartphone, PC/Laptop users, Tablet users
  - Proliferation of enabling Technologies (broadband/mobile internet)

Table 1 Statistics on Expected Growth of E-Tailing Factors; mn- in Million.

India statistics	2012	2020	CAGR
Mobile phone users, mn	380	600	6%
Smartphone users,mn	40	450	35%
PC/Laptop users,mn	50	150	15%
Tablet users,mn	4	36	32%
Broadband users, mn	60	180	15%

Source - Technopak, May 2013, Report on "E-tailing in India"

<sup>i</sup> Yourstory.com,August,2014, Manu Shrivastava, "Major milestones in the Indian e-commerce ecosystem that have led to multi-billion dollar investments"

<sup>ii</sup> Indiamicrofinance, July,2014, "Report on e-commerce business in India for 2014-15"

<sup>iii</sup> Technopak,May 2013, "E-tailing in India – Unlocking the potential, The need for India to analyze e-tailing on its own merit"

From the **supply** side, in recent times, bulk of funding is quite easily coming in from Venture Capitalists (VCs) for most new e-tail ventures in India like Urban Ladder, Pepper Fry, Zovi, Bluestone, and Lenskart.

Firms specific to niche verticals are also springing up (56 % focused vs 44% marketplace – revenue point of view in 2011). There are rapid plays on pricing – Rapid discounting models to build customer base. Also the cost of acquisition is quite high (Rupees 1100/- goes from the pocket of an e-tailer today to acquire a customer worth Rupees 450/-). Despite adequate funds, the start-ups fail owing to badly aligned go-to-market strategies. Hence the challenge is about crossing the chasm with effective go-to-market strategies.

### 6. Deriving the Factors (Best Practices) for Go-To-Market Strategies based on Literature Review and In-Depth Interview

We, the authors, have come up with a set of **six essential factors** for effective consideration and implementation of go-to-market strategies for e-tail companies. The factors have been exhaustively analyzed from sets of relevant research papers and through interviews of top-management of a leading jewelry firm, whose details follow below.

These factors or the best practices are important for the better customer experience(CX), strong brand identity, better customer service, improved convenience, collaboration between the stakeholders, higher customer empowerment and customer engagement.

And therefore concentrating on these factors will improve targeting and conversion rate, multichannel engagement and brand building across platforms from mobile to web.

The names of the factors with the corresponding meaning of the same are enlisted in the table-2 below.

**Table 2** Derived Factors for Go-To-Market Strategy and their Meanings

Factors	Meaning of the Factors
Competing with offline stores ( Value Proposition)	• Value in terms of time, convenience, money, assortment compared to offline retailers on a single window
Product differentiation	• Greater assortment, Uniqueness of Designs, Degree of Product Customization
Practices to enhance value and attract new online customers	• Home consultation, Cash on Delivery, door-step delivery, Offline campaigns, Community festivities, Product placements
Pricing flexibility	• Value Based, Competition based, and Location based price-value to customers. • Dynamic price setting methods. • Pricing based on New offerings, Discounts, Occasion based ,Target group based
Trust of consumers	• Trust to use online portals – interface, order fulfilment, transactions, contact points • Trust for the brand – Brand Equity • Reducing perceived risk – Financial, Product performance, Psychological, Time
Customer engagement and Loyalty	• Retention of customers who are already on-board and increasing their repeat purchase. • Metrics to measure engagement and loyalty

### 7. Literature Review and Findings

Factors that are responsible for effective go-to-market e-tail strategies are identified from the existing literature. The multiple tables below list the papers referred to and the corresponding findings pertinent to each factor. Further each paper referred to has been identified with a context and the broad variables that it uses. Future scope, if any, of the respective research papers have also been identified and have been recorded in the tables itself.

The factors in order of chronology are –

- Competing with offline stores (what is the value add of online shopping)
- Customers engagement strategies and generating leads and converting them
- Competition with offline stores, product differentiation, generating and converting leads
- Security issues and Competition with offline stores
- Type of customers
- Trust of customers

Following are some of the best practices or the factors from some key literatures. The tables describe the finding which is relevant for e-tail websites in across the industries to generate personalization, customer experience, brand identity and customer engagement

**Factor: Competing with Offline Stores (Value Add of Online Shopping) – Table 3 below**

**Table 3** Study: Paula J. Haynes & Valerie A. Taylor (2006)

Context: Online Retail Websites Analysis	
<p><b>Online strategic practices</b> for e-tail players are -</p> <ol style="list-style-type: none"> <li>1. Convenience Motivations</li> <li>2. Experiential Motivations</li> <li>3. Reducing Perceived Risk</li> <li>4. Size of Retailer-big, medium, large</li> <li>5. Operational Types- Pure Play, Brick &amp; Click</li> </ol>	<p>Findings from the paper *Convenience&gt; Trust&gt; Experiential The result is valid for all the e-tail players based on the size and the type of operation *’&gt;’ shows the relative weightage of practices</p>

**Factor: Customer Engagement Strategies and Generating Leads and Converting them Table 4 below**

**Table 4 Study: Deborah A. Colton, Martin S. Roth, William O. Bearden (2010)**

Context: Survey on E-Commerce Websites	
Drivers of international <i>e-tail Performance</i> are - market orientation, entrepreneurial orientation, foreign market orientation, brand strength, supplier relations, performance relative to objectives & revenue growth	
<ol style="list-style-type: none"> <li>1. Market orientation is the set of processes and activities to understand customer needs to satisfy customers</li> <li>2. Entrepreneurial orientation is a firm's inclination to take risks, favor change and innovation, and compete aggressively</li> <li>3. Foreign market orientation refers to an organization's knowledge about foreign markets</li> <li>4. Brand strength as the extent to which customers are aware of and recognize brands and view them favorably</li> <li>5. Supplier relations can be seen as the communication and coordination between the e-tail player and its primary supplier</li> </ol>	<p>Findings from the paper</p> <p>A more market oriented, customer-centric organizational culture will help a firm strengthen its brand and relationships with suppliers by understanding its customers both domestically and internationally.</p> <p>Stronger brands and relationships with suppliers can lead to a competitive advantage</p>

**Factor: Customer Engagement Strategies and Generating Leads and Converting them Table 5 below**

**Table 5 Study: Peters, Etal (2013)**

Context: Managing Social Media Metrics to Regulate IMC for E-Commerce Websites	
The paper evaluates the Social Media Metrics for the firms on four elements	
<ol style="list-style-type: none"> <li>1. Motives,</li> <li>2. Content,</li> <li>3. Network structure,</li> <li>4. Social roles &amp; interactions</li> </ol>	<p>Findings from the paper</p> <p>The metrics like vividness, interactivity, informational and entertainment content are important to measure the engagement and the experience (CX)</p> <p>The need for quick and consistent communication and response to the plethora of users across all interfaces is essential</p>

**Factor: Competition with Offline Stores, Product Differentiation, Generating and Converting Leads Table 6 below**

**Table 6 Study: Khalid, Etal.(2008)**

Context: E-Commerce Websites in Middle East	
A New Marketing Strategy for e-commerce:-	
<ol style="list-style-type: none"> <li>1. Right technology</li> <li>2. Legal control system</li> <li>3. Understanding the intangibles of customers</li> <li>4. Lack of awareness</li> <li>5. Low stimulation levels for online shopping</li> </ol>	<p>Findings from the paper</p> <p>Right technology – augmented depth &amp; breadth wise implementation of websites is critical in order to build high brand awareness.</p> <p>Lack of awareness because of low education levels, no stimulation of emotions are some major barriers.</p> <p>Legal System Control Internet environment and legal system control also act as impediment to generating trust for e-commerce</p>

**Factor: Type of Customers – Table 7 below**

**Table 7 Study: Rohm, Vanitha(2004)**

Context: Major Categories Sold Across the Online Retailers	
As per the paper, categories of online buyers according to shopping motives are :-	
<ol style="list-style-type: none"> <li>1. Convenience shopper</li> <li>2. Variety seeker</li> <li>3. Balanced buyers</li> <li>4. Store-oriented shoppers</li> </ol>	<p>Findings from the paper</p> <p>Convenience shopper: The convenience shopper is more motivated by convenience</p> <p>Variety seeker: The variety seeker is substantially more motivated by variety seeking across retail alternatives and product types and brands than any other shopping type</p> <p>Balanced buyers : Balanced buyers are moderately motivated by convenience and variety seeking(they are price sensitive)</p> <p>Store-oriented shoppers : The store-oriented shoppers are more motivated by physical store orientation (e.g., the desire for immediate possession of goods and social interaction)</p>

**Factor: Trust, Competing with Offline Stores – Table 8 below**

**Table 8 Study: Ian Fillis, Beverly Wagner(2005)**

Context: Small Firms and Web Portal Need Gap	
As per the paper, different forms of insecurities for small firms:	
<ol style="list-style-type: none"> <li>1. Security</li> <li>2. Privacy issues</li> <li>3. Competence-skill gap</li> <li>4. Segmentation issues</li> </ol>	<p>Findings from the paper</p> <p>Security and privacy and fear of technology, lack of interest/imagination, inertia in decision making, security fears, and reluctance to learn new skills are all impediments.</p> <p>Incompetence and skill gap of e-tailers in under-developed skills of salesforce, under investment in training, poor knowledge of start-ups processes are barriers to garnering trust of consumers.</p> <p>Community segmentation is a tough task which can happen on multiple basis as per need viz. age group, hobbies/life-style, common interests (like travel).</p>

**Factor: Trust of the Consumers – Table 9 below**

**Table 9 Study Sandra Etal. (2003)**

<b>Context: Risk Patronage for Internet Browsers and Shoppers of Various Income and Age Groups</b>	
According to the paper, there are four types of perceived risk: 1. Financial risk 2. Product performance risk- Difficult to judge quality of a product/service 3. Psychological risk- Do not trust that my personal information will be kept private 4. Time/convenience loss risk	Findings from the paper Users were categorized as browsers, heavy shoppers, or moderate shoppers Browsers suffer the highest amount of all the four risk followed by moderate shoppers and heavy shoppers In general we can say: Product performance risk> Financial Risk> Psychological Risk> Time Risk '>' shows the relative weightage of practices

**Factor: Trust of the Consumers – Table 10 below**

**Table 10 Study Colton Etal. (2010)**

<b>Context: Conceptual Study of Previous Works on Online Retailers</b>	
As per the paper, there are Five Levels of Trust 1. Interface features: website appearance & performance 2. Fulfilment of the offer: Consumer benefits, terms & conditions, guarantee/warranty & after sales service 3. Reputation policies: type of retailer, brand identity and recall 4. Website transactions: privacy, security and reassurance 5. Multiple contact points: Alternative ordering and customer relations	Findings from the paper Website appearances like content, technical sophistication, professionalism; website performance includes status indicators, order tracking, usability all generate <i>trust</i> . Terms and conditions of sale include transparency of offer, delivery times; guarantee/warranty including trusted third party transaction guarantor; after sale service include 'liberal' returns policy, customer services are all signatures of <i>trust</i> . Reputation include - brick-click/ pure-play e-tailers, <i>Brand identity</i> include social endorsements by establish virtual community, feedback forum; celebrity/expert endorsements, consumer comments recommendations and generosity

**8. Application of Derived Factors in the Context of an Online Jewelry Retailer**

CaratLane is a leading online retailer in jewelry in India. Founded in 2008, CaratLane made revenues of 144 crore in FY- 14, growing at a CAGR of 42 % from 50 crore in FY-11. The number of visitors on its website in FY-14 was 7.3 million, which saw a growth of 31 % YoY. CaratLane presently services to more than 150 cities in India.<sup>iv</sup>

**Table 11 Carat Lane’s Offerings’ Strategic Fit to Our Derived Go-To-Market Factors**

<b>Go-To-Market Factors</b>	<b>Present Target Group Offerings by CaratLane</b>
Competing with offline stores ( Value Proposition)	Try at home, Reduced price (25 % less), greater assortment (all designs) in one window, superior quality, jewelry education.
Product differentiation	Greater assortment, Customization by empowering the customers, Complete product details online.
Practices to enhance value and attract new online customers	Home consultation, Cash on Delivery, door-step delivery, experience lounge, Offline campaigns (wine and cheese crash course), Community festivities, Product placements in movies, online video series.
Pricing Flexibility	Reduced price levels compared to brick and mortar, because of reduced inventory levels and real estate cost. Comparative pricing is displayed locations wise, hence value based pricing for customers.
Trust of consumers	Certifications, testimonials from present customer base, try at home, videos, reviews, blogs, money back policy, life-time exchange, chat with employees
Customer engagement and Loyalty	Loyalty cards, Alliances and Partnerships with Premium institutions, Social media page, CRM, Online Ads, Social media engagement through offline campaigns and online contests

We analyzed the cause of the stupendous growth of CaratLane being a budding e-tail firm by studying their present offerings. After in-depth interviews with the top management of CaratLane, we have mapped CaratLane’s offerings and services to our go-to-market factors as derived in this paper (in table 2).

We realized that CaratLane’s products and services could be categorized and mapped into our derived go-to-market factors for an emerging e-tail and these have engendered improved targeting and conversion rate, multichannel engagement and trust and brand building for CaratLane for its entire customer segments by age and income. This example of CaratLane below further cements the fact that for any emerging e-tail to be successful today, its products and services must be aligned strategically to the factors(in table 2) that form the crux of this paper.

**9. Directions for Future Research**

The paper is a conceptual study to arrive at a set of prominent factors which are essential for effective GTM for e-tailers in emerging economies and in niche verticals. Future research should entail a descriptive study on the factors over a host of e-tailers to further cement the relationship empirically.

<sup>iv</sup>Case Study on CaratLane, HUL LIME (Lessons in Marketing Excellence) season 6, IIM-Kozhikode, September 2014

The factors are just guiding principles for a budding e-tailing firm. However for an e-tailer to be successful, we believe that principles (factors) along with people and processes should work in the best tandem.

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# Price Dependent Quadratic Demand Inventory Models with Constant Holding Cost and Inflation Rate



ISBN: 978-1-943295-01-2

**R.Venkateswarlu**  
GITAM University  
(rangavajhala\_v@yahoo.co.in)

**M.S. Reddy**  
BVSRR Engineering College, Chimakurthy  
(naveenasrinu@gmail.com)

*An attempt is made to develop an inventory model for perishable items when the demand rate is a quadratic function of price and the rate of deterioration is a linear function of time. It is also assumed that the holding cost is independent of time (i.e., constant). Under instantaneous replenishment with zero lead-time, EOQ is determined for optimizing the total profit under inflation rate. The sensitive analysis is presented with numerical example at the end.*

**Keywords:** Quadratic demand, inflation, price dependent, deterioration, holding cost

## 1. Introduction

It is true that the unit price and other inventory related costs are dependent on time. However, most of the inventory models in the literature have considered unit price and inventory related costs to be independent of time and constant over the period under consideration. Buzacott [1] modified the classical EOQ model incorporating constant inflation rate under different pricing policies. Misra [2], Gupta et al [3], Vrat and Padmanabhan [4] are some of the authors who have studied inventory models with special reference to inflation rate.

It is well known that the demand rate of any product is always in dynamic state. This variation is due to time or price or even with instantaneous level of inventory. An economic lot size model for price dependent demand under quantity and freight discounts was developed by Burwell [5]. An inventory system of ameliorating items for price dependent demand rate was considered by Mondal et al [6]. You [7] developed an inventory model with price and time dependent demand. Ajanta Roy [8] has developed an inventory model for deteriorating items with price dependent demand and time varying holding cost.

Inventory modellers so far have considered two types of price dependent demand scenarios, linear and exponential. The linear price dependent demand implies a uniform change in the demand rate of the product per unit price whereas exponential price dependent demand implies a very high change in demand rate of the product per unit price. These two scenarios are quite unusual in realistic situations. Thus quadratic price dependent demand may be an alternative approach to the existing two scenarios. So, it is reasonable to assume that the demand rate, in certain commodities, due to seasonal variations may follow quadratic function of time [i.e.,  $D(t) = a + bp + cp^2$ ;  $a \geq 0$ ,  $b \neq 0$ ,  $c \neq 0$ ]. The functional form given above explains the accelerated growth/decline in the demand patterns which may arise due to seasonal demand rate (Khanra and Chaudhuri [9]). We may explain different types of realistic demand patterns depending on the signs of  $a$  and  $b$ . Bhandari and sharma [10] have studied a Single Period Inventory Problem with Quadratic Demand Distribution under the Influence of Marketing Policies. Khanra and Chaudhuri [9] have discussed an order-level inventory problem with the demand rate represented by a continuous quadratic function of time. Sana and Chaudhuri [11] have developed a stock-review inventory model for perishable items with uniform replenishment rate and stock-dependent demand. Kalam et al [12] have studied the problem of production lot-size inventory model for Weibull deteriorating item with quadratic demand, quadratic production and shortages. An order level EOQ model for deteriorating items in a single warehouse system with price depended demand in non-linear (quadratic) form has been studied by Patra et al [13]. Venkateswarlu and Mohan [14] studied inventory model for time varying deterioration and price dependent quadratic demand with salvage value. Venkateswarlu and Reddy [15] developed time dependent quadratic demand inventory model under inflation. Recently, Venkateswarlu and Reddy [16] studied inventory models when the demand is time dependent quadratic demand and the delay in payments is acceptable.

In this paper, we try to develop an integrated model which contains both the perishability and inflation phenomena with price dependent quadratic demand situation. The inventory deterioration is assumed to be constant. The solutions of the models are presented and also discussed the sensitivity of the models at the end.

## 2. Assumptions and Notations

The mathematical model is developed on the following assumptions and notations:

- i) The Selling rate  $D(p)$  at time  $t$  is assumed to be  $D(p) = a + bp + cp^2$ ,  $a \geq 0, b \neq 0, c \neq 0$ . Where, ' $a$ ' is the initial rate of demand ' $b$ ' is the rate with which the demand rate increases and ' $c$ ' is the rate with which the change in the rate demand rate itself increases.
- ii) Replenishment rate is infinite and lead time is zero.
- iii)  $p$  is the selling price per unit.



- iv) The rate of inflation is constant
- v) The unit cost and other inventory related cost are subjected to the same rate of inflation, say  $k$ . This implies that the ordering quantity can be determined by minimising the total system cost over the planning period.
- vi)  $A(t)$  is the ordering cost at time  $t$ .
- vii)  $\theta(0 < \theta < 1)$  is the constant rate of deterioration.
- viii)  $C(t)$  denotes unit cost at time  $t$ .
- ix)  $I(t)$  is the inventory level at time  $t$ .
- x)  $Q(t)$  is the ordering quantity at time  $t=0$
- xi) ' $h$ ' is per unit holding cost excluding interest charges per unit per year.

### 3. Formulation and Solution of the Model

The objective of the model is to determine the optimum profit for items having price dependent quadratic demand and the rate of deterioration follows a linear function of time with no shortages.

The inventory level depletes as the time passes due to demand and deterioration during  $(0, t_1)$  and due to demand only during the period  $(t_1, T)$ .

If  $I(t)$  be the inventory level at time  $t$ , the differential equations which describes the inventory level at time  $t$  are given by

$$\frac{dI(t)}{dt} + \theta \cdot I(t) = -(a + bp + cp^2), \quad 0 \leq t \leq t_1 \tag{1}$$

$$\frac{dI(t)}{dt} = -(a + bp + cp^2), \quad t_1 \leq t \leq T \tag{2}$$

together with  $I(t_1)=0$  and  $I(T)=0$ .

The solution of equations (1) and (2) is given by

$$I(t) = (a + bp + cp^2) \left[ (t_1 - t) - (t_1 - t) \left( \frac{\theta t^2}{2} \right) + \left( \frac{\theta t_1^3}{6} - \frac{\theta^3}{6} \right) \right] \quad 0 \leq t \leq t_1$$

$$I(t) = (a + bp + cp^2)(t_1 - t) \quad t_1 \leq t \leq T$$

Let us consider the Ordering Quantity is  $Q$ . If  $t = T$  then  $I(0) = Q$

$$Q = (a + bp + cp^2) \left( T + \frac{\theta T^3}{6} \right)$$

Let  $C(t)$  denotes the unit cost at time  $t$ .

i.e.,  $C(t) = C_0 e^{kt}$  where  $C_0$  is the unit cost at time zero.

Let  $A(t)$  denotes the Ordering cost at time  $t$ .

i.e.,  $A(t) = A_0 e^{kt}$  where  $A_0$  is the ordering cost at time zero.

Total system cost during the planning period ' $\tau$ ' is the sum of the Material cost, ordering cost and Carrying cost. Assume that  $\tau = m \cdot T$ , Where ' $m$ ' is an integer for the number of replenishments to make during the period ' $\tau$ ', and ' $T$ ' is time between replenishments.

The Ordering cost during the period  $(0, \tau)$  is

$$\begin{aligned} & A(0) + A(T) + A(2T) + A(3T) + \dots + A(m-1)T \\ & = A_0 e^{(0)kT} + A_0 e^{(1)kT} + A_0 e^{(2)kT} + A_0 e^{(3)kT} + \dots + A_0 e^{(m-1)kT} \\ & = A_0 (1 + e^{kT} + e^{2kT} + e^{3kT} + \dots + e^{(m-1)kT}) \end{aligned}$$

The Ordering Cost is  $= A_0 \left( \frac{e^{k\tau} - 1}{e^{kT} - 1} \right)$  where  $\tau = mT$ .

The Material cost during the period  $(0, \tau)$  is

$$\begin{aligned} & Q[C(0) + C(T) + C(2T) + C(3T) + \dots + C(m-1)T] \\ & = Q[C_0 e^{(0)kT} + C_0 e^{(1)kT} + C_0 e^{(2)kT} + C_0 e^{(3)kT} + \dots + C_0 e^{(m-1)kT}] \end{aligned}$$

$$= QC_0(1 + e^{kT} + e^{2kT} + e^{3kT} + \dots + e^{(m-1)kT})$$

$$= QC_0 \left( \frac{e^{k\tau} - 1}{e^{kT} - 1} \right)$$

Similarly, The Carrying Cost/holding cost during the period (0, τ) is

$$C(t)h \int_0^T I(t) dt$$

But we have  $C(t) = C_0 \left( \frac{e^{k\tau} - 1}{e^{kT} - 1} \right)$  in the period (0, τ).

The Carrying Cost/holding cost is

$$= C_0 \left( \frac{e^{k\tau} - 1}{e^{kT} - 1} \right) h \int_0^T I(t) dt$$

$$= C_0 h \left( \frac{e^{k\tau} - 1}{e^{kT} - 1} \right) \left( \int_0^{t_1} I(t) dt + \int_{t_1}^T I(t) dt \right)$$

$$= C_0 h \left( \frac{e^{k\tau} - 1}{e^{kT} - 1} \right) \left[ (a + bp + cp^2) \left( \frac{t_1^2}{2} + \frac{\theta t_1^4}{12} \right) - \left[ \frac{(a + bp + cp^2)(T - t_1)^2}{2} \right] \right]$$

The total cost over the period (0, τ) is

= Ordering cost + Material cost + Carrying cost

$$= A_0 \left( \frac{e^{k\tau} - 1}{e^{kT} - 1} \right) + QC_0 \left( \frac{e^{k\tau} - 1}{e^{kT} - 1} \right) + C_0 h \left( \frac{e^{k\tau} - 1}{e^{kT} - 1} \right) \left( \int_0^{t_1} I(t) dt + \int_{t_1}^T I(t) dt \right)$$

$$= \left( A_0 + QC_0 + C_0 h \left( \int_0^{t_1} I(t) dt + \int_{t_1}^T I(t) dt \right) \right) \left( \frac{e^{k\tau} - 1}{e^{kT} - 1} \right)$$

$$= \left( A_0 + C_0(a + bp + cp^2) \left( T + \frac{\theta T^3}{6} \right) + C_0 h \left( (a + bp + cp^2) \left( \frac{t_1^2}{2} + \frac{\theta t_1^4}{12} \right) - \frac{(a + bp + cp^2)(T - t_1)^2}{2} \right) \right) \left( \frac{e^{k\tau} - 1}{e^{kT} - 1} \right)$$

If shortages are not allowed then the Sales revenue per cycle is given by

$$p \int_0^T D(p) dt = p \int_0^T (a + bp + cp^2) dt$$

$$= pT(a + bp + cp^2)$$

The total profit  $f(p, T)$  per unit time = (1/T) (Sales revenue – Total cost)

$$f(p, T) = p(a + bp + cp^2) - \left( A_0 + C_0(a + bp + cp^2) \left( T + \frac{\theta T^3}{6} \right) + C_0 h \left( (a + bp + cp^2) \left( \frac{t_1^2}{2} + \frac{\theta t_1^4}{12} \right) - \frac{(a + bp + cp^2)(T - t_1)^2}{2} \right) \right) \left( \frac{e^{k\tau} - 1}{e^{kT} - 1} \right)$$

The total profit is maximum if  $\frac{\partial (f(p, T))}{\partial p} = 0, \frac{\partial (f(p, T))}{\partial T} = 0$

i.e.,

$$\frac{\partial (f(p, T))}{\partial p} = \left[ \begin{array}{l} (a + 2bp + 3cp^2) - (b + 2pc)C_0 \left( T + \frac{\theta T^3}{6} \right) \left( \frac{e^{\tau k} - 1}{T(e^{\tau k} - 1)} \right) \\ - (b + 2pc)C_0 h \left( \frac{t_1^2}{2} + \frac{\theta t_1^4}{12} - \frac{(T - t_1)^2}{2} \right) \left( \frac{e^{\tau k} - 1}{T(e^{\tau k} - 1)} \right) \end{array} \right] = 0$$

And

$$\frac{\partial (f(p, T))}{\partial T} = \left[ \begin{array}{l} A_0 \left( \frac{e^{\tau k} - 1}{T^2(e^{\tau k} - 1)} \right) + (a + bp + cp^2)C_0 \left( T + \frac{\theta T^3}{6} \right) \left( \frac{e^{\tau k} - 1}{T^2(e^{\tau k} - 1)} \right) \\ + (a + bp + cp^2)C_0 h \left( \frac{t_1^2}{2} + \frac{\theta t_1^4}{12} - \frac{(T - t_1)^2}{2} \right) \left( \frac{e^{\tau k} - 1}{T^2(e^{\tau k} - 1)} \right) \\ - (a + bp + cp^2) \left( C_0 \left( 1 + \frac{\theta T^2}{2} \right) - C_0 h(T - t_1) \right) \left( \frac{e^{\tau k} - 1}{T(e^{\tau k} - 1)} \right) \\ + A_0 \left( \frac{ke^{\tau k}(e^{\tau k} - 1)}{T(e^{\tau k} - 1)^2} \right) + (a + bp + cp^2)C_0 \left( T + \frac{\theta T^3}{6} \right) \left( \frac{ke^{\tau k}(e^{\tau k} - 1)}{T(e^{\tau k} - 1)^2} \right) \\ + (a + bp + cp^2)C_0 h \left( \frac{t_1^2}{2} + \frac{\theta t_1^4}{12} - \frac{(T - t_1)^2}{2} \right) \left( \frac{ke^{\tau k}(e^{\tau k} - 1)}{T(e^{\tau k} - 1)^2} \right) \end{array} \right] = 0$$

The Optimal value of T is obtained solving equation f(p, T) by MATHCAD

$$\frac{\partial^2 (f(p, T))}{\partial p^2} = \left[ \begin{array}{l} (2b + 6cp) - (2c)C_0 \left( T + \frac{\theta T^3}{6} \right) \left( \frac{e^{\tau k} - 1}{T(e^{\tau k} - 1)} \right) \\ - (2c)C_0 h \left( \frac{t_1^2}{2} + \frac{\theta t_1^4}{12} - \frac{(T - t_1)^2}{2} \right) \left( \frac{e^{\tau k} - 1}{T(e^{\tau k} - 1)} \right) \end{array} \right]$$

$$\frac{\partial^2 (f(p, T))}{\partial T^2} = \left[ \begin{array}{l} A_0 \left( \frac{e^{\tau k} - 1}{T^3(e^{\tau k} - 1)} \right) - A_0 \left( \frac{ke^{\tau k}(e^{\tau k} - 1)}{T^2(e^{\tau k} - 1)^2} \right) \\ + (a + bp + cp^2)C_0 \left( 1 + \frac{\theta T^2}{2} \right) \left( \frac{e^{\tau k} - 1}{T^2(e^{\tau k} - 1)} \right) \\ - (a + bp + cp^2)C_0 \left( T + \frac{\theta T^3}{6} \right) \left( \frac{e^{\tau k} - 1}{T^3(e^{\tau k} - 1)} \right) \\ - (a + bp + cp^2)C_0 \left( T + \frac{\theta T^3}{6} \right) \left( \frac{ke^{\tau k}(e^{\tau k} - 1)}{T^2(e^{\tau k} - 1)^2} \right) \\ + (a + bp + cp^2)C_0 h \left( \frac{t_1^2}{2} + \frac{\theta t_1^4}{12} - \frac{(T - t_1)^2}{2} \right) \left( \frac{e^{\tau k} - 1}{T^3(e^{\tau k} - 1)} \right) \\ - (a + bp + cp^2)C_0 h(T - t_1) \left( \frac{e^{\tau k} - 1}{T^2(e^{\tau k} - 1)} \right) \\ - (a + bp + cp^2)C_0 h \left( \frac{t_1^2}{2} + \frac{\theta t_1^4}{12} - \frac{(T - t_1)^2}{2} \right) \left( \frac{ke^{\tau k}(e^{\tau k} - 1)}{T(e^{\tau k} - 1)^2} \right) \end{array} \right]$$

$$\frac{\partial^2 (f(p, T))}{\partial p \partial T} = \left[ \begin{array}{l} (b + 2cp)C_0 \left( T + \frac{\theta T^3}{6} + h \left( \frac{t_1^2}{2} + \frac{\theta t_1^4}{12} - \frac{(T - t_1)^2}{2} \right) \right) \left( \frac{e^{\tau k} - 1}{T^2(e^{\tau k} - 1)} \right) \\ - (b + 2cp)C_0 \left( 1 + \frac{\theta T^2}{2} - h(T - t_1) \right) \left( \frac{e^{\tau k} - 1}{T(e^{\tau k} - 1)} \right) \\ + (b + 2cp)C_0 \left( T + \frac{\theta T^3}{6} + h \left( \frac{t_1^2}{2} + \frac{\theta t_1^4}{12} - \frac{(T - t_1)^2}{2} \right) \right) \left( \frac{ke^{\tau k}(e^{\tau k} - 1)}{T(e^{\tau k} - 1)^2} \right) \end{array} \right]$$

Also satisfying the following condition

$$\frac{\partial^2 (f(p, T))}{\partial p^2} < 0, \quad \frac{\partial^2 (f(p, T))}{\partial T^2} < 0,$$

And

$$\left( \frac{\partial^2 (f(p, T))}{\partial p^2} \right) \left( \frac{\partial^2 (f(p, T))}{\partial T^2} \right) - \left( \frac{\partial^2 (f(p, T))}{\partial p \partial T} \right)^2 > 0$$

It is found that the optimality conditions are satisfied for the following two cases viz.,

- (i)  $b < 0$  and  $c > 0$  which gives retarded growth in demand model
- (ii)  $b < 0$  and  $c < 0$  gives accelerated decline in demand model

### 3.1 Numerical Example

To demonstrate the effectiveness of the models developed, a numerical example is taken with the following values for the parameters.

$$a=150, b=5, c=0.01, A_0=250,$$

$$C_0=4, \theta=0.1, i=0.05, k=0.04$$

The MATHCAD output is presented in Table-1 and Table-2 which contains the optimum values of time ( $T$ ), ordering quantity ( $Q$ ) and total profit  $f(p,T)$  of the system for various values of inflation parameter ( $k$ ) and deterioration parameter ( $\theta$ ). These tables provide certain important insights about the problem under study. Some observations are as follows:

The behaviour of both the models developed here is almost similar in nature but the rate of change is slightly different. The optimal values of cycle time, ordering quantity and total cost increases with an increase in the inflation rate parameter ' $k$ '. For some particular values of  $\theta$ , when the inflation rate  $k$  increases from 0.05 to 0.10, the cycle time and ordering quantity increases while the total profit  $f(p,T)$  also increases in both the models.

For some particular values of  $k$ , when  $\theta$  increases from 0.05 to 0.10, the cycle time and ordering quantity decreases whereas total profit  $f(p,T)$  increases in both the models.

**3.2 Sensitive Analysis**

We now study sensitivity of the models developed to examine the implications of underestimating and overestimating the parameters individually and all together on optimal value of cycle time, ordering quantity and total system profit. The results are shown in Table-3 and Table-4. The following observations are made from these two tables:

- (i) The ordering quantity ( $Q$ ), the unit price ( $p$ ) and the total system profit  $f(p,T)$  increases (decreases) with the increase (decrease) in the value of the parameter ' $a$ ' where as the cycle time ( $T$ ) is inversely related with the parameter ' $a$ '.
- (ii) Increase (decrease) in the values of the parameters ' $b$ ' and ' $c$ ' decrease (increase) the price per unit, ordering quantity and the total profit  $f(p,T)$  while the cycle time increases (decreases) with ' $b$ ' and decreases (increases) with ' $c$ '. However the rate of increase/decrease is marginal in case ' $p$ ' and ' $T$ '.
- (iii) The ordering quantity ( $Q$ ), the unit price ( $p$ ), and the total system profit  $f(p,T)$  increases (decreases) with the decrease (increase) in the value of the parameters ' $\theta$ ' and ' $C_0$ '.
- (iv) The optimum value of the total profit, ordering cost and cycle time is marginal but the unit price remain constant to the changes in the parameters  $A_0$
- (v) The total profit of the system is more sensitive than the cycle time and ordering quantity when the values of all parameters are under-estimated or over-estimated by 15%.

**Table 1 Retarded Growth Model (i.e.,  $a>0, b<0$  and  $c>0$ )**

S.No	a	b	c	k	p	T	f(p, T)	Q
1	150	-5	0.01	0.05	15.787	9.158	1008	2050
2	150	-5	0.01	0.06	15.785	9.295	1009	2117
3	150	-5	0.01	0.07	15.784	9.445	1009	2192
4	150	-5	0.01	0.08	15.782	9.612	1010	2279
5	150	-5	0.01	0.09	15.780	9.801	1011	2380
6	150	-5	0.01	0.10	15.778	10.017	1011	2499

**Table 2 Retarded Decline Model (i.e.,  $a>0, b<0$  and  $c<0$ )**

S.No	a	b	c	k	p	T	f(p, T)	Q
1	150	-5	-0.01	0.05	14.421	9.136	978.360	1980
2	150	-5	-0.01	0.06	14.419	9.271	978.956	2044
3	150	-5	-0.01	0.07	14.417	9.421	979.550	2129
4	150	-5	-0.01	0.08	14.416	9.587	980.141	2200
5	150	-5	-0.01	0.09	14.414	9.774	980.730	2297
6	150	-5	-0.01	0.1	14.412	9.988	981.316	2411

**Table 3 Retarded Growth Model ( $a>0, b<0$  and  $c>0$ )**

Parameters	% change	Change in p (%)	Change in T (%)	Change in f(p,T) (%)	Change in Q (%)
a	-15%	-15.6078	1.375846	-24.6693	-21.8049
	-5%	-5.23215	0.414938	-8.21538	-7.21951
	5%	5.263825	-0.38218	8.234127	7.121951
	15%	15.87382	-1.04826	24.70238	21.31707
b	-15%	20.05448	0.054597	9.52381	9.414634
	-5%	5.846583	0.010919	3.174603	3.121951
	5%	-5.20682	-0.01092	-3.16954	-3.12195
	15%	-14.0812	-0.03276	-9.53165	-9.41463

c	-15%	-0.76645	-0.02184	-0.19841	-0.29268
	-5%	-0.25971	-0.01092	-0.09921	-0.09756
	5%	0.266042	0.010919	0.099206	0.097561
	15%	0.798125	0.021839	0.198413	0.243902
C <sub>0</sub>	-15%	-0.03801	1.397685	0.793651	3.073171
	-5%	-0.01267	0.414938	0.297619	0.878049
	5%	0.012669	-0.38218	-0.19841	-0.82927
	15%	0.04434	-1.05918	-0.69444	-2.29268
$\theta$	-15%	-0.08868	6.693601	0.099206	4.682927
	-5%	-0.03167	2.096528	0	1.512195
	5%	0.031672	-1.98733	0	-1.5122
	15%	0.088681	-5.6235	-0.09921	-4.29268
A <sub>0</sub>	-15%	0	-1.23389	0.396825	-2.63415
	-5%	0	-0.40402	0.099206	-0.87805
	5%	0	0.404018	-0.09921	0.878049
	15%	0	1.190216	-0.29762	2.585366
All	-15%	-0.12035	8.113125	-14.2977	-8.43902
	-5%	-0.03801	2.522385	-4.72877	-2.68293
	5%	0.04434	-2.36951	4.761905	2.536585
	15%	-15.6078	1.375846	14.0873	7.414634

Table 4 Retarded Decline Model ( $A > 0$ ,  $B < 0$  And  $C < 0$ )

Parameters	% change	Change in $p$ (%)	Change in $T$ (%)	Change in $f(p,T)$ (%)	Change in $Q$ (%)
a	-15%	-4.79856	0.415937	-25.4286	-22.5253
	-5%	4.777755	-0.3831	-8.47623	-7.42424
	5%	14.27779	-1.06173	8.446789	7.373737
	15%	15.85188	-0.04378	25.41396	22.0202
b	-15%	4.798558	-0.01095	9.877755	9.494949
	-5%	-4.39637	0.010946	3.233983	361.3636
	5%	-12.1489	0.021891	-3.27742	-3.18182
	15%	0.603287	0.010946	-9.83237	-9.54545
c	-15%	0.194161	0	0.228137	0.252525
	-5%	-0.2011	-0.01095	0.076046	0.10101
	5%	-0.58942	-0.02189	-0.07605	-0.10101
	15%	-0.04161	1.368214	-0.22814	-0.25253
C <sub>0</sub>	-15%	-0.01387	0.404991	0.75463	3.030303
	-5%	0.013869	-0.3831	0.251543	0.909091
	5%	0.041606	-1.03984	-0.25154	-0.80808
	15%	-0.09708	6.698774	-0.75463	-2.22222
$\theta$	-15%	-0.03467	2.101576	0.071242	4.69697
	-5%	0.027737	-1.98117	0.023713	1.565657
	5%	0.090146	-5.63704	-0.02371	-1.46465
	15%	0	-1.20403	-0.07114	-4.29293
A <sub>0</sub>	-15%	0	-0.39405	0.368167	-2.57576
	-5%	0	0.394046	0.122756	-0.80808
	5%	0	1.160245	-0.12265	0.858586
	15%	-0.12482	8.099825	-0.36806	2.575758
All	-15%	-0.04854	2.517513	-14.3071	-8.43434
	-5%	0.041606	-2.36427	-4.73956	-2.67677
	5%	0.145621	-6.65499	4.66495	2.575758
	15%	-4.79856	0.415937	14.06844	7.474747

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# Multi - Objective Assembly Job Shop Scheduling Problems: A Mixed Integer Model



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**Midhun Paul**

**Sridharan R**

*National Institute of Technology Calicut*

(midhunpaule@gmail.com)

(sreedhar@nitc.ac.in)

**Radha Ramanan T**

*Indian Institute of Management Indore*

(ramanan@iimidr.ac.in)

*This paper presents a mixed integer linear programming model for scheduling an assembly job shop in a multi-objective environment. The objectives considered are minimization of makespan and total tardiness simultaneously. This work determines the extent of problem size for which exact solution can be generated for different product structures. Further, this work analyses the computational aspects with changes in the input parameters such as number of products, number of machines, and number of operations and level of structure. The other input parameters include processing time, precedence constraints of all components and product due date. The system consists of  $M$  machines, with  $N$  products to be manufactured. The components are first processed in a machine shop and then assembled in the assembly shop. Each component requires a given number of precedence constrained operations to be performed. The problem size analyzed in this study varies from three products and four machines to ten products and fifteen machines. The product structures considered in this study are single level assembly structure, two level assembly structure and three level assembly structure. The result shows the exact solution for each problem instance considered in this study and the range of problem level variation for which exact solution can be obtained.*

**Keywords:** Assembly Job Shop, Scheduling, Multi-Objective, LINGO

## 1. Introduction

For maintaining competitive advantage, an organization has to ensure proper scheduling of jobs and activities. Effective scheduling can improve profitability in terms of reduced lead time, on-time delivery, utilization of resources and reduced inventory. Scheduling problems are classified as single machine scheduling, flow shop scheduling, job shop scheduling problems, etc. In a job shop, there are ' $n$ ' jobs and ' $m$ ' machines. A job may need some or all these machines in a specific sequence according their requirement. In the literature, it is found that most of the studies focus only on conventional job shop system which processes 'string type' jobs only. However, Scheduling assembly job shop which have serial, assembly operations and multi-level jobs is relatively less investigated (Pereira, 2011).

A number of solution techniques to handle the Assembly Job Shop Scheduling Problem (AJSSP) have been developed over the years. The solution techniques include mixed integer programming, dispatching rules, constructive heuristics and meta-heuristics. It is found that almost all the studies on AJSSP focus on single objective optimization only. No significant research has been reported in the area of scheduling of an assembly job shop with multi-objective criteria. In the literature, it is also found that most of the studies on AJSSP uses approximation based techniques namely, dispatching rules and meta-heuristics for solving the problem. Research on AJSSP using optimization techniques such as mixed integer programming is very few compared to other techniques.

Tharumarajah et al. (1998) study the effect of distributed scheduling in a static environment by using mixed integer programming along with lower and upper boundaries. The objective of the work is to minimize the total tardiness. Guo et al. (2006) develop a universal mathematical model for the job shop scheduling problem in a mixed and multi-product assembly environment based on an apparel industry. A genetic optimization process is proposed to solve the model which includes a new chromosome representation, a heuristic initialization process and modified crossover and mutation operators. Dimiyati (2007) addresses a problem of scheduling in a make-to-order job shop with product assembly consideration. A mixed integer linear programming model is developed to solve the model in with the objective of makespan minimization.

Gomes et al. (2009) describe the problem of scheduling a flexible job shop with recirculation and assembly. They develop two mixed integer linear programming models and solve the problems using a due-date based objective function. The model adopts discrete and continuous approaches both in the modeling of time as well as in the assignment of jobs to machines. Saeid et al. (2012) propose a mixed integer linear programming model which includes process planning and scheduling tasks simultaneously in a flexible assembly job shop with sequence dependent setup times. The objective of this study is minimizing maximum completion time (makespan) of final products. The products structures consider have three stage assembly structures.

The present work proposes a mixed integer linear programming model for scheduling an assembly job shop in a multi-objective environment. The objective of this work is to minimize makespan and total tardiness simultaneously. This work determines the extent of problem size for which exact solution can be generated for different product structures. Further this

work analyses the computational aspects with the changes in the input parameters such as number of products, number of machines, number of operations and level of structure. Processing time, precedence constraints of all components and product due date are the other input parameters considered. In this study, the problem size varies from three products and four machines (3x4) to ten products and fifteen machines (10x15). The mathematical model of the assembly job shop is developed using the software LINGO (version 11.0). The product structures considered in this study are single level assembly structure, two level assembly structure and three level assembly structure

The rest of the paper is organized as follows: Section 2 describes the problem formulation. Section 3 presents the mathematical model. Section 4 provides the results and analysis. Conclusions are presented in section 5.

## 2. Problem Formulation

In a real manufacturing environment, scheduling of jobs is done by satisfying many objectives and considering many constraints simultaneously. However, it is important to develop an optimum methodology to solve multi-objective assembly job shop scheduling problems. The minimization of cost and maximization of customer satisfaction are two major issues in practice (Lei, 2008). A completion time related objective, namely, makespan aims to reduce production time and increase facility utilization which is a critical factor towards minimizing cost. The due date related objective of minimizing total tardiness aims to meet on-time delivery which is a critical factor towards realizing customer satisfaction. (Dileepal, 2012). Hence, the objectives considered in this work are simultaneous minimization of makespan and total tardiness.

### 2.1 Problem Environment

This problem environment considers a classical assembly job shop similar to many previous studies. The data includes the due dates of different products, the processing time of different operations, precedence constraints of all components, assembly level structure of different products and performance measures selected for the study. The system consists of two divisions, a machining shop and an assembly shop. Assembly starts only after all machining operations of an item are completed. Each component requires a given number of precedence constrained operations to be performed. Each operation can start only when its preceding operations are completed. The machining work center queue and assembly work center queue are assumed to have an infinite capacity. The final product moves out of the assembly work center when the assembly at the highest level is completed.

The routing of products is generated randomly such that each machining work center for processing has the same probability of being chosen. The processing times and the assembly operation times follow uniform distribution in the range 1-20 and 5-20 respectively. The number of operations for each item or subassembly follows uniform distribution in the range 2-7. The due-date of an arriving job  $i$  is determined using the method proposed by Adam et al. (1993) using the critical path length ( $l_i$ ), the allowance factor ( $c$ ) and job arrival time ( $t_i$ ), i.e.,  $d_i = t_i + c \times l_i$ . The allowance factor considered in all problems is 1.5.

Three types of product structure are used in this study:

- Single level assembly structure
- Two level assembly structure
- Three level assembly structure

The three different job types and their configurations are listed in Figure 2.1 and Table 2.1

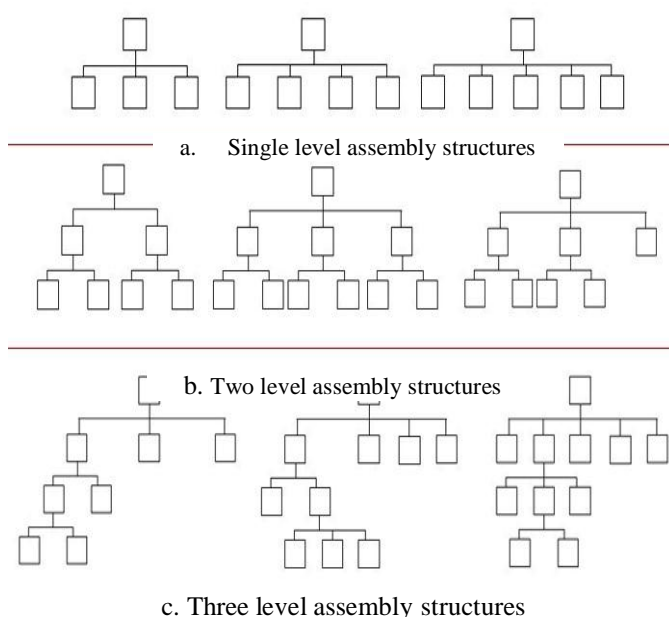


Figure 2.1 Types of Job Structures



Table 2.1 Details of Jobs with Different Configurations

Job type	Number of subassemblies at level 2	Number of Subassemblies at level 3	Number of Subassemblies at level 4
1 (Flat)	[2-5]	0	0
2 (Complex)	[2-5]	[4-6]	0
3 (Complex)	[3-5]	[2-3]	[2-3]

2.2 Assumptions

The assumptions made in this study are listed hereunder:

- Each machine can perform only one operation at a time.
- Preemption of jobs is not allowed.
- Precedence relationship between operations should be followed.
- In a given level of assembly, a job visits a machine only once.
- There are no alternative routes for jobs.
- Due date and job structure of each product are known in advance.
- Flow time includes processing time and waiting time only; setup, transport and loading times are assumed to be negligible.
- Machines are continuously available, i.e., there are no breakdowns

2.3 Mathematical Formulation

A Mathematical model that sequences the set of ‘N’ products over a set of ‘M’ is developed. Objective function is the minimization of the weighted sum of Makespan and tardiness simultaneously. ie

The notations used are:

*p*: Product index

*i*: Operation index

*j*: Precedence operation index

*k*: Machine index

*S*: Start time

*C*: Completion time

*p<sub>i</sub>*: Processing time

*D*: Due date

*h* : Weight assigned

*H*: High positive integer

*T*: Tardiness

*X*: Decision variable for generating a sequence between operations on the same machine

$$\text{Minimization of } Z = h (\text{tardiness}) + (1 - h) (\text{Makespan}) \tag{1}$$

$$= h \times \sum_{p=1}^N (T_p) + (1 - h) (\max (C_p)) \tag{2}$$

Subjected to:

$$S_{ik} \geq 0 \quad \forall i=1, \dots, N \tag{3}$$

$$C_{ik} - S_{ik} = t_{ik} \quad \forall i=1, \dots, N \tag{4}$$

$$S_{ik} \geq C_{jk} \quad \forall i (P_i \neq \emptyset) \text{ and } \forall j \in P_i \tag{5}$$

$$S_{ik} \geq C_{jk} - H * X_{ijk} \quad \forall k=1, \dots, M \text{ where } k_i = k_j = k \tag{6}$$

$$X_{ijk} + X_{jik} = 1 \quad \forall k=1, \dots, M \text{ where } k_i = k_j = k \tag{7}$$

$$X_{ijk} \in \{0, 1\} \quad \forall k=1, \dots, M \text{ where } k_i = k_j = k \tag{8}$$

$$\text{Max} (C_p) \geq (C_{ik}) \quad \forall i=1, \dots, N \tag{9}$$

$$T_p = \max (0, C_p - D_p) \tag{10}$$

The Constraint (3) ensures that the starting time of operation is positive. Constraint (4) ensures that the processing time of an operation is equal to the difference between its start and completion times, i.e., once an operation has started, it cannot be pre-empted until its completion. Constraint (5) means the starting time of one operation must be greater than or equal to the completion time of the previous operation. Constraint (6) ensures that no two operations can be processed simultaneously on the same machine. Constraints (7) and (8) ensure that the value of ‘X’ will always be 1 or 0 and the sum of the ‘X’ values for any operations *i, j* on the same machine will be always zero. Constraint (9) ensures that the makespan is the maximum completion time of all operations to manufacture the product. Constraint (10) defines the tardiness of each product as the difference between the completion time and due date.

3. Mathematical Model

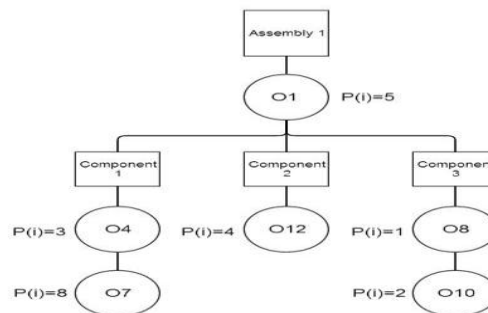
3.1 Illustrative Problem

A problem given by Dilleplal (2012) is considered for explaining the model. The objective is minimization of total weighted sum of tardiness and makespan. The specification of the problem instance is two products, six machines, and fifteen

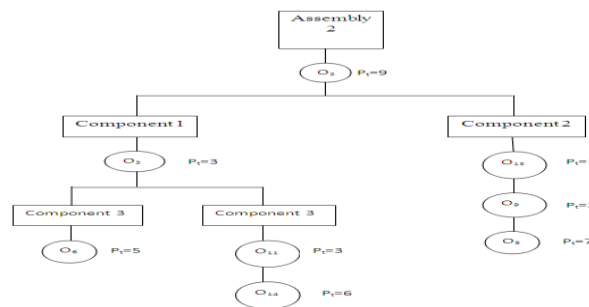
operations with two level product structures with seven components. Figure 3.1 shows the product structure 1 and figure 3.2 shows the product structure 2. Table 3.1 describes the operations which have to be scheduled on respective machines. ‘ $P_i$ ’ gives the processing time of each operation. The due date for product 1 is set as 16 and for product 2 as 21. The weight is set as 0.5.

**Table 3.1** Operations in Respective Machines

Machines	Operations
1	1, 2, 3
2	4, 5, 6
3	7, 8, 9
4	10, 11
5	12, 13, 14

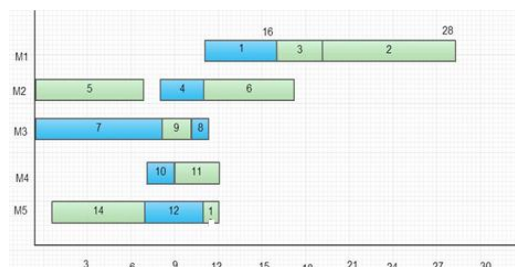


**Figure 3.1** Product Structure 1



**Figure 3.2** Product Structure 2

The Solver LINGO (version 11.0) is used for solving the problem. The system configuration is Intel i5 3.30 GHz processor, 4 GB RAM and 1 GB graphics card. The results obtained are as follows: makespan = 28; total tardiness = 7; flow time of Product 1 = 16; flow time of Product 2 = 28. All the values are in time units. The weighted value of makespan and tardiness is 17.5 with equal weights which are found to be the minimum possible value. The result of the program is validated with the results from the literature. The Gantt chart presented in Figure 3.3 shows the machine sequence of different operations.



**Figure 3.3** Gantt Chart

### 3.2 Numerical Examples

The performance of the proposed mathematical model is evaluated for various instances of multi-objective assembly job shop scheduling problem. Twenty five different problem instances based on the literature are considered and the problem sizes vary from 3 products and 4 machines to 15 products and 15 machines. Three types of product structures used in the present

study are single level assembly structure, two level assembly structure and three level assembly structure (Natarajan et al., 2007). The list of problem instances is given in Table 3.2. These problem instances are solved for all the three types of product structures with the condition that the Solver generates a global optimum solution before the specified interruption time. The interruption time of solver set as one hour.

**Table 3.2** List of Problem Instances

Problem No.	Number of Products	Number of Machines	Number of Operations
1	3	4	20
2	3	4	30
3	3	6	30
4	3	6	45
5	3	8	45
6	4	8	45
7	4	10	45
8	4	10	60
9	5	10	60
10	5	12	60
11	6	12	60
12	6	12	100
13	6	12	150
14	7	12	150
15	7	15	150
16	7	15	200
17	8	15	200
18	8	15	250
19	9	15	250
20	9	15	300
21	10	12	300
22	10	15	300
23	12	12	300
24	15	12	300
25	15	15	300

## 4. Results and Discussion

### 4.1 Three Levels of Structures under Equal Weights

Seventy five problem instances (25 problem instances in each level) under equal weight are considered. It is found that optimal solution could be generated for only 29 problems within the specified interruption time of one hour. Table 4.1 provides the weighted output value of makespan and tardiness for the problem instances involving single level product structure.

**Table 4.1** Weighted Output of Single Level Structure

Problem No.	Number of Products	Number of Machines	Number of Operations	Makespan	Tardiness	Weighted O/P
1	3	4	20	69	0	34.5
2	3	4	30	151	27.0	89.0
3	3	6	30	110	0	55.0
4	3	6	45	125	5.0	65.0
5	3	8	45	106	44.0	75.0
6	4	8	45	107	0	53.5
7	4	10	45	105	0	52.5
8	4	10	60	140	0	70.0
9	5	10	60	124	6.0	65.0
10	5	12	60	100	9.0	54.5
11	6	12	60	131	59.0	95.0
12	6	12	100	Interrupted		

The results shown in Table 4.1 reveals that in the case of single level structure, the model generates optimum solution for small size problems (3 products-4 machines and 4 products-8 machines) and medium size problems (5 products-10 machines and 5 products 12 machines). When the number of operations increases from 60 to 100 in the case of 6 products 12 machines, the Solver does not produce optimum result.

Table 4.2 provides the weighted output value of makespan and tardiness for the problem instances involving two level product structure.

**Table 4.2** Weighted Output of Two Level Structures

Problem No.	Number of Products	Number of Machines	Number of Operations	Makespan	Tardiness	Weighted O/P
1	3	4	20	77	19	48.0
2	3	4	30	113	83	98.0
3	3	6	30	95	33	64.0
4	3	6	45	131	9	70.0
5	3	8	45	115	12	63.5
6	4	8	45	94	14	54.0
7	4	10	45	89	5	47.0
8	4	10	60	117	6	61.5
9	5	10	60	97	0	48.5
10	5	12	60	93	3	48.0
11	6	12	60	105	81	93.0
12	6	12	100	Interrupted		

The results shown in Table 4.2 reveal that in two level structures, as in the case of single level structure, for small size and medium size problems (5 products-10 machines, 5 products-12 machines), the model generates optimum solution. When the number of operations increases from 60 to 100 (for example, in the case of 6 products-12 machines), the Solver is unable to produce the optimal solution.

Table 4.3 provides the weighted output value of makespan and tardiness for the problem instances involving three level product structure.

**Table 4.3** Weighted Output of Three Level Structures

Problem No.	Number of Products	Number of Machines	Number of Operations	Makespan	Tardiness	Weighted O/P
1	3	4	20	82	2	42
2	3	4	30	128	34	81
3	3	6	30	112	24	68
4	3	6	45	106	37	71.5
5	3	8	45	112	13	62.5
6	4	8	45	107	51	79
7	4	8	60	Interrupted		

From Table 4.3, it is evident that for smaller size problems (3 products-4 machines) only, the Solver generates optimum solution for three level structures. In the case of problems with 4 products-8 machines, the Solver generates solution for the instance containing 45 operations only. When the number of operations increases from 45 to 60, the Solver is unable to generate optimal solution within the specified time.

**4.2 Effect of Different Weights**

In this study, ten problem instances of single level structure under different weights are analysed. The different weights considered are 0.3, 0.5, and 0.7. The weighted output values of makespan and tardiness are summarized in Table 4.4. The results show that weights can be varied depending upon the requirements of a given situation.

**Table 4.4** Weighted Output Details for Different Problems

Problem No	Weight for Tardiness = 0.3			Weight for Tardiness = 0.5			Weight for Tardiness = 0.7		
	Makespan	Tardiness	Weighted O/P	Makespan	Tardiness	Weighted O/P	Makespan	Tardiness	Weighted O/P
1	69	0	48.3	69	0	34.5	69	0	20.7
2	131	53	107.6	151	27	89	151	27	64.2
3	107	4	76.1	110	0	55	110	0	33
4	122	2	86	125	5	65	135	0	40.5
5	106	44	87.4	106	44	75	138	18	54
6	105	4	74.7	107	0	53.5	107	0	32.1
7	97	14	72.1	105	0	52.5	105	0	31.5
8	140	0	98	140	0	70	140	0	42
9	111	44	90.9	124	6	65	118	22	50.8
10	100	9	72.7	100	9	54.5	109	28	52.3

**4.3 Sensitivity Analysis**

Sensitivity analysis aids in determine how computational complexity varies with number of operations, number of products and levels of product structures. For this analysis, the first eleven problems of single level structure and two level structures

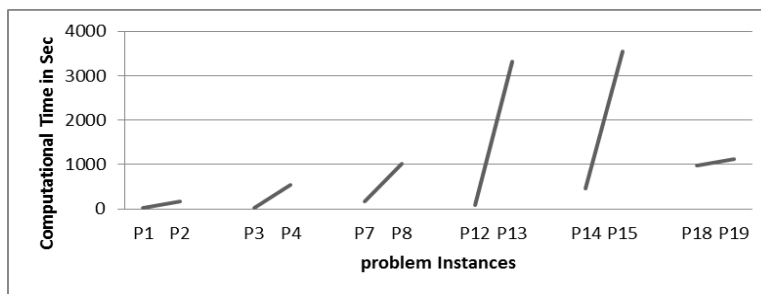
are selected. Table 4.5 and Table 4.6 provide the computational time taken for solving these problems. Problem instances P 1 to P 11 are single level assembly structure and P 12 to P 22 two level assembly structures. Figure 4.1, 4.2 and 4.3 show the changes in computational time when the variables such as number of operations, number of levels and number of products are changed.

**Table 4.5** Computational Time of Single Level Structure

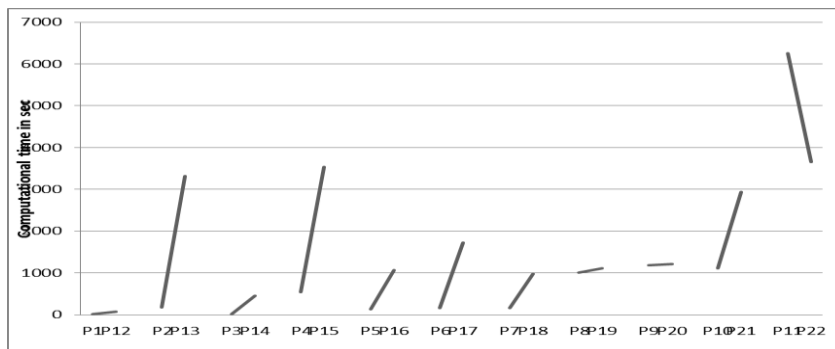
Problem No.	Number of Products	Number of Machines	Number of Operations	Execution Time hh:mm:sec
P1	3	4	20	00:00:17
P2	3	4	30	00:02:56
P3	3	6	30	00:00:17
P4	3	6	45	00:09:03
P5	3	8	45	00:02:17
P6	4	8	45	00:02:35
P7	4	10	45	00:02:40
P8	4	10	60	00:16:51
P9	5	10	60	00:19:44
P10	5	12	60	00:18:25
P11	6	12	60	01:00:20

**Table 4.6** Computational Time of Two Level Structures

Problem No.	No. of Products	No. of Machines	No. of Operations	Execution Time hh:mm:sec
P12	3	4	20	00:01:21
P13	3	4	30	00:55:18
P14	3	6	30	00:07:40
P15	3	6	45	00:59:04
P16	3	8	45	00:17:52
P17	4	8	45	00:28:39
P18	4	10	45	00:16:13
P19	4	10	60	00:18:33
P20	5	10	60	00:20:21
P21	5	12	60	00:48:58
P22	6	12	60	01:00:56



**Figure 4.1** Computational Time Changes vs. Number of Operations



**Figure 4.2** Computational Time Changes vs. Number of Levels

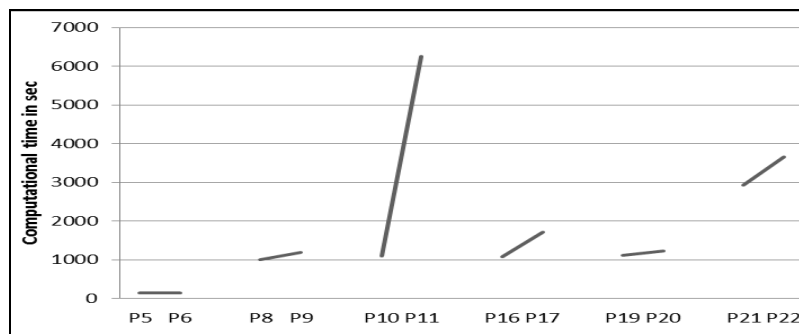


Figure 4.3 Computational Time Changes vs. Number of Products

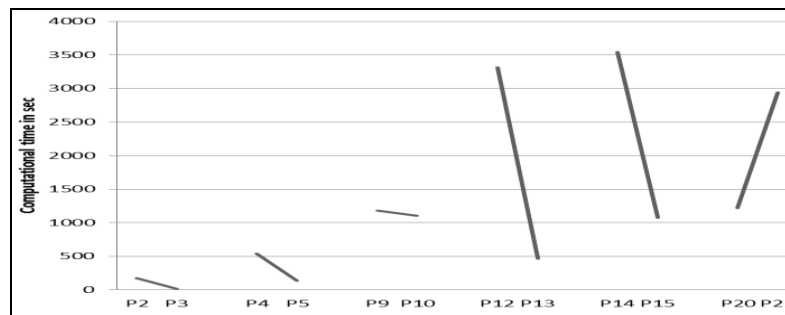


Figure 4.4 Computational Time Changes vs. Number of Machines

The following are the inferences drawn from Tables 4.5 and 4.6 and from Figures 4.1, 4.2, 4.3 and 4.4

- When there is an increase in number of operations, number of products and number of levels, computational time also increases. This means that these factors affect the computational complexity.
- When number of machines increases, it reduces computational time in almost all cases because it reduces the number of comparisons for selecting an operation on each machine. This establishes the relevance of priority rules for selecting a job on each machine.

## 5. Conclusion

Assembly Job shop scheduling problem is one of the relevant problems in operations research, which is continuously being updated in accordance with the results of the newest approaches. An exhaustive literature survey is conducted and it reveals that the scheduling of assembly job shop with multiple objectives is seldom considered by the researchers though it has significant practical interest. A detailed computational study is conducted to prove the efficiency of the proposed mixed integer programming model. Variables such as number of operations, level of structure, number of machines and number of products have significant effect on computational complexity. With an increase in the number of products, number of operations, and number of levels, the product complexity increases. The computational time drastically increases with the increase of product complexity. Mixed integer programming model is good to get exact solution for small sized problems and medium sized problems for single level and two level structure problems. For more complicated large sized problems, approximation based methods need to be used. This study proves the relevance of priority rules for large sized problems to reduce computational time.

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# Modelling and Analysis of a Green Vehicle Routing Problem



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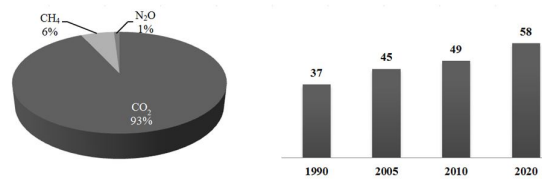
**Jabir E**  
**Vinay V. Panicker**  
**R. Sridharan**

*National Institute of Technology*  
(e.jabir@gmail.com)  
(vinay@nitc.ac.in)  
(sreedhar@nitc.ac.in)

*The classical vehicle routing problems are designed for distance or cost reduction. The routes generated by the model will be insensitive towards the environmental impact. In this work, a green vehicle routing problem is addressed. A meta-heuristic algorithm combining an Ant Colony Optimization algorithm with a Variable Neighbourhood Search algorithm is developed to solve the problem. The hybrid heuristic will search the solution space for the routing strategy, that minimizes the total supply chain cost which comprises of economic as well as emission cost. For consistency of solutions and solution convergence, the algorithm is tested on randomly generated problem instances.*

## 1. Introduction

The backbone of the current industrial logistic networks is the fossil fuel based transportation sector. The distance or the time travelled by the vehicles account for the major component of the logistics cost. A minimization problem will design the routes with less time or distance variable. Greening the routes means implementing an environmental friendly vehicle route which will reduce the Green House Gas (GHG) emission. Among the greenhouse gases, CO<sub>2</sub> has the major share in a global basis. Methane and N<sub>2</sub>O comes at the second and third with very less percentage contributions. The global emission scenario is shown in Figure 1.1(a). The inter-governmental panel on climate change is proposing a curb of 50%-80% GHG emissions by 2050 for avoiding serious and enduring climate change (4<sup>th</sup> assessment report of the inter-governmental panel on climate change). Figure 1.1(b) shows the global trend in CO<sub>2</sub> emissions through the last decade which shows a clear trend of increase. India emits more than 5% of global CO<sub>2</sub> emissions. In 2011, the transportation sector alone accounts for 22% of the global carbon emission (IEA STATISTICS, 2013).



**Figure 1.1(a)** Global GHG Emission. (IEA statistics, 2013) **(b)**. Estimated Global Emissions in GtCO<sub>2</sub>e (The Emissions Gap Report, 2012)

The classical vehicle routing problems aims at the possible economic cost reduction by proper assignment and demand allocation of potential clients towards a set of distribution centres. The general routing optimization problem will include the minimization of the distance travelled or time traversed for the customer service. The practical limitations of the business environment will impose the boundaries like maximum work hour constraints, maximum number and handling capacities of available transportation facilities and so on.

In this work, a multi-depot capacitated vehicle routing problem is analyzed. A supply chain cost reduction model is developed for the problem. Economic and environmental factors are considered in the supply chain cost structure. The economic factors considered in this study include route operating costs, fuel consumption costs and other operational costs. The environmental impact is measured in terms of cost of tons of CO<sub>2</sub> emission. Two algorithms namely, Ant Colony Optimisation (ACO) algorithm based heuristic and a hybrid algorithm combining ACO with Variable Neighbourhood Search (ACO-VNS) are proposed to solve the model. The algorithms are tested on problem instances randomly generated for a single product, two-echelon distribution-allocation supply chain.

In the literature, green-VRP can be broadly classified into three distinct problem scenarios, such as (i) Energy consumption based vehicle routing models (ii) Pollution and pollution reduction based models (iii) Waste management and reverse logistics related vehicle routing models. Lin et al. (2014) provides an outline of the research work in green logistics mainly confined from 2006 to 2012. Sbihi & Eglese (2007) has also reviewed the various scenarios coming under VRP and VRP variants such as, the green vehicle routing-scheduling problem and green logistics. Erdoğyan & Miller-Hooks (2012), Yong and Xiaofeng (2009), Xiao et al. (2012) and Ćirović et al. (2014) considers energy consumption based routing models. Wygonik (2011), Huang et al. (2012), Lin et al. (2014), Demir et al. (2014), Kuo et al. (2014) and Jovanović et al. (2014) elucidates the pollution based routing scenarios.

The rest of the paper is structured as follows. Section 2 describes the problem considered in the work. Section 3 discusses the solution methodology adopted in the work. Section 4 reports the computational study, followed by results and discussion. Finally, the conclusions and suggestions for future research are given in Section 5.

## 2. Problem Description: Green MDVRP

In this work, a multi-depot capacitated vehicle routing problem (MDVRP) is considered. The problem is inspired from the two-echelon forward supply chain of a single product, distribution model. The supply chain network consists of  $n$  customers and  $m$  depots. The demand sharing between the vehicles and the depots are not allowed in the model. As an obvious consequence, the customers with demand quantity greater than the truck load or depot capacity itself is not considered in the problem scenario. In order to ensure continuous flow of demand distribution, a customer will have an immediate successor and predecessor in a route. The optimization model has to allocate the customers to the depots by designing minimum cost routes. The total cost component includes two types of costs namely, economic cost and environmental cost. The economic cost includes the route dependent fixed cost, the route operating costs and the fuel consumption cost. The environmental costs are evaluated in monetary terms considering the CO<sub>2</sub> emissions. The assumptions imposed on the model are as follows:

- The demand of the customers is known.
- The capacities of depots and vehicles are known.
- The geographical location of the depots and the customers are known and mapped in to a Euclidean plane.
- Individual demand of each customer cannot exceed the capacity of a vehicle
- Each vehicle starts and ends the route at the same depot.
- Each depot and customer is visited by a vehicle exactly once i.e., the entire demand of the customer is met by a single vehicle.
- Homogeneous Vehicles are used. Capacity, speed and emission parameters are same.

### 2.1 Problem Formulation: Green MDVRP

The green MDVRP model is formulated as a variant of the canonical vehicle routing problem with capacitated routes and depots. The total supply chain cost of the model is a function of the distance travelled and the demand distribution pattern inside the route.

The notations used in the models are provided in Table 1.

Decision variables

$$x_{ijk} = \begin{cases} 1, & \text{if vehicle } k \text{ is travelling from node } i \text{ to node } j, \forall i \in I, j \in J, k \in K \\ 0, & \text{otherwise...} \end{cases}$$

$$f_{ij} = \begin{cases} 1, & \text{if customer } j \text{ is assigned to depot } i, \forall i \in I, j \in J \\ 0, & \text{otherwise} \end{cases}$$

Table 2.1 Notations

$I$	Set of depots ( $i=1,2,\dots,d$ ), where $d$ being the upper bound on the number of depots
$J$	Set of customers ( $j=1,2,\dots,c$ ), where $c$ being the upper bound on the number of customers
$V$	$I \cup J$
$l_{ij}$	Euclidian distance from node $i$ to node $j$ , for all $i \in V, j \in V$
$C_v$	Variable vehicle operating cost per unit distance
$T$	Fixed depot vehicle cost
$C_{fuel}$	Average fuel consumption cost per unit distance per unit vehicle weight
$F_{CO2}$	CO <sub>2</sub> emission cost per unit weight of vehicle per unit distance
$P_f$	Diesel fuel price per unit volume
$V_f$	Volume of fuel consumption per unit distance per unit vehicle weight
$W_p$	Weight of each delivered product (the weight of recycled products is neglected)
$W_{CO2}$	Weight of CO <sub>2</sub> emission per liter consumption of diesel
$P_{CO2}$	Average price per unit weight of CO <sub>2</sub>
$k$	Ratio of vehicle volume versus curb weight
$W_{cargo}$	Average Cargo weight when vehicle traverse a distance $l_{ij}$
$W_v$	Average gross weight per vehicle through travelling on each route
$d_j$	Demand of customer $j$ , for all $j \in J$
$Q_v$	Capacity of the depot vehicle

Objective function

Minimize

$$Z = \sum_{k \in K} \sum_{i \in I} \sum_{j \in J} T \times x_{ijk} + \sum_{i \in V} \sum_{j \in V} \sum_{k \in K} l_{ij} \times x_{ijk} \times v_f \left( P_f + P_{CO2} \times W_{CO2} \left( W_{Cargo} + \frac{W_{Curb}}{k} \right) \right) \quad (2.1)$$

Subject to

$$\sum_{j \in J} \sum_{i \in V} d_j \times x_{ijk} \leq Q_v, \quad \forall k \in K \tag{2.2}$$

$$\sum_{j \in J} d_j f_{ij} \leq W_i y_i, \quad \forall i \in I \tag{2.3}$$

$$\sum_{j \in J} \sum_{i \in V} x_{ijk} = 1, \quad \forall k \in K \tag{2.4}$$

$$\sum_{j \in V} x_{ijk} - \sum_{j \in V} x_{jik} = 0, \quad \forall i \in V, k \in K \tag{2.5}$$

$$\sum_{i \in I} \sum_{j \in J} x_{ijk} \leq 1, \quad \forall k \in K \tag{2.6}$$

$$x_{ijk} \in \{0, 1\}, \quad \forall i \in I, \forall j \in V, \forall k \in K \tag{2.7}$$

$$f_{ij} \in \{0, 1\}, \quad \forall i \in I, j \in V \tag{2.8}$$

The objective function (2.1) represents the total supply chain cost of the network. The economic side of the supply chain costs including the routing costs, travel costs and the fixed route building costs. The emission cost of the network is measured in monetary terms of the carbon emission. It depicts the environmental impact of the supply chain. Constraints (2.2) and (2.3) are the capacity constraints associated with the routes and the depots, respectively. Constraint (2.4) ensures that each customer belongs to exactly one route, and that each customer has only one predecessor in the route. Constraint (2.5) guarantees the continuity of each route, and that each route terminates at the depot where the route starts. . Constraint (2.6) ensures that a customer must be assigned to a depot if there is a route connecting them. Constraints (2.7) and (2.8) specify the binary variables.

### 3. Solution Methodology

The np hard MDVRP is solved using two algorithms namely, an ant colony optimization based heuristic and a hybrid meta-heuristic algorithm combining an Ant Colony Optimization (ACO) algorithm with a Variable Neighbourhood Search (ACO-VNS). The details of the solution methodology are provided in the following subsection. The solution representation is given in Figure 3.1. The numbers,  $i=1, 2, \dots, n$  are used for customers and  $n+1$  to  $n+m$  are used for representing depots. Zeros indicate the beginning or the end of a route. Every string must start by a depot element (i.e.  $string(i=1) \geq n+1$ ) and should end at a zero.

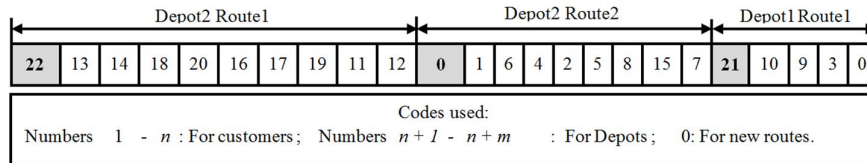


Figure 3.1 Solution Representation

#### 3.1 Ant Colony Optimization (ACO) Algorithm

An evolutionary Ant Colony Optimization (ACO) based algorithm is modeled as a constructive, route building heuristic to solve the green MDVRP. The ant behavior for searching the quality food is adapted for finding the routes that optimizes the total supply chain cost. Ants mimic the vehicles or trucks in the problem. Every ant makes a trail with a chemical substance called pheromone. Ants travel from a depot to a customer or from a customer to another customer. The best customer node selection is guided by the collective information stored as a presence of the chemical substance, known as ant pheromones. The probability of selecting a pair of nodes for the solution increases as more ants use the same link (depot-customer or customer-customer). The search is restricted by the problem boundary conditions for generating feasible solutions. The heuristic constructs a complete tour for the first ant prior to the second ant starting its tour.

The algorithmic parameters are (i) Magnitude of the pheromone intensity,  $\alpha$ , (ii) Magnitude of visibility,  $\beta$ , (iii) Evaporation rate of pheromone,  $\rho$ , (iv) Pheromone increment amount,  $Q$ , (v) Number of ants and number of iterations. The pheromone content between two nodes is represented using two matrices (depot-customer and customer-customer). All the elements in the initial pheromone matrix are set to  $\alpha$  value. Probability matrices between the depot to customer ( $P_{dc}$ ) and customer to customer ( $P_{cc}$ ) are calculated based on the initial values. The probability between the two nodes  $i$  and  $j$  is calculated using equation (3.1).

$$p_{ij}^k = \begin{cases} \frac{\tau_{ij}^\alpha \eta_{ij}^\beta}{\sum_{l \in N_i^k} \tau_{il}^\alpha \eta_{il}^\beta}, & \text{if } j \in N_i^k \\ 0, & \text{other wise} \end{cases} \tag{3.1}$$

where  $\tau_{ij}$  is the pheromone intensity between the nodes  $i$  and  $j$ . The  $N_i^k$  represents the feasible neighborhood of ant  $k$  based on the problem boundary constraints. The visibility parameter between the edges  $i$  and  $j$  of the ACO ( $\eta_{ij}$ ) is calculated using equation (3.2).

$$\eta_{ij} = \frac{1}{\text{function value between node } i \text{ and } j} \tag{3.2}$$

The ant travel starts from a randomly chosen depot. When it comes to the customer selection, the customer with the highest value of probability from the  $P_{dc}$  matrix is served. The route construction from the chosen depot changes the pheromone content, the vehicle product stock and the depot total serving potential. As an ant moves from one node to another, the pheromone content is updated using equation (3.3). The increment in the pheromone value is indicated as  $\Delta\tau_{ij}^k$ . The increment in the pheromone trail is determined by equation (3.4).

$$\tau_{ij} = \tau_{ij} + \Delta\tau_{ij}^k \tag{3.3}$$

$$\Delta\tau_{ij}^k = \begin{cases} \frac{Q}{L_k}, & \text{if ant } k \text{ uses edge}(i, j) \\ 0, & \text{other wise} \end{cases} \tag{3.4}$$

Where,  $Q$  is the pheromone increment amount and  $L_k$  is the function value by the ant  $k$  on the edge  $(i, j)$ . In this problem,  $L_k$  is the distance between the nodes for classical MDVRP.

The customer with the highest probability in the  $P_{cc}$  matrix with the already allocated customer is selected as the second customer. Then the pheromone trials between the selected nodes are updated. A route is constructed until the vehicle capacity constraint is met and the ant returns to the depot. If the depot has sufficient capacity to serve more customers, the second route is constructed. When a depot capacity constraint is met, next depot is selected randomly. The route building continued till all the customers are visited. When a solution is generated from an ant, the pheromone levels are updated by the evaporation process. The pheromone evaporation on edge  $(i, j)$  is updated using equation (3.5).

$$\tau_{ij} = (1 - \rho) \tau_{ij} \tag{3.5}$$

Where,  $\rho$  is the parameter that controls the pheromone evaporation rate.

When all the customers are served, the total supply chain cost is calculated. The best solution is stored and updated as more ants pass by. This procedure continues till the predetermined number of ants constructs the route. When a predetermined number of ants complete the construction of routes, the iteration number is incremented. The procedure is repeated till the predetermined number of ants and iterations are completed.

### 3.2 ACO-VNS Based Heuristic

The neighborhood region of the ACO solutions is explored by combining the meta-heuristic with a Variable Neighborhood Search. The  $k^{th}$  neighborhood in the  $n^{th}$  iteration,  $N_n^k$  is generated by swapping the  $i^{th}$  element of the solution with  $j^{th}$  elements, where  $j \neq i$ . The flow chart for the proposed hybrid ACO-VNS based heuristic is shown in Figure 3.2.

The neighborhood generation from a parent string is represented in the Figures 3.3 (a-c). The VNS algorithm will stop the iterations once the algorithm reaches the local minima. Two separate counters are used to count the number of ants and number of iterations. Once the ant counter attained a maximum pre-determined value the algorithm will stop sending new ants to find the solution and the control will straight away go to the next iteration. The algorithm will terminate when the number of iterations exceeds a maximum pre-determined value.

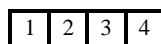


Figure 3.3(a) The Initial Customer Sequence of the VNS Algorithm.

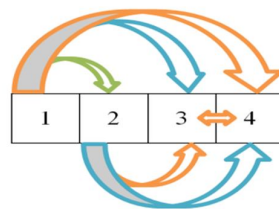


Figure 3.3(b) Neighbourhood Generation: Exchange Rules

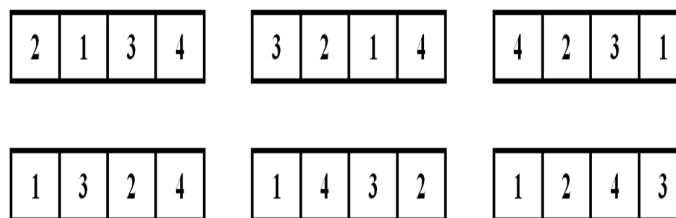


Figure 3.3(c) The New Neighbourhood Solutions.

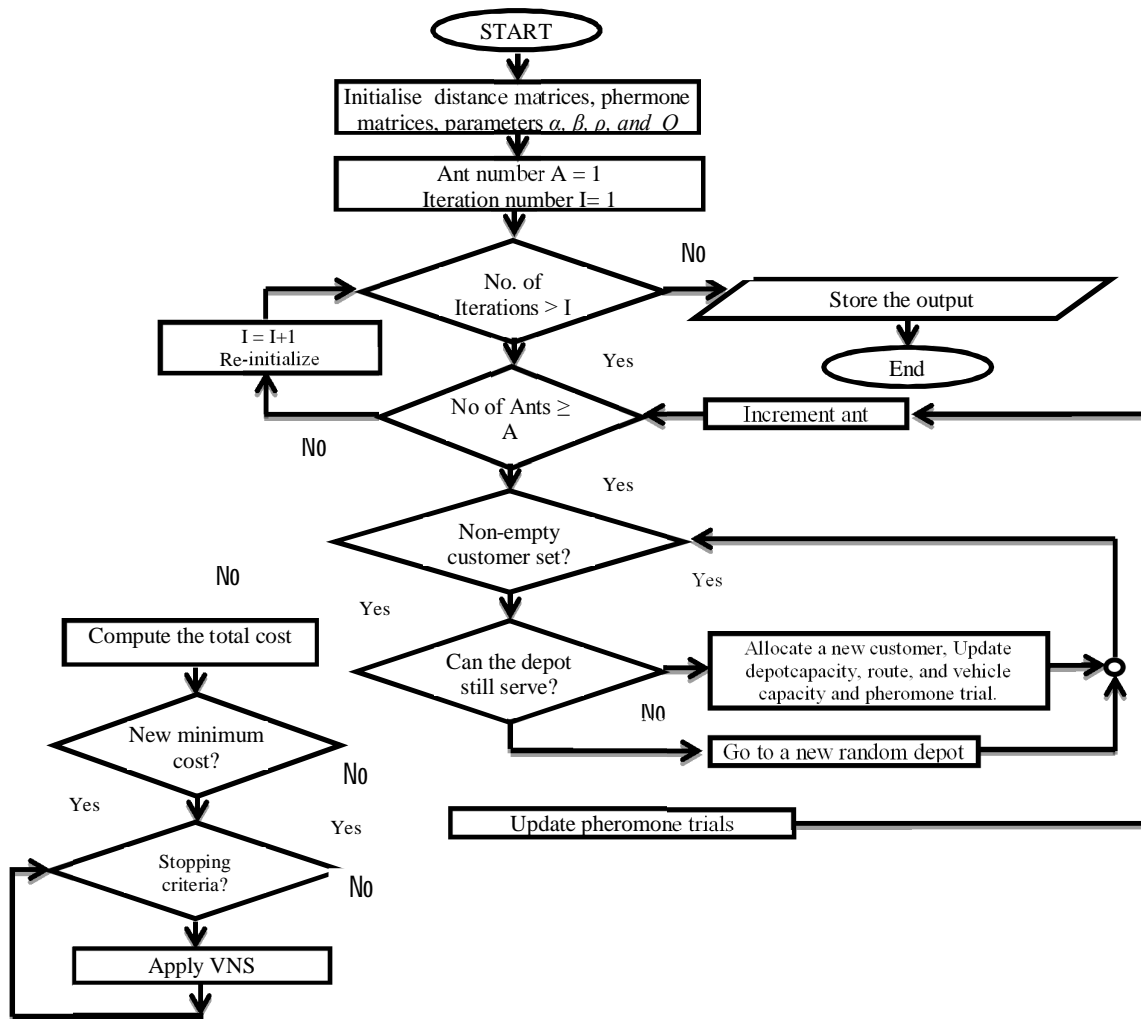


Figure 3.2 Flowchart of the proposed hybrid ACO-VNS based heuristic

#### 4. Computational Experiments

The developed algorithms are coded in MATLAB and implemented on a Core i3 processor at 2.13 GHz PC with 3 GB RAM to solve the problem. The algorithms are tested on a set of randomly generated problem instances.

##### 4.1 Problem Instances

The data for the MDVRP has been randomly generated. The problem instances are generated by varying different parameters such as the number of customers,  $n$ , number of depots  $m$  and vehicle capacity  $Q_v$ . There are two sets of problems for different parameter configurations. The number of depots considered is 2, 3, 5 and 10. The vehicle capacity considered is 70 or 150. The number of customers,  $n$  considered is  $n \in \{10, 15, 20, 30, 50\}$ . The other data (demands, depot capacities, fixed costs) are also integers. The problem instances are randomly generated with the following characteristics namely; (i) Demand follow a uniform distribution [20, 30]. (ii) Data pertaining to carbon emission and carbon costs are assumed based on Forbes (2009) and report of the Automotive Research Association of India (2008). The values for the various problem parameters are as follows.

$C_{fuel}$	\$1.0338
$T$	\$15/vehicle
$P_{CO_2}$	\$20
$W_{CO_2}$	0.027 Ton
$W_{prod}$	0.0189Ton
$V_f$	0.01653L/Ton/km
$F_{CO_2}$	\$0.89262/Ton/km
$W_{curb}$	16.2Ton
$K$	5

4.2 Parameter Settings

The Taguchi method of experimental design is conducted on a randomly generated problem instance and is adopted for the study. The values for the algorithmic parameters are as follows.

- Magnitude of pheromone intensity ( $\alpha$ ) = 0.4
- Magnitude of visibility ( $\beta$ ) = 2
- Evaporation rate of pheromone ( $\rho$ ) = 0.2
- Pheromone increment amount ( $Q$ ) = 4
- Number of ants = 100
- Number of iterations = 40

5. Results and Discussion

The developed algorithms are tested on a number of randomly generated instances. The generated problem instances are characterized by the following criteria (i) The number of depots ( $m$ ), (ii) The number of customers ( $n$ ) (iii) The vehicle capacity ( $Q_v$ ).

The solutions obtained for the problem instances using the proposed algorithms ACO and ACO-VNS are tabulated in Table 5.1.  $Cost_{max}$ ,  $Cost_{min}$  and  $Cost_{average}$  are the worst, best and average solutions obtained using the two heuristic algorithms in the computational study. The algorithms are tested for consistency by computing the deviation of the average solution from the best solution with respect to the average solution. The percentage deviation is calculated using the equation 5.1.

$$\% \text{ deviation} = \frac{Cost_{average} - Cost_{min}}{Cost_{average}} \times 100 \tag{5.1}$$

The percentage deviation of the ACO based heuristic varies from 0 % to 4.6774 % with a median value of 0.0244%. The ACO-VNS based heuristic also shows consistent performance with deviation ranging from 0 % to 1.5374 % with a median value of 0.0785%.

Table 5.1 Computational Results of Proposed Heuristics

PI	n	m	Q	ACO				ACO-VNS			
				Cost <sub>max</sub>	Cost <sub>min</sub>	Cost <sub>average</sub>	% deviation	Cost <sub>max</sub>	Cost <sub>min</sub>	Cost <sub>average</sub>	% deviation
1	10	2	70	4431.40	4431.4	4431.4	0.0000	4422.6	4422.6	4422.6	0.0000
2	10	2	70	5378.20	5378.2	5378.2	0.0000	5366.9	5366.9	5366.9	0.0000
3	15	2	70	7739.30	7738.6	7739.0	0.0052	7736.2	7734.8	7735.5	0.0090
4	15	2	70	6575.00	6575.0	6575.0	0.0000	6569.2	6567.7	6568.2	0.0076
5	20	3	70	10538.00	10538.0	10538.0	0.0000	10539.0	10537.0	10538.0	0.0095
6	20	3	70	5478.90	5476.6	5478.1	0.0274	4463.2	4448.1	4454.6	0.1459
7	20	3	150	9743.40	9686.3	9719.3	0.3395	96821.0	9670.8	9678.2	0.0765
8	20	3	150	5608.80	5608.8	5608.8	0.0000	4576.1	4576.1	4576.1	0.0000
9	30	3	70	13906.00	13873.0	13895.0	0.1583	13904.0	13870.0	13892.0	0.1584
10	30	3	70	7640.00	7640.0	7640.0	0.0000	6655.8	6594.0	6625.7	0.4784
11	30	3	150	16236.00	15769.0	15924.0	0.9734	14214.0	14130.0	14186.5	0.3983
12	30	3	150	7848.40	6841.3	7177.0	4.6774	5797.3	5797.3	5797.3	0.0000
13	50	5	70	26285.00	25457.0	25871.0	1.6002	26218.0	25425.0	25822.0	1.5374
14	50	5	70	13082.00	13041.0	13062.0	0.1608	9862.0	9728.9	9795.5	0.6799
15	50	5	150	28007.00	27995.0	28001.0	0.0214	24862.0	24821.0	24841.0	0.0805
16	50	5	150	13436.00	13426.0	13431.0	0.0372	10202.0	10079.0	10140.0	0.6016

PI – Problem Instance; n-number of customers; m - number of depots; Q- vehicle capacity

Table 5.2 provides the cost improvement obtained using the hybrid meta-heuristic over the ACO based algorithm. The solution diversification by introducing a variable neighborhood search is showing a clear improvement in the search results. The results show that there is an improvement on an average of 8.56 %, 6.85 % and 8.48 % in the economic cost, the emission cost and the total supply chain cost respectively. The percentage gain or loss in costs is also provided in Table 5.2. Figure 5.1 shows the comparison between the performances of the two heuristics.

Table 5.2 Comparative Study of ACO and ACO-VNS Results

PI	n	m	Q	ACO			ACO-VNS			%change in economic cost	%change in emission cost	%change in total cost
				Economic cost	Emission cost	Total cost	Economic cost	Emission cost	Total cost			
1	10	2	70	4192.0	239.4	4431.4	4189.0	237.6	4422.6	0.0716	0.7735	0.1986
2	10	2	70	5167.0	211.2	5378.2	5167.0	211.2	5366.9	0.0000	0.0000	0.2101
3	15	2	70	7326.0	412.6	7738.6	7323.0	411.8	7734.8	0.0410	0.1913	0.0490
4	15	2	70	6256.0	319.0	6575.0	6252.0	315.7	6567.7	0.0639	1.0135	0.1100
5	20	3	70	10240.0	297.8	10537.8	10238.0	298.9	10536.9	0.0195	-0.3857	0.0081
6	20	3	70	5223.0	253.6	5476.6	4213.0	235.1	4448.1	19.3375	7.2950	18.7798
7	20	3	150	9304.0	382.3	9686.3	9297.0	373.8	9670.8	0.0752	2.2413	0.1607
8	20	3	150	5284.0	324.8	5608.8	4280.0	296.1	4576.1	19.0008	8.8503	18.4130
9	30	3	70	13393.0	479.9	13872.9	13391.0	478.9	13869.9	0.0149	0.2181	0.0220
10	30	3	70	7312.0	328.0	7640.0	6294.0	300.0	6594.0	13.9223	8.5131	13.6901
11	30	3	150	14519.0	657.5	15176.5	13498.0	632.3	14130.3	7.0322	3.8211	6.8931
12	30	3	150	6407.0	434.3	6841.3	5389.0	408.3	5797.3	15.8889	5.9822	15.2600
13	50	5	70	24651.0	806.1	25457.1	24636.0	788.9	25424.9	0.0608	2.1307	0.1264
14	50	5	70	12502.0	538.9	13040.9	9362.0	366.9	9728.9	25.1160	31.9103	25.3967
15	50	5	150	26875.0	1132.1	28007.1	23802.0	1018.7	24820.7	11.4344	10.0168	11.3771
16	50	5	150	12677.0	749.4	13426.4	9532.0	547.2	10079.2	24.8087	26.9802	24.9299

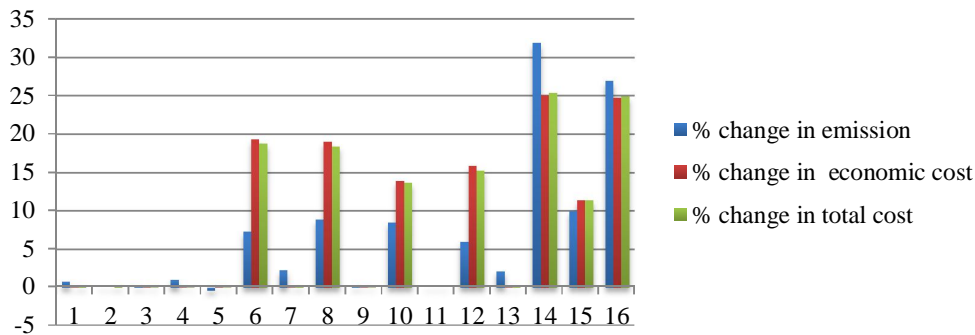


Figure 5.1 Comparative Study of ACO and ACO-VNS Results

Interestingly, for some solutions with a better economic cost as well as the total cost, the corresponding emission cost is worst. Overall, it is understood that the emission costs are much less compared to the economic cost. Hence, it can be inferred that the route selection decision is mainly dominated by the economic costs. Lin et al. (2014) also provides a similar observation while discussing the environmental analysis of a pickup and delivery problem. This optimization model is able to provide a direction to the routes of the classical vehicle routing problem based on the emission level.

### 6. Conclusion

In this work, a green-MDVRP problem is formulated. The carbon emission of the logistic network is added as a cost function to the routing costs for accounting the environmental impact of the supply chain. Two soft computing search procedures are developed to solve the discrete optimisation problem. An ACO based heuristic and a hybrid heuristic combining ACO and VNS are used to solve the problem near optimally. The algorithms are tested on randomly generated problem instances. The hybridisation provides significant improvement in the solutions. Based on the computational study, the results are found to be consistent over the test data. The computational results in this work provide guidelines for environmentally conscious and responsible route selection decisions.

In the current work, the study is limited to the carbon emissions. Future work can be conducted by considering other GHG emissions, noise levels and so on. The multi-objective scenarios where the decision maker wants a portfolio of solutions will be an interesting extension to the current study. Furthermore, the work can be extended for measuring carbon footprint of the supply chain network, life cycle assessment for supply chains, designing emission restricted routes, environment governance decisions and environmental tax calculations.

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# Mixed Model Production Sequencing in an Automobile Industry: A Case Study



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**Abdul Nazar K P**  
**V Madhusudanan Pillai**

*National Institute of Technology, Calicut*  
(nazarppns@gmail.com)  
(vmp@nitc.ac.in)

*Mixed Model Production (MMP) is a Just-In-Time (JIT) tool to achieve level production in multi-product environments. Products are sequenced to achieve organizational goals in MMP systems. Researchers consider Production Rates Variation (PRV) as a criterion to evaluate MMP sequences in JIT-centric systems. This paper analyses the existing production sequence in an automobile manufacturing industry in India. We use a heuristic approach to solve the production sequencing problem with the objective of minimizing PRV. The paper proposes a production sequence that has a small PRV value as compared to the existing sequence, which helps to achieve the JIT objectives.*

## 1. Introduction

### 1.1 Mixed Model Production Systems

Mixed Model Production (MMP) or Mixed Model Assembly Line (MMAL) is the Just-In-Time (JIT) tool to achieve level production. It is the production of multiple kinds of products on a repetitive basis, in a mixed fashion and at a single line or station (Nicholas, 1998). Production becomes smoother when batch sizes are small and theoretically maximal smoothing is achieved by scheduling production at final assembly in batches of size one. In a multi-product environment, it is necessary to develop a regular cycle among these items while ensuring a relatively smooth workload. MMP systems enable manufacturers meet demand for a variety of products in an efficient way. If the demand for each product is too low to use dedicated manufacturing lines or facilities, MMP is used to produce many similar but not identical products.

The major issues to be addressed in MMP systems are: (i) Designing and balancing the line and (ii) Sequencing the different product models. The Mixed model production sequencing is a problem of determining the sequence of introducing models to the mixed model assembly line. The sequencing has to be done considering the main organizational goals that are crucial to the efficient implementation of the Just-in-Time production system (Monden, 1983).

**Objectives in MMP Sequencing Problem:** Various objectives are considered in finding the optimal MMP sequences in literature. Boysen et al. (2009) categorized these goals broadly into two classes. (i) Minimizing work overload (utility workers) and (ii) Just-in-Time objectives. The objective of JIT-centric sequencing approaches is to distribute the material requirements evenly over the planning horizon. This is to achieve the steady demand rate of materials over time (Joo et al., 1993) which is an important condition for JIT manufacturing. Different models are composed of various product options and thus require different materials, subassemblies and parts. So the model sequence affects the demands of these items over time. As an assembly line is commonly coupled with preceding production levels by means of a JIT-supply of required materials, the model sequence needs to facilitate this. Therefore, a large number of researchers have approached the mixed model sequencing problem with this objective of keeping a constant usage rate of every part used in the production system. The goal chasing algorithm also belongs to this category. The first mathematical model of the Toyota system is proposed by Miltenburg (1989), which defines two basic production systems: the multi-level and the single-level system. Miltenburg (1989) formulated the mixed model sequencing problem as a non-linear integer programming problem with the objective of minimizing the total deviation of actual production rates from the desired production rates. Miltenburg and Sinnamon (1989) analyzed a mixed multi-level model assembly line with four levels such as products, subassemblies components and raw materials. Leu et al. (1996) developed a genetic algorithm to solve a sequencing problem with this goal for a multi-stage production system. Sumichrast and Clayton (1996) evaluated the existing algorithms for a sequencing problem with this goal. Sumichrast et al. (1992) compared several procedures for sequencing problems with this goal by using simulation analysis and provided guidelines for selecting most efficient sequencing method for achieving their objectives.

**Production Rates Variation:** Miltenburg (1989) introduced an assumption in mixed model production systems that all products require the same number and mix of parts in the model. Under this assumption, minimizing the variation in production rates of the final product achieves minimizing the variation in all parts usage rates. Then the multi-level scheduling problem reduces to a single level problem. Kubiak (1993) distinguished the part level and product level problems based on this assumption and called the product level problems as product rates variation (PRV) problems. It is also called Miltenburg's usage metric (Mansouri, 2005). The original multi-level problem was also called as Output Rate Variation (ORV) problem. Many researchers have used PRV as the criteria to evaluate the MMP sequences (Mansouri, 2005, Kubiak & Sethi, 1991). The research efforts on PRV are summarized by Kubiak (1993) as well as by Dhamala and Kubiak (2005). The

product rate variation is calculated using equation 1 shown in section 2. This is a measure of the deviation of actual production from the desired production and also a measure of production levelling.

**Genetic Algorithm in MMP Sequencing Problem:** The MMP sequencing is an NP-hard combinatorial optimization problem. Computational time is a critical factor in sequencing since it is a short term planning. Hence, a number of researchers have used evolutionary algorithms and other heuristic procedures in solving the MMP sequencing problem. Genetic Algorithm (GA) is the mostly used evolutionary algorithm in the MMP sequence optimization problem. Genetic algorithms are search algorithms that mimic natural selection and natural genetics. They work by applying the survival of the fittest strategy on string structures with ordered yet randomized information exchange to form robust global optimizers. Since its introduction by Holland (1977), various versions of the algorithm have been developed and have been used in a wide variety of applications particularly in combinatorial optimization problems.

To implement GA, a coding is employed to represent the parameters in the problem to be searched. Then, the search procedure is started by forming a population of initial solutions. Then the GA operations selection, crossover and mutation are employed to improve the search repetitively as measured by a fitness function. The process continues until the termination condition is reached. In the case of MMP sequencing problem, each solution is just a sequence of the parameter values of the problem (chromosome), and the individual sites on the chromosome where parameter values are stored are called genes (Leu et al., 1996). Each chromosome represents a sequence of models to be produced in a cycle ( e.g. ABABACAD or AAAABBCD) and each gene on the chromosome represents the individual model A, B, C or D. Once the number of units in a cycle is known, the initial population of random feasible initial solutions can be generated. Each initial solution is merely a different permutation of the feasible number of models. A fitness function is used to evaluate and select the better performing solutions that themselves become candidates for improvement using the genetic operations of crossover and mutation. The criterion to assess the sequences such as production rates variation (PRV) becomes the fitness function.

Although a number of genetic operators have been developed by different researchers (Starkweather, 1991) many of them need modification to satisfy the feasibility conditions of the sequencing in MMALs. The feasibility in the sequencing problem can be stated that the number of genes representing a model type should be equal to the number of units of that model type specified by MPS. The first research on the application of genetic algorithms MMP sequencing problem is carried out by Hyun et al. (1998). The objective was to solve single objective MMAL sequencing problems. They also proposed a method that can take advantage of the parallelism inherent in GAs to find diverse Pareto optimal solutions particularly for multiple objective sequencing problems in MMAL. The key to the method is a new evaluation and selection mechanism, called Pareto stratum-niche cubicle.

Ponnambalam et al. (2003) studied the performance of the selection mechanisms and showed that the genetic algorithm that uses the Pareto stratum-niche cubicle performs better than the genetic algorithm with the other selection mechanisms. They compared the Pareto stratum-niche cubicle and the selection based on scalar fitness function with respect to the objective of minimising variation in part-usage, minimising total utility work and minimising the setup cost. Kim et al. (1996) modified several existing binary operators to handle MMAL sequencing problem. They also developed a new binary operator called Immediate Successor Relation Crossover (ISRX). Mansouri (2005) proposed a Modified Genetic Algorithm (MOGA) which was able to find good solutions in terms of Pareto-optimality. Three genetic operators namely crossover, inversion and mutation, were used in the proposed MOGA. The major challenge in using GAs in MMP sequencing problem is to satisfy the feasibility condition during the genetic operations. The existing operators are to be modified, or new operators are to be developed to maintain the feasibility of the new solutions.

Though the MMP sequencing problems are well researched, real-world case studies reported are very few. Real sequencing problems involve a large number of product sets with high variance in demand. This case study analyses the existing production sequence in a leading automobile manufacturing industry in India. We use a heuristic approach to solve the production sequencing problem with the objective of minimizing PRV. The paper proposes a new production sequence that has a base and varying component. The resultant sequence has a small PRV value as compared to the existing sequence, which helps to achieve the JIT objectives.

## 2. The Problem Statement

This paper addresses the problem of optimizing MMP sequences with just-in-time objectives for an automobile manufacturing production line. The objective function considered is the minimization of Production Rates Variation (PRV). Continual and stable part supply can be realized when the demand rate of parts is constant over time. This objective is significant to a successful operation of the system. Under the assumption that all products require the same number and mix of parts in the model, the variation in production rates of the final product achieves minimum in all parts usage rates. Thus, the objective can be achieved by matching demand with the actual production. In this paper, the following model is used which is found in Mansouri (2005). This quantity can be taken a measure of production levelling.

$$U = \sum_{k=1}^{D_T} \sum_{i=1}^a \left( x_{i,k} - k \frac{d_i}{D_T} \right)^2 \quad (1)$$

$U$  = Production rates variation of a production sequence

$a$  = Number of unique products to be produced

$d_i$  = Demand for product  $i$ ,  $i=1,2,\dots,a$

$D_T$  = Total number of units for all products

$x_{i,k}$  = Total number of units of product  $i$  produced over stages 1 to  $k$ ,  $k = 1,2,\dots,D_T$

### 3. Analysis of the Existing Production Situation

One of the production lines in a leading automobile industry in India is selected for the case study on mixed model production sequencing. The line manufactures commercial passenger cars in different varieties. We collected production details for one week and summarized the data to identify the different models and the production sequence. Description of the various models manufactured is summarized in Table 3.1. It is observed that 15 models are produced in the same line. The number of each model is determined from the forecasted demand and any current orders. The 15 models are produced in a sequence that repeats after three days. Daily manufactured quantities of different models are given in Table 3.2.

**Table 3.1** Description of Different Models of Cars Manufactured

Model No.	Model Name (Names are not real)	Colour	AC Make (Names are not real)	Market	Drive	Destination/ Language
1	NS	PLW	TUBROS	DOMESTIC	RHD	INDIA/ENGLISH
2	NS	JTS	TUBROS	DOMESTIC	RHD	INDIA/ENGLISH
3	NS ER6	PLW	TUBROS	DOMESTIC	RHD	INDIA/ENGLISH
4	NX	PLW	TUBROS	DOMESTIC	RHD	INDIA/ENGLISH
5	NX	JTS	TUBROS	DOMESTIC	RHD	INDIA/ENGLISH
6	NX ER6	PLW	TUBROS	DOMESTIC	RHD	INDIA/ENGLISH
7	NX ER6	JTS	TUBROS	DOMESTIC	RHD	INDIA/ENGLISH
8	TA NG3	JTS	BHR	EXPORT	RHD	NA/NA
9	TA NG3	BGR	BHR	EXPORT	RHD	NA/NA
10	CLG MISTA	CVG	BHR	EXPORT	LHD	NA/NA
11	CLG MISTA	JTS	BHR	EXPORT	LHD	NA/NA
12	HALZA LHD	SPR	BHR	EXPORT	LHD	NA/NA
13	HALZA LHD	JTS	BHR	EXPORT	LHD	NA/NA
14	YX CBS ER6	JTS	TUBROS	DOMESTIC	RHD	INDIA/ENGLISH
15	YX CBS ER6	PLW	TUBROS	DOMESTIC	RHD	INDIA/ENGLISH

**Table 3.2** Existing Manufacturing Schedule

Model No.	Day 1 & Day 4	Day 2 & Day 5	Day 3 & Day 6
1	35	21	16
2	0	3	12
3	15	14	15
4	41	33	31
5	0	2	10
6	25	28	21
7	0	5	9
8	17	31	7
9	0	2	23
10	2	0	0
11	3	0	0
12	0	0	3
13	0	0	1
14	0	0	2
15	2	0	5
<b>Total</b>	<b>140</b>	<b>139</b>	<b>155</b>

**Analysis of the Current Production Sequence:** Two sequence parameters, the Production Rates Variation (PRV) and number of set-ups, are evaluated for the current production sequence. Table 3.3 shows that the PRV values for the sequence of all the days are much higher. The PRV is a measure of production levelling, and higher value indicates poor levelling of production. Since the set-up times are very small for the automated line, its value is less significant. The case study aims to propose a new production schedule that improves the PRV value and thus levelling the production process.

Table 3.3 Existing Production Sequences

Days	Production sequence	Number of set-ups	PRV
1 & 4	1 1 3 1 1 4 1 1 1 0 4 4 4 4 4 4 1 1 0 4 6 4 8 3 3 6 8 4 4 4 4 1 1 4 4 1 1 4 1 1 1 1 1 1 1 1 1 1 8 1 1 1 1 1 1 6 3 8 1 1 1 8 4 1 1 5 1 1 8 4 1 4 3 4 4 4 1 5 3 1 8 4 1 6 4 8 1 1 3 3 8 3 6 6 4 4 8 4 4 1 1 8 3 6 6 6 8 1 1 1 4 8 6 6 6 3 8 4 4 4 4 8 3 4 6 3 6 6 4 4 6 6 6 6 4 6 4 4 4 4 4 8 3 6 6 3 8 6 6 6	88	13409.44
2 & 5	8 1 1 1 1 8 4 1 1 4 8 4 1 1 6 4 8 1 4 4 4 8 4 1 4 4 8 6 4 4 1 8 1 4 1 6 8 4 4 3 3 8 3 6 6 1 8 1 3 4 3 8 4 6 4 3 8 4 6 3 3 8 6 3 1 8 6 3 2 6 8 1 1 4 6 8 1 4 8 7 4 8 6 4 8 4 1 8 2 4 8 4 4 8 6 4 8 1 3 8 6 6 8 4 6 8 4 3 8 7 7 8 7 6 8 4 7 8 2 6 6 6 8 6 3 6 5 5 4 4 6 6 6 6 6 9 3 6 9	114	10231.45
3 & 6	3 6 3 3 8 4 6 4 4 9 3 2 6 2 9 1 6 5 4 9 4 1 4 1 9 3 3 4 4 9 4 4 3 1 9 2 4 6 5 8 6 6 4 1 9 4 4 4 1 9 4 5 1 4 9 2 4 2 2 9 5 6 6 6 8 7 6 1 4 9 6 6 1 4 9 3 2 9 3 6 1 6 9 6 7 4 3 8 2 4 4 4 4 7 9 6 4 6 3 9 3 3 5 7 9 1 4 7 7 5 9 4 5 1 4 4 9 3 1 5 7 1 2 8 1 5 1 5 7 2 8 6 1 3 7 1 5 9 6 5 1 2 5 8 4 1 5 1 2 3 9 4 2 2 2 9 1 1 6 1 9 1 1 1 1 4 5	132	6088.74

From the weekly demand details, the average daily demand is calculated. This demand is used to determine a base production sequence that is to be repeated on all days. The genetic algorithm based approach is used to determine this base sequence with the objective of minimizing PRV value. Some models have to be produced in excess quantity over the base quantity. These are to be interspersed with the sequence. Table 3.4 shows the weekly demand details of individual models and calculation of base quantity (average demand). Table 3.5 displays the interspersions required for the models over the base quantity.

Table 3.4 Weekly Demand Details and Calculation of Average Daily Demand

Model No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Weekly Demand	144	30	88	210	24	148	28	110	50	4	6	6	2	4	14
Avg. Daily Demand (6 days per week)	24	5	14	35	4	24	4	18	8	0	1	1	0	0	2
Avg. Demand X 6	144	30	84	210	24	144	24	108	48	0	6	6	0	0	12
Balance Demand to be interspersed	0	0	4	0	0	4	4	2	2	4	0	0	2	4	2

Table 3.5 Interspersion of Balance Demand over the Base Production Quantity

Day\Model	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Day 1 & 4			1			1	1	1	1						
Day 2 & 5										1			1	1	1
Day 3 & 6			1			1	1			1				1	

#### 4. Genetic Algorithm (GA) Based Approach for Sequencing

The MMP sequencing problem falls into the category of NP-hard combinatorial optimization problems and thus a large sized problem may be computationally laborious to solve (Tsai, 1995). Computation time can be a critical factor in choosing a method of solving the sequencing problem since real time alteration of model sequences is often necessary when demand pattern changes or part shortage occurs (Hyun et al. 1998). Because of this, most of the researchers in this area use heuristic methods to solve MMP sequencing problem. This study uses a genetic algorithm based approach that consists of different stages as explained below.

**Representation and Initialisation:** In GA each chromosome represents a sequence of models to be produced in a cycle ( e.g. ABABACAD or AAAABBBCD) and each gene on the chromosome represents the individual model A,B,C or D. Once the number of units in a cycle is known, the initial population of random feasible initial solutions can be generated. Each initial solution is merely a different permutation of the feasible number of models. Initially, a population of random sequences are generated, and the population size is taken as 100.

**Fitness Function:** A fitness or evaluation function is used to evaluate and select the better performing solutions, which themselves become candidates for improvement using the genetic operations. The particular form of evaluation function depends on the objective function being considered. The fitness of an individual solution dictates the number of copies of that solution in the mating pool. The more copies an individual receives, the greater is the probability that the characteristics will be repeated in subsequent generations. Since the objective function considered in the present problem is a minimization problem, a transfer function is used to map this to a fitness function. The transfer function used in this paper is

$$F_i = T_{\max} - T_i$$

Where  $F_i$  is the fitness function of the chromosome  $i$ ,  $T_i$  is the objective function value of a sequence  $i$  and  $T_{max}$  is the largest objective function value in the current generation.

**Selection and Reproduction:** The reproduction operator is used to select individuals from the current population to become parents of the next generation. Parents are selected according to their fitness value. Here, roulette wheel selection is used as the selection process. According to this method, the probability of selection of a particular sequence  $P_i$  is calculated as

$$P_i = \frac{F_i}{\sum F_i}$$

where  $F_i$  is the fitness value of the sequence  $i$ .

**Genetic Operations:** The selected chromosomes go to the mating pool for genetic operations to be done on it. Here three genetic operators, crossover, inversion and mutation are used. Randomly 60 percent of the sequences in the mating pool go for crossover and mutation operations while 40 percent go for inversion and mutation operations.

**Crossover:** We used the modified order crossover (modOX) developed by Hyun et al. (1998). This crossover method preserves the feasibility of chromosomes after the operation. The elements from the mating pools are selected in pairs, and they undergo crossover with a crossover probability 0.8. Two crossover points are randomly selected from both the parents. The elements between crossover points in one parent (P1) are copied into an offspring O1 in the same position as they appear in P1. Then the copied elements are randomly deleted from the other parent P2 and the remaining elements in P2 are copied into the undetermined positions in the offspring in the same order as they appear in P2. The second offspring is created by alternating the roles of the two parents. The modOX crossover would create offspring that would preserve the relative order in parents. An example is given in Figure 3.1.

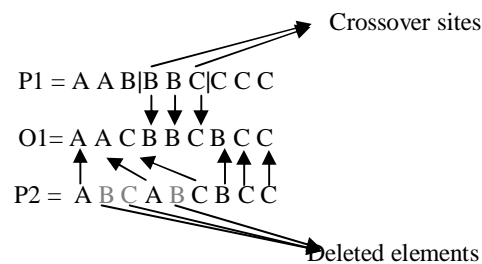
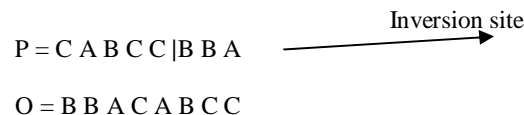


Figure 3.1 Modox Crossover

**Inversion:** Individual chromosomes are selected from the mating pool to undergo inversion operation with an inversion probability 0.8. A single inversion site is generated randomly in the parent string. Then the offspring is formed by inverting the string about the inversion site. The elements after the inversion site in the parent string are copied to the offspring to start from the first position. Then the remaining positions are filled with the elements of the parent string coming before the inversion site in the same order. An example is given below.



**Mutation:** After crossover or inversion operations, each string is selected for the mutation operation. A position in a string is selected for mutation with a mutation probability of 0.1. The element in the selected position of the string is randomly exchanged with another element in the same string. The mutation operation helps to extend the search into previously unexplored areas of the solution space.

**Replacement strategy:** When the genetic operations are completed for the present generation, the offsprings are evaluated based on the objective function and compared with the existing solutions in the mating pool. Only those solutions, which are well performing compared with the current solution, is admitted to the new population. Thus, the fittest among the two becomes the population for the next generation.

**Termination of the Genetic Algorithm:** In each generation, the best sequence is identified. The stopping criterion is implemented by means of a user-defined number (UDN). When succeeding iterations which do not improve the solution reaches the UDN, the algorithm is terminated. Here we use a UDN value equal to 50. On termination, the program gives the best sequence, its objective function value and the CPU time.

### 5. Computational Experimentations

The genetic algorithm (GA) based approach for the mixed-model sequencing problem is coded in Scilab version 5.4.1 and run on a Core i5 processor at 2.60 GHz with Windows 7 and 4 GB RAM. The program is validated by solving the example problems in Mansouri (2005) which resulted in getting the same optimal values. Here, the best sequence is based on the average daily demand, and it forms the base sequence. Table 5.1 shows the base sequence, number of set-ups required and the PRV value. The balance quantity of the models over the average demand is to be incorporated within this base sequence at the start of the day, at the end of the day, or uniformly throughout the day. We propose to manufacture these items at the end of each day so that the level production schedule is least disturbed. The resulting sequences of all the days are shown in Table 5.2. It shows that the PRV value for this proposed sequence is much less than that of the existing sequence.

**Table 5.1** Best Base Sequence Generated by the Algorithm

Base Sequence generated by the algorithm	No. of set-ups	PRV
1 3 4 6 1 4 9 8 3 6 6 4 8 4 1 4 2 9 8 5 6 1 4 3 4 8 6 1 7 3 4 6 1 8 2 4 9 4 1 4 6 8 5 7 6 1 6 4 3 8 4 1 1 4 1 1 6 8 4 9 3 8 1 4 1 2 3 6 1 6 4 1 5 8 4 6 4 1 2 4 1 6 6 4 3 9 3 7 8 1 8 4 1 4 4 1 6 3 5 1 9 8 4 6 6 4 8 1 5 4 1 7 3 4 6 1 8 2 4 9 3 6 4 6 8 3 1 1 4 3 4 6 4 8 6 1 4 2 9 8 5 6 1 4	134	305.46

**Table 5.2** Proposed Production Sequences

Day	Sequence	No. of set-ups	PRV
1 & 4	[Base sequence]+ 3 6 7 8 9	139	451.10
2 & 5	[Base sequence]+10 13 14 15	138	609.22
3 & 6	[Base sequence]+ 3 6 7 10 14	139	542.98

### 6. Results

We studied the operations in a car production line of an automobile manufacturing industry for 1 week and summarized the details of different models (Tables 3.1 and 3.2). It is identified that 15 models of cars are manufactured in the line. The existing production sequence is analysed by finding its production rates variation (Table 3.3). The average daily demand is calculated from the weekly demand of individual models. This forms the base sequence that repeats every day. The proposed genetic algorithm based approach generates the best base sequence. The plant has to produce some models above this base quantity. For this, the excess quantities of these models are produced at the end of each day. This gives an almost level production sequence on all the days. The Production Rates Variation (PRV) for the proposed schedule is only 5% of that of the existing sequence. But the number of set-ups required has increased (Table 5.2).

### 7. Conclusions

A new production schedule is proposed for the automobile manufacturing line using a genetic algorithm based approach. The existing production sequence is not levelled because the production quantity varies on each day. The PRV value is also high. The proposed production sequence supports the manufacturing plant to achieve level production, which in turn helps to become a Just-In-Time organization. The reduced value for production rates variation supports this claim.

The number of set-ups has increased slightly for the new sequence that can become an issue if the set-up times are considerable. This study has considered a single parameter, production rates variation, as the objective of sequencing. In practical situations, the organizations may have to consider other parameters, where the proposed sequence may not be efficient. Hence, further analysis of the system may identify more parameters that depend on the production sequence. The solution approach improves and becomes more realistic when these factors are considered in the objectives of the sequence optimization.

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# Analyzing the Barriers of World-Class Manufacturing (WCM) Practices Implementation using Graph Theoretic Approach



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**Rajesh Attri**

**Nikhil Dev**

YMCA University of Science and Technology

(rajeshattri2005@gmail.com)

(nikhildevgarg@yahoo.com)

*World-Class Manufacturing (WCM) practices are increasingly implemented by the manufacturing organizations in order to achieve the competitive advantage in the present competitive scenario. But, the implementation of WCM practices is not an easy task as it is always surrounded by the numerous barriers. In the present work, an effort has been made to analyze the barriers of WCM practices implementation using Graph Theoretic Approach (GTA) methodology. A WCM barrier index has been proposed in order to evaluate the obstructing power of these barriers. The proposed methodology is demonstrated with the help of an example.*

**Keywords:** Barrier, WCM, world-class manufacturing, GTA, index.

## 1. Introduction

The abstraction of trade barriers and associated competition between the organizations at the international level has positioned the organisations under dominant pressure to analyze their out-dated manufacturing practices (Haleem et al., 2012). This has forced the manufacturing organizations to adopt the prevailing world-class manufacturing (WCM) practices in order to succeed in the present cut-throat competitive scenario.

The commonly used WCM practices are Total Productive Maintenance (TPM), Total Quality Management (TQM), Six Sigma, Just in Time (JIT), Kaizen, Quality Circle (QC), Material Requirements Planning (MRP), Benchmarking, Business Process Reengineering (BPR), Enterprise Resource Planning (ERP) etc. The adoption of the WCM practices have resulted into the refinement of operations, better quality products at the economical prices, waste elimination, greater productivity. No doubt, WCM practices provide so numerous benefits; though, it is not a tranquil task to implement them. Literature analysis reveals that implementation of WCM practices are full of various hurdles which varies from organization to organization. Yamashina (2000) has enumerated various challenges to the world-class manufacturing. Hendry (1998) has identified various problems in applying world class manufacturing to make to order companies. Eid (2009) has identified the factors affecting the success of world class manufacturing implementation in less developed countries like Egypt.

Murugesan et al., (2012) have listed various barriers in implementing the world class manufacturing system (WCMS) in south Indian manufacturing organizations. Salaheldin, and Eid, (2007) have solicited the various obstacles in the implementation of world class manufacturing techniques in Egyptian manufacturing firms. Raj and Attri, (2010) have explained various barriers in the implementation of total quality management. Attri et al., (2013a) have identified various factors affecting the implementation of total productive maintenance. In another paper, Attri et al., (2013b) recognized various roadblocks in the total productive maintenance.

In literature, a number of approaches are presented to model or analyze the various systems and their associated elements. Graph Theoretic Approach (GTA) is most widely used technique for the modelling of the system under consideration in order to quantify them. GTA has been widely used for analysing the various systems in different areas of science, engineering, technology and management (Attri et al., 2013c; Dev and Attri, 2013; Dev et al., 2013a; 2013b; 2013c; 2014a; 2014b; 2015). Literature analysis has exposed that abundant authors have identified the several barriers in the implementation of WCM practices but the author did not come across the analysis of barrier of WCM implementation in manufacturing organizations using GTA. So, in the present work, an effort has been made to analyze the barriers of WCM implementation using graph theoretic approach.

## 2. Identification of Barriers Affecting the WCM Implementation

The barriers affecting the implementation of WCM practices are as follows:

- **Behavioural barriers:** These barriers are related to the human resources (employees) working in the organization for achieving its aims and objectives. This category of barrier includes the following barriers:
  - Lack of top management commitment
  - Resistance from the employees
  - Unwillingness of employees to adopt WCM practices
  - Poor leadership
  -
- **Cultural Barriers:** These barriers are related to the culture prevailing in the organization. These barriers affect the efficient working of the human resources inside the organization. This category of barrier includes the following barriers:



- Poor organizational culture
  - Poor quality consciousness
  - Strong union
  - Lack of cooperation/coordination
- **Educational Barriers:** These barriers are related to educational traits of the human resources working in the organization. This category of barrier includes the following barriers:
    - Lack of technical knowledge
    - Less educated employees
    - Lack of training and education
    - Lack of understanding of WCM concepts
- **Policy Barriers:** These barriers are the strategic barriers which affects the overall working of the organization. This category of barrier includes the following barriers:
    - Poor long term planning
    - Non-clarity of organizational objectives
    - Lack of clear vision
    - Poor allocation of roles and responsibilities
- **Financial Barriers:** These barriers are related to the financial resources. This category of barrier includes the following barriers:
    - High training cost
    - Lack of motivational schemes
    - Lack of resources
    - Lack of funds for improvement schemes

### 3. Graph Theoretic Approach (GTA)

Graph theoretic approach (GTA) is a flexible and useful tool to analyse and comprehend a particular system. This approach overcomes the limitations of existing conventional tools of representation like flow diagram, block diagram etc. These conventional tools are widely used for the representation of the system in the graphical form. But, the present approach i.e. GTA is more helpful for the analysis of a particular system. GTA consists of following elements:

- Digraph representation
- Matrix representation
- Permanent function representation

#### 3.1 Digraph Representation

Digraph is used to signify the variables and their interdependencies in terms of nodes and edges. In digraph, nodes represent the variable and edges represent the interdependencies among them. Digraph for a five variable is shown in Figure 1.

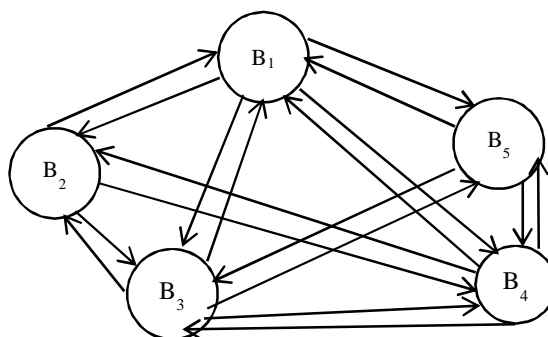


Figure 1 Digraph for Five Variables

#### 3.2 Matrix Representation

Digraph provides the visual analysis up to a limited extent but fails when the number of the variables increases and moreover, digraph becomes more complex. In the matrix representation, the size of the matrix depends upon the number of the variables in the digraph. For the considered five variable digraph, the matrix size will be 5x5. Here, in the matrix, the diagonal elements represent the inheritance of the variables and off-diagonal elements represent the interdependencies among the considered

variables. This matrix is also known as variable permanent matrix (VPM). VPM for the considered five variable diagram can be written as:

$$A = \begin{matrix} & \begin{matrix} B_1 & B_2 & B_3 & B_4 & B_5 \end{matrix} & \text{Variable } (B_i) \\ \begin{matrix} B_1 \\ b_{21} \\ b_{31} \\ b_{41} \\ b_{51} \end{matrix} & \begin{matrix} b_{12} \\ B_2 \\ b_{32} \\ b_{42} \\ b_{52} \end{matrix} & \begin{matrix} b_{13} \\ b_{23} \\ B_3 \\ b_{43} \\ b_{53} \end{matrix} & \begin{matrix} b_{14} \\ b_{24} \\ b_{34} \\ B_4 \\ b_{54} \end{matrix} & \begin{matrix} b_{15} \\ b_{25} \\ b_{35} \\ b_{45} \\ B_5 \end{matrix} & \begin{matrix} B_1 \\ B_2 \\ B_3 \\ B_4 \\ B_5 \end{matrix} \end{matrix} \quad (1)$$

**3.3 Permanent Function Representation**

Permanent is a standard matrix function which is widely used in the combinatorial mathematics (Jurkat and Ryser 1966; Attri and Grover, 2014). The value of permanent function assists in determining the value of numerical index. The permanent function of the VPM is computed in the similar manner as the determinant is computed. But, in the permanent function computation, all the negative signs which occur in the determinant are switched by the positive signs. The permanent of the equation (1) is written as:

$$\begin{aligned} per(A) = & \prod_1^5 B_i + \sum_j \sum_k \sum_l \sum_m (b_{ij} b_{jk} b_{kl} b_{lm}) B_i B_j B_k B_m \\ & + \sum_j \sum_k \sum_l \sum_m (b_{ij} b_{jk} b_{kl} + b_{ik} b_{lj} b_{jm}) B_i B_m \\ & + \left[ \sum_j \sum_k \sum_l \sum_m (b_{ij} b_{jk}) (b_{kl} b_{lm}) B_m \right. \\ & \left. + \sum_j \sum_k \sum_l \sum_m (b_{ij} b_{jk} b_{kl} b_{lm} + b_{ji} b_{lk} b_{mj} b_{il}) B_m \right] \\ & + \sum_j \sum_k \sum_l \sum_m [(b_{ij} b_{jk}) (b_{kl} b_{lm} b_{mk} + b_{km} b_{nl} b_{lk}) \\ & + \sum_j \sum_k \sum_l \sum_m (b_{ij} b_{jk} b_{kl} b_{lm} b_{mi} b_{ni} + b_{im} b_{ln} b_{mj} b_{kj} b_{jl})] \end{aligned} \quad (2)$$

**4. WCM Barrier Index (WCMBI)**

The WCM environment of an organisation is a function of these five barriers (as explained in the section 2) and their interdependence:

$$\text{WCM barrier index (WCMBI)} = f(\text{barriers}) \quad (3)$$

Here, the value of index depends upon the existence of the barriers and the level of interaction between the considered barriers.

$$\text{WCMBI} = f(\text{Barriers}) = f\{\text{Behavioural Barrier } (B_1), \text{ Cultural Barrier } (B_2), \text{ Educational Barrier } (B_3), \text{ Policy Barrier } (B_4), \text{ and Financial Barrier } (B_5)\} \quad (4)$$

In order to find the WCM barrier index of an organization, the permanent function of the WCM barrier matrix is computed in the similar manner as discussed in section 2. The value of the permanent function provides the value of WCM barrier index. But, in order to compute the permanent function of the WCM barrier matrix, the values of diagonal elements and off-diagonal elements are required. It may be noted here that the values of the elements (both diagonal and off-diagonal elements) should be used from the available literature data. But, if the data is not available in qualitative terms then values of the WCM barrier inheritance may be taken from Table 1. This concept has been employed by the various authors such as Raj and Attri, 2010; Kulkarni (2005); Wani and Gandhi (1999); Attri et al., (2014).

**Table 1** Quantification of WCM Barrier

Qualitative measure of WCM barrier	Assigned value of WCM barrier
Exceptionally low	1
Very Low	2
Low	3
Below average	4
Average	5
Above Average	6
High	7
Very high	8
Exceptionally high	9

Moreover, the numerical values for the interdependencies among the WCM barriers may be taken from the Table 2. But the values from the corresponding tables should be taken only after the proper elucidation by experts (Faisal et al. 2007, Wani and Gandhi 1999).

It may be noted here that the value of off-diagonal elements at the system/sub-system level can be determined from Table 2 but for the value of diagonal element, it is recommended to epitomize digraph for each WCM barriers with their sub-WCM barriers. So, the values of the diagonal elements at the system level should be taken from the permanent function value of sub-WCM barrier matrix but in case of sub-system level, the values should be taken from the Table 1.

**Table 2** Quantification of Interdependencies/off Diagonal Elements

Qualitative measure of interdependencies	$b_{ij}$
Very Strong	5
Strong	4
Medium	3
Weak	2
Very weak	1

The steps involved in the computation of WCMBI are as follows:

- Identify the various barriers affecting the WCM environment of the organization.
- Classify these barriers into different categories.
- Develop the digraph between the major barriers. This is the digraph at the system level.
- Develop the variable permanent matrix (VPM) for the major barriers. This is VPM at the system level.
- Develop the digraph between the sub-barriers of major categories. These are the digraphs at the sub-system level.
- Develop the VPM of sub-barriers from the digraph developed in previous step. These are the VPMs at the sub-system level.
- Put the values of inheritance and interdependencies in the VPM of sub-system level from Table 1 and Table 2 after the consultation with the experts.
- Compute the value of permanent function of VPM at the sub-system level.
- Now, put the value of inheritance in the VPM of system level from the permanent function value of sub-system level. But, the value of the interdependencies should be taken from Table 2 after consultation with the experts.
- Compute the value of permanent function of VPM at the system level. This value represents the value of WCMBI.
- Record the data for further analysis.

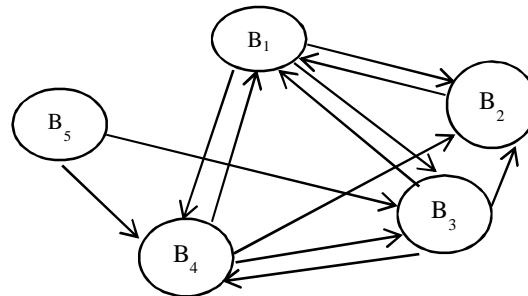
### 5. Demonstration of Proposed Methodology

In this section, an example of an organization is taken for the demonstration of the proposed methodology. The methodology discussed above is used for computing the index of WCM barriers.

**Step 1:** The various major barriers affecting the WCM environment of the organization are identified as discussed in section 3.

**Step 2:** The barriers identified in the step 1 are classified into different categories as discussed in section 2.

**Step 3:** The digraph is developed between the major barriers as presented in Figure 2. This is the digraph at the system level.



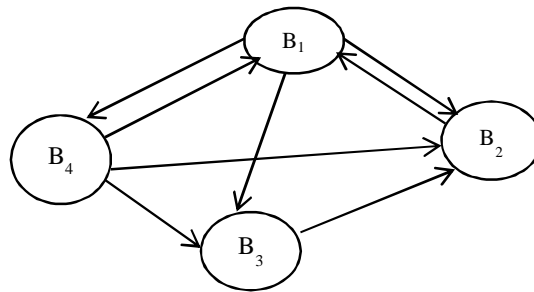
**Figure 2** WCM Barrier Digraph

**Step 4:** The variable permanent matrix (VPM) is developed for the major barriers. This is VPM at the system level.

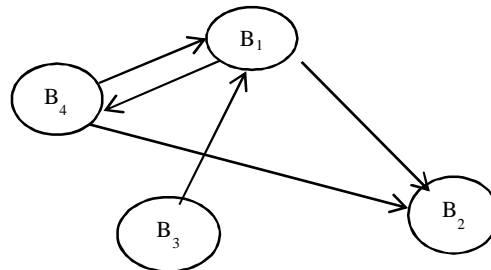
$$A^* = \begin{matrix} \begin{matrix} B_1 & B_2 & B_3 & B_4 & B_5 \\ \left. \begin{matrix} B_1 & b_{12} & b_{13} & b_{14} & 0 \\ b_{21} & B_2 & 0 & 0 & 0 \\ b_{31} & b_{32} & B_3 & b_{34} & 0 \\ b_{41} & b_{42} & b_{43} & B_4 & 0 \\ 0 & 0 & b_{53} & b_{54} & B_5 \end{matrix} \right\} & \begin{matrix} Barrier (B_i) \\ B_1 \\ B_2 \\ B_3 \\ B_4 \\ B_5 \end{matrix} \end{matrix} \end{matrix} \tag{5}$$

Here, in the above matrix, the diagonal elements denote the inheritance of WCM barriers but the off-diagonal elements characterizes the interaction among the WCM barriers.

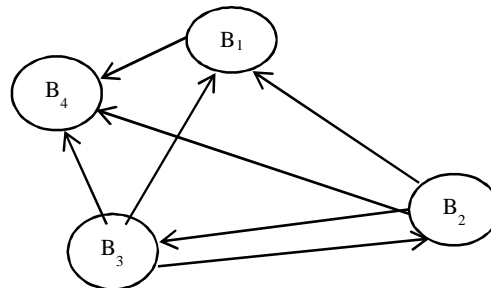
**Step 5:** The digraph between the sub-barriers of major barrier categories is developed as presented in Figures 3-7. This is the digraph at the sub-system level.



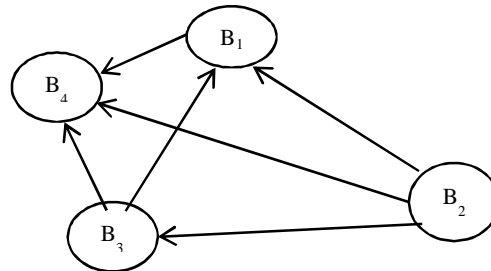
**Figure 3** Behavioural Barrier Diagram



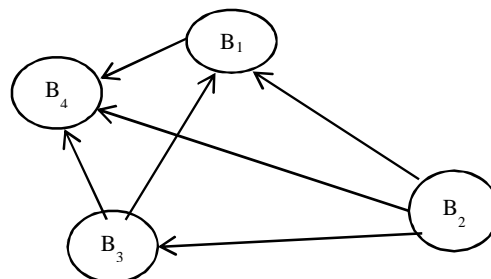
**Figure 4** Cultural Barrier Diagram



**Figure 5** Educational Barrier Diagram



**Figure 6** Policy Barrier Diagram



**Figure 7** Financial Barrier Diagram

**Step 6:** VPM is developed (equations 6-10) for the sub-barriers from the digraph developed in previous step. This is the VPM at the sub-system level.

$$B_1 = \begin{matrix} & B_1 & B_2 & B_3 & B_4 & \text{Sub-barrier}(B_i) \\ \begin{bmatrix} B_1 & b_{12} & b_{13} & b_{14} \\ b_{21} & B_2 & 0 & 0 \\ 0 & b_{32} & B_3 & 0 \\ b_{41} & c_{42} & c_{43} & B_4 \end{bmatrix} & & & & & \begin{matrix} B_1 \\ B_2 \\ B_3 \\ B_4 \end{matrix} \end{matrix} \tag{6}$$

$$B_2 = \begin{matrix} & B_1 & B_2 & B_3 & B_4 & \text{Sub-barrier}(B_i) \\ \begin{bmatrix} B_1 & b_{12} & 0 & 0 \\ 0 & B_2 & 0 & 0 \\ b_{31} & 0 & B_3 & 0 \\ b_{41} & c_{42} & 0 & B_4 \end{bmatrix} & & & & & \begin{matrix} B_1 \\ B_2 \\ B_3 \\ B_4 \end{matrix} \end{matrix} \tag{7}$$

$$B_3 = \begin{matrix} & B_1 & B_2 & B_3 & B_4 & \text{Sub-barrier}(B_i) \\ \begin{bmatrix} B_1 & 0 & 0 & b_{14} \\ b_{21} & B_2 & b_{23} & b_{24} \\ b_{31} & b_{32} & B_3 & b_{34} \\ 0 & 0 & 0 & B_4 \end{bmatrix} & & & & & \begin{matrix} B_1 \\ B_2 \\ B_3 \\ B_4 \end{matrix} \end{matrix} \tag{8}$$

$$B_4 = \begin{matrix} & B_1 & B_2 & B_3 & B_4 & \text{Sub-barrier}(B_i) \\ \begin{bmatrix} B_1 & 0 & 0 & b_{14} \\ b_{21} & B_2 & b_{23} & b_{24} \\ b_{31} & 0 & B_3 & b_{34} \\ 0 & 0 & 0 & B_4 \end{bmatrix} & & & & & \begin{matrix} B_1 \\ B_2 \\ B_3 \\ B_4 \end{matrix} \end{matrix} \tag{9}$$

$$B_5 = \begin{matrix} & B_1 & B_2 & B_3 & B_4 & \text{Sub-barrier}(B_i) \\ \begin{bmatrix} B_1 & 0 & 0 & 0 \\ 0 & B_2 & 0 & 0 \\ b_{31} & b_{32} & B_3 & b_{34} \\ b_{41} & b_{42} & 0 & B_4 \end{bmatrix} & & & & & \begin{matrix} B_1 \\ B_2 \\ B_3 \\ B_4 \end{matrix} \end{matrix} \tag{10}$$

**Step 7:** The values of inheritance and interdependencies are placed in the VPM of sub-system level from Table 1 and Table 2 after the consultation with the experts.

$$B_1 = \begin{matrix} & B_1 & B_2 & B_3 & B_4 & \text{Sub-barrier}(B_i) \\ \begin{bmatrix} 7 & 4 & 3 & 2 \\ 2 & 6 & 0 & 0 \\ 0 & 4 & 6 & 0 \\ 2 & 4 & 4 & 6 \end{bmatrix} & & & & & \begin{matrix} B_1 \\ B_2 \\ B_3 \\ B_4 \end{matrix} \end{matrix} \tag{11}$$

$$B_2 = \begin{matrix} & B_1 & B_2 & B_3 & B_4 & \text{Sub-barrier}(B_i) \\ \begin{bmatrix} 8 & 3 & 0 & 0 \\ 0 & 8 & 0 & 0 \\ 2 & 0 & 6 & 0 \\ 3 & 3 & 0 & 7 \end{bmatrix} & & & & & \begin{matrix} B_1 \\ B_2 \\ B_3 \\ B_4 \end{matrix} \end{matrix} \tag{12}$$

$$B_3 = \begin{matrix} & B_1 & B_2 & B_3 & B_4 & \text{Sub-barrier}(B_i) \\ \begin{bmatrix} 7 & 0 & 0 & 4 \\ 4 & 7 & 4 & 4 \\ 4 & 3 & 8 & 4 \\ 0 & 0 & 0 & 8 \end{bmatrix} & & & & & \begin{matrix} B_1 \\ B_2 \\ B_3 \\ B_4 \end{matrix} \end{matrix} \tag{13}$$

$$B_4 = \begin{matrix} & B_1 & B_2 & B_3 & B_4 & Sub-barrier(B_i) \\ \begin{bmatrix} 7 & 4 & 3 & 2 \\ 2 & 6 & 0 & 0 \\ 0 & 4 & 6 & 0 \\ 2 & 4 & 4 & 6 \end{bmatrix} & & & & & \begin{matrix} B_1 \\ B_2 \\ B_3 \\ B_4 \end{matrix} \end{matrix} \tag{14}$$

$$B_5 = \begin{matrix} & B_1 & B_2 & B_3 & B_4 & Sub-barrier(B_i) \\ \begin{bmatrix} 8 & 0 & 0 & 0 \\ 0 & 8 & 0 & 0 \\ 3 & 4 & 9 & 3 \\ 3 & 2 & 0 & 8 \end{bmatrix} & & & & & \begin{matrix} B_1 \\ B_2 \\ B_3 \\ B_4 \end{matrix} \end{matrix} \tag{15}$$

**Step 8:** The value of permanent function of VPM at the sub-system level is computed.

- B<sub>1</sub> = 2248
- B<sub>2</sub> = 2688
- B<sub>3</sub> = 3808
- B<sub>4</sub> = 2744
- B<sub>5</sub> = 4608

**Step 9:** Now, put the value of inheritance in the VPM of system level from the permanent function value of VPM at the sub-system level. But, the value of the interdependencies should be taken from the Table 2 after consultation with the experts.

$$A^* = \begin{matrix} & B_1 & B_2 & B_3 & B_4 & B_5 & Barrier(B_i) \\ \left. \begin{matrix} 2248 & 2 & 3 & 3 & 0 \\ 3 & 2688 & 0 & 0 & 0 \\ 4 & 3 & 3808 & 3 & 0 \\ 3 & 3 & 2 & 2744 & 0 \\ 0 & 0 & 4 & 4 & 4608 \end{matrix} \right\} & & & & & & \begin{matrix} B_1 \\ B_2 \\ B_3 \\ B_4 \\ B_5 \end{matrix} \end{matrix} \tag{16}$$

**Step 10:** At last, the value of permanent function of VPM at the system level is computed. The value of permanent function comes to be 29.09x10<sup>16</sup>. This value represents the value of WCMBI.

At present, it is recommended to compute the maximum and minimum values of WCMBI. WCMBI is computed for maximum value of a barrier i.e. all the sub-barriers of that particular barrier is having maximum value (e.g., 9 here). VPM for the maximum value of behavioural barrier is

$$B_{1Max.} = \begin{matrix} & B_1 & B_2 & B_3 & B_4 & Sub-barrier(B_i) \\ \begin{bmatrix} 9 & 4 & 3 & 2 \\ 2 & 9 & 0 & 0 \\ 0 & 4 & 9 & 0 \\ 2 & 4 & 4 & 9 \end{bmatrix} & & & & & \begin{matrix} B_1 \\ B_2 \\ B_3 \\ B_4 \end{matrix} \end{matrix} \tag{17}$$

The maximum value for the behavioural barrier comes out to be 7957. Similarly the maximum values of all the major barriers are computed. At last, maximum value of WCMBI comes out to be 16.92x10<sup>18</sup>.

In the same manner, WCMBI is computed for the minimum value of a barrier i.e. all the sub-barriers of that particular barrier are having minimum value (e.g., 1 here).

VPM for the minimum value of behavioural barrier is

$$B_{1Min.} = \begin{matrix} & B_1 & B_2 & B_3 & B_4 & Sub-barrier(B_i) \\ \begin{bmatrix} 1 & 4 & 3 & 2 \\ 2 & 1 & 0 & 0 \\ 0 & 4 & 1 & 0 \\ 2 & 4 & 4 & 1 \end{bmatrix} & & & & & \begin{matrix} B_1 \\ B_2 \\ B_3 \\ B_4 \end{matrix} \end{matrix} \tag{18}$$

The minimum value for the behavioural barrier comes out to be 117. Similarly the minimum values of all the barriers are computed. At last, minimum value of WCMBI comes out to be 3030.

The minimum and maximum value of WCMBI shows the range of WCMBI within which it may vary.

## 6. Discussion and Conclusion

The main objective of this paper is to identify and analyze the barriers affecting the implementation of world class manufacturing (WCM) practices using the graph theoretic approach (GTA) method. GTA helps in the quantification of barriers of the WCM adoption. For this purpose, WCMBI has been computed. This index (WCMBI) is a versatile and flexible tool for the managers of the manufacturing organizations in order to predict the existence of barriers in their organizations. In

other words, managers may find the weak link in their implementation process. The barriers having the high value of WCMBI need to be tackled more effectively and efficiently for the operational implementation of WCM practices in their organizations.

The developed GTA methodology helps in analysing the barriers of WCM adoption in manufacturing organizations. In the considered example, it was observed that the financial barriers are the main barriers in the effective implementation of WCM practices. It is then followed by educational barriers, policy barriers, cultural barriers and behavioural barriers. Moreover, it may be noted here that the current value of WCMBI in the considered example is nearer to the maximum value of WCMBI. So, organization needs to develop the proper strategies in order to handle them.

The proposed GTA methodology for the evaluation of WCM barriers is a new concept and it has the following limitations:

- The value of diagonal and off-diagonal elements in VPM has been decided with the help of experts' advice and it may result into some biasness.
- Digraph is developed on the opinion of experts.

So, in future, a questionnaire may be floated in the manufacturing organizations to determine the value of diagonal and off-diagonal elements in the VPM.

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# Combinatorics Approach Based Methodology Development for Power Plant Site Selection



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**Nikhil Dev**

**Rajesh Attri**

YMCA University of Science and Technology

(nikhildevgarg@yahoo.com)

(rajeshattri2005@gmail.com)

*In the present work a methodology based upon graph theory, matrix method and combinatorics is developed for the selection of power plant. Every site has its own benefits and constraints. These are dependent upon a large number of factors and sub-factors which are interdependent. Any site selection suitability has to be decided in light of these factors and sub-factors. In the present work, a mathematical model is developed to assess the impact of each factor and sub-factor in power plant site selection suitability index. All the factors and sub-factors are represented in the form digraph which is suitable for visual analysis. This digraph representation is further processed with the help of matrix method and combinatorics and result comes out in the form of a single numerical number called as power plant site selection suitability index. The proposed methodology is demonstrated with the help of an example.*

## 1. Introduction

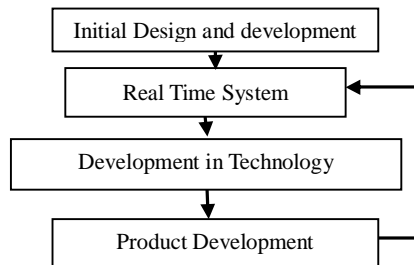
Power sector is one of the fastest growing sectors in India, which essentially supports the economic growth, better living standards and security for the future [1]. Electricity is the most widely used energy resource and average electric power consumption (EPC) is the indicator for the economic growth also. The electricity power sector needs to grow at the rate of 12% to maintain the present GDP growth rate of 8%. Presently, in India, the energy deficit is about 8.3% and the power shortage during the peak period is about 12.5%. The total installed capacity of the power generating units is about 1,24,310 MW. Thermal power generating units contribute 66.4% of total installed capacity. The average plant load factor of the thermal power generating units is 74.8%. (Source: Ministry of power website – www.powermin.nic.in).

To achieve the objective of electricity for all at economical price with higher reliability, it is required to concentrate on two points. Firstly new thermal power plants with advanced technology are to be installed with optimum economic and secondly the installed power plants are to be upgraded to enhance resource utilization efficiency (Figure 1). Therefore, a mass movement for performance improvement of power generating units is required a pick up so that all the Indian power generating units start achieving the world class standards. The earliest step of the movement is the selection of best suitable site for the power plant [2].

For the installation and operation of large scale power plants challenges are related with the economy, ease of operation, plant erection, operation, dismantling etc. [3]. In the present work, factors related with the site selection are identified and categorized into five macro categories. These categories are interdependent and contain some number of sub-factors which are also interdependent [4]. Therefore, for the selection of power plant it required to consider all the factors and sub-factors along with their respective weightage in the system. In this way the mathematical modelling is of the following type:

$$F(\text{Site Selection}) = aX_1 + bX_2 + cX_3 + dX_4 + eX_5 \quad (1)$$

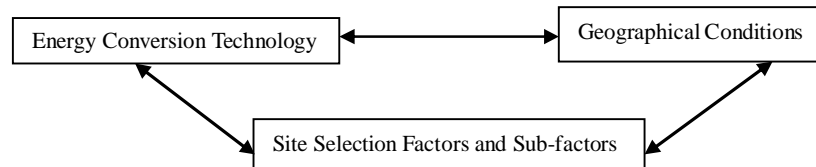
Where a, b, c, d and e are to represent the weightage of the factor for a particular factor category represented by  $X_1$ ,  $X_2$ ,  $X_3$ ,  $X_4$  and  $X_5$ . The weightage for the factors is assigned on the basis of their impact in the system. With this kind of modelling all the factors and sub-factors can be incorporated in the system analysis. Tangibility and intangibility is also taken care of in this modelling. The set of factors is connected with the interlinking set and due to this reason a lot of loops and dyads appear in mathematical modelling. For the solution to be near to real time situation, mathematical model is converted to some logical and easy to process representation. As the calculations are at a very large scale therefore, some computer programming tool is required to generate so that cost is decreased and time is also saved.



**Figure 1** Design and Development of the Product and Technology



In literature, a number of factors are enlisted and discussed which are responsible for the site selection of a power plant. At present, large scale electricity generation power plants are thermal power plants. Other technologies of electricity generation are either immature or non-commercial [5]. In the present work, site selection factors are identified and these are divided in to five categories in accordance to their nature. These factors are dependent/affected by a large number of sub-factors. These factors and sub-factors are discussed in the next section of the paper. The objective of the present work is to identify the best suitable site by considering these factors and sub-factors. Complexity of the system analysis is cobweb nature of factors and sub-factors which leads to the formation of loops and dyads in the system. Their number is also very large and dynamic in nature because geographical conditions for sites are dissimilar. Technology of energy conversion is also diverse in nature. Therefore, logic of analysis should be such that all the constraints are satisfied and model is capable to generate optimal solution. The logical diagram representing the interdependence of energy conversion technology, geographical conditions and site selection factors and sub-factors is as represented in Figure 2.



**Figure 2** Interdependence of Energy Conversion Technology, Geographical Conditions and Site Selection Factors and Sub-Factors

Therefore, the problem to be dealt in the present work is of the type which is having large number of attributes and decision is to be taken while considering all of these attributes [6]. To deal with such types of the problems a large number of logical techniques are available under the class multi-attribute decision making (MADM) techniques. In this line, graph theory is a systematic method to represent the factors and sub-factors. The graph is converted to matrix representation with the help of matrix method. Matrix method is a section of mathematics comprising of different ways to represent any real life problem into matrix form. The matrix carries the information in such a form that if any of the matrix elements is altered then whole information is altered. This shows that all of the matrix elements are interconnected. Any change, either in number of factors and sub-factors or their quantification, in any of them will affect the whole analysis. The information useful for the decision is expedited from the matrix representation with the help of combinatorics mathematics. The matrix representation is converted into permanent representation. This representation is evaluated with the help of computer programming tool developed in C<sup>++</sup>. This combination of mathematical and computational tools is helpful in the product and technology development as represented in Figure 1. In the present analysis, this combination is called as Graph Theoretic Analysis (GTA) [26-33].

In the forthcoming section, factor affecting the site selection are discussed. Based upon this discussion, these factors are divided into categories. Afterwards the mathematical model is developed and analysed with GTA.

## 2. Site Selection Factors

Factors affecting the selection of power are very large in number [6-26]. Power plant system is a very large and complex system. Its components and equipment's are affected by a large number of factors and parameters. The impact of factors or parameters may be permanent or of temporary nature. For example the impact of ambient air temperature on the power plant performance is factor of temporary nature. As the season changes, temperature and relative humidity also changes, due to this performance is affected, but it does not affect the power plant machinery permanently. On the other hand ingestion of foreign objects such as dust particles, chemicals etc. affect the power plant machinery permanently by causing corrosion, erosion and fouling. Therefore, it becomes difficult to study all of the components and factors by considering them as a whole. When all the factors are identified then these may be divided into sub categories. The division is based upon the characteristic and nature of the factor. In the present work, it is found to be suitable to categorize factors into following five divisions:

- a) Fuel
- b) Cost and tariffs
- c) Technical
- d) Labour
- e) Land

The identification and categorization of the factors may be seen somewhere else [26]. The nature blessed us with a very large and diverse kind of the fuels. For each and every fuel, energy conversion technology is also different. Based upon this theory the above mentioned five classes are suggested. In the present work, a methodology based upon Graph Theory, Matrix Method and Combinatorics is developed so that best type power plant can be selected. In literature, it is suggested that a lot of decision making techniques are available at hand for selecting the power plants. But for each kind of technique, it is required to develop a methodology for particular type of decision making. In the present situation, it is required that the methodology selected should be capable of fulfilling the following objectives:

1. The technique should be capable of analysing any number of categories while considering all of the factors identified under that category.
2. It must be a logical and easy to process technique so that the solution is near to real time situation.

3. If at any stage it is found that number of categories or factors are increased then it must be capable of incorporate that change.
4. The technique should be capable of quantifying tangible and intangible factors while considering their inter-dependence.
5. The methodology should be easy to process with some computer programming tool so that time and cost is saved.
6. For a site selection it is required to compare different systems. Therefore, methodology should be such that it is capable of dealing with different kind of systems.

From the literature survey, it is found that graph theory and matrix method is capable of fulfilling the above mentioned objectives. This methodology comprises of three different parts of the mathematics. It is the general practice that every real time problem is represented in the form of some figure or line diagram which is easy to understand. This representation is called as digraph in the graph theory which itself is branch of mathematics. With this, it is easy to have a feel about the interaction amongst system categories. Interaction amongst system categories is variable with change in location and power plant type. This digraph representation of system categories is to be processed with some computer programming tool. Methodology for the Graph Theory and Matrix Method (GTMM) is explained in the next section.

### 3. Graph Theory and Matrix Method

Availability of multiple sites and multiple technologies of energy conversion is grooming the power plant business day by day [1]. As the numbers of power plants are increasing fuel consumption is also increasing [2]. There is strong desire amongst the researcher for finding the alternate fuel and alternate technologies to harness their chemical energy [3]. Such as earlier gas turbine power plants were designed to operate on either liquid fuel or gaseous fuel [4]. But with the passage of time it was felt to develop the technology which may handle both types of fuel [5]. It was also found that all of the fuels composition changes from time to time and place to place [6]. Due to this reason their calorific value is also changed [7]. To cope the situation, fuel injection technology is improved. At present much stress is on the use of shell gas. Therefore, technology is to be improved so that shell gas may be used effectively and efficiently.

Therefore, all the decision making process are dependent upon the real time situation and as well as upon the data available with the managers. Based upon the data and decision taken, methodology is to be developed. Data can be collected either with the discussion or previous studies. Data is also of two types. Either it is physical data or abstract data. Physical data is obtained from a real life operating power plant. Some of the big organizations are having in house facilities to test any newly developed technology. At present some of the manufacturers are developing technologies for the analysis of aged components also. This data is stored in the organization for the further reference. Researchers may conduct field survey for obtaining the useful data. If the data is represented in some figures then it is physical data. Sometimes data or information is obtained in some vague sense such as high, low, more useful, less useful etc. rather then it is abstract data. Both kinds of data are useful if analyzed with the help of some logical and easy to understand technique.

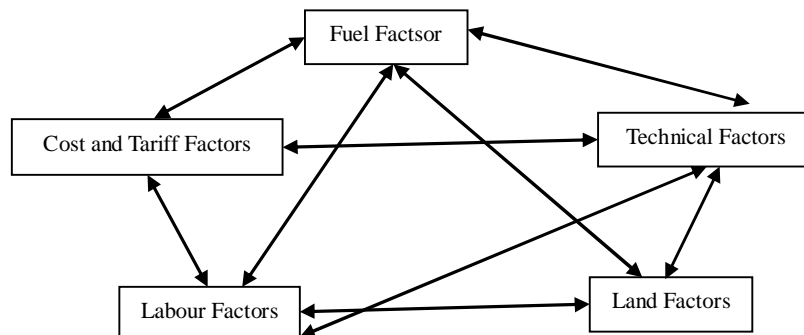


Figure 3 Graph Representing the Factors Category and their Interdependence

In the present work, factors are divided into five classes and all of these five classes are interdependent as shown in Figure 3. This interdependence is as explained henceforth.

#### Fuel Factors

Fuel is the driving force for any power plant. For different power plants it is dependent upon other factors categories as explained below:

- Its cost will be depending upon its availability near the power plant site [1]. If it is available in the nearby area then transportation cost will be less [2]. At larger distance its cost will be increased [3].
- Lesser is the efficiency of the plant higher is the fuel consumption [4].
- Fuel may be liquid, solid or gas or their combination [5]. The cost of fuel handling is variable from fuel to fuel [7]. Handling cost for solid fuel will be higher [6].
- For the solid fuel larger land area is required and land is required for the waste disposal also [8].

### Cost and Tariff Factors

There are different types of the cost associated with the power plant design and erection [9]. For different power plants these are dependent upon other factors categories as explained below:

- Cost of different fuel is different. Coal is comparatively cheaper than gaseous fuel [10]. Uranium is very costly fuel but its consumption is very less by mass [11].
- For a power plant to be of better quality it is desired that higher will be the investment [12]. Its maintenance cost will be higher but reliability and availability will also be higher [13].
- Labour cost is variable from place to place and it also varies with the expertise of labour [14].
- Land is costly near the populated area and the cost decreases as the plant location is preceded to remote places [15].

### Technical Factors

As the other factors are important so are the technical factors [16]. This factor category affects all other factors category [17]. The reason for this is as explained below:

- Liquid and gaseous fuels are relatively cleaner fuel than solid fuels [18]. They are lesser health hazard [19]. It is comparatively easy to handle them [20]. Deterioration of machinery is also very less [21].
- Better technology or newer technology is costlier than older one [22]. It is also expected that with the advent of new technology efficiency of energy conversion is also increased [23].
- For the effective implementation of any plan it is required that labour is skilled and its aptitude and attitude is for the betterment of the organization [24].
- Land requirement also changes with different techniques of energy conversion [25]. Such as gas turbine power plant requires lesser area than coal based steam power plant [26].

### Labour Factors

No machinery can work without its proper erection and maintenance [27]. The efficiency of operation is dependent upon the skill of the labour [28]. But higher skilled is the labour more is the cost it will demand [29]. Better amenities are also expected in that case [30]. This factor category is related with the others due to the following reasons:

- Fuel handling, feeding to plant and disposal of waste after using the fuel is a labour intensive phenomenon [31].
- Labour cost comprises of factors such location of the plant from the city, its skill and requirement of the labour [32]. Gas based power plant are easy to handle and need for the labour is lesser in number [33].
- As all of the machinery operation is dependent upon the labour therefore, technical efficiency of the power plant is fully dependent on the labour [1].
- Higher is the number of labour more is the requirement of site for the dwelling of basic amenities such as housing, medical facilities etc. [2].

### Land Factors

Size of the land is limited but the needs of human race are unlimited [3]. Therefore, land acquisition is must but it is desirable to utilize it optimally [4]. Effective use of land is in connection with the other factors and it is as explained following:

- Coal based power plants are preferred to install in the areas where coal is easily available [5]. In the similar manner gas based power plants are installed in the area where gas pipelines are laid [6].
- Land cost and tariffs laid on it are interrelated and variable from place to place [7]. More fertile is the land lesser is its utility for the industry and it will be secondary choice [8].
- If the land is in a very remote area then it is a possibility that grid for feeding the electricity may not be available [9].
- Scarcity of labour is also deepened in the desert and hilly area [10].

In graph theory no factor category should be independent [11]. If it is the case then it has to be modelled in a different way [12]. Any independent factor category gives birth to a different system category [13]. Every system factor category is the networking of many different sub-factors [14]. Sub-factors of a factor category are the cluster of factors affecting the macro factor category [15]. This division is to be carried out by regress discussion with the experts either from the industry or academic [16].

In real life situation any problem is analysed in terms of profit and loss. There are many factors leading to profit or loss. These factors may be either quantifiable or non-quantifiable. These non-quantifiable factors are intangible and these can be measured verbally. In day to day life their importance is given as most important, important or not important. With this type of information system analysis becomes more difficult. Therefore, there is need to adopt an appropriate scale so that the problem of quantification is simplified. At this point it is worth to mention that this process of quantification is very much quality sensitive. If the quality of expert advice available is high then the decision quality will also be better.

If all of the factors/sub-factors could be measured qualitatively cum quantitatively then decision is more near to real life situation [7]. This solution quality is deteriorated with the non-clarity of the data available with the expert [8]. In the present work a standard method of quantification i.e. STANINE is used for the quantification of factors and sub-factors [9]. At present a lot energy conversion methods/techniques are available in the market. Some of the new technologies based upon hydrogen such as fuel cell are also getting prominence day by day [10]. The different technology performance is affected by different factors and sub-factors [11]. Therefore, the number of factors cannot be finalized in any literature [12]. Similar is the

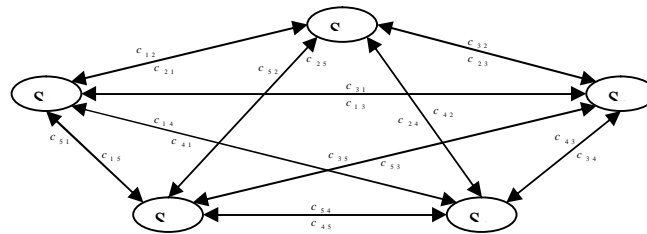
case with the quantification also. Any energy conversion technology assigned five star today may be less than or equal to this tomorrow [13]. Other factors such land acquisition are also dependent on other things such as government policies, resistance of people etc. Therefore, at this stage it is not possible to give any fixed method of quantification [14].

While analysing any problem with a large number of factors it is one of the most challenging task to retain information regarding all the factors and sub-factors [15]. As these factors are interdependent therefore, a loop of information is generated. This loop size is variable in nature [16]. Numbers of loops available in the system are also variable in number and interlinking [17]. Therefore, the methodology adopted for the decision making should be capable of fulfilling all the above mentioned objectives [18]. In the present work graph theory in conjunction with matrix method and combinatorics is adopted and its implementation is comprised of following three stages:

- Modeling of system and subsystem in terms of nodes and edges gives a structural representation in the form of directed graph. This representation is suitable for visual analysis and understanding of interrelationships among system and subsystems is developed inside the researcher.
- Matrix representation is the suitable mathematical transforming of the matrix representation. This is a standard representation of digraph which retains all of its information. It is a representation which is capable of representing all of its nodes and edges.
- Matrix transformation in to a more useful form is as the development of permanent function. This is called as more useful because permanent representation is easy to analyse with some computer programming tool. This is resulted that an index value is developed and relative comparison is carried out.

For the decision on site selection a number of factors comes in to picture and no set of factors or sub-factors may be called as the final solution for each and every kind of site selection. In the present work total five categories of factors are identified and these are containing many sub-factors. As mentioned above the solution will be obtained in the three steps, therefore, henceforth these three steps are explained one by one.

### 3.1 Digraph Representation



**Figure 4** Digraph Representing the five Attributes of Site Selection and their Interdependencies in the System (Attributes: Fuel Factors ( $S_1$ ), Cost and Tariff factors ( $S_2$ ), Technical factors ( $S_3$ ), Labour Factors ( $S_4$ ) and Land Factors ( $S_5$ ))

The digraph representation can be carried out in different ways [12]. The visual information contained in the digraph is variable from system to system [13]. If the power plant type is changed then all of the technologies used for the energy conversion are also changed [14]. In the present work digraph is represented as a combination of roundels and arrows [15]. In the roundels factor category is represented [16]. When it is for the visual inspection then it will be representing inheritance of the factor. The arrows represent the direction of the effect of one system on the other [17]. The length of the arrow is variable and gives no useful information [18]. In the present work total five factor categories are identified. This classification is as follows:

1. Fuel factors ( $S_1$ )
2. Cost and Tariff factors ( $S_2$ )
3. Technical factors ( $S_3$ )
4. Labour factors ( $S_4$ )
5. Land factors ( $S_5$ )

This categorization is user dependent [19]. Different users prefer to adopt different technologies of energy conversion. With change in location, state or country experts may identify more number of factors. It may be more convenient in that case to increase or decrease the number of divisions. If the numbers of divisions are increased then roundel will be higher in number. A digraph is prepared to represent the different attributes/factors/sub-factors of site selection with interaction amongst them. The interaction amongst them is known by the inter-dependency also. This is the classification pillared upon the user requirements. This is further dependent upon the technology selected for the energy conversion. The combination of inheritance and interdependence is represented in the form of digraph. This pictorial representation of the factors/sub-factors and their interaction is useful for the understanding of the system which is complex in nature. The clear understanding of the system makes it user friendly so that it may be processed with the help of some suitable, logical and fluent computational tool.

The digraph consists of a set of nodes which represents inheritance and symbolically represented as  $S = \{S_i\}$  where the subscript  $i=1, 2, \dots, N$  and a set of directed edges represented with the arrows and symbolically as  $E = \{c_{ij}\}$ . A node  $S_i$  in the digraph represents  $i^{\text{th}}$  parameter /factor /sub-factor and edges represent the interdependence between parameters /factor

/sub-factor. The total number of nodes, N, is equal to the number of parameters/factors/sub-factors considered for the site selection of the power plant and these will vary from plant to plant. In particular five attributes are identified responsible for site selection. If the entire five attribute are affecting each other then it is represented in the form of digraph (Figure 4). This presentation is very suitable for visual analysis but is not very suitable for computer processing.

**3.2 Matrix Representation**

For the extraction of the useful information from the digraph it is required to process it with the help of matrix method which is very conventional and old technique [20]. This has been used by many researchers earlier and the solutions achieved are near to real time situation [21]. In real time situation results are to be compared with the availability of different sites [22]. These sites are may be identified either by some government agency or it may be some private public partnership [23]. Therefore, for the comparison of two or more different situations it is suitable to have results in the form of some numerals [24]. It is easy to compare to number quantitatively in comparison to some qualitative values. Therefore, in the matrix representation the diagonal and non-diagonal elements are used to represent the inheritance and interdependence of the parameters/factors/sub-factors [25]. A digraph is a visual representation so it helps in analyzing the system to a limited extent only. The information obtained from the digraph may be summarized as:

- The information about the number of factors and sub-factors is obtained;
- Interaction in-between factors and sub-factors is visualized;
- Loops and dyads are easily identifiable;
- Interaction of loops and dyads is also visible.

The above mentioned features are useful and their mathematical information conversion (MIC) is obtained with the matrix method. As mentioned earlier digraph is a information in the form of set of nodes and edges [S, c]. This information in matrix form is represented as in the expression (2).

$$E = \begin{matrix} & \begin{matrix} i & j & k & \dots & m & n \end{matrix} \begin{matrix} \text{Systems} \\ i \\ j \\ k \\ \dots \\ m \\ n \end{matrix} \\ \begin{matrix} S_i & c_{ij} & c_{ik} & \dots & c_{im} & c_{in} \\ c_{ji} & S_j & c_{jk} & \dots & c_{jm} & c_{jn} \\ c_{ki} & c_{kj} & S_k & \dots & c_{km} & c_{kn} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ c_{mi} & c_{mj} & c_{mk} & \dots & S_m & c_{mn} \\ c_{ni} & c_{nj} & c_{nk} & \dots & c_{nm} & S_n \end{matrix} & \end{matrix} \quad (2)$$

The diagonal elements represent the contribution of attributes/factors/sub-factors in power plant site selection and the off diagonal elements represent interdependencies of each attribute in the matrix [28]. This form of matrix is also known as variable permanent matrix (VPM) representation of the Figure 4. Here it is worth to compare expression (1) and (2). In the expression (1) only weights are assigned to inheritance and interdependence and no interaction is taken care off. But in expression (2) interaction is also taken care off. This representation is to be developed as permanent function in order to process with computer programming tools [27].

**3.3 Permanent Representation**

Both digraph and matrix representations are not unique to represent power plant selection factors because they are altered by changing the labels of their nodes [29]. Therefore, to develop an unique representation that is independent of labeling, permanent function of the site selection attribute/factor/sub-factor matrix is proposed here. The permanent is a standard matrix function and is used in combinatorial mathematics [26-33]. It is the combination of the all of the factors/sub-factors, loops, dyads and their interaction. All of the information about the loops and dyads is retained in the permanent function [30]. The first grouping in the expression (3) represents the effect of all of the factors/sub-factors of power plant selection. In the present analysis the factors are divided into five broad classes. These all the five category of site selection should be present during the analysis. This group will be containing only single term comprising of all of the factors or sub-factors. In this interdependence of all the categories is represented by the presence of all of the factors or sub-factors. The second grouping is absent in absence of self-loops in the digraph.

It is an arrangement in the decreasing order of the factors category and increasing order of the loops and dyads. Therefore, third grouping (as number of terms are present therefore, it is called as grouping) contains the effect of dyads along with three factors inheritance. The effect of dyads is for the factors category other than the factors for which inheritance is taken care of. In the fourth grouping loops are visible to represent the interlinking of factors/ sub-factors. If the total number of parameter/factors/sub-factors is N in number then the total number of groups are N+1. In the fourth group three factor loops along with three factors inheritance is present and their number is dependent upon the number of interdependence amongst factors. If number of interlinking is higher than number of terms will also be higher. The fifth grouping is with two sub-groupings representing system inheritance and interdependence. The terms of this sub-grouping represents inheritance of two factor/sub-factor category along with the interdependence amongst remaining three factor categories.

The sixth groupings are the last part of the sub-groupings. It is containing all the loops and dyads of the interdependence. These loops and dyads are also interlinked. Due to their dependence analysis becomes complex and matrix expansion is also complicated. This can be achieved directly with the help of computer programming tool to expand or evaluate the permanent function. The development of the permanent function can be achieved by the visual inspection of the digraph shown in the Figure 4 also.

The permanent function containing information about loops and dyads is obtained in a similar manner as the determinant but unlike in a determinant where a negative sign appears in the calculation, in a variable permanent function positive signs replace these negative signs [31]. Permanent Function for a general case with n attributes (for matrix expression (2)) is written as:

$$\begin{aligned}
 Per(E) = & \prod S_i (Group - I) \\
 & + \sum_i \sum_j \sum_k \dots \sum_m \sum_n c_{ij}^2 S_i S_j S_m S_n \dots (Group - III) \\
 & + 2 \sum_i \sum_j \sum_k \dots \sum_m \sum_n (c_{ij} c_{jk} c_{ki}) S_i S_m S_n \dots (Group - IV) \\
 & + 2 \sum_i \sum_j \sum_k \dots \sum_m \sum_n (c_{ij} c_{jk} c_{ki} c_{il}) S_m S_n \dots (Group - V) \\
 & + \sum_i \sum_j \sum_k \dots \sum_m \sum_n (c_{ij}^2 c_{jk}^2) S_m S_n \dots (Group - V) \\
 & + 2 \sum_i \sum_j \sum_k \dots \sum_m \sum_n (c_{ij} c_{jk} c_{ki} c_{im} c_{mi}) S_n \dots (Group - VI) \\
 & + \sum_i \sum_j \sum_k \dots \sum_m \sum_n (c_{ij} c_{jk} c_{ki})^2 c_{im}^2 S_n \dots (Group - VI) \\
 & + \sum_i \sum_j \sum_k \dots \sum_m \sum_n (c_{ij}^2) (c_{kl}^2) (c_{mn}^2) \dots (Group - VII) \\
 & + 4 \sum_i \sum_j \sum_k \dots \sum_m \sum_n (c_{ij} c_{jk} c_{ki}) (c_{im} c_{mn} c_{in}) \dots (Group - VII) \\
 & + 2 \sum_i \sum_j \sum_k \dots \sum_m \sum_n (c_{ij} c_{jk} c_{ki} c_{il}) (c_{mn}^2) \dots (Group - VII)
 \end{aligned}
 \tag{3}$$

**3.4 Qualitative and Quantitative Evaluation of Factors and Sub-Factors**

Resultant impulse for the selection and non-selection of any power plant site is dependent upon the index value and for its calculation; all the tangible and intangible factors and sub-factors are to be quantified. In other words to calculate this index, the values of S<sub>i</sub> and c<sub>ij</sub> (expression 3) are required in the expression (3). The values of these factors/sub-factors and their interdependence/interlinking are found on the basis of the real time power plant data available with organisation and the experience of electricity operational and generational personals. There are numerous methods of quantification reported in the literature [1-33]. It is also reported that if exact data is not available then fuzzy score may also be implemented. With the help of fuzzy score any crisp data can be converted into some useful form. Stanine method is a standard method of judgment on a scale from 1 to 9 is adopted. Based upon this quantification, Table 1 is suggested for the quantification of inheritance and interlinking. These qualitative values of the interdependence of parameters are also assigned on a scale 1 to 5 with the qualitative suggestions of Table 2.

**Table 1** Quantification of Factors Affecting Cogeneration Cycle Power Plant Performance

S.No.	Qualitative measure of factors affecting the site selection for the power plants	Assigned value of factors S <sub>i</sub>
1	Affect of one site selection factor on the other is exceptionally low. It is the condition when two factors are almost independent and with change in the qualitative measure of one factor have no potential affect on the qualitative measure of the other factor.	1
2	Affect of one site selection factor on the other is very low and with change in the one factor other is not much affected. It may due to the reason that two factors are related to each other but their affecting impact is not eminent.	2
3	This value will be assigned when the affect of one factor on the other is low. This affect should be higher than the previous category.	3
4	With this quantification inheritance value is changed from low to below average. It is to represent that impact of the factor in the system is increasing. This increasing effect is also going to affect other factor categories.	4
5	It is one of the three broad categories i.e. high, average and low. The factors falling in this category are having a medium affect in the system. With change in their inheritance system performance is affected moderately.	5
6	If it is found that factor inheritance is somewhat more than average then these are kept in this category. It is the category representing inheritance higher than average.	6
7	In this category factors having high impact in the system are kept and from this point inheritance starts playing a role which is having the slope higher than previous categories.	7
8	If the inheritance of any factor category is very high then it is covered in this section. This value should be somewhat less than isentropic.	8
9	This quantification represents that the factors category is having very high impact in the system. This may be called as exceptionally high. It may be an isentropic case.	9

**Table 2** Quantification of Interdependencies

S. No.	Qualitative measure of interdependencies	C <sub>ij</sub>
1	Very Strong	5
2	Strong	4
3	Medium	3
4	Weak	2
5	Very weak	1

#### 4. Steps of the Methodology Developed

In the foregoing sections, a methodology based upon graph theoretic methodology is developed for the evaluation of power plant site. The methodology can be summarized in the following steps:

1. Identify the various parameters/factors/sub-factors affecting the selection of power plant site. Parameters/factors/sub-factors may or may not differ from power plant to power plant depending on its size.
2. Develop digraph between the major parameters/factors/sub-factors categories depending on their interdependencies.
3. Develop variable permanent matrix for parameters/factors/sub-factors. This will be a matrix of size 5×5, with diagonal elements representing inheritance of parameters/factors/sub-factors and off-diagonal elements representing interactions among them.
4. Substitute the value of inheritance and inter-dependency of parameters/factors/ sub-factors in the variable permanent matrix. The value of inheritance (diagonal element) of attribute is to be decided on the basis of scale 1-9 and value of inter-dependency is decided by the experts either from academia and industry on the basis of scale 1–5.
5. Compute the value of permanent function using computer programming tool which is the index value.
6. Record the results of study and document them for future analysis.

#### 5. Working Example

The understanding of the proposed methodology is best suited to neurons with the help of an example from the real life. It is as explained hence forth.

1. Factors responsible for the selection of power plant are categorized into five classes. This division is based upon their nature and real time situation. It is as represented in Figure 3.
2. The digraph based upon this division is as represented in Figure 4.
3. The permanent matrix for the best suitable case and worst case is as represented in expression 4 and 5.

$$Best\ Case = \begin{bmatrix} 9 & 5 & 5 & 5 & 5 \\ 5 & 9 & 5 & 5 & 5 \\ 5 & 5 & 9 & 5 & 5 \\ 5 & 5 & 5 & 9 & 5 \\ 5 & 5 & 5 & 5 & 9 \end{bmatrix} \quad (4)$$

$$Worst\ Case = \begin{bmatrix} 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \end{bmatrix} \quad (5)$$

4. The value of the permanent function for the best and worst case is respectively 156796 and 124. In real time situation the power plant site selection index will vary in-between these two values.
5. Record these values for the future analysis.

#### 6. Limitations of Present Study

In the present study various factors related to power plant site selection are identified and categorized in context to Indian power generation organization. The results of the present methodology are dependent upon the information collected from the field and experts from the academia. This information is to be collected and normalized for the analysis. All the exertion is survey based and labour is to be utilised for the same. The accuracy of the result will increase as the number of survey questionnaire will increase. The questionnaire is to be prepared with the help of expert advice available with the decision makers. This limitation can be overcome with increasing the people to be questioned.

#### 7. Scope for Future Work

Research in any field is full with the scope of future work. As the number of power plant is increasing the technology associated with the power plant technology is also changing. This change in energy conversion technology is variable from place to place and from country to country. Some countries are technically advanced and they are having latest technology for the energy conversion. At present a lot of research is going on the nano-technology and heat transfer in the field of power plants. The heat transfer capabilities are further dependent upon the large number of factors. These factors are also variable. Their identification and quantification is a challenge for the researchers. In the similar manner other technologies are associated with a lot of challenges which require careful attention.

#### 8. Conclusion

In the present work parameters/factors/sub-factors affecting site selection for a power plant are identified and categorized into five classes. These five classes are interdependent. Due to this reason a combination of graph theory, matrix method and combinatorics is applied for the evaluation of site suitability. The result comes out in the form of an index called as site suitability index. The proposed methodology is explained with the help of an example. From the example, it may be concluded that present methodology may be applied for the power plant selection.

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# Management Challenges in Uncertain Environment

## Selected Papers of the Twelfth AIMS International Conference on Management

**Omprakash K. Gupta** is a professor in the College of Business at University of Houston – Downtown in Texas, USA. He has previously been at Purdue University, Prairie View A&M University, Ball State University, Washington State University, IIM Ahmedabad, and CMC Ltd. He was the founder director of Nirma Institute of Management. Dr. Gupta has published widely in refereed journals such as Management Science, European J. of Operations Research, Journal of Business Ethics, Journal of OR Society, etc. He is the editor-in-chief of Int. J. of Operations and Quantitative Management, AIMS International Journal of Management, and The Management Faculty. He has received several teaching, research and service awards. He has been frequently invited to deliver speeches. He is also the founder of AIMS International and International Forum of Management Scholars.

**Shivprakash Agrawal** is a Director at Parul University Vadodara. He had previously worked as Project Manager at Unisys Corporation, Chief General Manager at Rishabh Software, Professor and head of Computer Engineering Department at Sardar Vallabhbhai Patel Institute of Technology and Dean at Babaria Institute of Technology. His area of interest includes Enterprise Resource Planning, Software Engineering, Software Project Management and Business Information System. He has presented several research papers in national and international conferences. He has worked at key positions for Computer Society of India and IT Forum of Vadodara. He is also the Managing Editor for AIMS International Journal of Management and The Management Faculty.



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