American Journal of Engineering Research (AJER)

American Journal of Engineering Research

Volume-3 Issue-7

Research Paper   **Open Access**

The Assessing of Financial Performance of Accepted Banks in Stock Exchange Market by means of ELETERE Technique

Ali Sorayaei[1], Nahid Hassanpour [2],Seyedeh Maryam Karimzadeh Armaki [3] , Zahra Atf [4]

[1]*Professor and Faculty member of Islamic Azad University, Babol, Iran,*
[2]*Master of Management of Islamic Azad University, Babol, Iran*
[3] *Student of Management of Islamic Azad University, Babol, Iran*
[4] *Master of Management, lecturer of Payam Noor University,*

Abstract: - Bank managers are stakeholders of the data analysis for financial performance that these data are important for them. In this regard, they consider valuable financial information and evaluate the bank's situation and will decide according it. This paper presents a method for systematic assessing banks' financial performance. The analysis is based on a set of criteria related to the financial performance of banks.
The purpose of this research, ranking the bank listed in Tehran Stock Exchange, according to financial criteria. After a comprehensive review of the research literature and the idea of financial experts have been identified criteria to assess the financial performance of banks (liquidity factors, factors, profitability, and capital adequacy and risk asset structure factors). To increase the accuracy of the study, the weight of financial factors calculates with AHP-FUZZY method. Finally, the final weights obtained, the ELECTRE algorithm has been implemented to rank the banks. The results show that the KAR AFARIN bank is on top and ANSAR Bank, PASARGAD and the EGHTESAD NOVIN were ranked second, third and fourth and the MELAT bank, SADERAT and TEJARAT got the ratings from the eighth to the tenth.

Keywords: - *Assessing, financial, performance, stock exchange, banks, Ahpfuzzy, Electre.*

I.   INTRODUCTION

The growth and prosperity of any country depend on the proper planning and investment and, and the industrial and economic development also depends upon considering to the more investment into the companies and listed banks in securities. Thus, proper guidance of cash flows and wandered funds to the manufacturing and businesses services give rise to the economic growth, increased GDP, employment and increased per capita income and finally, the general prosperity will follow. Undoubtedly, creation of proper environment for healthy and productive investment and strength of the capital market are one of the most important steps that can be taken by those involved in the economic fortunes of the country. It is clear that investment should be done in industries that

✓   Have more value-added
✓   Incur more income to invest

Evaluation of the listed companies and banks in exchanges demands identification of a number of factors, so that the decision-making process is combined with the complexity and difficulties. The decision has been always a difficult process and in the current conditions, that change will happen very fast, undoubtedly decision making has also a rapid pace (Qayy and Nikoomaram, 2005). Rating of accepted banks in Tehran Stock Exchange, based on the financial criteria, has been the important issues that, unfortunately, so far little research has been done respect with it. The aim of this research which has been conducted in Tehran Stock Exchange is ranking of the banks according to financial criteria.

II.   RESEARCH HYPOTHESIS

Descriptive studies often have no hypothesis, for the researcher seeks information that is not already there and there is no theoretical basis for predicting of variables and its distribution. Since the state of variables changes over time, so previous research cannot be used to predict them accurately. As mentioned before, in descriptive - analytical study which was carried out with the aim of investigating the states, hypothesis has no fundamental need and instead of making assumptions, we can conduct the research through setting the research questions (Azkia, Darban Astaneh, 2003).

III.   DEFINITION OF CONCEPTS AND TERMINOLOGIES

Assessment of performance: the assessment shows how things are not moving forward as planned and objectives. The assessment also shows what good work is going on. Therefore, the next opportunities will be achieved based on these conditions. This reveals the necessity of attention to performance evaluation. Performance appraisal is the process by which the performance of employers is measured with it and when done properly, employees, supervisors, managers, and ultimately, the organization will benefit it (Madanie Mohammadie, 2006).

Ranking: ranking of banks is one of the most important tools to identify the strengths, weaknesses, opportunities and threats for external companies. Ranking of companies follows some inner and outer organizational purposes (Qdrtyan Kashan and Anvari Rostami, 2004).

Capital: capital means investment funds and from the savings which is operated or spent in the form of machinery, buildings, tools, skills, or cash. In economy, the wealth that is used to produce more wealth is called capital (Momenie and Najafi Moghadam, 2004).

Capital adequacy: capital adequacy is from the direct capital to the sets of assets. Therefore, firstly, since the ratio of capital adequacy is the most important quantitative indicators to evaluate the performance of small banks and credit institutions, and secondly, achieving to a specified minimum capital adequacy ratio is seen as an indicator of the bank's credit position, and as different aspects of performance (such as changes in portfolio risk, profitability, size, etc.) can affect and thus, should be given the necessary attention to it and think of some strategies for its improvement (Rahmani and Haider, 2007).

Financial performance: the degree of involvement of a company for achieving financial goals of shareholders for increasing their wealth. Operative goals which the director manager follows them mainly for increasing the wealth of shareholders and includes indicators and criteria which can be used for measurement of financial performance of a business firm (Devinney and et all, 2004).

IV.   REVIEW OF LITERATURE

•   Reza Zadeh (2010) evaluated the performance of the portfolio management in investment companies listed in Tehran Stock Exchange. Data used in this research has been collected through monthly data of investment companies published by the Stock Exchange. The population of the study consisted of 14 investment companies in the form of 188 investee companies that their share has been studied from April 2002 to March 2003. The main variables of the study include returns, systematic risk and unsystematic risk beta and indicators of Termyz, Jensen, Sharpe, M2, appraisal ratio for investment enterprises. Research hypotheses were tested through using mean and median and Kendall correlation coefficient tests and findings were analyzed through these tests. The results of the findings indicate that investment firms haven't had a better performance than the market portfolio for evaluation of the performance of investment companies considering that both systematic and non-systematic risk are essential.

•   Momenie and Najafie Moghaddam (2013), calculates approximately 170 companies in 13 different industries for the assessment of the economic performance of listed companies in Tehran exchange and according to the values,   the weights of each index are calculated by of Shaown entropy technique and finally, the rank of each company was determined by the technique TOPSTS.

•   Wang and Lu (2008) investigated assortment technique for determining of representing financial rates in their study. When companies evaluate their performance, using all (financial) tax rates for the investigation is impossible. For evaluation of financial performance of a company, only some available financial rates   are investigated and selected as evaluation criteria. In general, tax rates are offered sequentially, first they are assorted, and then the first category of each representative is selected as evaluation criteria to be used. For classification of tax rates, a clustering method is proposed that tax rates of different companies are partitioned with the same species in the same category. In other words, a fuzzy relation is presented so that the number of categories can be set up. Once again, the rates are classified and the representative indicator for each cluster will be identified. Where N the number of categories is not clear, the proposed classified method classify tax rates in

categories. Thus, in the absence of number of categories, the clustering method is not applicable. In accounting, tax rates on the balance sheet or the income are divided into four main categories: solvency, debt and asset turnover, return on investment. In this study, 24 tax rates are divided based on four categories.

- Kalvgras et al[1], (2005), in their paper on evaluation of the financial performance of agricultural enterprises - businesses with multi-criteria decision-making systems approach examined 11 financial ratios of the three groups in terms of profitability, solvency power and performance management and for this they used PROMETHEE for this work. This article is an introduction to financial decision-making approach which is based on multi-criteria analysis technique PROMETHEE and reviews the financial performance of agriculture and business companies and finally, through the assessment of the production, processing and marketing will be greatly benefited. The result of this study increases our understanding about the financial viability of the tested companies, and can be the first step toward making a financial decision-making tool. Thus, financial managers can have clear signs whether the financial needs of their company strategies and market behavior may create modifications or not?

V.   METHODOLOGY

The study is a descriptive survey research. Also, since the results of this research can be practically used, a case study research is applied. The inferential statistical tools have been used for data analysis. In addition, in the process of study, library and field research have been exploited as an integral component of scientific research.

The present population includes two categories:

The first set is expert and second is the listed banks in stock exchange:

First category: this category includes banking and financial experts who among these 18 experts were randomly selected and their views on the importance and calculation of measurement and benchmarks were applied using AHPFUZZY technique.

VI.   DATA ANALYSIS

Data analysis was conducted in two parts, which it is as follows:

- AHP-FUZZY test has been used for ranking the factors and options for each of them.
- ELECTRE test has been used for the assessment of financial performance of banks and their ranking.

VII.   AHP- FUZZY

technique is considered as a fuzzy multiple criteria decision making technique MADM[2] and has the advantage that they can evaluate

different options considering to the a variety of measures which lack the same units. This is a significant advantage over traditional methods that all criteria should be converted to the same units. The main advantage of MADM techniques is that they have the ability to simultaneously analyze and evaluate quantitative and qualitative criteria. AHP and TOPSIS are the most common techniques of MADM (Asgharpour, 2004).

VIII.   ELECTRE METHOD[3]

ELECTRE method is the most important technique of compensation. This method is based on the concept of outranking relation[4]. The result is based on a set of ranks. In this method, $A_p \rightarrow A_q$, p and q options are not

superior to other options, however the decision maker accepts Ap to Aq the preference risk, the procedure is in 8 step as follows:

First step: normalization

Second step: weighted normalization matrix[5]

Third step: Determination of concordance[6] and disconcordance[7] set

Fourth Step: Calculation of the coordinate matrix

Fifth Step: Calculation of the inconsistency matrix

---

[1]. Kalogeraset al

[2]. Multi Attribute Decision Making

[3]. Elimination- Et Choice Translation Reality

[4]. Outranking

[5]. weighted normalization matrix

[6]. Concordance

[7]. Discordance

sixth Step: Determination of effective coordination matrix
Seventh Step: characterization of heterogeneity of matrix
Eighth step: Determination of the overall and effective matrix

IX.   DATA COLLECTION

There are several ways to gather information appropriate to the period of study, time of the study.

Sources of data collection are divided into two categories: primary and secondary sources of information. The secondary sources of data are consisted of articles, books, research, studies and thesis done in this field (which has been collected by libraries and Internet sites). The primary data is also collected through using questionnaires and financial and banking statements.

Data analysis:

**Effective factors in the assessment of financial performance in banks

** In the next table of the next page, factors and associated options are given:

Table 1: Effective factors in the assessment of financial performance in banks

Name	Factors	options
Q1	Liquidity	total facilities on total deposits Cash holdings plus bonds + and total deposits
Q2		all facilities on total deposits
Q3	Structure of assets	Total of facilities to total of asset
Q4		ammunition claims by each facility
Q5		total earnings by total assets
Q6		fixed assets to total assets
Q7	**Profitability**	Return on Assets
Q8		Ratio of return on operating income
Q9		Return on equity on industry holders
Q10	**Capital adequacy**	Equity of shareholders on to total assets
Q11		The ratio of operating income to total assets

X.   DETERMINATION THE WEIGHT OF ELEMENTS AND OPTIONS WITH AHP-FUZZY

After collecting data and calculating the geometric mean, we formed a matrix of pair wise triangle comparisons of criteria and P4, and then calculated weights and prioritize them. In the following, calculations of liquidity factor benchmark

are given as an examples.

Table 4-2 - Triangular paired comparison matrix of liquidity factor questions

Liquidity Factors	Q1	Q2
Q1	$(1,1,1)$	$(\frac{1}{2},\frac{2}{3},1)$
Q2	$(1,\frac{3}{2},2)$	$(1,1,1)$

After the formation of BL triangular paired comparison matrix for values of S_K, as the following products M_{IJ} in M_{KL}, we compute its coordination (I,M,U).

Table 4.7 - Calculation of S_K for liquidity questions matrix

Liquidity factor	$\sum_{J=1}^{N} M_{KL}$		$\sum_{J=1}^{M}\sum_{J=1}^{N} M_{IJ}$		S_K
Q1	(1.5,1.667,2)	×	(0.2,0.240,0.286)	=	(0.3,0.4,0.571)
Q2	(2,2.5,3)		(0.2,0.240,0.286)		(0.4,0.6,0.857)

Now, turn to the calculation of magnitude in the amount of SK cash index of SP compared to the rest of the index and then from each series, the smallest value is calculated and brought in a separate table.

$$V(S_1 \geq S_2) = \frac{u_1 - I_2}{(u_1 - I_2) + (m_2 - m_1)} = \frac{0/571 + 0/4}{(0/571 - 0/4) + (0/6 - 0/4)} = 0/4615$$

$$V(S_2 \geq S_1) = \frac{0/857 - 0/3}{(0/857 - 0/3) + (0/4 - 0/6)} = 1$$

When m2> m1, it is not necessary to compute a large degree and it suggests that we use the number 1, as well, to compute a large degree one Si on the other Si, we act as the following table, then we obtain normalized weight of index and finally the number of normalized weights of index $W_i = \frac{w'}{\sum w'l}$ relations

based on the following table:

$$V(S_1 \geq S_2) = Min\, V(0.4615)$$

$$V(S_2 \geq S_1) = Min\, V(1)$$

The above numbers are normalized weight of liquidity index.

$$\sum w'l = (1.4615)$$

Now, based on the relation $W_i = \frac{w'}{\sum w'l}$ the number of weights normalized liquidity index is obtained.

$$W_i = [0.3158, 0.6842]^T$$

All of the above steps, namely the procedures for fuzzy calculation of as described above should be repeated for individual index and total index so that their normalized weights can be obtained as follows.

Factor matrix $W = (0.3918, 0.1336, 0.3331, 0.1416)^T$

Asset structure factor $W = (0.1784, 0.1865, 0.5452, 0.0898)^T$

Profitability factor $W = (0.2481, 0.2512, 0.5007)^T$

Capital adequacy factor $W = (0.6842, 0.3158)^T$

After obtaining the that is described in the following table.

Table 3- coefficients for criteria importance and options using AHP-FUZZY

Index	relative weights	options	relative weights	final weights	prioritization
Liquidity factor	0.3918	total facilities on total deposits Cash holdings plus bonds + and total deposits	0.3158	0.1237	2
		all facilities on total deposits	0.6842	0.2680	1
Asset structure factor	0.1336	Total of facilities to total of asset	0.1784	0.0238	3
		ammunition claims by each facility	0.1865	0.0249	2
		total earnings by total assets	0.5452	0.0728	1
		fixed assets to total assets	0.0898	0.0119	4
Profitability factor	0.3331	Return on Assets	0.2481	0.0826	3
		Ratio of return on operating income	0.2512	0.0836	2
		Return on equity on industry holders	0.5007	0.1667	1
Capital adequacy factor	0.1416	Equity of shareholders on to total assets	0.0968	0.6842	1
		The ratio of operating income to total assets	0.0447	0.3158	2

11. Ranking f banks using ELECTRE
The result of ranking of banks based on financial measures are as follows:

$$A6 > A7 > A10 > A5 > A1 > A3 > A4 > A9 > A2 > A8$$

Table 4.7 Ranking of banks based on financial performance

Row	Sign	Bank	Rating
1	A1	Post bank	5
2	A2	SADERAT bank	9
3	A3	PARSIAN	6
4	A4	SINA	7
5	A5	NOWIN EGHTESAD	4
6	A6	KAR AFARIN	1
7	A7	ANSAR	2
8	A8	TEJARAT	10
9	A9	MELLAT	8
10	A10	PASARGARD	3

XI. DISCUSSION AND COMPARISON

Inside the country, this kind of research has been conducted only by Rostamie and et al (2011). They assessed the financial performance of banks listed on the stock exchange of Tehran using TOPSIS technique. Their results show that the entrepreneur bank has had better financial performance than other banks, which it is consistent with the results of the present study.

XII. CONCLUSIONS

Commercial banks are financial institutions, which accumulate stagnant funds of people and will grant businessmen, industrialists and other facilities applicants**.**
In fact, bank provides the transfer of resources from those who will not invest for various reasons, such as lack of knowledge and technique, shortage of capital and fear of investment risk or unable to cooperate in economic activities to persons who need financial resources for investment and since the aim of commercial bank is gaining profit, it is natural that the bank should absorb more inexpensive sources ever more and offers with the highest interest rate to credit applicants.

Therefore, the basic and fundamental objective similar to other nonprofit organizations is to maximize the wealth of its owners. For the increasing wealth of the shareholders, bank Management must decide whether the bank should gain assets with lower quality and more income or assets to higher quality and less risk, or whether the bank should. Ranking of banks can mirror entirely the state of different banks relative to other competitors and identify strengths and weaknesses and the opportunities and internal threats to the banks, but an issue that is important is ratings model, criteria and appropriate mathematical techniques for ranking. What this study is to evaluate and rank its financial performance which has been accepted in Tehran Stock Exchange. The results show that banks of Ansar, Entrepreneur, Pasargard and modern economy ranked first, second and fourth, respectively, and Mellat, Saderat and Tejarat were acquired from the eighth to tenth, respectively.

REFERENCES

[1] Asgharpour, MJ, (2006), Multi-criteria decision making and, Tehran, Tehran University Press.
[2] Reza Zadeh, M., (2010), performance appraisal of portfolio management in investment companies in Tehran Stock Exchange, administration research, Second year, second edition, pp. 157.
[3] Momeni, M., Najafi Moghadam, A. (2004), evaluation of economic performance of listed companies in Tehran Stock Exchange by using TOPSIS? Economic Review Quarterly, Volume 1, Number 3.
[4] Qodratian Kashan, Seyed AbdolJabar and Anvarie Rostamie, Ali Asghar (2004), design of comprehensive model for evaluation of performance and ranking of the companies, Humanity instructor quarterly, winter (2004)
[5] Qayy, Nasrin , Alirezaei, MR and Nikoomaram, H., (2005), evaluating the performance of investment companies listed in Tehran Stock Exchange through data encapsulation mathematical benchmarking analysis , Economic Research, Spring (2004).
[6] Azkia, M., Darban Astaneh , AR, Functional methods in research, Kayhan publication, Tehran, first edition, 2002.

Research Paper   Open Access

Random Supply, Costant Lead Times and Quadratic Backorder Costs. For Inventory Model (M, T)

Dr. Martin Omorodion
Joseph Ayo Babalola University Ikeji – Arakeji, Nigeria

ABOUT THE AUTHOR

BS.c (Bristol)   *Economics with Statistics*
MS.c (Wales)   *Statistics*
MS.c (Birmingham)   *Computer Science*
Ph.D   *Operational Research*
A.I.A   *Associate of the Institute of Actuaries*

Abstract: *-* This paper considers the inventory costs for the (M.T) model in which the backorder costs is quadratic, supply is continuous and lead time is constant.
Use is made of series 1: Inventory Model (M.T) with quadratic costs and continuous lead times.
The inventory cost for fixed M (maximum re-order level) and constant lead times is averaged over the states of M. Supply is assumed to follow a gamma distribution. The inventory costs for the model, random supply, constants lead time and quadratic costs are thereby derived.

I.   INTRODUCTION

In inventory costs for fixed M and constant lead times obtained in series 1 is averaged over the states of M. M is assured to be a gamma variate. Demand during the lead time is normally distributed.
The inventory costs for fixed M (maximum re-order level) when the cost of a backorder was quadratic function of the length of time excluding the cost of stockouts dependent only on the number of stockouts equation 14 of series 1.

II.   LITERATURE REVIEW

Zipkin (2006) threats both fixed and random lead times and examines both stationary and limiting distributions under different assumptions.
Bartsimas (1999) in his paper "probabilistic service level guarantee in make-to-stock, considered both linear and quadratic inventory costs and backorder costs".
Pritibhushan (2008) in his paper. 'A note in Bernoulli demand inventory model presents a simple-item, continuous monitoring inventory model with probabilistic demand for the item and probabilistic lead time of order replacement'.

Hadley and Within (1972) extensively developed the inventory model (M.T) for constant lead times and linear backorder costs.

Random Supply Constant lead time and quadratic backorder costs. Series 2
Since the supply is a random variable the maximum re-order cover M would vary. Similarly M follows a gamma distribution. T becomes the only control parameter. The probability density function of M, u(M)

$$u(\mathrm{M}) = \frac{esp\,(\mu \mathrm{M})\mathrm{M}^{v-1}\mu^{v}}{\lceil(v)} \qquad\qquad v > 0 \quad M > 0 \qquad\qquad (1)$$

$$C = \frac{Rc + S}{T} + hc\left(M - DL - \frac{DT}{2}\right) + \frac{b_1}{T}(G_5(M, T + L) - (G_5(M, L)) + \left(b_2 + \frac{hc}{T}\right)$$

$$(G_6(M, T + L) - (G_6(M, L) + \frac{b_3}{T}(G_7(M, T + L) - G_7(M, L))$$

Where $G_5(M, T) = \sqrt{\sigma^2 T}\left(g\left(M - \frac{DT}{\sqrt{\sigma^2 T}}\right) - (M - DT)F\left(\frac{M - DT}{\sqrt{\sigma^2 T}}\right)\right)$

Multiplying by U(M)

$$U(M)G_5(M, T)\frac{\sqrt{\sigma^2 T}\ esp - \mu M\ M^{v-1}\mu^v}{\lceil(v)}\ g\left(\frac{M - DT}{\sqrt{\sigma^2 T}}\right) - \frac{\sqrt{\sigma^2 T}\ esp^{-\mu M}\mu^v}{\lceil(v)}\ F\left(\frac{M - DT}{\sqrt{\sigma^2 T}}\right)$$

Let $G_{15}(T) = \int_U^\infty u(M)\ G_5(M, T)dM$ (2)

Substituting for U (M)G_5(M, T) integrating and simplifying we have

$$G_{15}(T) = \frac{\sqrt{\sigma^2 T}}{\lceil(v)}\ \mu^v esp\left(\frac{\mu^2\sigma^2 T}{2} - D\mu T\right)\sum_{i=0}^{v-1}\binom{v - 1 - 1}{i}(D - \mu\sigma^2 T)^{v-1-i}\left(\frac{\sigma^2 T}{2}\right)^i$$

$$+\frac{\mu^v}{\lceil(v)}\ esp\left(\frac{\mu^2\sigma^2 T}{2} - D\mu T\right)\left[DT\sum_{z=1}^{v}\binom{v-1}{i}\sum_{i=0}^{\frac{v-z}{2}}\binom{v - z - i}{i}(DT - \mu\sigma^2 T)^{v-z-2i}\left(\frac{\sigma^2 T}{2}\right)^i\right]$$

$$-\sum_{z=1}^{v+1}\sum_{i=0}^{\frac{v-2}{2}-z}\left(\frac{v!}{\mu^2(v + 1 - z)!}\right)\binom{v + 1 - 2 + z}{i}\left[(DT - \mu\sigma^2 T)^{v+1-z-2i}\left(\frac{\sigma^2 T}{2}\right)^i\right]$$

$$G_6(M, T) = \left(\frac{\sigma^4}{4D^3} + \frac{DT^2}{2} + \frac{\sigma^2 M}{2D^2} - TMV + \frac{M^2}{2D}\right)$$

$$F\left(\frac{M-DT}{\sqrt{\sigma^2 T}}\right) + \frac{\sqrt{\sigma^2 T}}{2}\left(T - \frac{\sigma^2}{D^2}\right) - \frac{M}{D}\ g\left(M - \frac{D}{\sqrt{\sigma^2 T}}\right) - \frac{\sigma^4}{4D^3}\ esp\left(\frac{2DM}{\sigma^2}\right)F\left(\frac{M+DT}{\sqrt{\sigma^2 T}}\right)$$ (3)

Multiplying by U (M)

$$U(M)G_6(M, T) = \left[\left(\frac{\sigma^4}{4D^3} + \frac{DT^2}{2}\right) + \left(\frac{\sigma^2}{2D^2} - T\right) + M^v + \frac{M^{v+1}}{2D}\right]\frac{(esp - \mu^v)\mu^v}{\lceil(v)}$$

$$\left(\frac{M - DT}{\sqrt{\sigma^2 T}}\right) + \frac{\sqrt{\sigma^2 T}}{2}\left(\left(T - \frac{\sigma^2}{2D}\right)M^{v-1} - \frac{M^v}{D}\right)\frac{esp - \mu M\ \mu^v}{\lceil(v)}\ g\left(\frac{M - DT}{\sqrt{\sigma^2 T}}\right)$$

$$-\frac{esp\ (-\mu M)\ \mu^v M^{v-1}}{4D^3\lceil(v)}\ esp\left(\frac{2DM}{\sigma^2}\right)F\left(\frac{M-DT}{\sqrt{\sigma^2 T}}\right)$$ (4)

Let $G_{16}(T) = \int_0^\infty u(M)\ G_5(M, T)dM$ (5)

Substituting for U(M) G_2 (M, T) integrating and simplifying we have

$$G_{16}(T) = \frac{\mu^v esp\ (\mu^2\sigma^2 T - D\mu T)}{\lceil(v)}\left[\left(\frac{\sigma^4}{4D^3} + \frac{DT^2}{2}\right)\sum_{z=1}^{v}\sum_{i=0}^{\frac{v-z}{2}}\frac{(v-1)!}{\mu^2(v-2)!}\binom{v - z - i}{2}\right.$$

$$\sum_{z=1}^{\frac{v+2}{2}}\frac{(v+1)!}{\mu^2(v+2-z)!}\sum_{z=0}^{\frac{v+2-z}{2}}\binom{v + 2 + z + i}{i}(DT - \mu\sigma^2 T)^{v+2-z-2i}\left(\frac{\sigma^2 T}{2}\right)^i + \left(\frac{\sigma^2 T}{2}\right)^i$$

$$\sum_{z=1}^{v+1}\sum_{i=0}^{(v+1-z)/2}\frac{v!}{\mu^2(v + 1 - z)}\binom{v + 1 - z - i}{i}(DT - \mu\sigma^2 T)^{v+1-z-2i}\left(\frac{\sigma^2}{2D^2} - T\right)^i$$

$$+\frac{\sigma^2 T}{2}\frac{\mu^v esp\left(\frac{\mu^2\sigma^2 T}{2} - D\mu T\right)}{\lceil(v)}\left(T - \frac{\sigma^2}{D^2}\right)\sum_{Z=0}^{\frac{v-1}{2}}\binom{v - 1 - i}{i}(DT - \mu\sigma^2 T)^{v-1-2i}\left(\frac{\sigma^2 T}{2}\right)^{2i} - \frac{1}{D}$$

$$\sum_{i=0}^{\frac{v}{2}}\binom{v - 2}{i}(DT - \mu\sigma^2 T)^{v-2i}\left(\frac{\sigma^2 T}{2}\right)^i - \frac{\mu^v esp\left(\frac{\mu^2\sigma^2 T}{2} - D\mu T\right)}{\lceil(v)\ 4D^3}$$

$$\sum_{z=1}^{v}\sum_{i=0}^{\frac{v-2}{2}}\frac{(v-1)!}{\left(\mu - \frac{2D}{\sigma^2}\right)^2(v - 2)}(DT - \mu\sigma^2 T)^{v-z-2i}\left(\frac{\sigma^2 T}{2}\right)^i$$ (6)

Substituting T for L

$$\frac{G_7(M, D)}{D} = -\left(-\frac{M^3}{3D^3} - \frac{\sigma^2 M^2}{2D^4} + \frac{\sigma^4 M^2}{2D^5} + \frac{\sigma^6}{4D^6} - \frac{\sigma^2 T^2}{2D^2} + \frac{T^2 M}{D} - \frac{T^3}{3} - \frac{TM^2}{D^2}\right)F\left(\frac{M - DT}{\sqrt{\sigma^2 T}}\right)$$

$$+\frac{1}{\sqrt{\sigma^2 T}}g\left(\frac{M-DT}{\sqrt{\sigma^2 T}}\right)\left(-\frac{2}{3}\frac{\sigma^2 MT^2}{D^2}-\frac{\sigma^2 T^3}{3D}+\frac{\sigma^2 MT}{3D^3}+\frac{\sigma^4 MT}{2D^4}+\frac{\sigma^4 T^2}{6D^3}+\frac{8\sigma^6 T}{D^5}\right)$$

$$+\frac{\sigma^6}{4D^6}esp\left(\frac{2DM}{\sigma^2}\right)F\left(\frac{M+DT}{\sqrt{\sigma^2 T}}\right) \tag{7}$$

Multiplying by U(M) and simplifying

$$U(M)=\frac{G_7(M,T)}{D}=\frac{esp(-\mu M)\mu^v}{\lceil(v)}\left[\frac{M^{2+v}}{3D^3}+M^{1+v}\left(\frac{\sigma^2}{2D^4}-\frac{T}{D^2}\right)+M^v\left(\frac{\sigma^4}{2D^5}+\frac{T^2}{D}\right)\right.$$

$$\left.+M^{v+1}\left(\frac{\sigma^6}{4D^6}-\frac{\sigma^2 T^2}{6D^3}+\frac{8\sigma^6 T}{D^5}\right)M^{v-1}+\frac{\sigma^6}{4D^6}esp\left(\frac{2DM}{\sigma^2}\right)\frac{esp(-\mu M)M^{v-1}\mu^v}{\lceil(v)}F\left(\frac{M+DT}{\sqrt{\sigma^2 T}}\right)\right. \tag{8}$$

Let $G_{17}(T)=U(M)G_7(M,T)dM$

Then substituting for U(M) G_7 (M,L+T)

Integrating and simplifying

$$G_{17}(T)=\frac{\mu^v}{\lceil(v)}esp\left(\frac{\mu^2\sigma^2 T}{2}-D\mu T\right)\left[\frac{1}{3D^3}\sum_{z=1}^{v+3}\sum_{i=0}^{(v-z+3)/2}\frac{(v+z)!}{\mu^z(v+3-z)}\binom{v+3-z-i}{i}\right.$$

$$(DT-\mu\sigma^2 T)^{v+2-z-2i}\left(\frac{\sigma^2 T}{2}\right)^i+\left(\frac{\sigma^4}{2D^5}+\frac{T^2}{D}\right)\sum_{z=1}^{v+1}\sum_{i=0}^{\frac{v+1-2}{2}}\frac{v!}{\mu^z(v+1-z)}\binom{v+1-z-i}{i}$$

$$(DT-\mu\sigma^2 T)^{v+1-z-2i}\left(\frac{\sigma^2 T}{2}\right)^i+\left(\frac{\sigma^6}{4D^6}+\frac{\sigma^2 T^2}{2D^2}+\frac{T^3}{3}\right)\sum_{z=1}^{v}\sum_{i=0}^{\frac{v-2}{2}}\frac{(v-1)!}{\mu^z(v-z)}\binom{v-z-i}{i}$$

$$(DT-\mu\sigma^2 T)^{v-z-2i}\left(\frac{\sigma^2 T}{2}\right)^i\right]+\frac{\mu^v}{\lceil(v)}esp\ (\mu^2\sigma^2 T-D\mu T)\left(-\frac{2}{3}\frac{\sigma^2 T^2}{D^2}+\frac{\sigma^2 T}{3D^3}+\frac{\sigma^4 T}{2D^4}\right)$$

$$\Sigma_{i=0}^{v/2}\binom{v-1}{i}(DT-\mu\sigma^2 T)^{v-2i}\left(\frac{\sigma^2 T}{2}\right)^i+\left(\frac{\sigma^2 T^3}{3D}+\frac{\sigma^4 T^2}{6D^3}+\frac{8\sigma^6 T}{D^5}\right)\Sigma_{i=0}^{\frac{v-1}{2}}\binom{v-i-1}{i}$$

$$(DT-\sigma^2 T)^{v-2i}\left(\frac{\sigma^2 T}{2}\right)^i\right]+\frac{\sigma^6}{4D^6}esp\left(\frac{\mu^2\sigma^2 T}{2}-D\mu T\right)\Sigma_{z=1}^{v}\Sigma_{i=0}^{\frac{v-2}{2}}\frac{(v-1)!}{\left(\mu-\frac{2D}{\sigma^2}\right)^z(v-z)!}\binom{v-z-i}{i} \tag{9}$$

$$\binom{v-z-i}{i}(DT-\mu\sigma^2 T)^{v-z-2i}\left(\frac{\sigma^2 T}{2}\right)^{2i}$$

Hence averaging the inventory costs for fixed M over the states of M over the states of M we obtain the inventory cost for variable M

$$C=\frac{Rc+S}{T}+\frac{hcv}{\mu}-hc\left(DL+\frac{DT}{2}\right)+\frac{b_1}{T}\left(G_{15}(T+L)-G_{15}(L)\right)+\frac{b_2+hc}{T}-G_{16}(L)+\frac{b_3}{T}\left(G_{17}(T+L)-G_{17}(L)\right)$$

$$\left(G_{16}(T+L)-G_{16}(L)\right) \tag{10}$$

III.   IMPACT OF THE STUDY

The study will enable industries or organizations having thousands of items in their warehouses located in various locations of the world and items supplied by different manufacturers with accurately use realistic lead times in arriving at their inventory cost.

In many of such cases lead times are not constant.

Expressing lead time as continuous gives a more realistic estimate of inventory costs.

REFERENCES

[1]   *Bertimas D (1999), Probabilistic Service Level Guarantee in make-to-stock, citeseerx.ist.psu.edu*
[2]   *Hadley and Whitin (1972), Analysis of Inventory Systems, John Hiby and Sons Inc. N.Y.*
[3]   *Sinha Pritibhushan (2008), A note on Bernonlli Demand Inventory Model, Decision Vol. 35, January – June.*
[4]   *Singha D, Tripathi R.P and Mishra T (2013), "Inventory model with non-instantaneous receipt and the exponential demand rate under trade credits, International Journal of Modern Mathematical Science (3), 154-165.*
[5]   *Zipkin Paul (2006), Stochastic lead times in continuous-time inventory models, Naval Research Logistic, 21 Nov. 2006.*

Research Paper   Open Access

Inventory Model (M,T) With Quadratic Backorder Costs And Continuous Lead Time Series 1

Dr. Martin Osawaru Omorodion
Joseph Ayo Babalola University, Ikeji-Arakeji, Nigeria.

ABOUT THE AUTHOR

BS.c (Bristol)	*Economics with Statistics*
MS.c (Wales)	*Statistics*
MS.c (Birmingham)	*Computer Science*
Ph.D	*Operational Research*
A.I.A	*Associate of the Institute of Actuaries*

Abstract: - We have assumed in this paper that demand follows a normal distribution, and lead times follow a gamma distribution and backorder costs is quadratic.
The (M, T) Model an order is made to bring it to M at review time. The model is derived from the (nQ,R,T) model which at review time an integral multiple Q is ordered. After deriving the inventory costs for (nQ, R,T) we set Q 0 to obtain the (M,T) inventory costs by making use of the differentiation of the (nQ,R,T) model.
The (M,T) inventory costs for constant lead times is then averaged over the states of the lead times. Extensive use is made of the Bessel functions of imaginary argument. $\longrightarrow$

I. INTRODUCTION

In deriving the (M,T) model in which an order is placed to bring inventory level to M, we make use of the (nQ,r,T) model in which the quantity ordered at review time is an integral multiple of Q, nQ n = 1,2,3…, We have derive the inventory costs for (nQ,R,T) and take the limit. Q 0 and setting R=M to obtain the (M,T) inventory costs.
We treating the backorder costs $(C_\beta(t)$ as quadratic for the length of time t, of the backorder $C_\beta(t) = b_1 + b_2 t + b_3 t^2$.
The dead time is assumed to follow a gamma distribution.
After deriving the inventory costs for (M,T) model with constant lead times, when then average the inventory costs order the states of the lead times.

II. LITERATURE REVIEW

Pektria (2012) used annual costs to derive an expression for the EOQ using price dependent demand in quadratic form. Bertsimas (1). in his paper "Probabilistic service level Guarantee in makes-to stock, considered both linear and quadratic inventory costs and backorder costs".
Nasir, Packnejad, and Afficoo (2012)., utilized EOQ model with non-linear holding cost.
Hadley and Whitin[2] extensively developed the model (M,T) for constant lead time and linear backorder costs.
Zipkin (2006) treats both fixed and random lead times and examines both stationary and limiting distributions under different assumptions.

(nQ,R,T) Model, Quadratic Backorder Costs
$C_\beta(t)$ is the backorder cost (nQ,R,T) stands for the model in which at review time, the inventory position or the amount on hand plus on order at review time is less than or equal to R and the quantity ordered is a multiple of

Q. demand D follows a normal distribution at lead time, $C_\beta(t)$ the expected backorder costs where t is the length of time of a backorder is given by $C_\beta(t) = b_1 + b_2 t + b_3 t^2$. Demand distribution is

$$g(\mu,\ \sigma^2 t) = \frac{1}{2\pi\sqrt{\sigma^2 t}}\,esp -\frac{1}{2}\left(\frac{x-\mu}{\sqrt{\sigma^2 t}}\right) -\infty\ \ x < \infty \dots\dots\dots\dots\dots\dots(1)$$

If the inventory position of the system is $R + Y$ immediately after the review at time t, then the expected backorder costs at time $t + L$.

$$= \frac{1}{Q}\int_0^Q D\int_0^L \int_0^t \frac{C_\beta(t-z)}{\sqrt{\sigma^2 t}} g\left(\frac{R+Y-Dz}{\sqrt{\sigma^2 t}}\right) dz\,dt\,dy$$

Similarly the expected backorder costs at time $t + L + T$

$$= \frac{1}{Q}\int_0^Q D\int_0^{L+T}\int_0^t C_\beta(t-z) g\left(\frac{R-Y-Dz}{\sqrt{\sigma^2 t}}\right) dz\,dt\,dy$$

Noting that $C_\beta(t) = b_1 + b_2 t + b_3 t^2$

Which gives $= \dfrac{1}{Q}\int_0^Q D\int_0^L D\int_0^t \dfrac{(b_1 + b_2(t-z) + b_3(t-z))}{\sqrt{\sigma^2 t}} g\left(\dfrac{R+Y-Dz}{\sqrt{\sigma^2 t}}\right) dz\,dt\,dy$

and $\quad \dfrac{1}{Q}\int_0^Q D\int_0^{L+T}\int_0^t \dfrac{(b_1 + b_2(t-z) + b_3(t-z)^2)}{\sqrt{\sigma^2 t}} g\left(\dfrac{R+Y-Dz}{\sqrt{\sigma^2 t}}\right) dz\,dt\,dy \dots\dots\dots\dots$

Integrating the b_1 factor first and simplifying we have

$$\frac{b_1 \sigma^2 LD}{2DQ}\left(\left(1+\left(\frac{R-DL}{\sqrt{\sigma^2 L}}\right)^2\right)F\left(\frac{R-DL}{\sqrt{\sigma^2 L}}\right) - \left(\frac{R-DL}{\sqrt{\sigma^2 L}}\right)g\left(\frac{R-DL}{\sqrt{\sigma^2 L}}\right)\right)$$

$$\frac{b_1 \sigma^2 LD}{2DQ}\left(\left(1+\left(\frac{R+Q-DL}{\sqrt{\sigma^2 L}}\right)^2\right)F\left(\frac{R+Q-L}{\sqrt{\sigma^2 L}}\right) - R\left(\frac{R+Q-L}{\sqrt{\sigma^2 L}}\right)g\left(\frac{R+Q-L}{\sqrt{\sigma^2 L}}\right)\right) \dots$$

Integrating the b_2 factor and simplifying we have

$$\frac{b_2}{Q}\left(\frac{D^2 L^3}{6} - \frac{\sigma^2 R}{6D^3} - \frac{DL^2}{2} - \frac{\sigma^2 R^2}{4D^2} + \frac{\sigma^2 L^2}{4} + \frac{LR^2}{2} - \frac{R^3}{6D} - \frac{\sigma^6}{8D^4}\right)F\left(\frac{R-DL}{\sqrt{\sigma^2 L}}\right)$$

$$+ \frac{b_2}{Q}\left(\sqrt{\sigma^2 L}\left(\frac{DL^3}{6} - \frac{LR}{3} + \frac{R^2}{6D} + \frac{\sigma^2 L}{12D} + \frac{\sigma^2 R}{4D^2} + \frac{\sigma^4}{4D^3}\right)g\left(\frac{R-DL}{\sqrt{\sigma^2 L}}\right)\right)$$

$$+ \frac{\sigma^6}{8D^4 Q}\,esp\left(\frac{2DR}{\sigma^2}\right)F\left(\frac{R+DL}{\sqrt{\sigma^2 L}}\right)$$

Integrating the b_3 factor and simplifying we have

$$\frac{b_3 D}{Q}\left(\frac{R^4 L^3}{12D^3} + \frac{\sigma^2 R^3}{6D^4} + \frac{\sigma^4 R^2}{4D^5} + \frac{\sigma^6 R}{4D^6} + \frac{\sigma^8}{8D^7} - \frac{L^2 \sigma^2 R}{2D^2} + \frac{L^2 R^2}{2D} - \frac{RL^3}{3} + \frac{L^3 \sigma^2}{3D} - \frac{R^3 L}{3D^2} + \frac{L^4 D}{12}\right)F\left(\frac{R-DL}{\sqrt{\sigma^2 L}}\right)$$

$$- \frac{b_3}{Q}.2\sqrt{\sigma^2 LD}\,g\left(\frac{R-DL}{\sqrt{\sigma^2 L}}\right)\left(\frac{\sigma^2 RL}{24D^3} + \frac{\sigma^4}{24}\frac{R}{D^4} - \frac{R^2 L}{8D^2} - \frac{\sigma^2 L^2}{8D} + \frac{L^2 R}{8D} - \frac{L^3}{24} + \frac{R^3}{24D^3} + \frac{\sigma^2 R^2}{12D^4} + \frac{\sigma^4 R}{8D^5} + \frac{\sigma^6}{8D^6}\right)$$

$$- \frac{1}{8}\frac{\sigma^8}{D^6}\frac{b_3}{Q}\exp\left(\frac{2DR}{\sigma^2}\right)F\left(\frac{R+DL}{\sqrt{\sigma^2 L}}\right)$$

Putting the factors together we have the inventory costs C excluding the costs dependent in stockouts only

$$C = \frac{Rc}{T} + \frac{S.Pout.}{T} + hc\left(\frac{Q}{2} + R - DL - \frac{DT}{2}\right)$$

$$+ \frac{b_1}{QT}\left(G_1(R_1T + L) - G_1(R_1L) - G_1(R + Q, T + L) + G_1(R_1L)\;\right]$$

$$+ \frac{hc + b_2}{QT}\left(G_2(R_1T + L) - G_2(R_1L) - G_2(R + Q, T + L) + G_2(R + Q, T + L) + G_2(R + Q, L)\right)$$

$$+ \frac{b_3}{QT}\left(G_3(R_1T + L) - G_3(R_1L) - G_3(R + Q, T + L) + G_3(R + Q_1L)\right)$$

$$+ \frac{s}{QT}\left(G_{01}(R_1T + L) - G_{10}(R_1L) - G_{10}(R + Q, T + L) + G_4(R + Q, L)\right)\ldots\ldots\ldots\ldots(2)$$

Where $G_1(R,L) = \dfrac{\sigma^2 L}{2}\left(\left(1 + \left(\dfrac{R - DT}{\sqrt{\sigma^2 T}}\right)^2\right)F\left(\dfrac{R - DT}{\sqrt{\sigma^2 T}}\right) - \left(\dfrac{R - DT}{\sqrt{\sigma^2 T}}\right)g\left(\dfrac{R - DT}{\sqrt{\sigma^2 T}}\right)\right)$ ...(3)

$$G_2(R_1T) = \left(\frac{D^2 T^3}{6} - \frac{\sigma^4 R}{4D^3} - \frac{DT^2 R}{2} - \frac{\sigma^2 R^2}{4D^2} + \frac{\sigma^2 T^2}{4} + \frac{TR^2}{2} - \frac{\sigma^6}{8D^4} - \frac{R^3}{6D}\right)F\left(\frac{R - DT}{\sqrt{\sigma^2 T}}\right)$$

$$+ \left(\frac{DT^{5/2}\sigma}{6} - \frac{\sigma T^{3/2}}{3} - \frac{\sigma T^{1/2}R^2}{6D} - \frac{\sigma^3 T^{3/2}}{12D} + \frac{\sigma^3 T^{1/2}R}{4D^2}\right.$$

$$+ \left.\frac{\sigma^5 T^{1/2}}{4D^3}\right)\left(g\left(\frac{R - DT}{\sqrt{\sigma^2 T}}\right) + \frac{\sigma^6}{8D^4}esp\left(\frac{2DR}{\sigma^2}\right)\right)F\left(\frac{R + DT}{\sqrt{\sigma^2 T}}\right)\ldots\ldots\ldots\ldots(4)$$

From

$$G_3(R_1T) = D\left(\frac{R^4}{12D^3} + \frac{\sigma^2 R^3}{6D^4} + \frac{\sigma^3 R^2}{4D^5} + \frac{\sigma^2 R^2}{4D^2} + \frac{\sigma^6 R}{4D^5} + \frac{\sigma^8}{8D^7}\right)$$

$$- \left(\frac{\sigma^2 R^2}{2D^2} + \frac{T^2 R^2}{2D} - \frac{R^3}{3} + \frac{T^3}{3D} - \frac{R^3}{3D^2} + \frac{T^{4D}}{12}\right)F\left(\frac{R - DT}{\sqrt{\sigma^2 T}}\right)$$

$$- 2\sqrt{\sigma^2 T}D\left(\frac{\sigma^2 RT}{24D^3} + \frac{\sigma^4 T}{24D^3} - \frac{R^2 T}{8D^2} + \frac{\sigma^6}{8D^6}\right)g\left(\frac{R - DT}{\sqrt{\sigma^2 T}}\right)$$

$$- \frac{1}{8}\frac{\sigma^8}{D^2}esp\left(\frac{2DR}{\sigma^2}\right)F\left(\frac{R - DT}{\sqrt{\sigma^2 T}}\right)\ldots\ldots\ldots\ldots\ldots(5)$$

$$G_4(R,T) = \left(\frac{(R - DT)^2}{2D} + \frac{\sigma^2 R}{2D^2} + \frac{\sigma^4}{4D^3}\right)F\left(\frac{R - DT}{\sqrt{\sigma^2 T}}\right)$$

$$+ \left(\frac{\sqrt{\sigma^5 T}}{2}\left(T - \frac{\sigma^2}{D^2} - \frac{R}{D}\right)g\left(\frac{R - DT}{\sqrt{\sigma^2 T}}\right) - \frac{\sigma^4}{4D^3}F\left(\frac{R + DT}{\sqrt{\sigma^2 T}}\right)esp\left(\frac{2DR}{\sigma^2}\right)\right)$$

Model (M,T) Continuous Lead Time and Quadratic backorder costs
We will derive model (M, T) for the quadractic costs from the (nQ, R, T) model derived above by taking its limit Q → 0 and setting R to M.
Differentiating with respect to R the costs

$$\frac{\partial G_1(R,T)}{dR} = -\left(\sqrt{\sigma^2(T + L)}\,g\left(\frac{R + DT}{\sqrt{\sigma^2 T}}\right) - (R - DT)F\left(\frac{R + DT}{\sqrt{\sigma^2 T}}\right)\right)\ldots\ldots(7)$$

and we set G$_5$ (R,T) such that differentiation is

$$= -G_{11}\left(R_1T + L\right)$$

Similarly

Lim Q ⟶ 0

$$G_3\left(\frac{R+Q,L}{Q}\right) = -G_{12}(R,TL) \quad\cdots\cdots\cdots\cdots\cdots(8)$$

Where G$_6$ (R,T) =

$$\left(\frac{\sigma^4+2D^4T^2}{4D} + R\frac{\left(\sigma^4+2D^4T^2\right)}{2D} + \frac{R^2}{2D}\right)F\left(\frac{R+DT}{\sqrt{\sigma^2T}}\right) + \frac{1}{2}\left(\sigma T^{3/2} - \frac{\sigma^3 T^{1/2}}{D^2} - \frac{T^{1/2}R}{D}\right)$$

$$g\left(\frac{R+DT}{\sqrt{\sigma^2T}}\right) - \frac{\sigma^4}{4D^3}esp\left(\frac{2DR}{\sigma^2}\right)F\left(\frac{R+DT}{\sqrt{\sigma^2T}}\right) \quad\cdots\cdots\cdots(9)$$

Similarly

$$\text{Lim } G \quad \frac{\left(R+Q,L\right)}{Q} = -G_{13}(R,L) \quad\cdots\cdots\cdots\cdots(10)$$

$$_3$$

Q ⟶ 0

Where G$_{13}$ (R, T) =

$$-D\left(\frac{R^3}{3D^3} + \frac{\sigma^2R^2}{2D^4} + \frac{\sigma^4R}{2D^5} + \frac{\sigma^6}{4D^6} - \frac{\sigma^2T^2}{2D^2} + \frac{T^2M}{D} - \frac{T^3}{3} - \frac{R^2T}{D^2}\right)F\left(\frac{R+DT}{\sqrt{\sigma^2T}}\right)$$

$$+ \frac{D}{\sqrt{\sigma^2T}}g\left(\frac{R+DT}{\sqrt{\sigma^2T}}\right)\left(\frac{-2}{3}\frac{\sigma^2RT^2}{D^2} + \frac{\sigma^2T^3}{3D^4} + \frac{\sigma^2R^2T}{3D^3} - \frac{\sigma^4RT}{2D^3}\right)$$

$$\left(+ \frac{\sigma^4T^2}{6D^3} + 8\frac{\sigma^6T^2}{D^5}\right) + esp\left(\frac{2DR}{\sigma^2}\right)F\left(\frac{R+DT}{\sqrt{\sigma^2T}}\right)\frac{\sigma^6}{4D^5} \quad\cdots\cdots\cdots\cdots(11)$$

Similarly

$$\text{Lim Q} \longrightarrow 0 \quad G_4\frac{\left(R+Q,L\right)}{Q} = -R_0(R,L) \quad\cdots\cdots\cdots\cdots(12)$$

Where $$R_0(R,T) = \left(T - \frac{R}{D} - \frac{\sigma^2}{2D^2}\right)F\left(\frac{R+DT}{\sqrt{\sigma^2T}}\right)$$

$$+ \frac{\sqrt{\sigma^2T}}{D\sqrt{2\pi}}esp - \frac{1}{2}\left(\frac{R+DT}{\sqrt{\sigma^2T}}\right)^2 + \frac{\sigma^2}{2D^2}esp\left(\frac{2D^2}{\sigma^2}\right)F\left(\frac{M+DT}{\sqrt{\sigma^2T}}\right) \quad\cdots\cdots\cdots(13)$$

The cost equations for model (M, T) excluding the cost of stockouts dependent only on the number of stockouts

$$C = \frac{R_1+S}{T} + hc\left(M - DL - \frac{DT}{2}\right) + \frac{b_1}{T}\left(G_{11}(M,T+L)\right)$$

$$-C_5(M,L)) + \frac{(b^2+hc)}{T}\left(G_6(M,T+L) - G_6(M,L + \frac{b_3}{T}\left(G_7(M,T+L) - G_7(M,L)\right)\right. \quad (14)$$

Let

$$G_8(R) = \int_0^\alpha H(L)G_5(R,L)dl \quad\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots(15)$$

$$G_9(R) = \int_0^\alpha H(L)G_6(R,L)dL \quad\cdots\cdots\cdots\cdots\cdots\cdots\cdots(16)$$

$$G_{10}(R) = \int_0^\alpha H(L)G_7(R,L)dL \quad\cdots\cdots\cdots\cdots\cdots\cdots\cdots(17)$$

$$G_{11}(R) = \int_0^\alpha H(L)G_5(R,T+L)dL \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots(18)$$

$$G_{12}(R) = \int_0^\alpha H(L)G_6(R,T+L)dL \dots\dots\dots\dots\dots\dots\dots\dots\dots(19)$$

$$G_{13}(R) = \int_0^\alpha H(L)G_7(R,T+L)dL \dots\dots\dots\dots\dots\dots\dots\dots\dots(20)$$

From equation (7)

$$G_5(M,L) = \sqrt{\sigma^2 L}\, g\left(\frac{m-DL}{\sqrt{\sigma^2 L}}\right) - (M-DL)F\left(\frac{M-DL}{\sqrt{\sigma^2 L}}\right) \dots\dots\dots\dots\dots(21)$$

Multiplying by H(L) where $H(L) = \alpha^k \dfrac{\exp t L^{k-1}}{\big\rangle(k)}$

Hence $H(L)G_{11}(M,L) = \dfrac{\alpha^k \exp(-\alpha L)}{\big\rangle(k)}\left[L^{k1/2} g\left(\dfrac{m-DL}{\sqrt{\sigma^2 L}}\right) - (ML^{k-1} - DL^k)F\left(\dfrac{m-DL}{\sqrt{\sigma^2 L}}\right)\right]$ ....(22)

Noting that from

$$\int_0^\alpha H(L)g\left(\frac{x-DL}{\sqrt{\sigma^2 L}}\right)\frac{1}{\sqrt{\sigma^2 L}}dl = \frac{\alpha^k}{\sigma\sqrt{2\pi}}esp\frac{\left(\frac{Dx}{\sigma^2}\right)}{\big\rangle(k)}\left[2\left(\frac{x^2}{2\alpha+\sigma^2+D^2}\right)^{1/2(k-1/2)}\right]$$

$$K_{k-1/2}\left(\frac{x}{\sigma^2}(2\alpha\sigma^2+D^2)^{1/2}\right]$$

If K is an integer then

$$K_{k-1/2}(Z) = K_{1/2}(Z)\sum_{j=0}^{k-1}\frac{(k+j-1)!}{j!(k-j-1)!}(2Z)^{-j}$$

Where $K_{\frac{1}{2}}(Z) = \dfrac{\sqrt{\pi}}{\sqrt{2}}(Z)^{\frac{-1}{2}}\exp(-Z)$

Hence $K_{\frac{1}{2}}(Z) = \sqrt{\pi}\displaystyle\sum_{j=0}^{k-1}\dfrac{(k+j-1)!}{j!(k-j-1)!}(2Z)^{-j-\frac{1}{2}}\exp(-Z)$

Where $K_v\left(2\sqrt{BY}\right)$ denotes Bessel function of imaginary argument.

Letting $\theta^2 = 2\alpha\sigma^2+D^2$

From equation

$$\int_0^\alpha H(L)F\left(\frac{x-DL}{\sqrt{\sigma^2 L}}\right)dL$$

$$= \frac{\alpha^k}{\sigma\sqrt{2\pi}}esp\frac{\left(\frac{Dx}{\sigma^2}\right)}{\big\rangle(k)}\sum_{z=1}^{k}\frac{(k-1)!}{\alpha^2(k-z)!}\left[2D\left(\frac{x}{\theta}\right)^{k-z+1/2}K_{k-z+1/2}\left(\frac{x\theta}{\sigma^2}\right)\right]$$

$$+ 2x\left(\frac{x}{\theta}\right)^{k-z+1/2}K_{k-z+1/2}\left(\frac{x\theta}{\sigma^2}\right) \dots\dots\dots\dots(24)$$

Applying (23) and (24)

$$G_8(M) = \int_0^\alpha H(L)G_{11}(M,L)dL$$

$$G_8(M) = \frac{\alpha^k \sigma esp\left(\frac{DM}{\sigma^2}\right)}{\sqrt{2\pi}}\left[2\left(\frac{M}{\theta}\right)^{k+1/2}K_{k+1/2}\left(\frac{M\theta}{\sigma^2}\right)\right]$$

$$-\frac{\alpha^k \sigma esp\left(\frac{DM}{\sigma^2}\right)}{2\sigma\sqrt{2\pi})(k)}\left[M\sum_{z=1}^{k}\frac{(k-1)!}{\alpha^2(k-z)!}\left(2D\left(\frac{M}{\theta}\right)^{k-z+1/2}K_{k+1/2}\left(\frac{M\theta}{\sigma^2}\right)+2M\frac{M}{\theta}^{k-z+1/2}K_{k-z+1/2}\left(\frac{M\theta}{\sigma^2}\right)\right)\right.$$

$$\left.+D\sum_{z=1}^{k+1}\frac{k!}{\alpha^z(k+1-z)!}\left(2D\left(\frac{M}{\theta}\right)^{k-z+3/2}K_{k-z+1/2}\left(\frac{M\theta}{\sigma^2}\right)+2M\left(\frac{m}{\theta}\right)^{k-z+1/2}K_{k-z+1/2}\left(\frac{M\theta}{\sigma^2}\right)\right)\right.$$

From equation (9)

$$G_{12}(M,L) = \left(\frac{\sigma^4}{4D^3}+\frac{DL^2}{2}+\frac{M\sigma^2}{2D^2}-ML+\frac{M^2}{2D}\right)F\left(\frac{m-DL}{\sqrt{\sigma^2L}}\right)$$

$$+\frac{1}{2}\left(\sigma L^{3/2}-\frac{\sigma^3 L^{1/3}}{D^2}-\sigma\frac{L^{1/2}M}{D}\right)g\left(\frac{M-DL}{\sqrt{\sigma^2L}}\right)$$

$$-\frac{\sigma^4 esp\left(\frac{DM}{\sigma^2}\right)}{4D^3}zF\left(\frac{M+DL}{\sqrt{\sigma^2L}}\right)\quad\text{...(26)}$$

Simplifying

$$G_6(M,L) = \left[\left(\frac{\sigma^4}{4D^3}+\frac{\sigma^2}{2D^2}+\frac{M^2}{2D}\right)-ML+\frac{DL^2}{2}\right]F\left(\frac{m+DL}{\sqrt{\sigma^2L}}\right)$$

$$+\frac{1}{2}\left(-L^{1/2}\left(\frac{\sigma^3}{D^2}+\frac{\sigma M}{D}\right)+\sigma L^{3/2}\right)g\left(\frac{M+DL}{\sqrt{\sigma^2L}}\right)$$

$$-\frac{\sigma^4}{4D^3}esp\left(\frac{2DM}{\sigma^2}\right)F\left(\frac{M+DL}{\sqrt{\sigma^2L}}\right)\quad\text{...(27)}$$

Multiplying by $H(L) = \dfrac{\alpha^k \exp-\alpha L}{)(k)}$

Hence

$$H(L)G_{12}(M,L) = \frac{esp(-\alpha L)\alpha^k}{)(k)}\left[\left(\frac{\sigma^4}{4D^3}+\frac{\sigma^2 M}{2D^2}+\frac{M^2}{2D}\right)\right]$$

$$L^{k-1}-ML^k+\frac{DL^{K+1}}{2}F\left(\frac{m+DL}{\sqrt{\sigma^2L}}\right)-\frac{1}{2}\frac{\alpha^k\exp(-\alpha L)}{\sqrt{(k)}}$$

$$\left[\left(\frac{\sigma^3}{D^2}+\frac{\sigma M}{D}\right)L^{k-1/2}-\sigma L^{k+1/2}\right]g\left(\frac{M+DL}{\sqrt{\sigma^2L}}\right)$$

$$-\frac{\sigma^4}{4D^3}esp\left(\frac{Dm}{\sigma^2}\right)F\left(\frac{m+DL}{\sqrt{\sigma^2L}}\right)esp\frac{(-\alpha L)L^k\alpha^k}{)(k)}$$

Noting that

$$\int_0^\alpha H(L)F\left(\frac{x+DL}{\sqrt{\sigma^2 L}}\right)esp\left(\frac{Dx}{\sigma^2}\right)dL$$

$$=\frac{\alpha^k}{2\sigma)(k)}\cdot\frac{1}{\sqrt{2\pi}}\sum_{z=1}^{k}\frac{(k-1)!}{\alpha^2(k-z)!}\left[-20\left(\frac{k}{\theta}\right)^{k-z+1/2}K_{k-2+1/2}^{\left(\frac{x\theta}{\sigma^2}\right)}\right]$$

$$+2x\left(\frac{x}{\theta}\right)^{k-z-1/2}K_{k-z-1/2}^{\left(\frac{x\theta}{\sigma^2}\right)}\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots(29)$$

Where $\theta^2 = 2\alpha\sigma^2 + D^2$

Hence

$\int_0^\alpha H(L)G_{12}(M,L)dL$ applying (23), (24) (29)

We have

$$G_{15}(M)=\frac{\alpha^k esp\left(\frac{DM}{\sigma^2}\right)}{2\sigma\sqrt{2\pi})(k)}\left[\left(\frac{\sigma^4}{4D^3}+\frac{\sigma^2 M}{2D^2}+\frac{M^2}{2D}\right)\sum_{z=1}^{k}\frac{(k-1)!}{\alpha^2(k-z)!}\left(2D\left(\frac{M}{\theta}\right)^{k-z+1/2}K_{k-z+1/2}^{\left(\frac{m\theta}{\sigma^2}\right)}\right)\right]$$

$$2\left(\frac{M}{\theta}\right)^{K-Z+1/2}k_{K-Z+1/2}^{\left(\frac{M\theta}{\sigma^2}\right)}-M\sum_{Z=1}^{K+1}\frac{K!}{\alpha^2(K+1-Z)!}$$

$$\left(2D\left(\frac{M}{\theta}\right)^{k-z+3/2}K_{k-z+3/2}^{\left(\frac{M\theta}{\sigma}\right)}+2M\left(\frac{M}{\theta}\right)^{k-z+1/2}K_{k-z+1/2}^{\left(\frac{M\theta}{\sigma^2}\right)}\right)$$

$$+\frac{D}{2}\sum_{z=1}^{k+2}\frac{(k+1)!}{\alpha^2(k+2-z)!}\left(2D\left(\frac{M}{\theta}\right)^{k-z+5/2}K_{k-z+5/2}^{\left(\frac{M\theta}{\sigma^2}\right)}\right)$$

$$+2M\left(\frac{M}{\theta}\right)^{k-z+3/2}K_{k-z+5/2}^{\left(\frac{m\vartheta}{\sigma^2}\right)}-\frac{\alpha^k esp\left(\frac{2M}{\sigma^2}\right)}{2\sqrt{2\pi})(k)}$$

$$\left[2\left(\frac{\sigma^3}{D^2}+\frac{\sigma M}{D}\right)\left(\frac{M}{\theta}\right)^{k+1/2}K_{k+1/2}^{\left(\frac{m\theta}{\sigma^2}\right)}-\sigma\left(\frac{M}{\vartheta}\right)^{K+3/2}K_{k+3/2}^{\left(\frac{m\theta}{\sigma^2}\right)}\right]$$

$$-\frac{\sigma^4\alpha^k esp\left(\frac{DM}{\sigma^2}\right)}{\sqrt{2\pi}4D^3 2\sigma)(k)}\left[\sum_{z=1}^{k}\frac{(k-1)!}{\alpha^2(k-z)!}\right]$$

$$\left(2M\left(\frac{M}{\theta}\right)^{k-z+1/2}K_{k-z+1/2}^{\left(\frac{M\theta}{\sigma^2}\right)}-2D\left(\frac{M}{\theta}\right)^{k-z+1/2}K_{k-z+1/2}^{\left(\frac{M\theta}{\vartheta^2}\right)}\right)\dots\dots\dots\dots\dots\dots.(30)$$

Simplifying $G_{13}(M,L)$ equation (3)

We have

$$G_{13}(M,L)=-D\left[\left(\frac{M^3}{3D^3}+\frac{\sigma^2 M^2}{2D^4}+\frac{\sigma^4}{2D^5}+\frac{\sigma^6}{4D^6}\right)\right]$$

$$-\frac{M^2L}{D^2}+L^2\left(\frac{M}{D}-\frac{\sigma^2}{2D^2}\right)-\frac{L^3}{3})F\left(\frac{M-DL}{\sqrt{\sigma^2L}}\right)$$

$$+\frac{D}{\sqrt{\sigma^2}}g\left(\frac{M-DL}{\sqrt{\sigma^2}L}\right)\left[\left(\frac{\sigma^2M^2}{3D^3}+\frac{\sigma^4M}{2D^4}\right)L^{1/2}\right]$$

$$+\frac{8\sigma^6}{D^5}L^{1/2}+L^{3/2}\left[\left(-\frac{2\sigma^2M}{3D^2}+\frac{\sigma^4}{6D^3}\right)+\frac{\sigma^2L^{5/2}}{3D}\right]$$

$$+\frac{\sigma^6}{4D^6}esp\left(\frac{2DM}{\sigma^2}\right)F\left(\frac{M+DL}{\sqrt{\sigma^2}L}\right)\dots\dots\dots\dots\dots\dots(31)$$

Hence H(L)

$$H(L)G_{13}(M,L)=\frac{\alpha^k esp(-\alpha L)}{\big)(k)}\left[\left(\frac{M^3}{3D^3}+\frac{\sigma^2M^2}{2D^4}+\frac{\sigma^4M}{2D^5}+\frac{\sigma^6}{4D^6}\right)\right]$$

$$-\frac{M^2L^k}{D^2}+L^{k+1}\left(\frac{M}{D}-\frac{\sigma^2}{2D^2}\right)-\frac{L^{k+2}}{3})$$

$$F\left(\frac{M-DL}{\sqrt{\sigma^2L}}\right)+\frac{1}{\sigma}g\left(\frac{M-DL}{\sqrt{\sigma^2}L}\right)\left(\frac{\sigma^2M^2}{3D^3}+\frac{\sigma^4M}{2D^4}\right)L^{k-1/2}$$

$$+\frac{8\sigma^6}{D^5}L^{k-1/2}+L^{k+1/2}\left(\frac{\sigma^4}{6D^3}-\frac{2}{3}\frac{\sigma^2M}{D^2}\right)$$

$$+\frac{\sigma^2}{3D}L^{k+3/2}\ ]\frac{esp(-\alpha L)\alpha^k}{\big)(k)}+\frac{\sigma^6}{4D^6}esp\left(\frac{2DM}{\sigma^2}\right)$$

$$\frac{\alpha^k esp(-\alpha L)L^{k-1}}{\big)(k)}F\left(\frac{R+DL}{\sqrt{\sigma^2L}}\right)\dots\dots\dots\dots\dots\dots\dots(32)$$

Hence integrating

$$G_{16}(M)=\int_0^\infty H(L)G_{13}(M,L)dL \quad \text{applying (23) (24) and (29)}$$

We have

$$G_{16}(M)=\frac{\alpha^k}{2\sigma}\frac{esp\left(\frac{DM}{\sigma^2}\right)}{\big)(k)\sqrt{2\pi}}\left[\left(\frac{M^3}{3D^3}+\frac{\sigma^2M^3}{2D^4}+\frac{\sigma^4M}{4D}+\frac{\sigma^6}{4D^5}\right)\right]$$

$$\sum_{z=1}^k\frac{(k-1)!}{\alpha^z(k-z)!}\left(2D\left(\frac{M}{\theta}\right)^{k-z+1/2}K_{k-z-1/2}\left(\frac{m\vartheta}{\vartheta}\right)+2M\left(\frac{M}{\theta}\right)^{k-z-1/2}K_{k-z-1/2}\left(\frac{M\theta}{\sigma^2}\right)\right)$$

$$-\frac{M^2}{D^2}\sum_{z=1}^{k-1}\frac{k!}{\alpha^2(k+1-2)!}\left(2D\left(\frac{M}{\theta}\right)^{k-z+3/2}K_{k-z+3/2}+2M\left(\frac{M}{D}\right)^{k-z+1/2}K_{k-z+1/2}\left(\frac{M\theta}{\sigma^2}\right)\right)$$

$$+\left(\frac{M}{D}-\frac{\sigma^2}{2D^2}\right)\sum_{z=1}^{k+2}\frac{(k+1)!}{\alpha^z(k+2-z)!}\left(2D\left(\frac{M}{\theta}\right)^{k-z+5/2}K_{k-z+5/2}\left(\frac{M\theta}{\sigma^2}\right)\right)$$

$$+ 2M\left(\frac{M}{\theta}\right)^{k-z+3/2} K_{k-z+3/2}\left(\frac{M\theta}{\sigma^2}\right)) - \frac{1}{3}\sum_{z=1}^{k+3}\frac{(k+1)!}{\alpha^z(k+3-z)!}$$

$$+ 2D\left(\frac{M}{\theta}\right)^{k-z+7/2} K_{k-z+7/2}\left(\frac{M\theta}{\sigma^2}\right) + 2M\left(\frac{M}{\theta}\right)^{k-z+5/2} K_{k-z+5/2}\left(\frac{M\theta}{\sigma^2}\right)$$

$$+ \frac{esp\left(\frac{DM}{\sigma^2}\right)}{\sqrt{2\pi\sigma^2}}\frac{\alpha^k}{)(k)}\left[2\left(\frac{\sigma^2 M^2}{3D^3} + \frac{\sigma^4 M}{2D^4} + \frac{8\sigma^6}{D^5}\right)\left(\frac{M}{\theta}\right)^{k+1/2}\right]$$

$$K_{k+1/2}\left(\frac{M\theta}{\sigma^2}\right) + 2\left(\frac{\sigma^4}{6D^3} + \frac{2\sigma^2 M}{3D^2}\right)\left(\frac{M}{\theta}\right)^{k+3/2} K_{k+3/2}\left(\frac{M\theta}{\sigma_2}\right)$$

$$+ \frac{2\sigma^2}{3D}\left(\frac{M}{\theta}\right)^{k+5/2} K_{k+5/2}\left(\frac{M\theta}{\sigma^2}\right)\ ]$$

$$+ \frac{esp\left(\frac{DM}{\sigma^2}\right)}{\sqrt{2\pi\sigma^2}}\frac{\alpha^k}{)(k)}\cdot\frac{1}{\sqrt{2\pi}}\left[\sum_{z=1}^{k}\frac{(k+1)}{\alpha^z(k-z)!}\left(-2\left(\frac{M}{\theta}\right)^{k-z+1/2}\right)\right]$$

$$+ 2M\left(\frac{M}{\theta}\right)^{k-z-1/2})K_{k-z-1/2}\left(\frac{M\theta}{\sigma^2}\right)\ \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots(33)$$

Using equation (3)

$$G_{16}(M,L+T) = \sigma(L+T)^{1/2} g\left(\frac{M-D(L+T)}{\sqrt{\sigma^2(L+T)}}\right) - [(M-DT)-DL]$$

$$F\left(\frac{M-D(L+T)}{\sqrt{\sigma^2(L+T)}}\right)\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots(34)$$

Multiplying by H(L)

$$H(L)G_5(M,L+T) = \frac{\sigma\alpha^k esp(-\alpha L)L^{k-1}(L+T)^{1/2}}{\sqrt{2\pi})(K)} g\left(\frac{M-D(L+T)}{\sqrt{\sigma^2(L+T)}}\right)$$

$$- \frac{\alpha^k esp(-\alpha L)}{)(k)}\left[(M-DT)L^{k-1}-DL^k\right]F\left(\frac{M-D(L+T)}{\sqrt{\sigma^2(L+T)}}\right)\dots\dots\dots\dots\dots\dots\dots(35)$$

Hence applying (23), (24) and (29)
Let

$$G_{11}(M,T) = \int_0^\infty H(L)G_5-(M,L+T)dL$$

$$= \frac{\sigma esp}{\sqrt{2\pi})(k)}\left(\alpha T + \frac{DM}{\sigma^2}\right)\alpha^k \sum_{j=0}^{k-1}(-T)^j\binom{k-1}{j}\left(2\left(\frac{M}{\theta}\right)^{k-j+1/2} K_{k-j+1/2}\left(\frac{M\theta}{\sigma^2}\right)\right)$$

$$+ \frac{\alpha^k}{2\sigma\sqrt{2\pi}} esp\frac{\left(\alpha T + \frac{DM}{\sigma^2}\right)}{)(k)}\sum_{j=0}^{k-1}(-T)^j\binom{k-1}{j}\sum_{z=1}^{k-j}\frac{(k-1-j)}{\alpha^z(k-j-z)!}$$

$$\left(2D\left(\frac{M}{\theta}\right)^{k-j-z+1/2}K_{k-j-z+1/2}\left(\frac{M\theta}{\sigma^2}\right)-2M\left(\frac{M}{\theta}\right)^{k-j-z-1/2}K_{k-j-z-1/2}\left(\frac{M\theta}{\sigma^2}\right)\right)$$

$$(M-DT)-D\sum_{j=0}^{k}(-T)^{j}\binom{k}{j}\sum_{z=1}^{k+1-j}\frac{(k-j)!}{\alpha^z(k+1-j-z)!}\left(2D\left(\frac{M}{\theta}\right)^{k-j-z+3/2}\right.$$

$$\left.K_{k-j-z+3/2}\left(\frac{M\theta}{\sigma^2}\right)+2M\left(\frac{M}{\theta}\right)^{k-j-z+4/2}K_{k-j-z+1/2}\left(\frac{M\theta}{\sigma^2}\right)\right]$$

Subsisting L+T for L and simplifying
From equation (31)

$$G_{13}(M,L+T)=\left[\left(\frac{M^3}{3D^3}+\frac{\sigma^2M^2}{2D^4}+\frac{\sigma^4M}{2D^5}+\frac{\sigma^6}{4D^6}-\frac{M^2T}{D^2}\right)\right]$$

$$-\frac{M^2L}{D^2}+\sum_{z=0}^{2}\binom{2}{\iota}T'L^{2-i}\left(\frac{M}{D}-\frac{\sigma^2}{2D^2}\right)$$

$$-\frac{1}{3}\sum_{t=0}^{3}\binom{3}{\iota}T'L^{3-t}\quad]F\left(\frac{M-DL}{\sqrt{\sigma^2L}}\right)+\frac{1}{\sigma}g\left(\frac{M-DL}{\sqrt{\sigma^2(L+T)}}\right)$$

$$\left[\left(\frac{\sigma^2M^2}{3D^3}+\frac{\sigma^4M}{2D^4}+\frac{8\sigma^6}{D^5}\right)\right](L+T)^{1/2}$$

$$+\left(\frac{\sigma^4}{6D^3}-\frac{2\sigma^2M}{3D^2}\right)(T+L)^{3/2}+\sigma^2(L+T)^{1/2}\sum_{t=0}^{2}\binom{2}{\iota}T^iL^{2-i}\right]$$

$$+\frac{\sigma^6}{4D^6}esp\left(\frac{2DM}{\sigma^2}\right)F\left(\frac{M+DL}{\sqrt{\sigma^2L}}\right)\dots\dots\dots\dots\dots\dots\dots\dots(37)$$

Multiplying by H(L) we have

$$H(L)G_{13}(M,L+T)=-\frac{\alpha^kesp(-\alpha L)}{\rangle(k)}\left[\left(\frac{M^3}{3D^3}+\frac{\sigma^2}{2D^4}+\frac{\sigma^4M}{2D^5}+\frac{\sigma^6}{4D^6}-\frac{M^2T}{D^2}\right)L^{k-1}\right.$$

$$+\frac{M^2L^k}{D^2}+\sum_{i=0}^{2}\binom{2}{i}T^iL^{k+-i}$$

$$\left(\frac{M}{D}-\frac{\sigma^2}{2D^2}\right)-\frac{1}{3}\sum_{i=o}^{3}\binom{3}{i}T^iL^{k-i+2}\quad]F\left(\frac{M-DL}{\sqrt{\sigma^2L}}\right)$$

$$+\frac{\alpha^k}{\sigma}esp\frac{(-\alpha L)}{\rangle(k)}(L+T)^{1/2}g\left(\frac{M+D(L+T)}{\sqrt{\sigma^2(L+T)}}\right)\left[\left(\frac{\sigma^2M^2}{3D^3}+\frac{\sigma^4M}{2D^4}+\frac{8\sigma^6}{D^5}\right)\right.$$

$$+\frac{\sigma^4T}{6D^3}-\frac{2\sigma^2MT}{3D^2}\quad]L^{k-1}+\left(\frac{\sigma^4}{6D^3}-\frac{2\sigma^2M}{3D^2}\right)L^k$$

$$+\sigma^2\sum_{i=0}^{2}\binom{2}{i}T^iL^{k-1+1}\quad]+\frac{\sigma^6}{4D^6}esp\left(\frac{2DM}{\sigma^2}\right)$$

$$\frac{\alpha^k esp(-\alpha L)L^{k-1}}{\big\rangle(k)}F\left(\frac{M+DL}{\sqrt{\sigma^2 L}}\right)\dots\dots\dots\dots\dots\dots\dots\dots\dots(38)$$

Applying (23, (24, (25)

$$G_{19}(M,T)=\int_0^\alpha H(L)G_{12}(M,L+T)$$

$$=\frac{\alpha^k esp(\alpha T+\frac{DM}{\sigma})}{\sqrt{2\pi}\big\rangle(k)2\sigma}\left[\left(\frac{M^3}{3D^3}+\frac{\sigma^2 M^2}{2D^4}+\frac{\sigma^4 M}{2D^5}+\frac{\sigma^6}{4D^6}-\frac{M^2 T}{D^2}\right)\right]$$

$$\sum_{z=1}^{k-1}\binom{k-1}{j}^j\sum_{z=1}^{k-j}\frac{(k-1-z)!}{\alpha^2(k-j-z)!}\left(2D\left(\frac{M}{\theta}\right)^{k-j-z+1/2}\right)$$

$$K_{k-j-z+1/2}{}^{\left(\frac{M\theta}{\sigma^2}\right)}+2M\left(\frac{M}{\theta}\right)^{k-j-z-1/2}K_{k-j-z-1/2}{}^{\left(\frac{M\theta}{9}\right)}$$

$$+\frac{M^2}{D^2}\sum_{j=0}^{k}\binom{k}{j}(-T)^j\sum_{z=1}^{k+1-j}\frac{(k-j)}{\alpha^2(k+1-j-z)!}\left(2D\left(\frac{M}{\theta}\right)^{k-j-z+3/2}K_{k-j-z+3/2}{}^{\left(\frac{M\theta}{\sigma^2}\right)}\right)$$

$$+2M\left(\frac{M}{\theta}\right)^{k-j-z-1/2}K_{k-j-z-1/2}{}^{\left(\frac{M\theta}{\sigma^2}\right)}$$

$$+\left(\frac{M}{D}-\frac{\sigma^2}{2D^2}\right)\sum_{t=0}^{2}\binom{2}{t}T\sum_{j=0}^{k+1-t}(-T)^j\binom{k+1-i}{j}$$

$$+\sum_{z=1}^{k+2+i-j}\frac{(k+1-2-j)!}{\alpha^2(k+2-\iota-z)!}\left(2D\left(\frac{M}{\theta}\right)^{k-j-z+5/2}K_{k-j-z+5/2}{}^{\left(\frac{M\theta}{\sigma^2}\right)}\right)$$

$$+2M\left(\frac{M}{\theta}\right)^{k-j-z+3/2}K_{k-h-z+3/2}\left(\frac{M\theta}{\sigma^2}\right)$$

$$-\frac{1}{3}\sum_{t=0}^{3}\binom{3}{\iota}T^\iota\sum_{j=0}^{k+z-i}(-T)^\iota\binom{k-t+2}{j}\sum_{z=1}^{k+3-i-j}\frac{(k+2-1-j)!}{\alpha^2(k+3-i-z)!}$$

$$2D\left(\frac{M}{\theta}\right)^{k-j-z+7/2}K_{k-j-z+7/2}\left(\frac{M\theta}{\sigma^2}\right)+2M\left(\frac{M}{\theta}\right)^{k-j-z+5/2}K_{k-j-z+5/2}{}^{\left(\frac{M\theta}{\sigma^2}\right)}$$

$$+esp\left(\alpha T+\frac{DM}{\sigma^2}\right)\frac{\alpha^k}{\big\rangle(k)}\left[\sum_{j=0}^{k-1}(-T)^j\binom{k-1}{j}\left(\frac{M^3}{3D^3}+\frac{\sigma^2 M^2}{2D^4}+\frac{\sigma^2 M}{2D^5}+\frac{\sigma^2}{4D^6}-\frac{M^2 T}{D^2}\right)\right]$$

$$+\frac{\sigma^2 M}{2D^5}+\frac{\sigma^6}{4D^6}-\frac{M^2 T}{D^2}-2\left(\frac{M}{\theta}\right)^{k-j+1/2}K_{k-j+1/2}{}^{\left(\frac{m\vartheta}{\sigma^2}\right)}$$

$$+2\left(\frac{\sigma^4}{6D^3}-\frac{2\sigma^2 M}{3D^2}\right)\sum_{j=0}^{k}(-T)^j\binom{k}{j}\left(\frac{M}{\theta}\right)^{k-i+3/2}$$

$$K_{k-j+3/2}{}^{\left(\frac{M\theta}{\sigma^2}\right)}+2\sigma^2\sum_{i=0}^{2}(-T)\binom{k-i+1}{j}$$

$$\left(\frac{M}{\theta}\right)^{k-i-j+5/2} K_{k-i-j+5/2} \left(\frac{M\theta}{\sigma^2}\right) + \frac{\sigma^6}{4D^6} \frac{\alpha^k esp\left(\frac{DM}{\sigma^2}+\alpha T\right)}{\big)(k)2\sigma\sqrt{2\pi}} \sum_{j=0}^{k-1}\binom{k-1}{j}(-T)^j$$

$$\sum_{z=1}^{k-j}\frac{(k-1-j)!}{\alpha^2(k-j-z)!}\left(-2D\left(\frac{M}{\theta}\right)^{k-j-z+1/2} K_{k-j-z+1/2}\left(\frac{M\theta}{\sigma^2}\right)\right) + 2M\left(\frac{M}{\theta}\right)^{k-j-z-1/2} K_{k-j-z-1/2}\left(\frac{M\theta}{\sigma^2}\right)$$

From equation (27) substituting L+T for L

$$G_{12}(M_1 L+T) = \left[\left(\frac{\sigma^4}{4D^3}+\frac{\sigma^2 M}{2D^2}+\frac{M^2}{2D}-TM\right)-LM+\frac{D}{2}\sum_{j=0}^{2}\binom{2}{2}T^2 L^{2-2}F\left(\frac{M-D(L+T)}{\sqrt{\sigma^2(L+T)}}\right)\right]$$

$$+\frac{\sqrt{(L+T)}}{2}\left[-\left(\frac{\sigma^3}{D^2}+\frac{\sigma M}{D}-\sigma L\right)g\left(\frac{M-D(L+T)}{\sqrt{\sigma^2}(L+T)}\right)\right]$$

$$-\frac{\sigma^4}{4D^3}esp\left(\frac{2DM}{\sigma^2}\right)F\left(\frac{M+D(L+T)}{\sqrt{\sigma^2}(L+T)}\right)\dots\dots\dots\dots\dots\dots(40)$$

Multiplying by H(L) we have

$$H(L)G_{12}(M_1 L+T) = \left[\left(\frac{\sigma^4}{4D^3}+\frac{\sigma^2 M}{2D^2}+\frac{M^2}{2D}-TM\right)-L^{k-1}\right]$$

$$-L^k+\frac{D}{2}\sum_{z=0}^{2}\frac{2}{\iota}T^2 L^{k+1-\iota}F\left(\frac{M-D(T+L)}{\sqrt{\sigma^2(T+L)}}\right)$$

$$+\frac{1}{2}(L+T)^{1/2}\left[-\left(\frac{\sigma^3}{D^2}+\frac{\sigma M}{D}-\sigma T\right)L^{k-1}+\sigma L^k\right]$$

$$g\left(\frac{MD(T+L)}{\sigma^2(T+L)}\right)-\frac{\sigma^4}{4D^3}\alpha^k\frac{esp(-\alpha L)}{\big)(k)}esp\left(\frac{2DM}{\sigma^2}\right)F\left(\frac{M+DL}{\sqrt{\sigma^2 L}}\right)\dots\dots\dots\dots(41)$$

Let $G_{18}(M,T)=\int_0^\alpha H(L)G_{12}(M,T+L)dL$ and $\dots\dots\dots\dots\dots\dots\dots\dots\dots(42)$

Applying (23) (21) and (29)
We have

$$G_{18}(M,T)=\frac{\alpha^k \exp(\alpha T+\frac{DM}{\sigma^2})}{\sqrt{2\pi}\big)(k)\sqrt{2\pi}}\left[\left(\frac{\sigma^4}{4D^3}+\frac{\sigma^2 M}{2D^2}+\frac{M^2}{D}-TM\right)\right]$$

$$\sum_{j=0}^{k-1}(-T)^j\binom{k-}{j}\sum_{z=1}^{k-j}\frac{(k-1-j)!}{\alpha^2(k-j-z)!}$$

$$\left(2D\left(\frac{M}{\theta}\right)^{k-j-z+1/2} K_{k-j}\left(\frac{M\theta}{\theta}\right)+2M\left(\frac{M}{\theta}\right)^{k-j-z-1/2} K_{k-j-z-1/2}\left(\frac{M\theta}{\theta}\right)\right)$$

$$-M\sum_{z=1}^{k}(-T)^j\binom{k}{j}\sum_{z=1}^{k+1-j}\frac{(k-j)!}{\alpha^2(k+1-j-z)!}$$

$$\left(2D\left(\frac{M}{\theta}\right)^{k-j-z+1/2}K_{k-j}{}^{\left(\frac{M\theta}{\theta}\right)}+2M\left(\frac{M}{\theta}\right)^{k-j-z-1/2}K_{k-j-z-1/2}{}^{\left(\frac{M\theta}{\theta}\right)}\right)+\frac{D}{2}\sum_{i=0}^{2}\binom{2}{t}T^{2}\sum_{j=0}^{k+1-2}(-T)^{j}$$

$$\binom{k+1-2}{j}\sum_{z=t}^{k+2-t-j}\frac{(k+1-\iota-j)!}{\alpha^{2}(k+2-\iota-j)!}\left(2D\left(\frac{M}{\theta}\right)^{k-j-z-2+5/2}\right)$$

$$K_{k-j-z-t+5/2}+2M\left(\frac{M}{\theta}\right)^{k-j-z-2+3/2}K_{k-j-z-2+3/2}{}^{\left(\frac{M\theta}{\sigma^{2}}\right)}$$

$$+\frac{\alpha^{k}esp(\alpha T+\frac{DM}{\sigma^{2}})}{2\sqrt{2\pi}\big)(k)}\left[-2\left(\frac{\sigma^{3}}{D^{2}}+\frac{\sigma M}{D}-\sigma T\right)\sum_{j=0}^{k-1}T^{j}\binom{k-1}{j}\right]$$

$$\left(\frac{M}{\theta}\right)^{k-j+1/2}K_{k-j+1/2}{}^{\left(\frac{M\theta}{\sigma^{2}}\right)}+\sigma\sum_{j=0}^{k}(-T)^{j}\binom{k}{j}\left(\frac{M}{\theta}\right)^{k-5+3/2}K_{k-j+3/2}{}^{\left(\frac{M\theta}{\sigma^{2}}\right)}$$

$$-\frac{\sigma^{4}}{4D^{3}}\frac{\alpha^{k}esp(\alpha T+\frac{DM}{\sigma^{2}})}{\big)(k)2k\sqrt{(2\pi)}}\sum_{j=0}^{k-1}(-T)^{j}\binom{k-1}{j}\sum_{z=1}^{k-1}\frac{(k-1-j)!}{\alpha^{2}(k-j-z)!}$$

$$\left(-2D\left(\frac{M}{\theta}\right)^{k-j-z+1/2}K_{k-j-z+1/2}{}^{\left(\frac{M\theta}{\sigma^{2}}\right)}+2M\left(\frac{M}{\theta}\right)^{k-j-z-1/2}K_{k-j-z+1/2}{}^{\left(\frac{M\theta}{\sigma^{2}}\right)}\right)\dots\dots\dots(43)$$

Hence averaging than inventory cost of (M, T) over the states of L from equation (14) excluding the stockout cost

$$C=\frac{Rc+s}{T}+hc\left(M-\frac{Dk}{\alpha}-\frac{DT}{2}\right)+\frac{b_{1}}{T}(G_{17}(M,T)-G_{14}(M))$$

$$+\frac{(hc+b_{2})}{T}(G_{18}(M,T)-G_{15}(M))+\frac{b_{3}}{T}(G_{19}(M,T)-G_{16}(M))\ \dots\dots\dots\dots\dots(44)$$

III. IMPACT OF STUDY

The study will enable industries, or organizations with thousands of items in their warehouses in different locations to express their backorder costs more accurately in non linear formulations. This would give more realistic inventory costs for holding items in various locations of the world.

REFERENCES

[1] Bertimas .D. (1999), "*Probabilistic Service level Guarantee in Make-to-stock*, Citeseere.ist.psn.edu.
[2] Hadley and Whitin (1972), *Analysis of Inventory System,* John Wiley Inc, NY.
[3] Nasri Farrokh, Paknejod, Jaed, and Affisco John F, (2012), *EOQ Model with non-linear holding costs*, www.relsi.org/proc/2012.
[4] Pektria .S.K. (2012) "*An inventory Replenishment Policy for Deteriorating Items under Inflation in a stock Dependent Consumption Market with shortage, International Journal of Trans disciplinary Research*, Vol. 6, No 1.
[5] Zipkin .P., (2006) '*Stochastic leadtimes in continuous-time inventory models, Naval Research Logistics*', 21 Nov. 2006.

Research Paper　　　　　　　　　　　　　　　　　　　　　　　　　　　　Open Access

Circuit Averaging for Boost Converter Involving Generation of Pseudo-Random Carrier Modulation via PSIM

Anant Kumar Verma, Dr. Gagan Singh
(ELECTRICAL ENGINEERING DEPARTMENT, DIT university, Dehardun, INDIA)
(ELECTRICAL ENGINEERING DEPARTMENT, DIT university, Dehardun, INDIA)

Abstract: - The paper reflects the approach towards the understanding of the circuit averaging method used for the power converters. Various software simulation packages are available for the purpose to be served such as MATLAB (Simulink), LTspice, PSIM (power electronics, motor drives, and dynamic system simulation) etc. A mathematical analysis is done for modeling the Boost converter (Step-Up) ideally as well as practically. An implementation of the Pseudo-random carrier modulation scheme is worked on the software package PSIM. Semiconductor devices used in power electronics systems(PES) increases the effects of audible switching noise, electromagnetic interference etc, which is one of the major concern while designing the power converters.

I.　　INTRODUCTION

In power electronics Boost converter is the basic topology under DC–DC converter, whose behavior serves to convert a DC input voltage to a Higher DC output voltage, which has been widely used in engineering. It is an important step for designing of a Boost converter is to model and analyze this converter according to the real requirements. Many appropriate models have been made by researchers to establish and explore the corresponding analysis method. Up to now, a few good models have been proposed to describe the Boost converter, and a few good analysis methods have been explored to investigate the dynamic behavior.[1] For example, under the assumption that the switching frequency is much higher than its characteristic frequency, the averaged model, which is used to derive the small signal model, can be obtained by averaging the circuit variable within each switching cycle to describe the dynamic behavior of the Boost converter in the low frequency region.[1-2] Controller design for any system needs knowledge of system behavior. Usually involves a mathematical description of the relation established for inputs to the process, state variables, and output. When system is described in the form of mathematical equations which gives an insight behavior of the system (process) is called model of the system. This paper describes an efficient method to learn, analyze and simulation of power electronic converters, using Averaged models. The MATLAB (Simulink), LTspice, PSIM software packages are used to simulate power converters. Our study aims at development of the model for basic converters and studying its open loop behavior, so this model can be used in case of design of any closed loop system. The averaged model can be obtained by using the state-space averaging[2] or the circuit averaging technique.[3] Since the circuit averaging technique, whose advantages are its simplicity and clearer insight into the converter behavior, is applied to derive the transfer functions of the open-loop Boost converter operating in the either continuous conduction mode (CCM) or Discontinuous conduction mode(DCM) of operation .

II.　　BOOST CONVERTER MODELING

In system control design, system modeling is probably the most important phase in any form of work. The simulation objectives depend on the circuit model. If the goal is to predict the behavior of a circuit before it is built. A designer needs to have good system model information to know the system dynamics. Due to the difficulty involved in solving general nonlinear equations due to presence of nonlinear semiconductor devices, all the governing equations will be put together in a block diagram form and then simulated using LTspice program. LTspice will solve these nonlinear equations numerically, and provide a simulated response of the system dynamics.
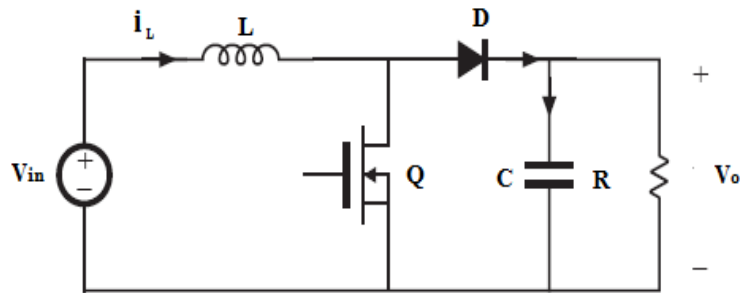
Fig. no.1. Schematic diagram of a boost converter.

The boost converter of Fig. no. 1 with a switching period of 'T' and a duty cycle of 'd' is given. Again, assuming continuous conduction mode of operation, the state space equations when the main switch is ON are shown by,

$$\begin{cases} \dfrac{di_L}{dt} = \dfrac{1}{L}(V_{in}) \\ \dfrac{dv_o}{dt} = \dfrac{1}{C}(-\dfrac{v_o}{R}) \end{cases}, \quad 0 < t < dT, \quad Q:ON \tag{1}$$
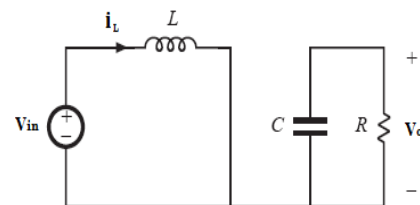
Fig. no.2. when Switch is ON

and when the switch is OFF

$$\begin{cases} \dfrac{di_L}{dt} = \dfrac{1}{L}(V_{in} - v_o) \\ \dfrac{dv_o}{dt} = \dfrac{1}{C}(i_L - \dfrac{v_o}{R}) \end{cases}, \quad dT < t < T, \quad Q:OFF \tag{2}$$
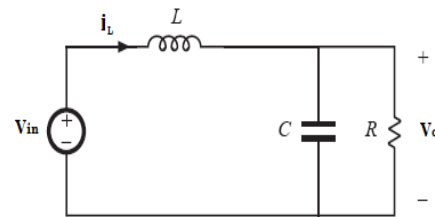
Fig. no. 3. when Switch is OFF

III.   RULES AND CIRCUIT AVERAGING

There are three important RULES in learning power electronics converters [4]:

- Inductor Volt-sec balance.
- Capacitor charge balance.
- Small ripple Approximation.

Under steady-state conditions power converter output response is periodic in nature and hence rather applying Fourier analyses to the output waveforms. It is best suited that we should apply these rules in steps so as we can easily apply our conventional KVL and KCL rules in a simpler manner.

1. Inductor volt-sec balance:

$$< V_L > = \frac{1}{T} \int_0^T v_L(t)\, dt$$

2. Capacitor charge balance:

$$< i_c > = \frac{1}{T} \int_0^T i_c(t)\, dt$$

3. Small ripple approximation:

In a well versed designed power converter, the output voltage ripple is small. Therefore we can easily neglect the ripple from output voltage.

$$v_o(t) = V + v_{ripple}(t) \tag{3}$$
$$\| v_{ripple} \| \ll V \tag{4}$$
$$v \approx V \tag{5}$$
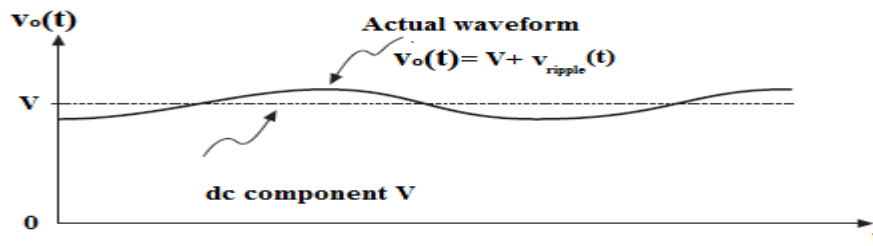
Fig. no.4. Small ripple approximation.

4.　Averaging of the boost converter obtained in two states of switch Q:
So to make our implementation easy and simpler we take an average of the equations sets 1 and 2 with respect to the duty ratio d.

$$L\frac{di_L}{dt} = v_{in} - (1-d)v_o \tag{6}$$

$$c\frac{dv_o}{dt} = (1-d)i_L - \frac{v_o}{R} \tag{7}$$
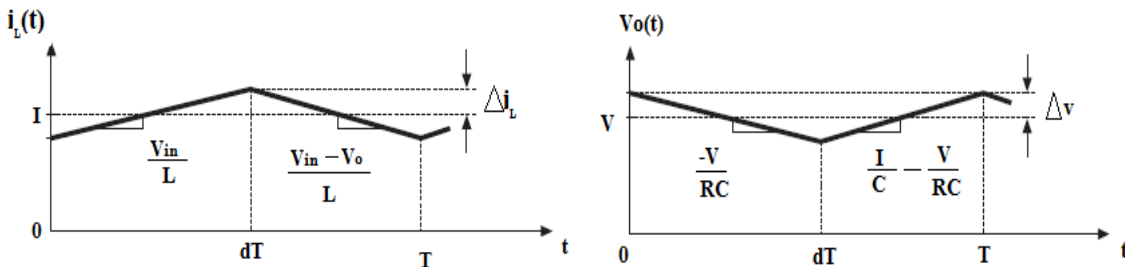
Fig. no.5 Behavior of inductor current and output voltage switch Q changes its ON state to OFF state.

Hence ,we are able to predict the response of the boost converter on the above basis in a simpler manner. Averaged switched model has been made in LTspice for analysis of the converter ratio which gives relationship between output voltage and input voltage.(here switch is the averaged model of the semiconductor devices)

$$k = \frac{V_o}{V_{in}} = \frac{1}{1-d} \tag{8}$$
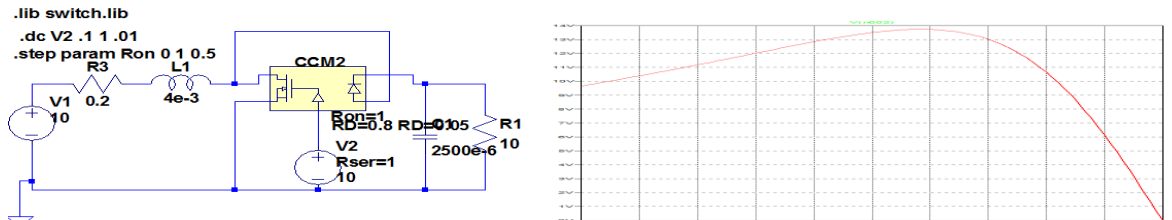
Fig. no.6 Converter ratio K changes as duty ratio changes with respect to Vin=10v ,R=10,C=2.5mh,L=4mh.

IV.　GENERATION OF PSEUDO-RANDOM CARRIER

　　　Generating of pseudorandom carrier[6] is simple task as proposed in our previous work using MATLAB(Simulink).Similarly we have tried to achieve the Pseudorandom carrier waveform using some Analog to Digital converter ,D-Flip-Flops and using some digital logic gates. By sensing the output voltage ripple ,Analog to digital converter generates corresponding bits which are shifted and XOR-ed using a digital logic according to desired frequency so that multiplexer can be controlled to generate Pseudorandom carrier via PSIM.
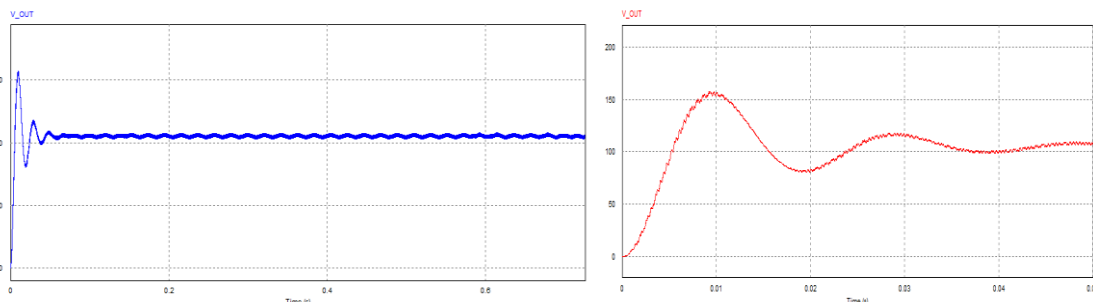
Fig. no.7 Steady-state and transient analysis of a boost converter using Pseudorandom carrier and DC-signal as reference.
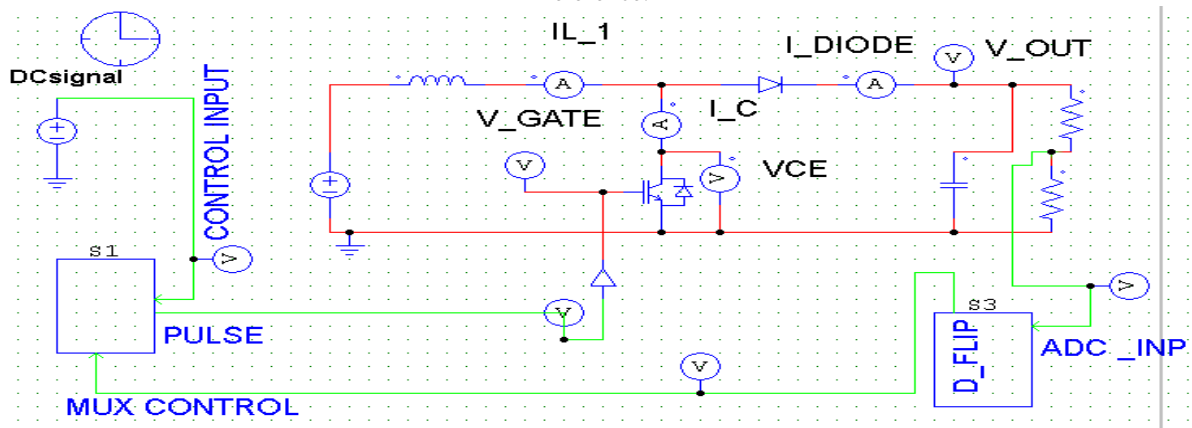
Fig. no.8. Implemented open loop boost converter using PSIM.
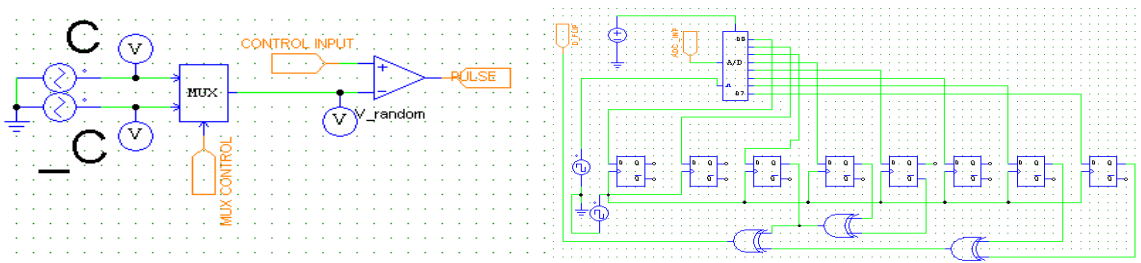
Fig. no.9. Internal block S1 and S3 for implementation of PSEUDO-RANDOM-CARRIER.

ZERO DEGREE PHASE SHIFT   180 DEGREE PHASE SHIFT

MUX CONTROL INPUT
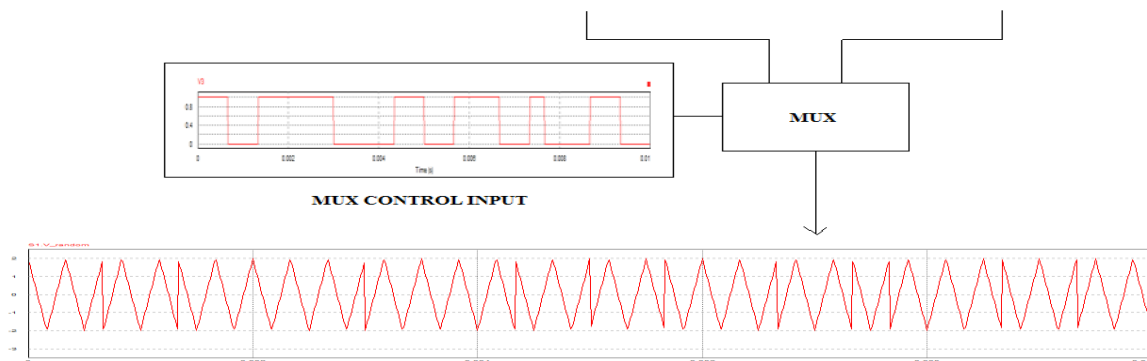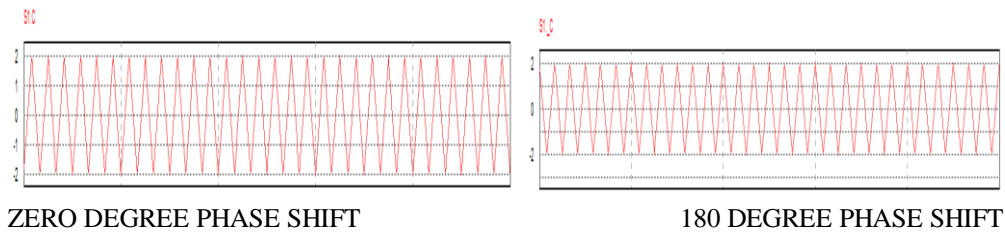
Fig. no.10 Generated Pseudo-random Carrier using PSIM.

V.   CONCLUSION

The average model of method of Boost converter is simpler to take up learning in power converter field .our study can further be taken up for example to study the average model of the basic non-ideal converter. And we improve the model by using the duty ratio constraint; derive the open-loop transfer function and closed-loop transfer function of the model. Finally it can be examined under the different simulation tools available. In future a hardware implementation of Pseudo-random carrier waveform will be implemented using various function generator integrated circuits.

REFERENCES

[1] Kazimierczuk M K , *Pulse-width Modulated DC–DC power converters* (London: John Wiley and Sons, 2008).

[2] Zhang W P ,*Modeling and Control of Switching Converter* (Bejing: China Electric Power Press, 2006).

[3] Tse C K ,*Complex Behavior of Switching Power Converters* (New York: CRC Press, 2004).

[4] R.D. Middlebrook, "Topics in Multiple- Loop Regulators and Current-Mode Programming" *IEEE PESC Proceedings,* June 1985.

[5] Joachim Holtz, "Pulsewidth Modulation- A Survey", IEEE Trans, Industrial electronics, Vol. 39,no.5,December 1992.

[6] Anant Kumar Verma, A Distinct Pseudo-Random Carrier Modulation Approach for a Boost Converter, IEEE conference on Communication Systems and Networks Technology,Bhopal,INDIA,2014.

[7] Sun J, Mitchell D M, Greuel M F. Averaged modeling of PWM converters operating in discontinuous conduction mode[J]. IEEE Trans. Power Electron, 2001, 16(4): 482-492.

[8] Muhammad H. Rashid, *Power Electronics- Ciruits, Devices, andApplications(* 9th edn., New York ,Springer-Verlag, , 2011).

[9] N. Mohan, T. M. Undeland, W. P. Robbins, *Power Electronics: Converters, Applications, and Design* (*2nd ed*., . (NY), John Wiley & Sons,Inc1993).

Research Paper   Open Access

Design and analysis of highway windmill electric generation

Suresh Mashyal[1], Dr. T. R. Anil[2]
[1]Mechanical Engineering, Maratha Mandal Engineering College, Belgaum, India
[2]Mechanical Engineeringt,Gogte Institute of Technology, Belgaum, India

Abstract: - The work deals with designing a portable highway wind turbine, which is to be contribute towards the global trend in wind energy production in a feasible way. Wind turbines are traditionally employed in rural areas; the main goal the work is to design a wind turbine that can be used in cities. In particular, the turbines will use the wind draft created by vehicles on the highway to generate electricity. The idea is to offset the amount of pollution created by burning fossil fuels by introducing a potential source of clean energy. As the automobiles moves from highways/expressways, there is a creation of pressure column on both the sides of the road. This pressure column is created due to imbalance of high pressure/low pressure energy band created by the automobiles. Due to this pressure band wind flow and create pressure thrust. The pressure thrust is sufficient to generate electricity through designed wind turbine.

I.   INTRODUCTION

Wind energy is the fastest growing source of clean energy worldwide. This is partly due to the increase in price of fossil fuels. The employment of wind energy is expected to increase dramatically over the next few years according to data from the Global Wind Energy Council. A major issue with the technology is fluctuation in the source of wind. There is a near constant source of wind power on the highways due to rapidly moving vehicles. The motivation for this project is to contribute to the global trend towards clean energy in a feasible way. Most wind turbines in use today are conventional wind mills with three airfoil shaped blades arranged around a vertical axis. These turbines must be turned to face into the wind and in general require significant air velocities to operate. Another style of turbine is one where the blades are positioned vertically or transverse to the axis of rotation. These turbines will always rotate in the same direction regardless of the fluid flow.
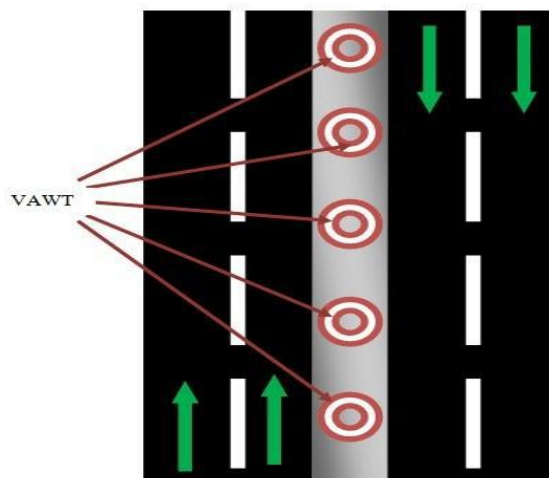
Figure 1 Turbine on highway divider

A very novel way of re-capturing some of the energy expended by vehicles moving at high speeds on our nation's highways We know how much air turbulence is generated by vehicles moving at speed particularly trucks. This would involve mounting vertical axis wind turbines at the centre of the roads that would be driven by the moving air generated by the passing traffic. The excess energy generated could be fed back into the grid or power up the villages nearby. While we'll never recover much of the energy wasted pushing air out of the way of a sixteen wheeler, even a fraction could be a significant source of power. Average vehicle speeds on the valley highways are approximately 70 mph. This power production estimate will increase exponentially with an increase in wind turbulence speed. We believe that the wind stream created over the freeways by our primary mode of transportation will create an average annual wind speed well beyond the baseline of 10 mph. In Fig. 1 shows rough sketch of highway wind turbine located on divider. Power generation is less in the downwind sector of rotation. Consideration of the flow velocities and aerodynamic forces shows that, nevertheless, a torque is produced in this way which is caused by the lift forces. The breaking torque of the drag forces in much lower, by comparison. In one revolution, a single rotor blade generates a mean positive torque but there are also short sections with negative torque.

II.   WORKING PRINCIPLE
2.1 Wind induced by moving vehicles in the direction of the wind turbine

The moving vehicles may be all types of light or heavy vehicles running on road, such as two, three, four wheelers or even bigger vehicles. If the wind is properly directed towards the wind turbine blades, optimum electricity may be generated. The desired direction of wind is obtained by a means for channeling wind, in the direction of the wind turbine. Channeling of wind in a desired direction may be obtained by, at least one truncated cone or pyramid shaped housing or a pair of planar members converging towards the blades of the wind turbine. Aerodynamics is the science and study of the physical laws of the behavior of objects in an air flow and the forces that are produced by air flows. The shape of the aerodynamic profile is decisive for blade performance. Even minor alterations in the shape of the profile can greatly alter the power curve and noise level. The aerodynamic profile is formed with a rear side, is much more curved than the front side facing the wind. Two portions of air molecules side by side in the air flow moving towards the profile at point A will separate and pass around the profile and will once again be side by side at point B after passing the profile's trailing edge. As the rear side is more curved than the front side on a wind turbine blade, this means that the air flowing over the rear side has to travel a longer distance from point A to B than the air flowing over the front side.

Figure 2: Rotation of wind turbine

III.   CONSTRUCTION
3.1 Blades: Wind turbine blades have on aerofoil type cross section and a variable pitch. While designing the size of blade it is must to know the weight and cost of blades. The ideal wind generator has an infinite number of infinitely thin blades. In the real world, more blades give more torque, but slower speed, and most alternators need fairly good speed to cut in. 2 bladed designs are very fast (and therefore perform very well) and easy to build, but can suffer from a chattering phenomenon while yawing due to imbalanced forces on the blades. 3 bladed designs are very common and are usually a very good choice, but are harder to build than 2-bladed

designs .Going to more than 4 blades results in many complications, such as material strength problems with very thin blades. Even one-bladed designs with a counterweight are possible.
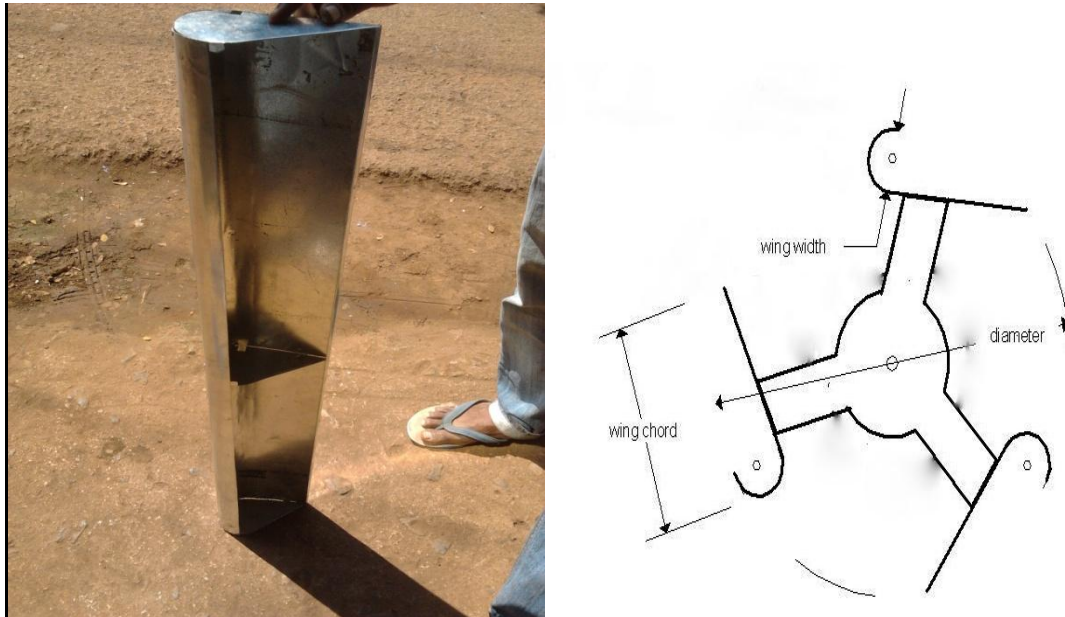
Figure 3 Turbine Blade

This number defines how much faster than the wind speed the tips of your blades are designed to travel. Your blades will perform best at this speed, but will actually work well over a range of speeds. The ideal tip speed ratio depends on rotor diameter, blade width, blade pitch, RPM needed by the alternator, and wind speed. Higher TSRs are better for alternators and generators that require high rpm but the wind speed characteristics at your particular site will make a big difference also. If in doubt, start in the middle and change your blade design depending on measured performance. The sketch and photo of designed blade is shown in Fig. 3.And Detail dimensions of blade is shown in Tab. 1.

Table 1 Designed Blade Dimensions

Sl.No.	Descriptions	Dimension
1	Length	1000 mm
2	Width	163.10 mm
3	Wind chord	163 mm
4	Wing width	76.72 mm

3.2 Center Shaft
The shaft of the turbine consists of a single 1500mm length of steel measuring 25mm in diameter. The use of steel over a lighter metal such as cast iron was based on the availability of materials. The top and bottom ends mild steel of length 1inch each are respectively are fixed to give strength to the hollow shaft. A solid shaft rotating at 75 rpm is assumed to be made of mild steel. The yield strength of a mild steel shaft material (C50) from design data is 380Mpa [1]. (380/ (2x 2)) The safe load is 300N (Approx 30Kg).The shaft of length 1500mm is subjected to bending and torsion stresses. The diameter of shaft taken is 25 mm is safe after testing both bending and torsion [2] .

3.3 Generator: For generation of electricity from the designed our vertical axis wind turbine, we chose a dynamo which has the capacity to light a bulb of 12 V. The selected dynamo is shown in Fig. 4.
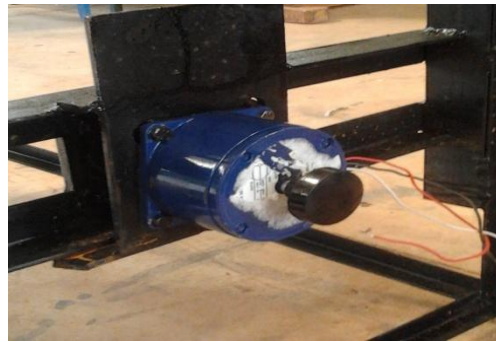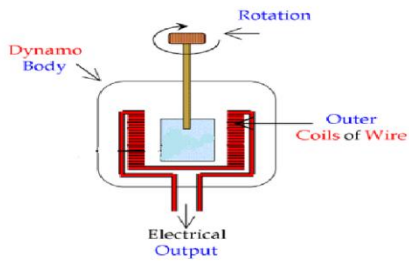
Figure 4 Generator

3.4 Bearing: For the smooth operation of Shaft, bearing mechanism is used. To have very less friction loss, the two ends of shaft are pivoted into the same dimension bearing. The Bearing has diameter of 2.54cm. Bearings are generally provided for supporting the shaft and smooth operation of shaft. The Fig. 5 shown the ball bearing used in the turbine.

Figure 5 Ball Bearing

3.5 Electrical Components: The charge controller is there to prevent damage to the batteries. If the batteries are near to full charge, but the wind is blowing strongly, the charging current needs to be reduced to prevent damage to the battery. The 1 Amp diode bridge rectifiers is shown in Fig. 6.
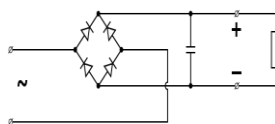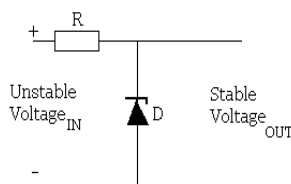
Figure 6 Amp diode bridge rectifier

The charge controller will divert some power from the generator away from the battery and into a dump load. This can be anything from a series of bulbs to a heating coil in the simplest systems this excess energy is wasted using this circuit we can store energy in battery without reverse flow and current.

IV.   RESULTS
The results are taken on the basis that, 100 vehicle travelled at average speed of 70 km/hr at regular average wind speed of 4.5 m/s for the duration of 2hrs. The electric power generated from designed wind turbine is approximately 200 Watt –hr.

V.   CONCLUSION
Conclusively, extensive data is collected on wind patterns produced by vehicles on both sides of the highway. Using the collected data, a wind turbine is designed to be placed on the medians of the highway. Although one turbine may not provide adequate power generation, a collective of turbines on a long strip of highway has potential to generate a large amount of energy that can be used to power streetlights, other public amenities or even generate profits by selling the power back to the grid. This design concept is meant to be sustainable and environmentally friendly. Additionally, a wind turbine powered by artificial wind has a myriad of applications.

Theoretically any moving vehicle can power the turbine such as an amusement park ride. The highway wind turbine can be used to provide power in any city around the globe where there is high vehicle traffic.

REFERENCES

[1]   G.R.Nagpal, Tool Engineer and Design (Khanna Publishers 6th, Reprint, 2006)
[2]   H. G. patil, Design data hand book (Pooja Publication, 2nd Edition, 2010)

Review Paper   Open Access

Comprehensive view on chemistry, manufacturing & applications of lanolin extracted from wool pretreatment

Amit Sengupta[*] and Jagadananda Behera
Scientist at COE in Sportech Lab at Wool Research Association, Thane, Maharashtra, India
(Attached to Ministry of Textiles, Govt. of India)

Abstract: - Lanolin also called wool wax or wool grease is a yellow waxy substance secreted by the sebaceous glands of wool-bearing animals. Most lanolin used by humans comes from domestic sheep breeds that are raised specifically for their wool. Crude lanolin constitutes about 5–25% of the weight of freshly shorn wool. The wool from one Merino sheep will produce about 250–300 ml of recoverable wool grease. Lanolin is extracted by scouring the wool in hot water with a detergent to remove dirt, wool grease (crude lanolin), suint (sweat salts), and anything else stuck to the wool. The wool grease is continuously removed during this washing process by centrifugal separators, which concentrate it into a wax-like substance melting at approximately 38°C. Lanolin and its many derivatives are extracted from wool scouring liquor and converted to a value added products that are generally used extensively in both the personal care (e.g. in high value cosmetics, facial cosmetics, lip products, etc.) and health care sectors. It is frequently used in protective baby skin treatment and as a treatment for sore nipples in breastfeeding mothers. Lanolin is used commercially in many industrial products ranging from rust-proof coatings to lubricants.

Keywords: - *Wool Grease, Grease Recovery, Lanolin Refinement, Applications*

I.   INTRODUCTION

Wool is a natural, protein, multi-cellular, staple fibre from the fleece of domesticated sheep. Wool fibre contains different contaminants such as Natural, acquired and applied. Natural impurities in the fleece consist primarily of wool grease and suint that are produced by the sheep. Wool grease is secreted from the sheep's skin and accumulates in the wool fibre as it grows. Wool grease is a mixture of fats and oils with a combined melting point of approximately 40°C. After separation during scouring, wool wax is contaminated with detergent and suint and is, therefore called wool grease, as distinct from wool wax [1]. Wool grease can be emulsified in water by the addition of a detergent. Suint is made up from a mixture of primarily potassium-based salts of fatty acids, such as oleic and stearic acids. It is excreted from the sweat glands of the sheep and dries onto the skin and wool fibres. Suint is highly soluble in water and can be isolated from the raw wool by aqueous extraction. Acquired impurities are picked up from the animal's natural environment and can be categorized as mineral or vegetable contaminants. Mineral contaminants include dirt, dust, sand and stones. These are usually quite straightforward to remove by washing. Vegetable matter (VM) caught in the animal's fleece commonly includes straw, grass, seedpods, pieces of plant tissue and twigs. Parasites such as ticks and blowfly maggots as well as faeces attached to the wool are generally defined as VM along with the true vegetable contaminants. Applied impurities cover the range of farm chemicals such as sheep dip and fertilizers applied directly to the sheep or to the pasture upon which they are grazing. These generally only occur in trace quantities and can be very difficult to separate from the other contaminants.

The use of crude wool grease washed from the fleece of sheep has been known for centuries. The ancient Greeks (about 700 B.C.) are known to have extracted it by boiling wool and skimming "fat" from the surface. Liebrich and Braun of Germany are credited with developing the first refined neutral wool grease and coining the name "lanolin" in 1882.

Table 1 Ingredients of Merino and crossbred wool [1]

Ingredients	Merino	Crossbred
Fibre	49	61
Dirt	19(6.3-43.8)	8 (7.9)
Suint	6 (2-12)	8 (2.2-12.1)
Grease	16 (10-25.4)	11 (1.6-8.5)
Water	10	12

Table 2 Typical effluent characteristics (after wool grease recovery) [2-10]

Parameters	Contaminant Heavy Scour Effluent	Rinse Water
Biological Oxygen Demand (BOD) [mg/L]	9,800 – 50,000	200 – 1,000
Chemical Oxygen Demand (COD) [mg/L]	30,000 – 100,000	500 – 2,000
Total Suspended Solids (TSS) [mg/L]	20,000 – 60,000	100 – 700
Solvent Extractable (SE) [mg/L]	1,000 – 2,000	50 – 1,500

II.   CHEMICAL COMPOSITION OF WOOL GREASE

Wool Grease is a natural substance excreted from the sebaceous gland attached to the root of each wool fibre in the basal layer of the sheep's skin [2].
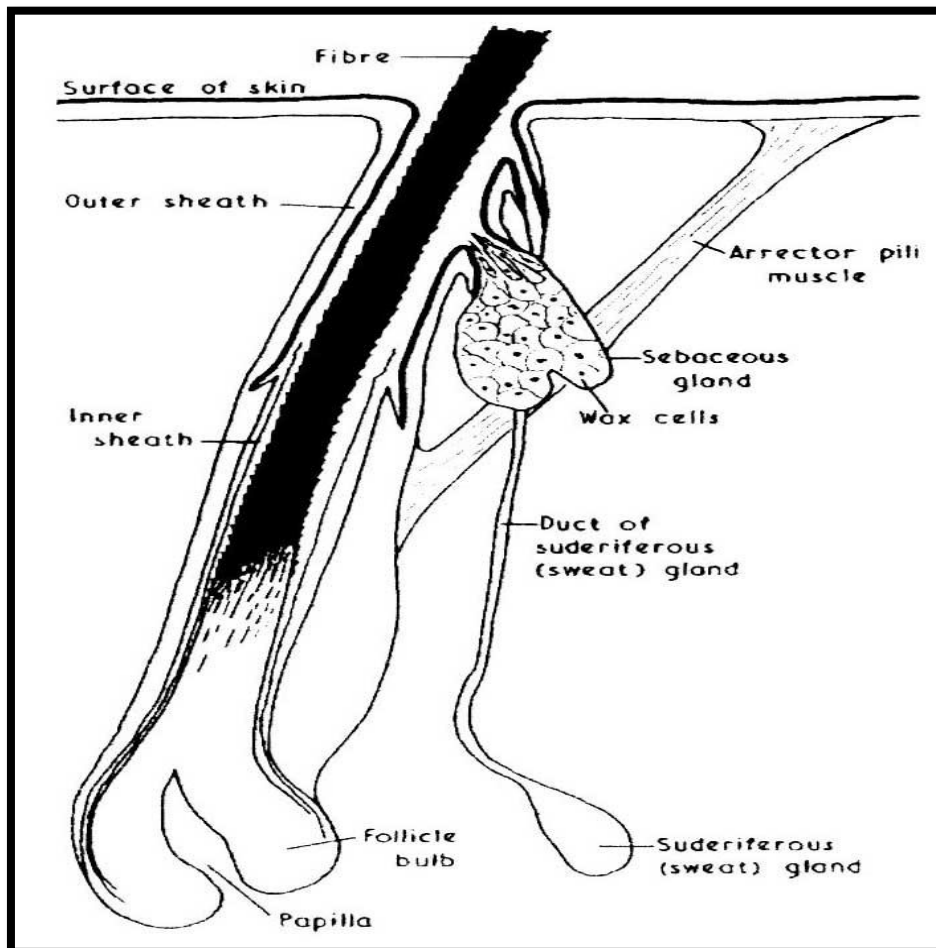
Fig 1 Dermal detail of a wool follicle

The wax excretion forms a hydrophobic coating on the fibre, protecting it from the elements. By chemical definition, the absence of glycerol in this oily excretion makes it a wax. Wool wax itself is a complex mixture of naturally occurring esters of water, insoluble alcohols and higher fatty acids.

Table 3 Physical properties of wool wax [3-10]

Physical Property		Approximate content value
Colour		Yellow to pale brown
Specific Gravity (15^oC)		0.94-0.97
Refractive Index (40^oC)		1.48
Melting point		35-40 ^{o}C
Free acid content		4-10%
Free alcohol content		1-3%
Iodine value (Wijs)		15-30
Sponification value		95-120
Molecular weight (Rast; in Salol)		790-880
Proportion of fatty acid		50-55%
Acids:	Melting Point	40-45 ^{o}C
	Iodine value (wijs)	10-20
	Mean Molecular weight	330g/mol
Alcohol:	Melting Point	55-65 ^{o}C
	Iodine value (wijs)	40-50
	(Dam)	70-80
	Mean Molecular weight	370 g/mol

Isolation of specific esters is extremely difficult and seldom attempted [3-10] but detailed analysis has been carried out on the free acids and alcohols from which the esters are formed. In 1954 a large range of wool wax acids were identified and found to fall into 4 distinct series: normal (Fig a), *iso-* (Fig b) *anteiso-* (Fig c), and *hydroxy-*acids (Fig d). Examples of each series are given below:

a) *n*-hexadecanoic acid
(palmitic acid)

b) *iso*-hexadecanoic acid
(*iso*-palmitic acid)

c) 14-methylhexadecanoic acid
(*anteiso*-palmitic acid)
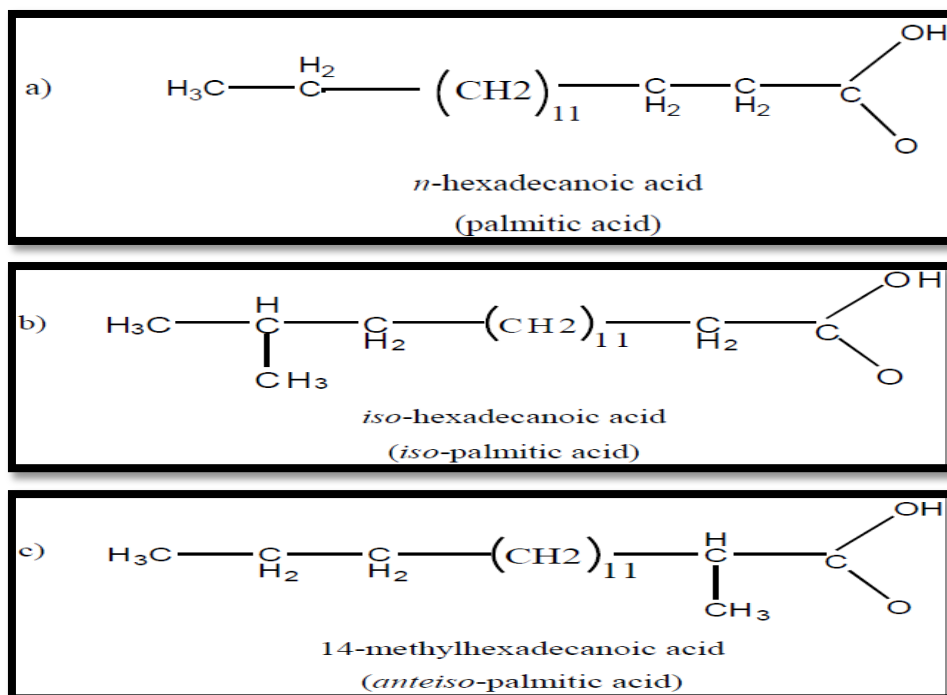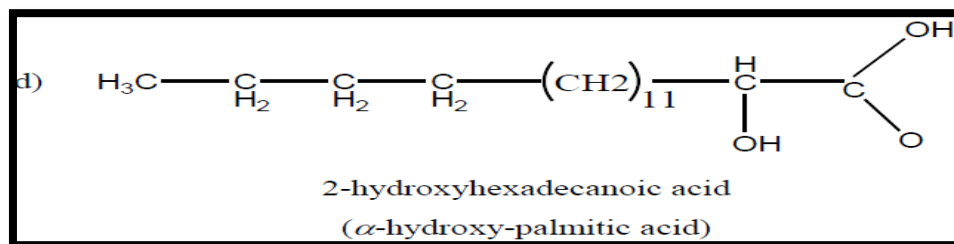
Fig 2 (a, b & c) Structure of wool wax acids

Table 4 Acidic fraction of wool wax

Acidic Fraction	Approximate content (% of total Acids)
n-acid	7
Iso-acid	22
Anteis-acid	29
α-Hydroxy-n-acids	25
α-Hydroxy-iso-acids	3
Total	86
Residual (Speculated to be mostly saturated acids)	14

The free alcohol component is primarily made up of three groups: aliphatic alcohols, sterols, and isocholesterol. A summary of these groups and their constituents is given in Table 5.

Table 5 Alcoholic fraction of wool wax

Alcoholic Fraction		Approximate content (% of total Acids)
Aliphatic Alcohol	n-alcohol	4
	Iso- alcohol	6
	Anteis- alcohol	7
	n-Alkan-1,2-diols	0.5
	Iso-Alkan-1,2-diols	25
	Iso-Alkan-1,2-diols	3
	Sterols	28
	Isocholoresterol	27
	Hydrocarbons	1
	Total	78
	Unidentified Residue	22

From a practical perspective, the wool grease dispersed in scour effluent consists of two main fractions, typically referred to as 'oxidised' and 'unoxidised' wool grease. The oxidised wool grease has been shown to be associated with the tip of the wool staple where the grease is exposed to the air and the external environment while the unoxidised fraction has been shown to be more predominant at the base and centre of the wool staple [3-10]. It is generally agreed that the oxidised fraction has a higher density than the unoxidised, but the actual values reported in various works vary widely.

III.   WOOL GREASE RECOVERY

Due to its low specific gravity, unoxidised wool wax is most commonly recovered by passing the scour effluent through a centrifuge. At present, stacked disc centrifuges similar to those employed in the dairy industry are used in either a 2 or 3 stage separation and purification process. The main processes used throughout the world for wool grease recovery involve some combination of thermal cracking and centrifuging. Solvent extraction methods have been extensively developed and typically give a very high quality product [3-10], but these technologies have never gained widespread use.
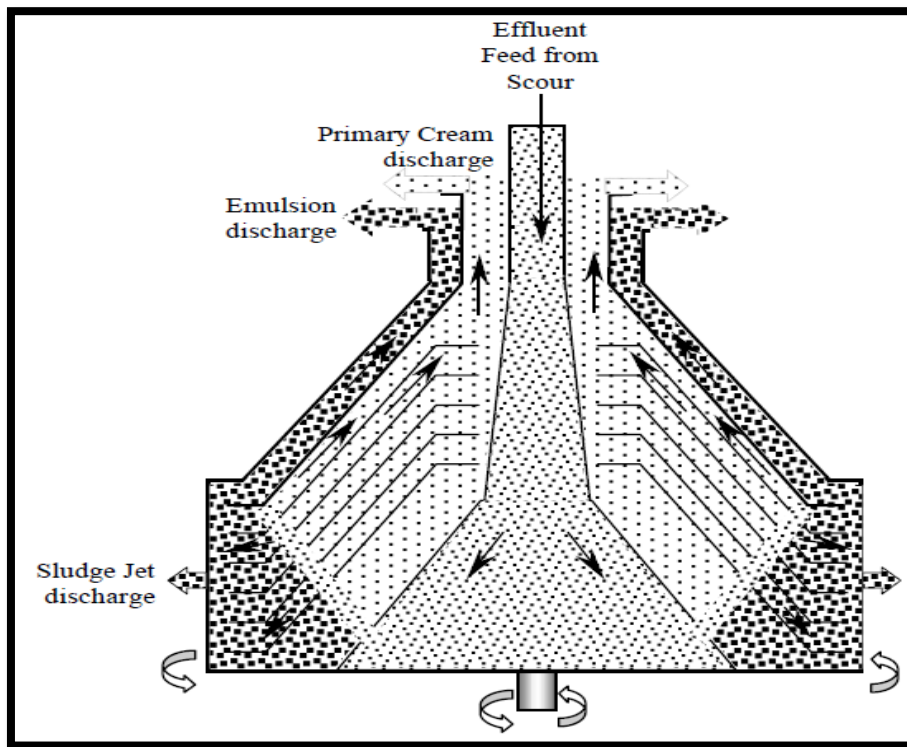
Fig 3 Primary centrifuge

3.1 SINGLE-STAGE WOOL GREASE RECOVERY

Scour effluent heated to at least 64°C is fed from above into the centre section of the primary centrifuge as shown in Figure 3. Inside the centrifuge the effluent flows into the stack of cone shaped discs, which rotate at approximately 6000rpm [1-10]. In the disc stack the lighter wool grease flows upwards between the discs towards the centre of the bowl where it is discharged as primary cream. A second emulsion phase flows downwards between the discs due to its higher density, from where it flows up the walls of the outer bowl and is also discharged at the top of the centrifuge. Any dirt and heavy solids in the feed are also carried downwards between the discs but, due to having higher density than the aqueous emulsion phase, do not flow up the walls with the emulsion phase and are continuously discharged through jets in the bottom of the bowl wall. The primary cream is then fed into a thermal-cracking tank where it is held for in excess of five hours at approximately 90°C. Over this period the cream splits into three distinct phases.
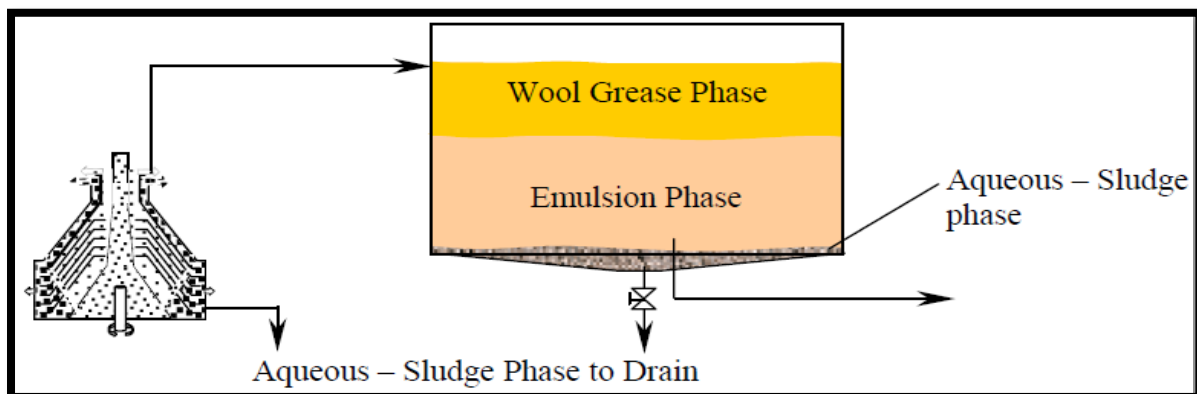
Fig 4 Single-stage wool wax recovery

After the solution has been given time to separate, the heavy aqueous phase is drawn off the bottom of the tank to drain, the emulsion phase is recycled to the centrifuge and then the wool grease floating in the top of the tank is drawn off into drums. Due to the rising value of recovered wool grease and mounting restrictions on effluent discharges, single stage wool grease recovery is no longer used in the main stream scouring industry.

3.2 TWO-STAGE WOOL GREASE RECOVERY

In a two-stage system, primary centrifuges and thermal cracking tanks are again used, but this time the cream and emulsion from the cracking tank is fed to a bank of secondary centrifuges for further purification. In a two-stage system the cream from the primary centrifuges is around 60 – 80% wool wax. The product from the secondary centrifuges is typically in excess of 99% pure. [10]
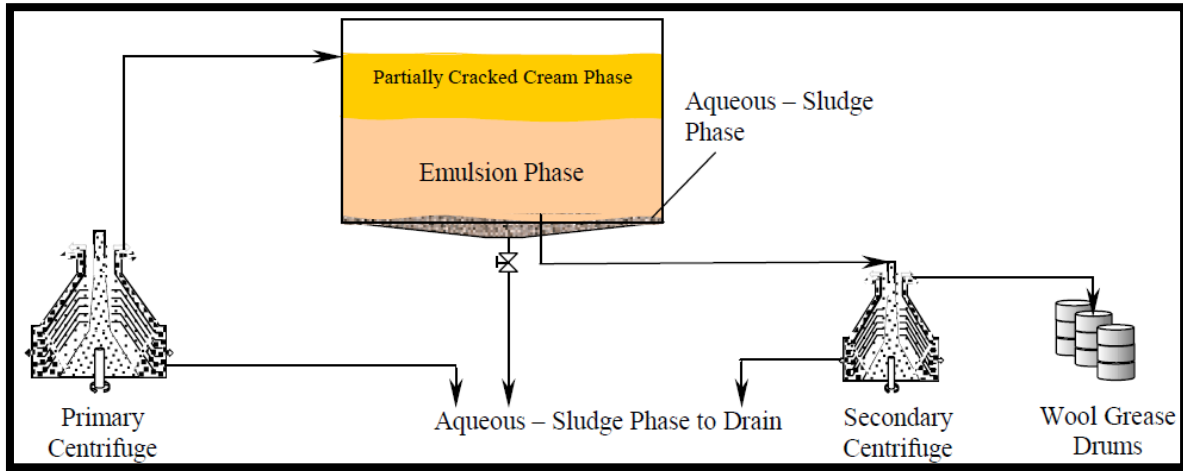
Fig 5 Two-Stage Wool Grease Recovery

3.3 THREE-STAGE WOOL GREASE RECOVERY

In a three-stage system a greater overall proportion of the wool grease is recovered from the effluent by the primary centrifuges. The resultant primary cream however is typically only 10 – 20% grease. This high volume low strength primary cream is then thermally cracked and passed through the secondary centrifuge at approximately 90°C resulting in a secondary cream containing 70– 80% wool grease. The cream from the secondary centrifuge, still at 90°C, is then passed to a purifying centrifuge where it is mixed with clean hot water (which aids in washing impurities from the grease) and is then separated to produce wool grease with purity in excess of 99%.
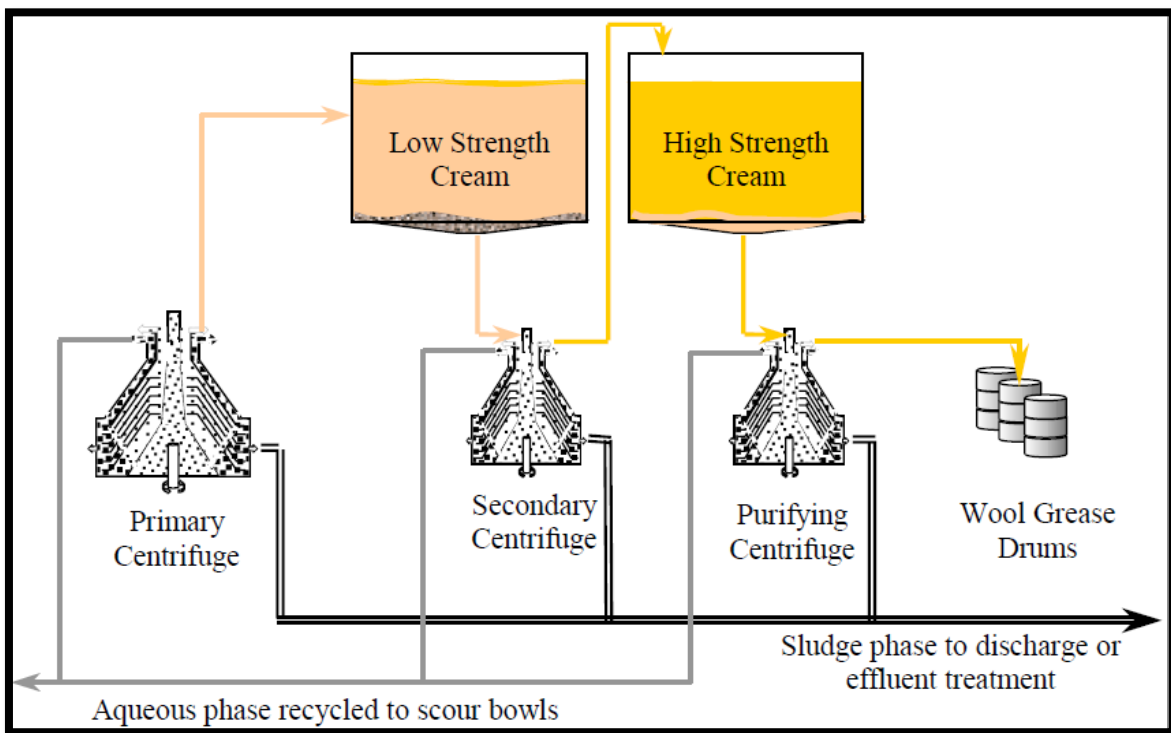
Fig 6 Three-Stage Wool Grease Recovery

IV. LANOLIN REFINEMENT

The harvested wool wax is a dark, highly viscous and greasy paste. In this crude form, it can be used in several technical applications. However, due to the colour, peculiar odour and sizeable amount of impurities it retains at this stage, the wool wax must be refined further before it can be used in cosmetic products and by the pharmaceutical industry [11, 12].

Table 6 Constituents of Lanolin Alcohols and Lanolin Fatty Acids [13]

Lanolin Alcohols	Number Identified	Contents (wt%)	Carbon Length	Carbon Length of Major Fractions
Aliphatic Mono-Alcohols				
Normal	16	1.6	C14-C34	C24,C26
Iso	11	6.5	C14-C36	C20,C22,C26
Anteiso	11	9.0	C17-C35	C21,C25,C27
Aliphatic 1,2 diols Normal	14	0.4	C12-C2	C16,C18,C20
Iso	9	5.9	C14-C3	C18,C20,C22,C24
Anteiso	8	2.4	C15-C29	C21,C23
Total of aliphatic alcohols	69	25.8		
C27 Sterols				
Cholesterol		38.0		
Dihydrocholesterol		trace		
Cholesta-3,5-dien-7-one		3.6		C27
C30 Trimethyl Sterols				
Lanosterol		14.8		
Dihydrolanosterol		10.3		
3-Hydroxylanosta-8-en-7-one		1.6		C30
Hydrocarbons & undetermined		5.9		
Total unsaponified matters		100.0		
Non-Hydroxy Fatty Acids				
Normal	27	12.1	C8-C38	C14,C16, C24,C26
Iso	17	22.1	C8-C40	C14,C16,C18,C20,C26
Anteiso	18	26.3	C7 -C41	C15,C19,C21,C25,C27
Hydroxy Fatty Acids				
Normal	23	21.8	C10-C32	C16
Iso	12	4.5	C12-C34	C18,C24
Anteiso	12	0.8	C11-C33	C23,C25
Hydroxy Fatty Acids				
Normal	14	3.0	C22-C36	C30,C32
Iso	8	0.8	C22-C36	C30,C32
Anteiso	7	1.3	C23-C35	C25,C31
Total	138			
Unsaturated fatty acids	42	2.1		C16,C18
Polyhydroxy fatty acids	—	4.7		—
Total fatty acids confirmed	180	99.5		

4.1 FIRST STAGES OF REFINEMENT

The techniques and materials used for refining lanolin vary from processor to processor. Generally, the first step involves the break-up of soaps and removal of acid-soluble impurities by refluxing the crude wool wax in an aqueous acid solution. After separation and disposal of the aqueous phase, the free fatty acids in the wax are neutralized via an alkaline treatment, preferably using a sodium hydroxide or carbonate solution. The resulting soaps, which are formed by the reaction of fatty acids with alkali metal ions such as sodium, can be extracted using mixtures of ethanol or isopropanol with water. The alcohols function both as a co-solvent and an agent to reduce the emulsifying properties of surfactant molecules. This makes sure that undesired materials are washed out of the wax mixture effectively.

4.2 IMPROVING THE PURITY

Depending on the desired purity grade, this extraction procedure can be repeated with more highly concentrated alcohol mixtures. A further reduction of contaminants can be achieved through treatment with adsorbents, such as activated carbon, followed by filtration. Residual pesticides and odours can be removed by exposure to high vacuum and simultaneous heating of the wool wax. This processing step also reduces the amount of free lanolin alcohols. By slightly varying vacuum and temperature conditions, their content can be reduced to less than 3% by weight, which is crucial if the desired result is product hypoallergenicity.

4.3 COLOUR CHANGE

At this stage in the refinement process, most of the impurities - free fatty acids, detergents and pesticides will be sufficiently reduced and the product will be pleasantly deodorised. The dark colour will have faded into a pale yellow tone. While the colour of the refined lanolin has nothing to do with its quality, some cosmetic applications require bright lanolin. This can be achieved by bleaching the wax with common oxidative reagent such as: hydrogen peroxide. If the lanolin is not bleached, then small concentrations of another approved antioxidant, such as butylated hydroxytoluene (BHT), are usually added at the end of the refinement process. This stops the air getting to the lanolin, preventing superficial degradation by autoxidation.

4.4 FINAL STEPS

Finally, residual water is removed through a vacuum-drying process to give refined lanolin anhydrous, a pale, ointment-like substance with a scarcely recognisable odour.

Table 7 Components of Crude centrifugal wool wax and refined pharmaceutical lanolin [13]

Component	Crude centrifugal wool wax	Refined pharmaceutical lanolin
Water	1-5% w/w	0.05% w/w
Free fatty acids	1-8% w/w	0.30% w/w
Free fatty alcohols	6-12% w/w	2.50% w/w
Wax esters	75-90% w/w	97.0% w/w
Water soluble salts of potassium and sodium	0.1-0.2 w/w	Not Quantified
Lipid soluble salts of calcium, magnesium, iron, aluminium	0.2-2.0 w/w	Not Quantified
Detergent residues	0.1-1.0 w/w	0.02% w/w
Pesticide residues	20-150 mg kg-1	0.8 mg kg-1
Polyaromatic hydrocarbons	0.1-0.5 mg kg-1	0.08 µg kg-1
Particulate insoluble matters	0.1-2.0	not quantified
Peroxide value	Not quantified	12.0 meq. kg-1
Colour	Dark brown	Pale to yellow
Odour	Peculiar smell	Almost odorless

It is soluble in organic solvents like diethyl ether, chloroform and chloroform/methanol mixtures, but poorly soluble in ethanol. It does not dissolve in (but is mixable with) water, forming stable water-in-oil (w/o) emulsions.

V.　APPLICATION OF LANOLIN AND ITS DERIVATIVES

Uses of Lanolin and its derivatives are as follows [14-25]:

5.1 LANOLIN AS A PERSONAL CARE

Wool wax is a natural substance, designed by nature to soften both skin and wool fibres, and to protect them against adverse weather conditions. The best known uses of refined wool wax products (lanolin and lanolin derivatives) are in medicine, cosmetics and toiletries, which take advantage of these natural protective qualities. Lanolin is a key ingredient in some of the world's most popular cosmetics and pharmaceuticals. Without it, they would not have the emollient qualities that protect and care for our skin and hair. The composition of lanolin resembles the intercellular lipids of the stratum corneum. This is the outermost layer of the skin, which consists of cholesterol, cholesterol derivatives and free fatty acids. These lipids play a crucial role in the skin's moisture control. Under normal conditions, water continuously evaporates from the skin's surface. Insufficient rehydration from lower epidermal layers leads to a dry, inflexible and brittle stratum corneum. Anhydrous lanolin can absorb more than 200% of its weight in water (WW) to form stable water-in-oil (w/o) emulsions. It's also capable of redistributing this moisture to environments of low relative humidity [11].

Fig 7 Lanolin is also used in lipsticks and eye make-up

Lanolin is also widely used in:
- foundation creams and other skin-cream products as an emulsifier, stabiliser, emollient and skin moisturiser;
- oil-based skin lotions and cleansing oils as a skin moisturiser and to control viscosity;
- toilet soaps as a superfatting agent, minimising the dehydrating effect of detergents, and to retain perfume;
- aftershaves as a skin moisturiser and to control viscosity;
- nail polish removers to prevent the defatting of the surrounding skin;
- lipsticks and eye make-up as a film modifier and crystal inhibitor, for more uniformly dispersed pigment;
- hair dressings and shampoos, as a conditioner against drying, scaling and brittleness of the hair shaft;
- hair sprays, as a plasticiser;
- hair bleaching agents, as a pH-stable emulsifier.

5.2 MEDICAL APPLICATIONS: Lanolin is widely used in:
- ointment bases, burns dressings and wound sprays
  - as an emulsifier, stabiliser and emollient
  - to support the wound healing process
  - to deliver active ingredients through the skin (trans-dermal);
- pigmented medications (e.g. zinc oxide), as a dispersing agent;
- topical products for cutaneous infections (e.g. acne) and in deodorising toiletries, as an anti-microbial and disinfectant.
- ophthalmic ointments, as an emollient with high physiological compatibility and low irritation potential;
- suppositories substantial base, as a carrier for active ingredients;
- surgical adhesive tapes, as an impregnating agent, plasticiser and skin-suited stack enhancer;
- chewing gum bases as a food additive (physiologically compatible emollient);
- pre-blended combinations for specific purposes, such as absorption bases.

5.3 INDUSTRIAL APPLICATION
Lanolin is also used in various industrial applications such as:
▪ **Anti-corrosive effect on ferrous metals**
It is biodegradable and non-toxic, making it an ecologically friendly substance. Lanolin is also compatible with numerous additives that modify the consistency and characteristics of the resulting protective films (e.g. hard, soft, water soluble or insoluble). Strongly corroded seawater tanks and ships can be rust-protected with low viscous lanolin products. In the floor method, the liquids are dispersed on the weathered underground. The oil then creeps into the cavities of the rust structure, where it displaces the water by attaching to the metallic surface, forming a thick and durable anti-corrosive layer. The high penetration potential of lanolin-based anti-corrosive preparations makes them attractive for rust treatment and prevention on automobile parts, especially on old-timers. Some Special anti-corrosive applications and functions
▪ As a dewatering rust preventative for saltwater-resistant protection of ships and seawater tanks.
▪ For protection and conservation of ferrous vehicle and vintage car parts such as:
  o crevices of front and car boot lid, wheel house, mudguard, underbody parts and so on;
  o engineering parts like cylinder pistons during storage;
  o chromed parts for better resistance against road salt, seawater and acid rain;
  o for regeneration of bitumen underbody protection.
▪ For conserving items such as military hardware, conduits, pipelines, machinery, roofing tiles, sheets, plates, tools, steel wire ropes, surfaces of wood and fabric, and so on.

➢ **Lubricant applications**
Combined with its anti-corrosive potential, lanolin is also a valuable lubricating and conserving material for all types of engineering parts. Other special applications are
  ▪ Lubrication grease for engineering parts.
  ▪ Metal cutting oil.
  ▪ Lubricant for metal processing, e.g. rolling, grinding, pressing and so on.
➢ **Leather and textiles**
To protect leather from natural degradation processes, it must be treated by chemical tanning agents to create a durable product from an organic source. Lanolin is a widely used ingredient for fat liquors, that are applied after tanning to soften leathers.
Lanolin is used in products for:
  • treating and processing tanned leather
  • weathered leather, as a nourishing oil and emollient
  • shoe polishes, as an emulsifier and gloss enhancer
  • Textiles, as an emollient that gives a soft finish.
➢ **Other Industrial uses:**
▪ In paints, spraying varnishes and inks:
  o as a dispersing agent for homogeneous covering properties
  o preventing aggregation and precipitation of pigments to improve handling of paints
  o as an agent to decrease the drying time
  o as a penetration inhibitor for inks
  o to give and control fluidity.
▪ In polishing waxes and abrasives.
▪ As a paper conditioner:
  o enhancing paper softness
  o imparting steam resistance for wrappings of surgical instruments that have to be sterilized.
▪ In industrial hand-cleaner creams and lotions as a superfatting agent to minimise the dehydrating effect of detergents.
▪ In oil-binding agents, due to the high oil-binding capacity of lanolic acid metal soaps.
▪ In concrete waterproofing products.
▪ In numerous other applications, such as aircraft glues, conveyor belt wax, special greases, jointing pastes, vulcanising pastes and so on.

VI.   CONCLUDING REMARKS

Detergent oriented wool scouring before dyeing is one of the pollution causing process in the mills contributing to the maximum of the total BOD, COD and TDS load in effluent. Lanolin is extracted by scouring the wool fibre in hot water with detergent and other auxiliary chemicals to remove dirt, wool grease (crude

lanolin), suint (sweat salts), and anything else stuck to the wool. The wool grease is continuously removed during this washing process by centrifugal separators, which concentrate it into a wax-like substance melting at approximately 38°C. Separation of wool grease from scouring liquor causes reduction in effluent load contributing less problem areas for waste-water treatment and discharging of wastewater into surface water and also useful to produce value added products (Ex: Lanolin) that are used as a Personal Care like- cosmetics and toiletries, medical application like- ointment bases, burns dressings and wound sprays and in different industrial applications like- Anti-corrosive effect on ferrous metals, Lubrication, Leather and textile industry, Paint and spray vanishes. Lanolin is not a significant allergen. As the incidence of allergies is less than approximately 6 per million then lanolin is less of an allergen than fish, eggs, strawberries, etc. Super-refined lanolin is available recording even lower incidence of allergies which is ideal for the use in hypoallergenic cosmetics such as Lanocreme [13]. Apart from the above mentioned applications, there is lot of scope to produce different value added products by using various derivatives of wool grease. So, future research should be focus on the technical textile application and hygienic and hypoallergenic applications in medical textiles and other industrial applications.

VII. ACKNOWLEDGEMENT

REFFERENCES

[1] AK Roy Chowdhury., *Textile preparation and dyeing*, (*Oxford & IBH publishing Co. Pvt. Ltd*., 2006.)
[2] E.P.G Ghol. , L.D Vilensky., *Textile science*
[3] WRONZ, Introduction to Wool and the Wool Industry. Study Notes, Wool Research Organisation of New Zealand, Christchurch, 2001
[4] E.V . Truter., Wool Wax Chemistry and Technology, *Cleaver-Hume Press Ltd.*, London , 1956
[5] R.G. Stewart, The Integration of Effluent Treatment with Scouring in New Zealand, WRONZ Report, WRONZ, Christchurch, 1974
[6] R.G. Stewart, Woolscouring and Allied Technology. Christchurch, Wool Research Organisation of New Zealand, 1988
[7] Source: Matthew J. Savage, Integrated Treatment Processes For Primary Wool Scouring Effluent, 2002
[8] J.H Brooks. , H Baumann., The Stabilisation of Scour-Liquor Emulsion by Proteins Extracted from Wool, *Journal of the Textile Institute*, 74, 1983, 249 - 255.
[9] J. H. Brooks, The Interfacial Tension of Greases from the Tip and Base of the Wool Fibre and the Role of Interfacial Tension in the Scouring of Raw Wool, *Journal of the Textile Institute* , **75**, 1984, 278 – 284,.
[10] Source: TOPNZ, Wool scouring Course Notes, The Open Polytechnic of New Zealand, 1992
[11] Rogers, G. F. C. and Mayhew, Y. R. (1995). Thermodynamic and Transport Properties of Fluids. Oxford, Blackwell.
[12] Source: http://www.lanolin.com/news.html
[13] Source:http://www.alluredbooks.com/sample_pages/chem_manu_cosm_3rdedit_vol3_p559_563.pdf
[14] Source: E.W. Clark, The History and Evolution of Lanolin,1999
[15] Source: http://www.lanocreme.com/en/lanolin/benefits.aspx
[16] Source:http://www.imperial-oel-import.de/products/technical-lanolins-and-wool-greases.html
[17] WS Simpson and GH Crawshaw, Wool: Science and technology, Woodhead Publishing Limited in association with The Textile Institute, Cambridge, England
[18] Source: http://www.lanicare.com/lanolin.html
[19] Source:http://realizebeauty.wordpress.com/2009/06/03/what-is-lanolin-and-is-it-really-a-wonder-moisturiser/
[20] Source: Andrew Banham, Lanolin and its derivatives
[21] Source: http://en.wikipedia.org/wiki/Lanolin
[22] J Floyd, Metzger, Method of separation of lanolin from crude wool-grease, 1919 (US 1330210 A)
[23] Source: https://www.truetest.com/PatientPDF/Patient_Wool%20Alcohols.pdf
[24] Source: http://www.nipponseika.co.jp/eng/industry/lanolin.htm
[25] Source: http://www.mypatchlink.com/pdf/wool_alcohol.pdf

Research Paper　　　　　　　　　　　　　　　　　　　　　　　　　Open Access

Cost Overrun Assessment Model in Fuzzy Environment

Savita Sharma[1] and Pradeep K. Goyal [2]

1 Senior Lecturer, Department of Civil Engineering, Govt. Polytechnic College , Ajmer, India.
2 Associate Professor,Department of Civil Engineering, Govt. Engineering College, Ajmer, India.

Abstract: - This paper presents an application of fuzzy logic for developing cost overrun assessment model using Fuzzy toolbox of MATLAB Program Software. Construction industry   is considered as one of the most dynamic and risky industrial sector. Due to risks and uncertainties associated with the projects, project objectives are not achieved as desired as has been stipulated. Project failure takes place in terms of project delay, cost over runs and poor quality. The cost is considered as one of the most important success parameter of any project. The cost overrun factors are identified based on literature review and expert opinion which is ranked using Relative Important Index (RII) scale. Graphs showing the variation of cost overrun for different combination of cost overrun factors are obtained. The method is illustrated with the help of an example.

I.　　　INTRODUCTION

Construction industry   is considered as one of the most dynamic and risky industrial sector. Many construction projects do not attain all their desired goals due to the presence of risks and uncertainties intrinsic in the project. These lead to failure of project in terms of project delay, cost over runs and poor quality. Cost is considered as an important key parameter for the success of any project. Many authors have suggested that 'risk cost' should be adopted as an assessment scale [1,2,3,4]. In spite of the importance of this factor, construction industry is full of projects that functionally operate with extensive cost overrun. Cost overrun in projects generates a considerable financial loss to both contractor and owners. Hence, cost risk assessment has become an essential part of the construction industry. To avoid construction cost overrun, there is need to develop a cost overrun assessment model as a decision support tool for the project managers, cost estimators for the construction projects before the bidding stage.

Many researchers have studied for the identification of cost overrun factors in the construction industries [5, 6, 7, 8, 9, 10]. An extensive literature review   has been conducted by Sharma and Goyal   for identification of cost overrun factors in construction industry [11].

Risk assessment is considered as one of the most important part of the risk management process. The main objective of modelling of risks and uncertainty in forecasting construction cost is to analyse the effect of associated uncertainty on cost overrun. There are two approaches to develop a model (i) simple classical method (ii) advanced models. Examples of simple classical methods include   sensitive analysis, fault tree analysis, event tree analysis, failure mode &effect critical analysis etc. Whereas, the models based on monte –carlo simulation for stochastic modelling analysis and fuzzy set theory are considered as advanced models of risk assessment. Fuzzy set theory is a branch of modern mathematics that is suitable for uncertain or approximate reasoning that involves human intuitive thinking .The fuzzy set theory is used to address the uncertainties associated with construction activities, which in itself has the potential to deal with the vagueness, uncertainty and subjective nature of any problems [12, 13, 14].

The main objective of this study is to present an application of the cost overrun assessment model for Indian construction industry using Fuzzy Logic. The method is applied to analyze a small survey from expert of construction field and indentify important cost overrun factors.

II　　　METHODOLOGY

The cost overrun factors are identified through the extensive literature review and with the help of expert's opinion. These cost overrun factors are then ranked and assessed for their importance index. After

ranking the cost overrun factors, model is developed in fuzzy inference system. The assessment model for the cost overrun factors is developed using fuzzy logic as per procedure explained here.

2.1 Ranking of cost overrun factors
    The following procedure is adopted to calculate the rank and assess the importance index of cost overrun factors:
(i)The cost overrun factors prevailing in the construction industry are identified.
(ii)A questionnaire   survey is conducted through personal interview for judging the level of importance of the above identified factors. The respondents are asked to indicate the relative importance of these factors.
(iii)The five-point scale ranged from 1 (not important) to 5 (extremely important) is adopted to calculate the relative importance indices (RII) for each factor. The relative importance index (RII) is calculated by using the relation [15] given below:

$$RII = \frac{\sum W}{A * N}$$

where W is the weighting given to each factor by the respondent (ranging from1 to 5), A is the highest weight and N is the total number of respondent.

2.2 Modelling in fuzzy inference system
    In this step, the fuzzy logic model is designed for predicting the cost overrun in Mamdani type inference using the fuzzy toolbox of MATLAB. There are five primary graphical user interface tools for building, editing, and observing in the fuzzy inference systems toolbox. The procedure to develop a model using Fuzzy Inference System (FIS) of MATLAB is shown in Fig.1.

2.2.1 Defining input and output variables
The identified cost overrun factors are considered as input variable for the assessment model and the output variable is taken as the "cost overrun probability".

2.2.2 Defining membership functions for variables
    The membership function represents the fuzziness degree of linguistic variables. Membership functions give a numerical meaning for each label. There are different shapes of membership functions, viz, triangular, trapezoidal, Gaussian, bell-shaped, piecewise-linear etc. Triangular and trapezoidal fuzzy membership functions are used in this study as they are widely used. A triangular fuzzy number x (see Fig.2) with membership function $\mu_A(x)$ is defined by

$$\mu_A(x) = \begin{cases} \dfrac{x-a}{b-a} & if \quad a \leq x \leq b \\ \dfrac{x-c}{b-c} & if \quad b \leq x \leq c \\ 0 & otherwise \end{cases}$$

A trapezoidal fuzzy number x (see Fig.3) with membership function $\mu_A(x)$ specified by four parameters {a, b_1, b_2, c} having a lower limit a, an upper limit c, a lower support limit b_1, and an upper support limit b_2, where, a < b_1 < b_2 < c, can be   defined by

$$\mu_A(x) = \begin{cases} \dfrac{x-a}{b_1-a} & if \quad a \leq x \leq b_1 \\ 1 & if \quad b_1 \leq x \leq b_2 \\ \dfrac{x-c}{b_2-c} & if \quad b_2 \leq x \leq c \\ 0 & otherwise \end{cases}$$

2.2.3 Defining rules

Rules, which connect input variables to output variables, are defined in order to perform inference. Each rule is a logical inference and depends on the state of input and output variables. With the help of fuzzy rules values can be incorporated between the conventional evaluation of the precise logic 1 and 0. It also include logical operations such as "and", "or", "not" and "if-then". 'IF ... THEN ...' forms are used in the present study to relate inputs to output variables in terms of linguistic variables. The number of rules depends on the number of inputs and outputs, and the required performance of the system.Mamdani type fuzzy inference method is used for the present study for their wide application in the construction industry.

2.2.4 Assigning the weights to the fuzzy rules

The relative importance indices for the cost overrun factors which are calculated in section 2.1 are assigned as fuzzy rules weight.

2.2.5 Defuzzification

Defuzzification is the process in which outcomes of control models in the form of fuzzy numbers can be converted to precise output numbers. Therefore, in this stage, fuzzy outcomes of fuzzy control model, including effects of all input variables of problem, and considering integrated effects of them by accessing various cost overrun phenomenons by fuzzy rules, are undergone fuzzy removing process and probability of cost overrun is determined as an exact number in the interval of zero to one. The complete procedure is shown in the form of flow chart as shown in Fig.4.

III   NUMERICAL STUDY

For the numerical study, a small survey is conducted in Rajasthan(India) for illustration purposes of the above methodology. The cost assessment model is developed for the identified predominant cost overrun factors in the construction projects .These cost overrun factors are obtained through literature survey and consultation with ten engineers working in the leading construction companies in Rajasthan, who has vast and specialized experience in the specific project. The following seven important cost overrun factors are considered for this study as shown in Fig. 5.

3.1 Ranking of Cost overrun factors

For ranking the above identified factors, an expert opinion is taken from the ten engineers/consultants in the field of construction industry. Relative importance indices (RII) are calculated for each factor, which are shown in Table 1.

It is clear from the Table 1 that the extremely important factor which affects the cost overrun is inadequate planning and scheduling and it has rank 1 according to Relative importance index. Whereas the hostile socio-economic condition has lowest rank among all cost overrun factors which are considered in the study.

3.2 Analysis steps for the model development:

To develop the model, following steps are performed on fuzzy logic tool box of MATLAB.
(i)   Construct a seven input, one output system in the FIS editor. The identified cost overrun factors and "cost overrun " are entered as input members and output member respectively. These are shown in the Fig.6
(ii) Membership functions associated with all of the input and output variables are defined in membership function editor. All the parameter related to their membership function of each variable is given in the Table 2. An example of membership function of fluctuation of price material is shown in Fig. 7.
(iii) In order to perform fuzzy inference, rules which connect input variables to output variables are defined. For the present model 35 rules are constructed in the form of IF-THEN. Five of them are given below.
 Rule1: if the probability of fluctuation in price of material is very low the cost   overrun is very low
 Rule2: if the probability of fluctuation in price of material is low the cost overrun is low
 Rule3: if the probability of fluctuation in price of material is medium the cost overrun is   medium
Rule4:if the probability of fluctuation in price material is high the cost overrun is high
 Rule5: if the probability of fluctuation in price of material is very high the cost overrun is very high

(iv) The relative importance indices (RII's) of cost overrun factors are assigned as weightage to the fuzzy rules to develop the assessment model to estimate the probability of cost overrun. Since the RII's of the cost overrun factors have different values, the fuzzy rules weights will differ accordingly. So that each if-then rule will have different weights, showing relative importance of fuzzy rules. These are presented in Table 3

(v)   The rule viewer displays a roadmap of the whole fuzzy inference process. The rule viewer shows how the shape of the certain membership function influences the overall result. The Fig. 8 shows the rule view of the system.

(vi) Finally, the input-output mappings are obtained by choosing view menu and under it view surface. Fig.9 shows the variation of experience of contractor and fluctuation of material prices with respect to cost overrun. Similarly, variation of cost overrun for different combination of input variables can be obtained. Fig.10 shows the variation of short bid preparation time and experience of contractor with respect to cost overrun. Variation of experience of contractor and planning and scheduling with respect to cost overrun is shown in Fig.11. These types of three- dimensional graphical views can be analyzed by the owner and contractor easily and quickly.

IV   CONCLUSIONS

A systematic procedure is presented for developing the cost overrun assessment model in fuzzy environment using Fuzzy toolbox of MATLAB Program Software. The procedure consists of identification of cost overrun factors and assesses their rank according to relative importance index. Using these relative importance indexes, model has been developed in fuzzy inference system (FIS).Different graphs are plotted to show the variation of different combination of cost overrun factors with the cost overrun. These graphs are directly useful for contractor and owner to understand the effect of combination of cost overrun factors over cost overrun.

REFERENCES

[1].   Franke, A., "Risk analysis in project management", International Journal of Project Management, Vol. 5(1), 1987, pp.   29- 34.
[2].   Paek, J.H., Lee, Y.W. and Ock, J.H, "Pricing Construction Risks: Fuzzy Set   Theory",   Journal of Construction   Engineering and Management, 119(4), 1993, 743-756.
[3].   Williams, T, "A classified bibliography of recent research relating to project risk management", European Journal of Operational Research,Vol .85,1995,pp. 18-38.
[4].   Taroun, A., Yang, J.B. and Lowe, D., "Construction Risk Modelling and Assessment: Insights from a Literature Review", The Built & Human Environment Review, Volume 4, Special Issue 1, 2011, PP.87-97
[5].   Jackson, S. , " Project cost overrun and risk management in Greenwood ", Proceedings of Association of Researchers in Construction Management 18th Annual ARCOM Conference, Newcastle, Northumber University, UK, 2-4 September,2002.
[6].   Koushki, P. A., Al-Rashid, K and Kartam, N., "Delays and cost increases in the construction of private residential projects in Kuwait", Construction Management and Economics, Vol.23 (3), 2005, pp. 285-294.
[7].   Creedy, G. , "Risk factors leading to cost overrun in highway projects. Sidwell", Proceeding of Queenland University of Technology Research Week International Conference, 4–8 July, 2005, Brisbane, Australia.
[8].   Iyer , K.C. and Jha, K.N. , "Factors Affecting Cost Performance: Evidence from Indian Construction Projects", International Journal of Project Management, Vol. 23,2005, pp. 283-295.
[9].   Azhar, N., Farooqui, R. U. and Ahmed, S. M., "Cost overrun factors in construction industry in Pakistan", Proceeding of first international conference on construction in developing countries (ICCIDE-1) , 4-5 August,2008, Karachi, Pakistan.
[10]. Rahman,I.A., Memon,A.H. & Abd. Karim,A.T., " Relationship between Factors of Construction Resources Affecting Project Cost", Modern Applied Science; Vol. 7 (1),2013. pp. 67-75.
[11]. Sharma S and Goyal P.K.," Cost overrun factors and project cost risk assessment in construction industry- a state of the art review", International journal of civil engineering,Vol. 3,issue 3,2014,pp.139-154.
[12]. Kangari, R. and Riggs, L.S, "Construction Risk Assessment by Linguistics", IEEE Transaction on Engineering Management, Vol. 36(2), 1989, pp. 126-131.
[13]. Tah,J.H.M. and Carr,V. , "A proposal for construction project risk assessment using fuzzy logic", Construction Management and Economics, vol. 18,2000, pp. 491-500.
[14]. Baloi, D. and Price, A.D.F., "Modelling global risk factors affecting construction cost performance", International Journal of Project Management ,Vol.21 (4),2003, pp. 261-269.
[15]. Kometa ST, Olomolaiye PO, Harris FC. , "Attributes of UK construction clients influencing project consultants' performance", Construction Management and Economics 12, 1994, pp. 433–443.
[16]. Zadeh, L., "Fuzzy sets", Information Control, 1965, 8: 338-353.

Table 1:   Relative importance Index for cost overrun factor

S.N.	Factors causing cost overrun	Number of respondents scoring					RII	rank
		Not important	Slightly important	Moderately important	High impor tant	Extremely important		
1	Fluctuation in price material	0	0	1	2	6	0.82	3
2	Lack of Experience in contract work	2	2	2	2	4	0.80	4
3	Short Bid preparation time	1	1	1	2	5	0.78	5
4	Lowest Bidding procurement procedure	1	1	1	3	4	0.76	6
5	Inadequate planning and scheduling	0	0	1	3	6	0.90	1
6	Poor management of site and supervision	0	0	2	3	5	0.86	2
7	Hostile Socio - economic condition	3	2	2	1	2	0.54	7

Table 2: linguistic variables used in model and their membership function

variables	Range	MFs	No of MFs	Name of the parameters
Input parameter				
Fluctuation in price material	[0 -1]	trapmf	5	1.very low 2.low 3.medium 4.high 5.very high
Lack of Experience in contract work	[0 -1]	trapmf	5	1.very low 2.low 3.medium 4.high 5.very high
Short Bid preparation time	[0 -1]	trapmf	5	1.very low 2.low 3.medium 4.high 5.very high
Lowest Bidding procurement procedure	[0 -1]	trapmf	5	1.very low 2.low 3.medium 4.high 5.very high
Inadequate planning and scheduling	[0 -1]	trapmf	5	1.very low 2.low 3.medium 4.high 5.very high

Poor management of site and supervision	[0 -1]	trapmf	5	1.very low 2.low 3.medium 4.high 5.very high
Hostile Socio - economic condition	[0 -1]	trapmf	5	1.very low 2.low 3.medium 4.high 5.very high
Output parameter				
Cost overrun	[0 -1]	trapmf	5	1.very low 2.low 3.medium 4.high 5.very high

Table 3: Sample fuzzy rules for the of cost assessment model and rules weight

S.N.	Rules	Rule weight
1	If the probability of fluctuation in price of material is very low the cost overrun is very low	0.82
2	If the probability of Lack of Experience in contract work is very low the cost overrun is very low	0.8
3	If the probability of Short Bid preparation time is very low the cost overrun is very low	0.78
4	If probability of Lowest Bidding procurement procedure is very low the cost overrun is very low	0.76
5	If the probability of Inadequate planning and scheduling is very low the cost overrun is very low	0.9
6	If the probability of Poor management of site management and supervision is very low the cost overrun is very low	0.86
7	If the probability of hostile economic condition is very low the cost overrun is very low	0.54

FIS Editor   Membership Function   Rule Editor

Surface View   Rule Viewer
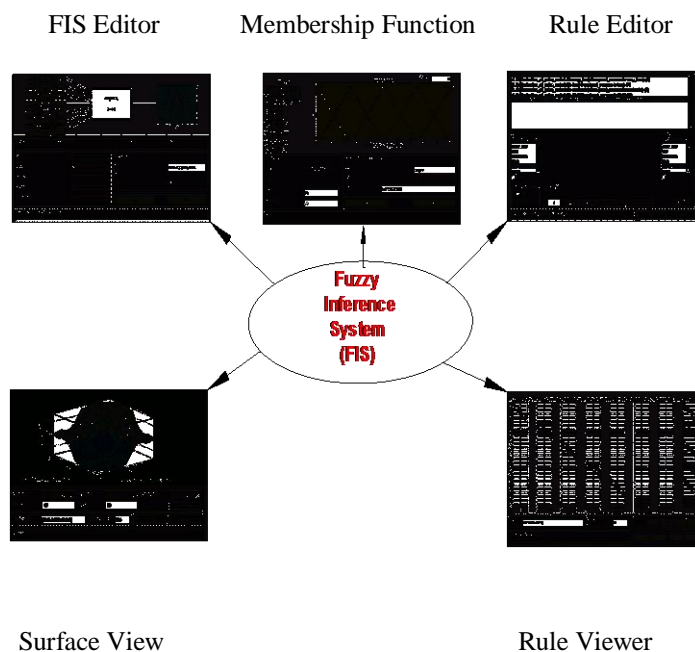
Fig. 1: Fuzzy inference process
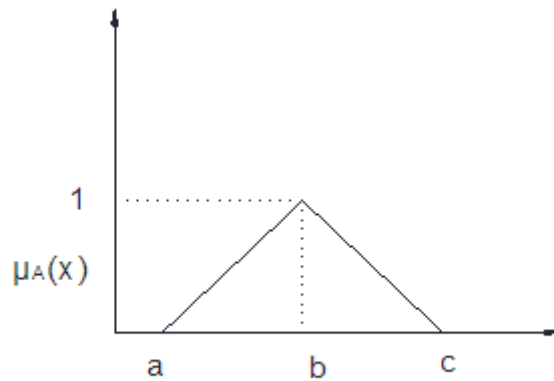
Fig.2 Triangular fuzzy number
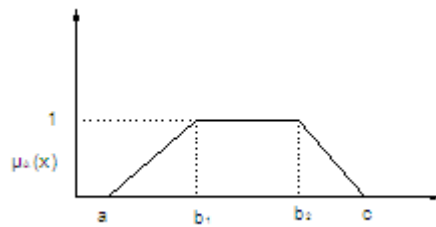
Fig3: Trapezoidal fuzzy number
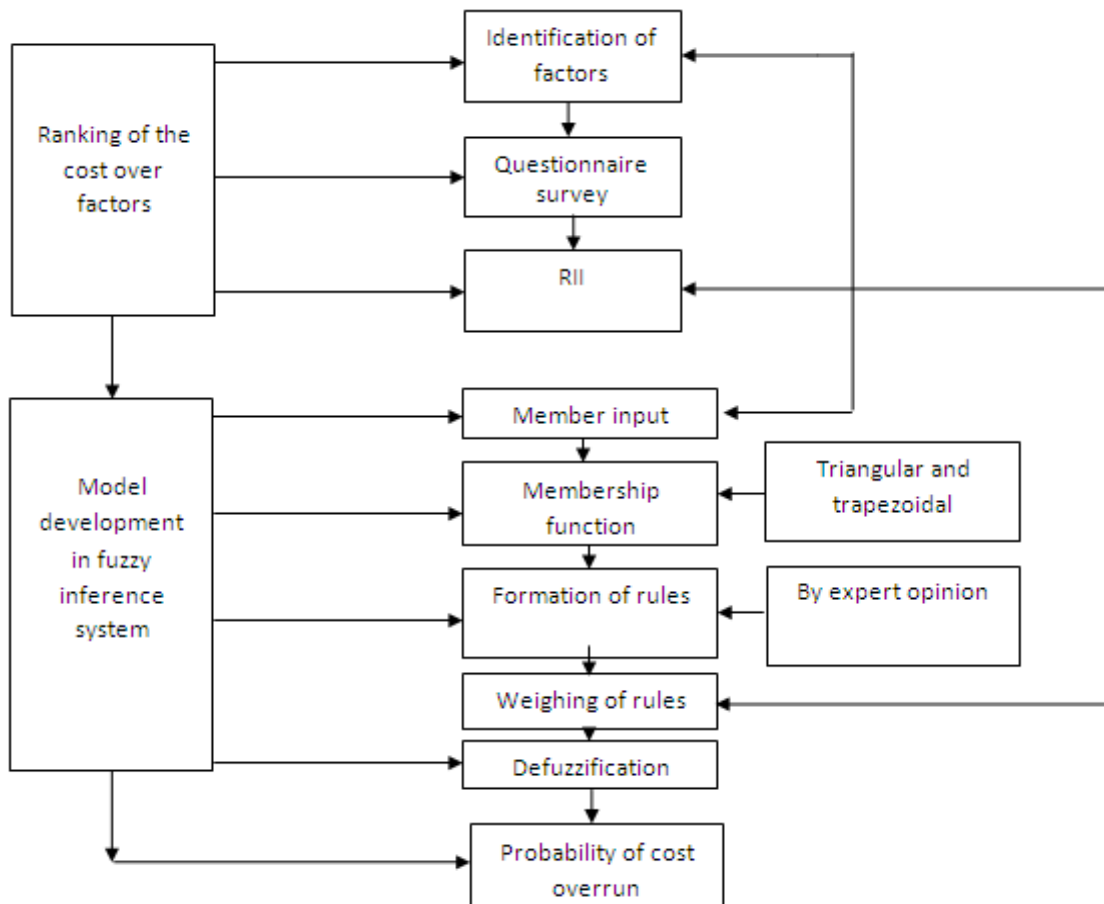
Fig 4: Flow diagram for the development of cost assesment model in fuzzy inference system
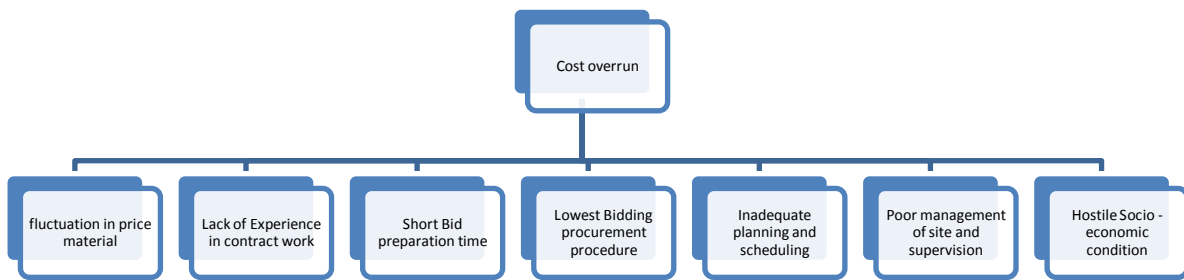
Fig. 5:   Cost overrun factors
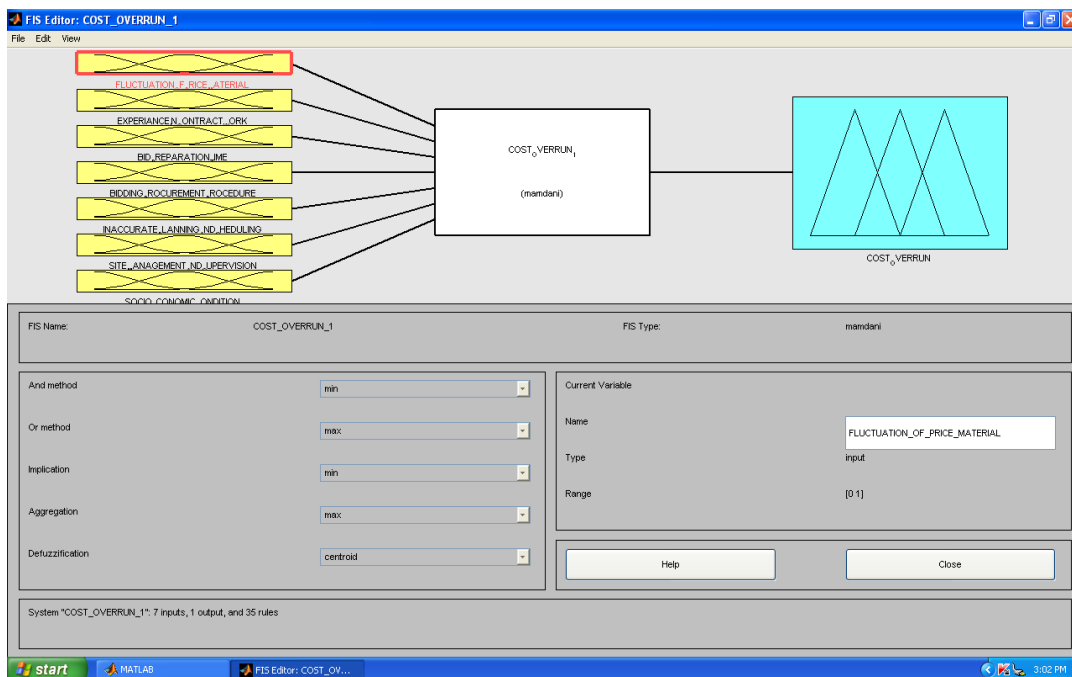
Fig 6: Input and output members for cost overrun assessment model
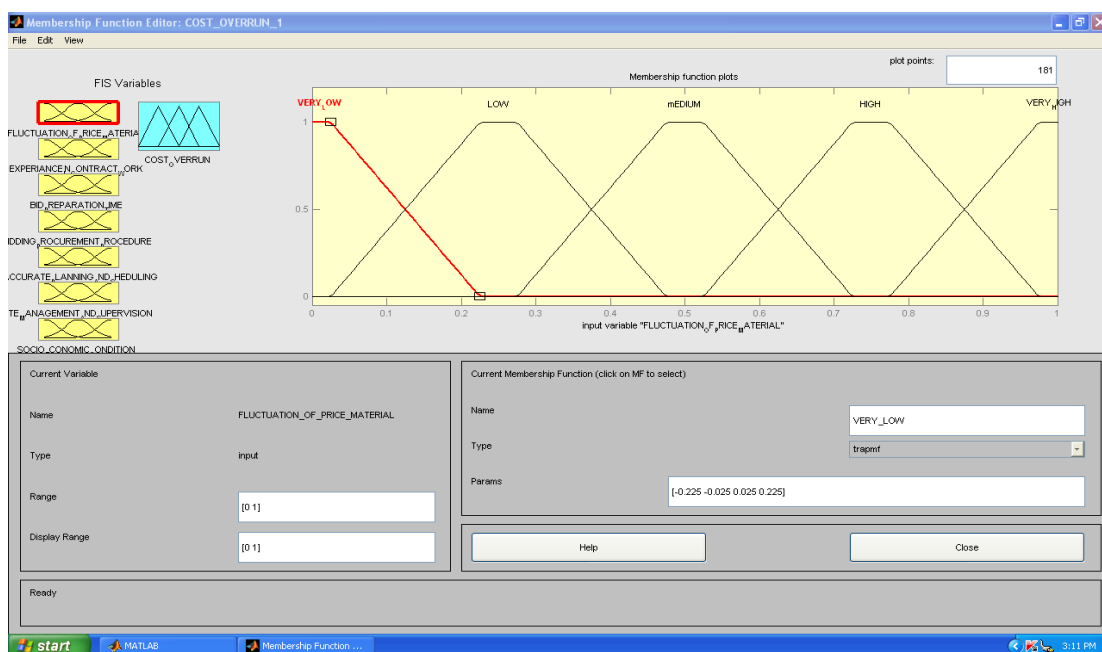
Fig. 7: Membership function for the cost assessment model
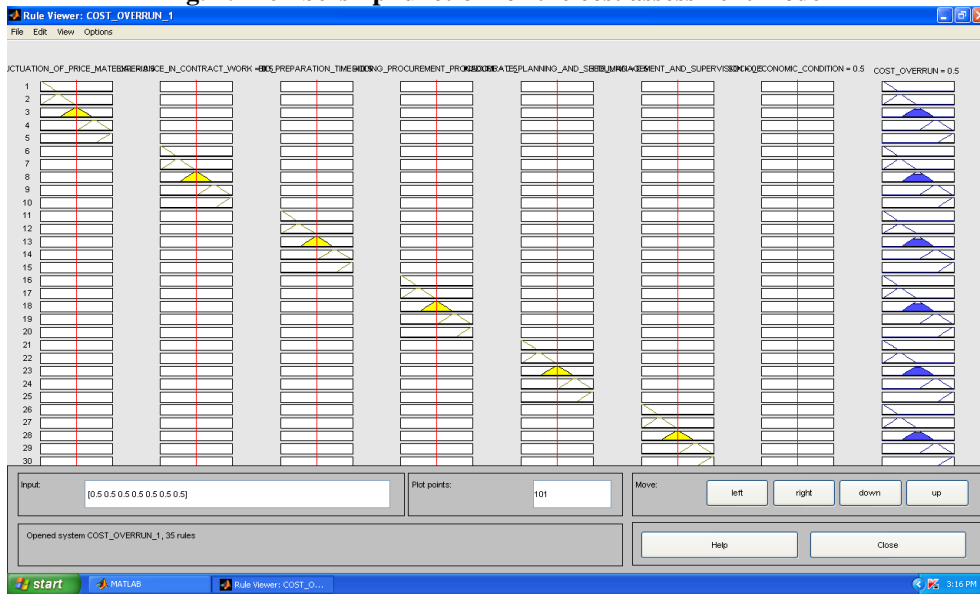
Fig. 8 : Defuzzification process for the cost assessment model
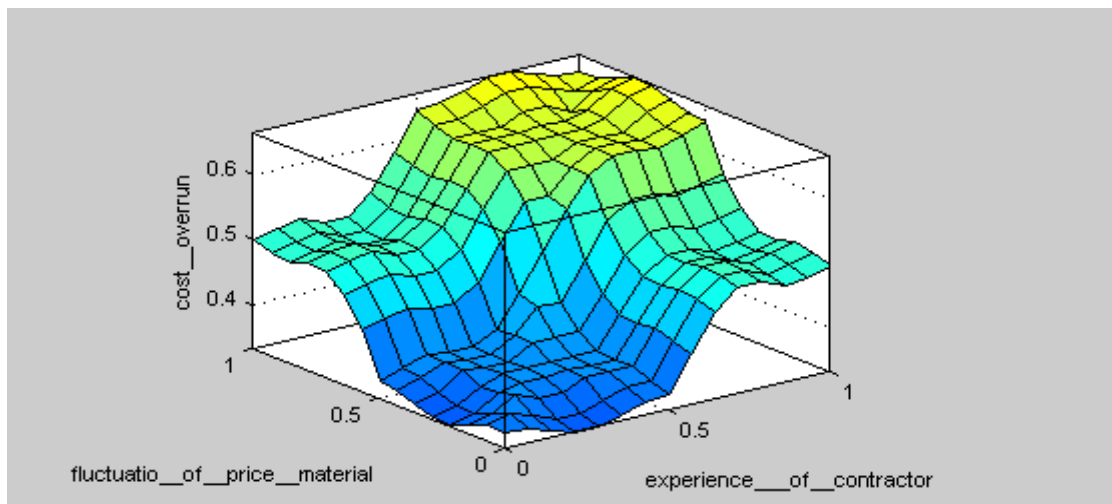
Fig.9: Variation of fluctuation of price material and experience of contractor with respect to cost overrun
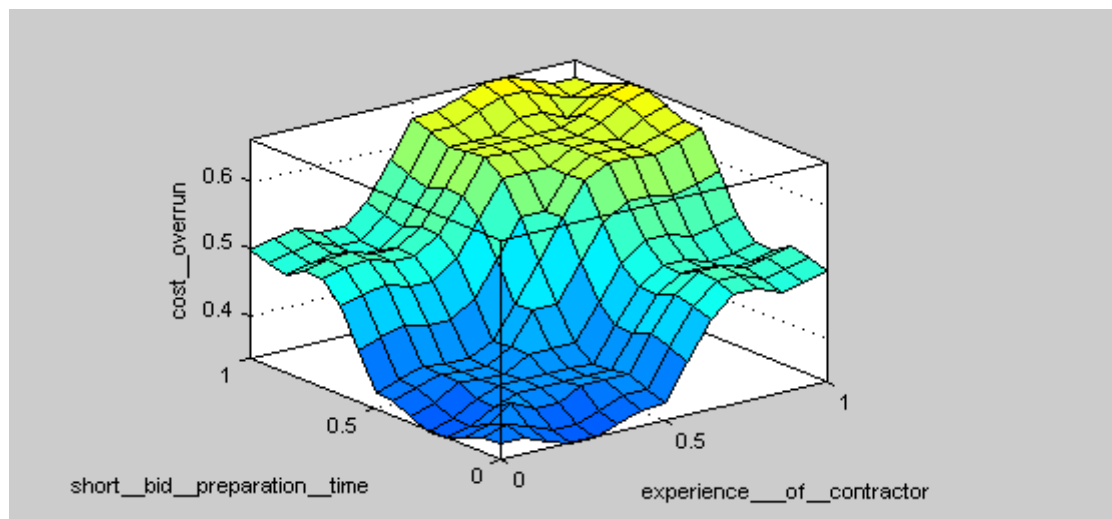
Fig.10: Variation of short bid preparation time and experience of contractor with respect to cost overrun
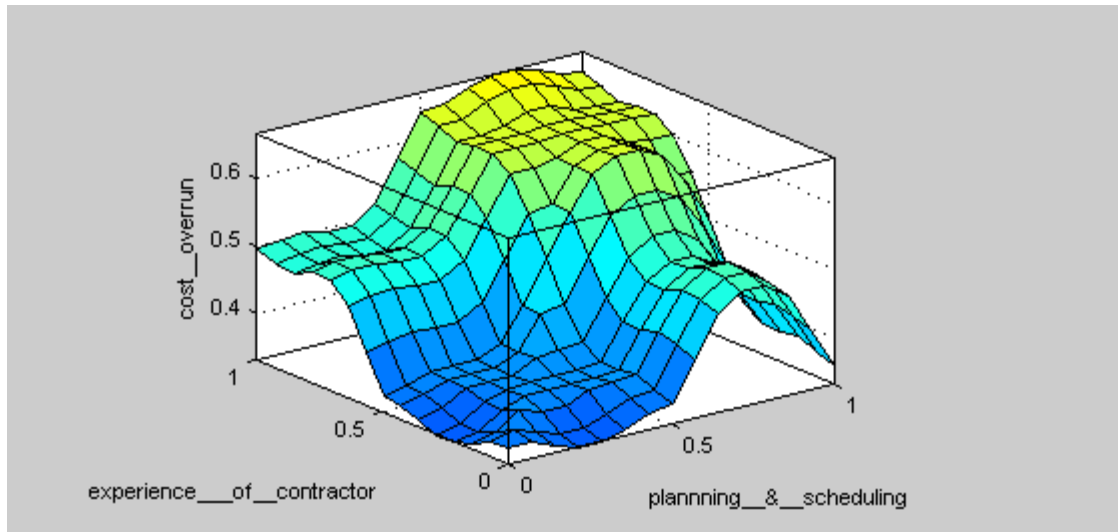
Fig.11: Variation of experience of contractor and planning and scheduling with respect to cost overrun

Performance Evaluation of Fuzzy Logic Controller with Conventional PI (Designed at Higher Dilution Rate) Controller for continues Bioreactor.

Ballekallu Chinna Eeranna, G.Prabhaker Reddy[2]
[1]Dept. of Petroleum Engineering, Lords Institute of engineering and Technology, Hyderabad, India,Phone: 91-9866400329,

Abstract: *- In this paper, a fuzzy logic controller for unstable continuous Bioreactor is proposed. The essential idea is the controller's gain tuning based on the error pattern (difference of controlled variable and its set point) and fuzzy rules. The performance of the proposed controller is compared with conventional PI (designed at higher dilution rate). Simulation results show that when the gain of nonlinear process has a big change, proposed controller has better performances than PI.*

Keywords: - *Fuzzy logic control, Bioreactor, Input Multiplicities, productivity.*

I.　　INTRODUCTION

Input multiplicity occurs when two or more sets of input variables provide the same output conditions. Biological processes can exhibit complex nonlinear behavior such as multiplicity. A number of published papers have reported input and output multiplicity found in various Biological processes.

In recent years the industrial application of advanced control techniques for the process industries has become more demanding, mainly due to the increasing complexity of the processes themselves as well as to enhanced requirements in terms of product quality and robustness properties of systems under feedback control. In this work, the design and evaluation of , unlike model based nonlinear controller, the lesser computationally involved fuzzy logic controller of for bioreactor is presented to overcome the control problems associated with conventional PI controller due to input multiplicities.

II.　　PROCESS DESCRIPTION

We consider here an isothermal continuous bio reactor, which can be described by the following unstructured model equations for simulation studies to evaluate the proposed controller (Henson,M.A.and. Seborg,D.E. (1982)) :

Cell Balance:

$$\frac{dX}{dt} = -DX + \mu X$$

Substrate Balance:

$$\frac{dS}{dt} = D(S_f - S) - \mu \frac{X}{Y}$$

Product Balance:

$$\frac{dP}{dt} = -DP + (\alpha\mu + \beta)X$$

At t = 0, X=X_s, S=S_s, P=P_s

The specific growth rate model is assumed to exhibit both substrate and product inhibition:

$$\mu = \mu_m \{[1-(P/P_m)]S\}/(K_m + S + S^2/K_i)$$

Where α, P_m, K_m and K_i are respectively the maximum specific growth rate, product saturation constant, substrate saturation constant and substrate inhibition constant. The nominal values of the parameters and the operating conditions used in the present study are given as: $\alpha=2.2$ g/g, b=0.2 g/g, mm =0.48 h^{-1}, P_m= 50 g/l, K_m=1.2 g/l, K_i=22 g/l , S_f=20 g/l and Y=0.4 g/g (Chidambaram,M and Reddy, G.P. (1995)).
If the biomass and substrate are of negligible value when compared to that of the product, the productivity Q can be defined as the amount of product cells produced per unit time:

$$Q = DP$$

The steady state solution of Eqs. (1) to (5) are obtained in order to calculate D for a given value of Q as:

$$b_1 D^4 + (b_2 - h_1) D^3 + (b_3 - h_2) D^2 - h_3 D - h_4 = 0$$

$$h1 = \alpha^2/Sf$$
$$h2 = \alpha\{2S_f\beta - Q[1/Y + (S_f\alpha/Pm)]\}$$
$$h3 = (\alpha/Pm\ Y)\ Q^2 - Q[(2\alpha\beta S_f/Pm) + (\beta/Y)] + S_f\beta^2$$
$$h4 = (\beta/Pm)[(Q^2/Y) - \beta S_f Q]\qquad \text{with}$$
$$b1 = \alpha^2 a/\mu_m\ ;\quad b2 = (2\alpha\beta/\mu_m)\ a - (\alpha Q/\mu_m)\ b\ ;$$
$$b3 = (\beta^2/\mu_m)a - (Q\beta/\mu_m)\ b + (Q^2/\mu_m)\ c\qquad \text{and}$$
$$a = (S_f^2/K_I) + S_f + Km\ ;\qquad b = [1+2(S_f/K_I)]/Y;$$
$$c = 1/(Y^2K)$$

The numerical solution of Eq. (7) gives three positive real roots and one negative root. Of three positive roots, the lowest value of the root gives negative value of S from the steady state solution of the model equations. Hence for the operating condition chosen in this work, only two positive realistic values for D are obtained.The steady state values of X,S,P and hence Q are calculated for the operating conditions. Fig. 1 shows the steady-state response of Q versus D and for a given value of Q there are two values of D due to input multiplicities.

Also, it exhibits the maximum productivity value of 3.7 (g/lh) i.e., Q at the peak. In the present work, it is proposed to study the fuzzy logic controller performance near the optimum value as any controller cannot designed at optimum with slope value is zero. The value of Q near the optimum is 3.5 (g/l h) is selected and it is obtained with either D = 0.22 1/h or D=0.13 1/h. At the lower value of D, the steady state gain is positive, here at the larger value of D the gain is negative
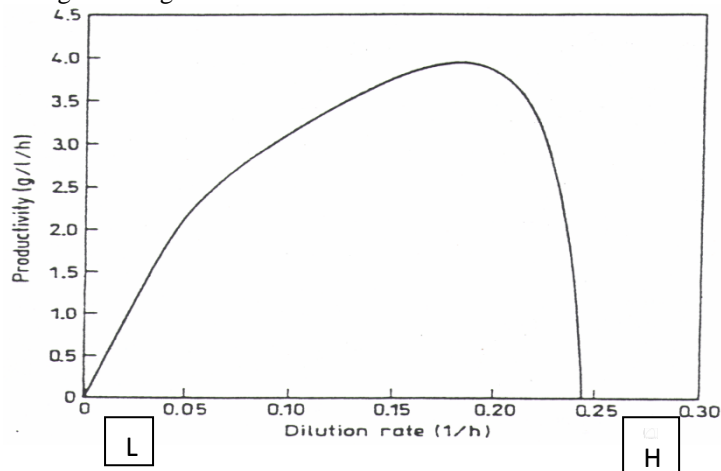
Fig.1 Productivity (Q) verses dilution rate (D) at the steadystate condition.
L- Lower dilution rate and H=Higher dilution rate

III.   DESIGN OF A FUZZY LOGIC CONTROLLER

In the fuzzification step, the productivity and productivity rate are selected as input variables to the fuzzy controller. Universes of discourse of these input variables are divided into three fuzzy sets and they are linguistically called as HIGH, LOW and OK as shown in the Figs. 2 & 3. The Gaussian membership functions with the appropriate ranges have been used for these fuzzy sets. The lower and higher values of the dilution rate (D) have been selected as Fuzzy output variables.
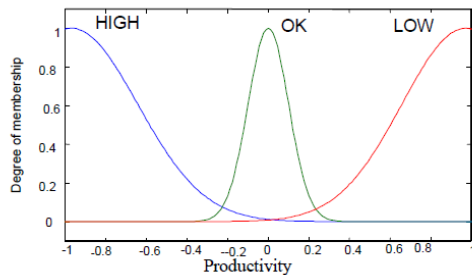
Fig. 2 Fuzzy sets of Productivity   Fig. 3 Fuzzy sets of Productivity rate
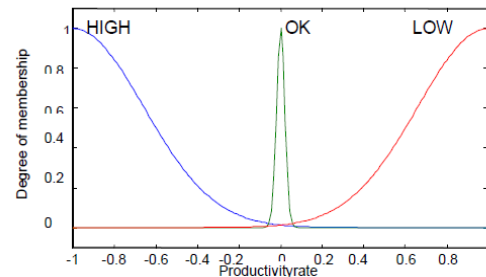
Similar to the input variables the universe of discourse of the output variables is divided into three fuzzy sets with linguistic names INCREASE, DECREASE, and NORMAL as shown in the Figs.4 &.5.
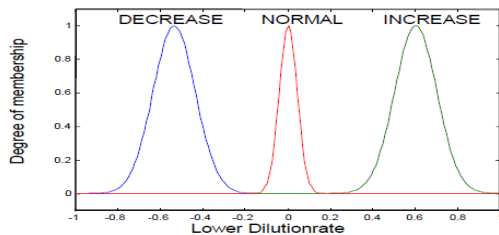
Fig.4 Fuzzy sets of lower dilution rate   Fig.5 Fuzzy sets of higher dilution rate
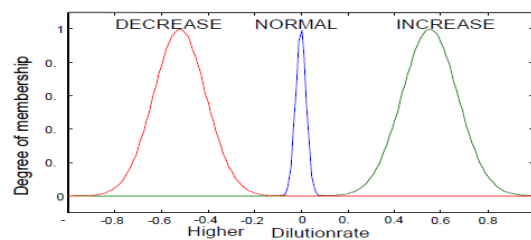
In the rule base, the rules have been considered to generate the control action at lower and higher values of dilution rate (D). The rule base takes into account the opposite behavior at both the input values. i.e. process gain is positive at lower input value and it is negative at higher input value.
The six rules are:
(1) If(productivity is HIGH)then (lower_Dilutionrate isDECREASE)(higher_Dilutionrate is INCREASE)
(2) If (productivity is LOW) then (lower_Dilutionrate is INCREASE)(higher_Dilutionrate is DECREASE)
(3) If (productivity is OK) then (lower_Dilutionrate is NORMAL)(higher_Dilutionrate is NORMAL)
(4) If (productivity is OK) and (productivityrate is HIGH) then (lower_Dilutionrate is DECREASE)(higher_Dilutionrate is INCREASE)
(5) If (productivity is OK) and (productivityrate is LOW) then (lower_Dilutionrate is INCREASE)(higher_Dilutionrate is DECREASE)
(6) If (productivity is OK) and (productivityrate is OK) then (lower_Dilutionrate is NORMAL)(higher_Dilutionrate is NORMAL)

The centroid method has been used to obtain the crisp value in the dilution rate. The fuzzy controller always provides two crisp values i.e. one is at lower value (D = 0.13 h^{-1}) and the other is at higher value (D= 0.22 h^{-1}) in dilution rates for control action and the value, which is nearer to the operating value between these two, is to be selected for the implementation.

IV.   RESULTS AND DISCUSSION

The performance of proposed fuzzy logic controller and conventional PI controller to the Continuous bioreactor with input multiplicities in dilution rate is evaluated using the closed loop block diagrams as shown in Figs 6 & 7. These block diagram are developed using MATLAB version 6.1 and its associated SIMULINK and FUZZY LOGIC tool boxes. The scaling factors (gains):Gain=3,Gain1=0.02 Gain2=0.0046, Gain3=0.00032 for the fuzzy logic controller have obtained by trial and error method from simulation studies. The parameters of conventional PI
controller used in the simulation studies are, Kc=-0.005, τI =9.35 h (Chidambaram,M and Reddy, G.P. (1995)).
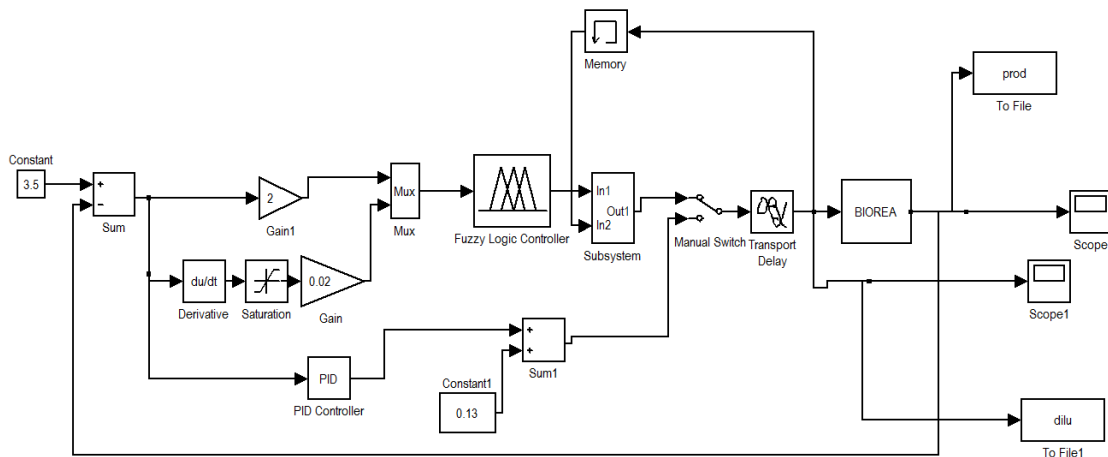
. 6. Block diagram for fuzzy logic controller & conventional PI controller
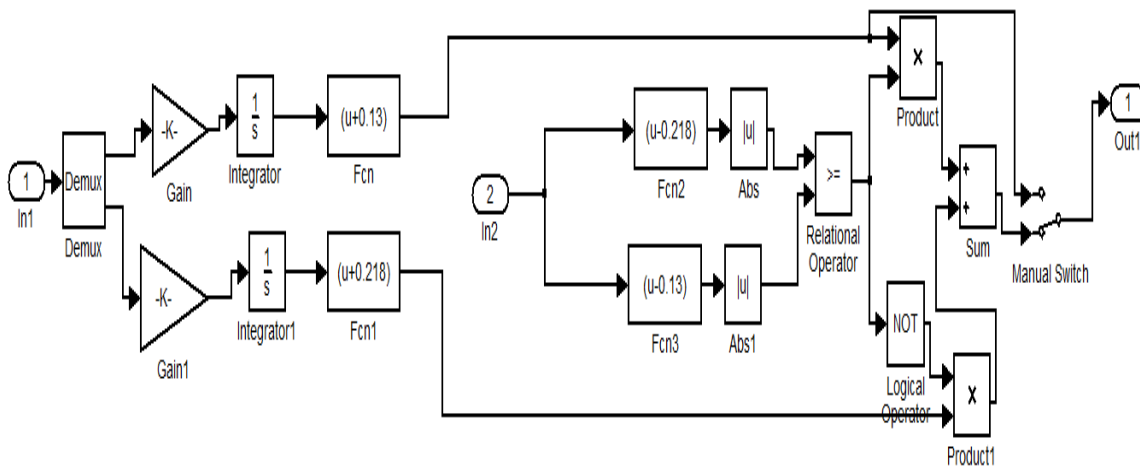
Fig. 7. Block diagram for subsystem of fuzzy logic controller shown in Fig. 6

4.1 At higher input Dilution rate (D=0.218 hr^{-1})

Servo problem: The closed loop responses at two operating points for set point change of $\pm10\%$, have been obtained and are presented in Figures from 8 and 9. In these Figures, the response of PI is compared with fuzzy logic controller. For +10% changes in set point, here the PI gives stable response and offset 0.05%, whereas the fuzzy logic controller reaches the set point in 40 hrs of time. These results show that fuzzy controller performance has been faster and offset free response than that of PI controller. Similar kind of faster responses are obtained for -10%. The performances of Fuzzy logic control remain superior at two operating points.
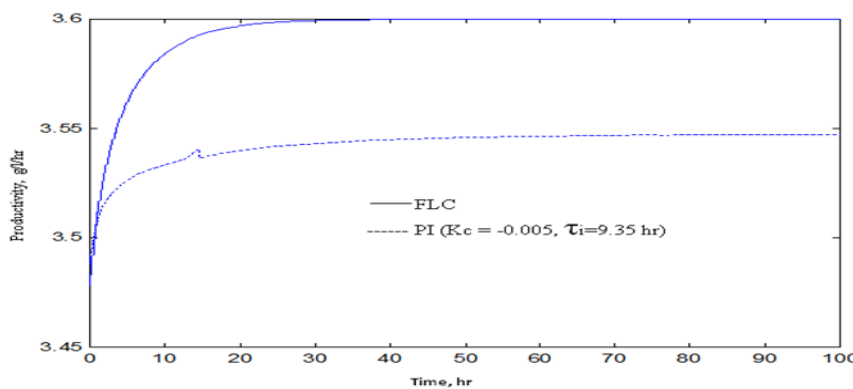
Fig 8 Closed loop response of productivity for step change in set point from 3.5 to 3.6 (+10%) at higher input
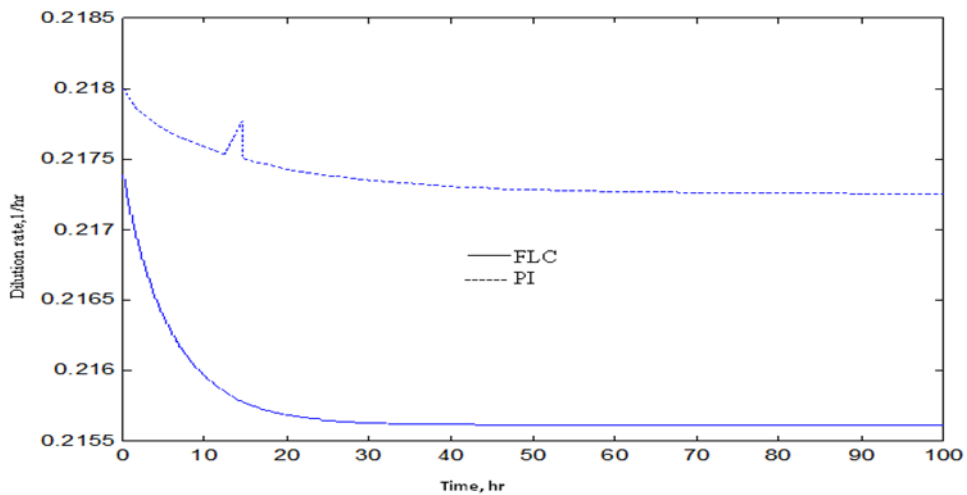
Fig 9. Control action in Dilution rate vs. time as shown in Fig 8

Regulatory problem:

Regulatory response in productivity of fuzzy logic and conventional PI is shown in Fig. 10 for a step change in substrate feed concentration (S_f) from 20 to 24(+20%) g/l. This result shows that the fuzzy logic controller faster than that of the linear PI.

Proposed fuzzy logic controller reaches set point with in 30 hrs, where as PI reaches after 50 hrs. Proposed fuzzy logic controller has maximum deviation of less than 2% where as PI controller has a lager deviation of about 6 %. Fuzzy logic controller has lower settling time than the PI controller. The corresponding control actions in terms of dilution rate are smooth and they are shown in fig.11.
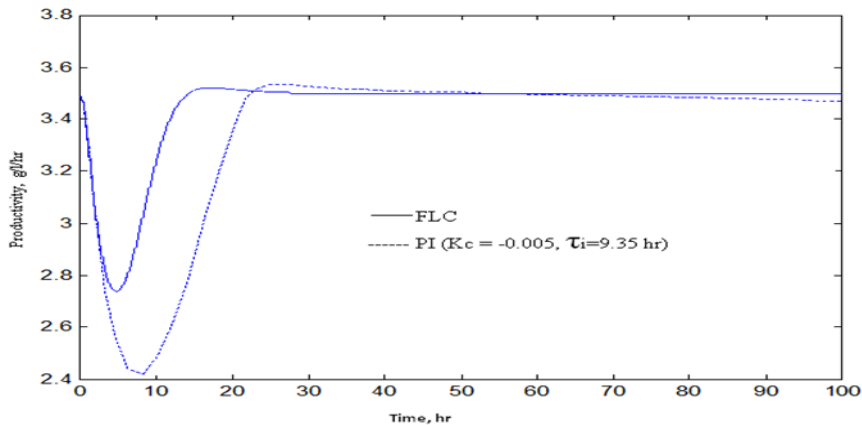
Fig 10. Closed loop response of productivity for a change in Sf from 20 to 24 (+20%) at higher input

.
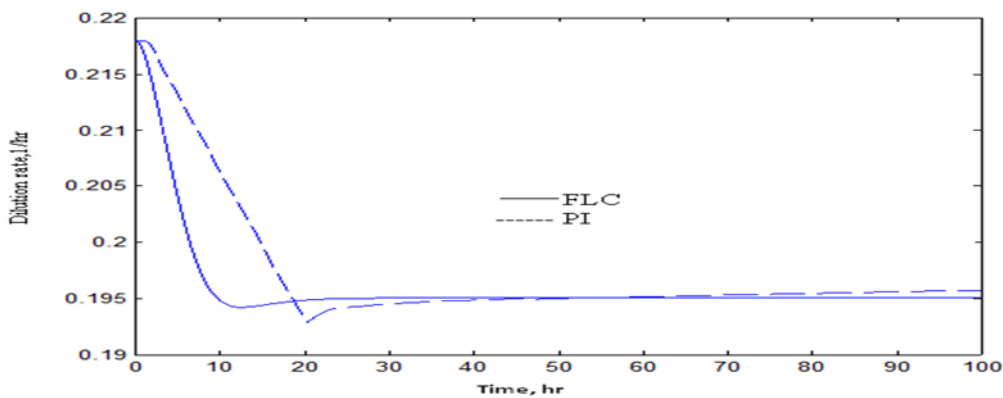
Fig 11 Control action in Dilution rate vs. time as shown in Fig 10

V.   CONCLUSIONS

For a continuous bioreactor with input multiplicities in dilution rate, the performance of present fuzzy logic controller productivity is found to much superior to that of the conventional PI controller at higher dilution rate. where as the linear PI controller (designed at higher dilution rate) will give unstable responses and results in wash out condition. Thus, the present fuzzy logic controller is superior to linear PI controller productivity and can overcome the control problems due to the input multiplicities

REFERENCES

[1]   Koppel, L.B.(1983) Input multiplicities in process control, Chemical Engineering Education, pp58-63, & 89-92. Mamdani,E.H., Assilian, S.(1975) An experiment in linguistic synthesis with a fuzzy logic controller International, Journal of Man-Machine Studies.7pp1-13.
[2]   Srinivas,M and Chidambaram, M(1995) Fuzzy logic control of an unstable bioreactor, Bioprocess Engineering. 12 135-139
[3]   Henson,M.A.and. Seborg,D.E. (1982) Nonlinear control strategies for continuous fementer ” Chemical engineering Science,47pp821-835.
[4]   Srinivas,M and Chidambaram, M(1995) Fuzzy logic control of an unstable bioreactor, Bioprocess Engineering. 12135-139.
[5]   Mamdani,E.H., Assilian, S.(1975) An experiment in linguistic synthesis with a fuzzy logic controller
[6]   International Journal of Man-Machine Studies.7pp1-13. Michio Suzeno (1985) An introduction survey to Fuzzy control, Information Sciences, 36 pp59-83.
[7]   Reddy, G.P. and Chidambaram, M (1995) Nonlinear control of bioreactors with input multiplicities in dilution rate, Bioprocess Engineering. 12pp 151-155.

Research Paper   Open Access

Approximate Solution of the Dirichlet Problems in Polar Co-Ordinates

Azadeh Hosseinpour[1], Mohammad Javad Ojaghi [2], Arezoo Hosseinpour[3]

[1] *Young Researcher and Elite Club, Kermanshah Branch, Islamic Azad University, Kermanshah, Iran*
[2] *Young Researchers and Elite Club, Kermanshah Branch, Islamic Azad University, Kermanshah, Iran*
[3] *Young Researchers and Elite Club, Kermanshah Branch, Islamic Azad University, Kermanshah, Iran*

Abstract: - This paper is concerned with the investigation of the Helmholtz type equation with the Dirichlet boundary conditions in polar co-ordinates .We present a numerical method for solving this equation and obtain the matrix form of equations. For our purpose define the mesh points in the $r - \theta$ plane by the points of intersection of the circles $r = ih, (i = 1, ..., n)$ and the straight lines $\theta = j\delta\theta, j = 0,1,2, ...$

I.   INTRODUCTION

Many physical problems involve solving elliptic equations with circular boundaries. Finite difference problems involving circular boundaries usually are solved more conveniently in polar co-ordinates than Cartesian co-ordinates. In this case, we first transform the rectangular coordinate system into the convenient polar or cylindrical coordinates. In the present paper, we consider Helmholtz equation

$$U_{xx} + U_{yy} + \lambda U = F(x, y)$$

With the Dirichlet boundary conditions on Ω, where λ is a positive real constant. The Helmholtz equation or reduced wave equation is an elliptic partial differential equation. It takes its name from the German physicist Hermann Helmholtz (1821-1894), a researcher in acoustics, electromagnetism, and physiology. This equation occurs when we are looking for mono frequency or time harmonic solutions for the wave equation.
A. S. Fokas introduced a new method for solving boundary value problems for linear and for integrable nonlinear PDEs [1]. Daniel ben-Avraham and Athanassios S. Fokas applied this method to the Helmholtz equation [2]. We want to solve this problem in polar co-ordinates. K. Mohseni and T. Colonius presented a numerical treatment of polar coordinate singularities [4]. There are other methods to solve pure problems in polar or cylindrical coordinates [6, 3]. In the next section, we present a finite difference scheme for solution of Helmholtz equation.

II.   FINITE DIFFERENCE SCHEME

Let us consider E.q (1) on $\Omega = \{(x, y) | x^2 + y^2 < 1\}$ with the Dirichlet $U = g$ boundary conditions on Ω. Note that if $\lambda = 0$, the Helmholtz differential equation reduces to Laplace equation $U_{xx} + U_{yy} = F(x, y)$ In this paper, we only consider those solutions U of (1) which are defined and analytic in the real variables x, y for domain Ω in the plane R^2. By using the polar coordinate transformation $x = r\cos\theta$ and $y = r\sin\theta$ where $r = (x^2 + y^2)^{1/2}$ and $\theta = \arctan\frac{y}{x}$, and setting $u(r, \theta) = U(x, y)$ and $f(r, \theta) = F(x, y)$ E.q (1) becomes:

$$u_{rr} + \frac{1}{r}u_r + \frac{1}{r^2}u_{\theta\theta} + \lambda u = f(r, \theta) \qquad 0 < r < 1, 0 < \theta < 2\pi$$

For non-zero values of r there is no problem, but at $r = 0$ the right side appears to contain singularities. In this case, we can replace the polar co-ordinate form of equation by its Cartesian equivalent. In the present paper, we choose a grid which the grid points are in the $r - \theta$ plane as follow:

$$r_i = \frac{2i + 1}{2}\Delta r \qquad i = 0,1, ..., n + 1$$

$$\theta_j = j\Delta\theta \qquad j = 0,1,\ldots,m+1$$

The notations u_{ij}, f_{ij} and g_j are used for the finite difference approximations of $u(r_i, \theta_j)$, $f(r_i, \theta_j)$ and $g(\theta_j)$ respectively.

By using the central difference scheme for E.q (1) we have:

$$\left(1 - \frac{1}{2i+1}\right)u_{i-1j} + a_i u_{ij}\left(1 + \frac{1}{2i+1}\right)u_{i+1j} + \frac{4}{(2i+1)^2(\Delta\theta)^2}u_{ij-1} + \frac{4}{(2i+1)^2(\Delta\theta)^2}u_{ij+1} = f(r_i, \theta_j)$$

where $a_i = \lambda - 2 - \frac{8}{(2i+1)^2(\Delta\theta)^2}$. By

$$U = \begin{bmatrix} u_1 \\ u_2 \\ \vdots \\ u_n \end{bmatrix} \quad , \quad u_i = \begin{bmatrix} u_{i1} \\ u_{i2} \\ \vdots \\ u_{im} \end{bmatrix} \qquad i = 1,\ldots,n$$

The linear system of equations is as follows:

$$AU = B$$

where A is a $mn \times mn$ matrix which can be written in partitioned form as:

$$A = \begin{pmatrix} B_1 & C_1 & & & \\ A_2 & B_2 & C_2 & & \\ & \ddots & \ddots & \ddots & \\ & & A_{n-1} & B_{n-1} & C_{n-1} \\ & & & A_n & B_n \end{pmatrix}$$

for $i = 1,2,\ldots,n$ we have:

$$B_i = \begin{pmatrix} a_i & \frac{4}{(2i+1)^2(\Delta\theta)^2} & & \\ \frac{4}{(2i+1)^2(\Delta\theta)^2} & a_i & \frac{4}{(2i+1)^2(\Delta\theta)^2} & \\ & \ddots & \ddots & \ddots \\ & & \frac{4}{(2i+1)^2(\Delta\theta)^2} & a_i \end{pmatrix}$$

And $A_i = (1 - \frac{1}{2i+1})I_{m\times m}$ and $C_i = (1 + \frac{1}{2i+1})I_{m\times m}$. B also is a column vector determined by the boundary values as follow:

$$B = \begin{pmatrix} b_1 \\ b_2 \\ \vdots \\ b_n \end{pmatrix}$$

where

$$b_1 = \begin{pmatrix} f(r_1, \theta_1) - \left(1 - \frac{1}{3}\right)u_{01} - \frac{4}{9(\Delta\theta)^2}u_{10} \\ f(r_1, \theta_2) - \left(1 - \frac{1}{3}\right)u_{02} \\ \vdots \\ f(r_1, \theta_m) - \left(1 - \frac{1}{3}\right)u_{0m} - \frac{4}{9(\Delta\theta)^2}u_{1m+1} \end{pmatrix} \quad , \quad b_i = \begin{pmatrix} f(r_i, \theta_1) - \frac{4}{(2i+1)^2 9(\Delta\theta)^2}u_{i0} \\ f(r_i, \theta_2) \\ \vdots \\ f(r_i, \theta_m) - \frac{4}{(2i+1)^2(\Delta\theta)^2}u_{im+1} \end{pmatrix}$$

where $i = 2,\ldots,n-1$ and

$$b_1 = \begin{pmatrix} f(r_n, \theta_1) - \left(1 + \frac{1}{2n+1}\right)u_{n+1,1} - \frac{4}{(2n+1)^2(\Delta\theta)^2}u_{n,0} \\ f(r_n, \theta_2) - \left(1 + \frac{1}{2n+1}\right)u_{n+1,2} \\ \vdots \\ f(r_n, \theta_m) - \left(1 + \frac{1}{2n+1}\right)u_{n+1,m} - \frac{4}{(2n+1)^2(\Delta\theta)^2}u_{n,m+1} \end{pmatrix}$$

A is a tridiagonal and invertible matrix, therefore this system has a unique solution. There are a lot of methods for solution these linear system equations; you can see [5].

III.   CONCLUSION

Our purpose in this article is solving the Dirichlet problems for the Helmholtz equation. Here, a numerical method for solving this problem is investigated. We first obtain Helmholtz equation in polar co-

ordinate. Afterwards, we present an implicit scheme and obtain the matrix form of this equation. Finally, the obtained system can be solved by various methods.

REFERENCES

[1] A. S. Fokas, On the integrability of linear and nonlinear PDEs, J. Math. Phys. 41 (2000) 4188.
[2] Daniel ben-Avraham and Athanassios S. Fokas, The solution of the modified Helmholtz equation in a triangular domain and an application to diffusion-limited coalescence, Phys. Lett. A. 263 (1999) 355-359.
[3] K. Fukagata, N. Kasagi, Highly energy-conservative finite difference method for the cylindrical coordinate system, J. Comput. Phys. 181 (2002) 478-498.
[4] K. Mohseni, T.Colonius, Numerical treatment of polar coordinate singularities, J. Comput. Phys. 151 (2000) 787-795.
[5] R. A. Sweet, A cyclic reduction algorithm for block tridiagonal systems of arbitrary dimension, SIAM J. Numer. Anal. 14 (1977) 706.
[6] R. Verzicco, P.Orlandi, A finite-difference scheme for three-dimensional incompressible flows in cylindrical coordinates, J. Comput. Phys. 123 (1996) 402-414.

Research Paper   Open Access

THE GLOBAL POLITICS?...(A New theory on "Universal Dam")

M.Arulmani, V.R.Hema Latha,
B.E. (Engineer, M.A., M.Sc., M.Phil.(Biologist)

Abstract: - This scientific research article focus that the "**FISSION**", "**FUSION**" in Astronomical terms shall be considered as the "**GLOBAL POLITICS**" of super nature by **decay, Annihilation** of atoms for formation of various matters for betterment of human and sustainability of life system on the "**EARTH PLANET**".

"**RAIN**" shall be considered as the one of the fundamental matters of universe essential for all life. This research focus that "**Earth**" shall be considered as the "**UNIVERSAL DAM**" acts as a storage device of "**Rain**" in the form of "**OCEAN**" for existence of all matters of universe under "**ELECTROMAGNETIC EQUILIBRIUM**". In proto Indo Europe Language the "**Earth Planet**" shall be called as "**MA-DAM**". Ma-Dam shall mean Universal dam of "**Natural Rain Water Harvest**".
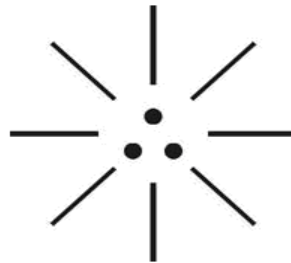
(MA-DAM)

*"**Rain** shall be considered as the natural product of "**Fission**", "**Fusion**" action for the betterment of mankind and sustainability of life".*

- Author

Keywords: -   b) *Philosophy of "**Earth dam**"*
a) *Philosophy of "**White Blood**"*   c) *Philosophy of "**J-politics**"*

I.   INTRODUCTION

It is focused that rain shall be considered as the natural product given by super nature for the benefit of mankind. The "**Ancient Dam**" shall be considered as the judicial way of storing the rainwater for best intermittent use of it before reaching the **Ocean**. But today "**global level human politics**" going on sharing of **ocean, border, dam water**, due to high level intelligent act of "**intellectual politicians**". This research attempts to focus the philosophy of "**POLITICS**" within the following cope.
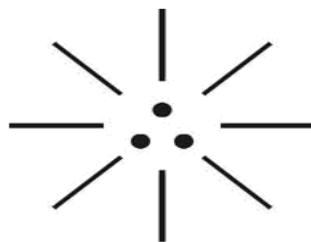
(POLITICS LOGO)

i)   "**Politics**" shall mean "**Godly rule**"
ii)   "**Politics**" are like "**Fission and Fusion**"
iii)   "**Politics**" is for promoting "**Peace of life**"

II.   HYPOTHESIS AND NARRATION

a) Philosophy of Rain?...

It is hypothesized that the philosophy of "**Rain**" shall be considered as the "**Natural Product**" due to impact of "**J-Radiation**" of super nature by action of "**Fission**" and "**Fusion**" of fundamental particles of "J-Radiation". The consistent impact of J-Radiation shall also be called as "**J-politics**" or "**Godly politics**".

(i)

(RAIN)

(ii)

(Godly Politics)
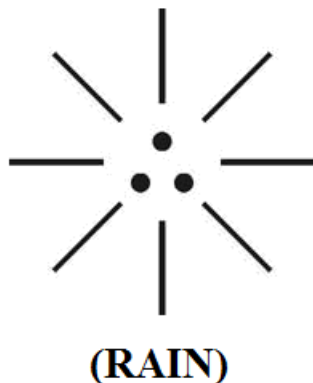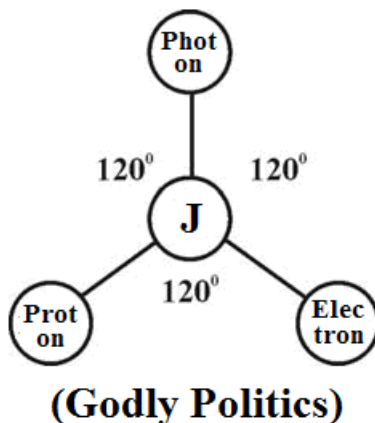
b) Rain is organic or inorganic?...

It is hypothesized that rain shall be considered as **purely inorganic** contains only fundamental ions of PHOTON, ELECTRON, PROTON and free from **atoms** hydrogen, carbon, nitrogen, ozone. Whereas the oceans considered contains atoms, molecules subsequently acquired during natural process of osmosis and reverse osmosis due to impact of variation in salinity level of ocean in different regions. In fact the rain water shall be considered as having PH value of zero and the ocean water considered contains billions of **species** PH ranging from above zero level to 14.

c) Philosophy of ocean?...

It is hypothesized that the philosophy of ocean shall be considered as the "**Transformed state**" of natural rain and collected in the "**EARTH DAM**" in three geological ages for existence of all matters under "**electromagnetic equilibrium**" condition such as coal, coke, lignite, minerals, various types of rocks, soils, formation of natural sands, etc. It is hypothesized that the earth dam considered constructed strongly and continue to be strong enough for another **1000 years** definitely. The "**ocean**" shall be considered as "**Image**" of "**Rain**". The Philosophy of rain and ocean shall be described as below.
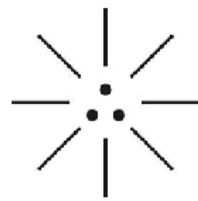
RAIN
(White Blood)

EARTH DAM
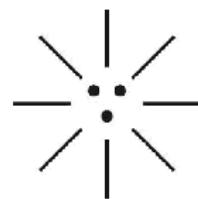
OCEAN
(Fertilized Liquid)

d) How long earth resources will come?...

It is hypothesized that the formation of all resources on the earth planet such as coal, coke, lignite, crude oil, various rocks, minerals, natural gases etc shall be considered due to impact of consistent variation in **salinity potential gradient**. It is further hypothesized that the **earth resources** continue to be in existence and reformed as long as oceans on the earth planet exists. But the fundamental quality of resource fuels varies due to growth of **species fuels.** The whole oceans considered containing billions of different types of fuel cells exists under varied pressure, density, temperature environment.

e) Etymology of word "Dam"?...

Case study shows that "**Dam**" is considered as a **barrier** that is built across the river in order to stop the water from flowing. The dam is also called as "**Reservoir**".

Further the meaning word "**dam**" is also considered as "**Mother of mankind**". It is hypothesized that the word "Dam" might be derived from proto Indo Europe (PIE) language "**MA-DAM**". 'MA-DAM' shall mean "**Earth planet**" or "**Mother of universe**" (Thai-e).
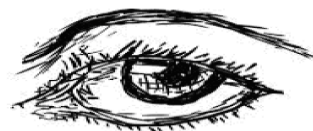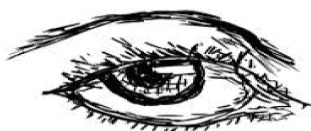
MA-DAM
(MADAM)

f) Case study on Damascus?...

Case study shows that in ancient history "**Damascus**" is referred as city in the river "**Barada**" which rises in the snows of the Anti-Lebanon range and gives the city an **abundant water supply**. It is hypothesized that the word Damascus might be derived from the proto Indo Europe origin word "**MA-DAM**" (Super structure).

g) Case study on Mullai Periyar Dam?...

Case study shows that Mullai Periyar Dam was designed and constructed by eminent British engineer **John Pennycuick** (15th January, 1841 - 9th March, 1911). The dam was constructed judicially for effective water management to divert westward flowing in the Arabian sea towards eastward for useful irrigation purpose to help the dry land area depending on only Vaigai river. The dam constructed across the Periyar river enhanced to the tune of 2.23 lakh acres irrigation in Theni, Dindigul, Madurai, Sivaganga, Ramnad district from the initial irrigation area of 1.69 Lakhs Acre.

Case study shows that though there was acute shortage of fund during British colonial rule, Jone Pennycuick Sold all his **pennies** of own property in England and could manage and completed the dam construction in 1895 for the benefit of **INDIAN FARMERS** especially for the southern part of Tamilnadu. Case study shows that he does not have any account with "**SWISS BANK**". It is emphasized that **John Pennycuick** shall be called as "**PONMANACHEMMAL**" of **Maruthai.** Ponmanachemmal shall also mean **Marshal of Marshland** (Marutham).
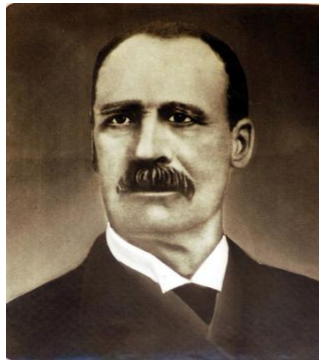
(PONMANACHEMMAL)

"I am going to be only once in the earthly world hence I need to do some good deeds here"

- John Pennycuick

h) Case study on Krishna Raja Sagara Dam?...

Case study shows that the popularly known as KRS dam was constructed across **Kaveri river** near Mysore in Karnataka State. It was constructed in 1924 by eminent engineer M. Visvesvaraya with **vision** for irrigation benefit of **southeast part of India.** Case study shows that Kerala, Andrapradesh, Karnataka states were formed only during 1st November, 1956 under states reorganization act. Shri. Visvesvaraya shall also be called as "**SON OF KAVERI THAI-e**".

i) Case study on Kallanai Dam?...

Case study shows that Kallanai dam was constructed before 2000 years by Chola King and subsequently remodeled by British rule during 19th Century by captain Caldwell a military engineer. The dam is also called as Grand Anicut and irrigated land area of initially about 69,000 acres and by 20th century nearly about 1 million acres. The dam is still very strong.

III. CONCLUSION

It is focused that the philosophy of "**Dam**" shall be considered as the "**Barrier**" between "**Rain**" and "**Ocean**" for sustainability of "life".

It is further focused that the "**natural resource**" of water shall be well managed by effective "**Leadership Qualities**" with enriched "**common sense**" preferably with "**Radiation status**" by the leaders who dedicated themselves to the "**Nations**".
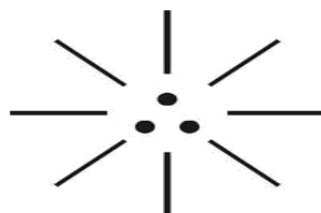
(LAW OF RULE)

i) **Right dot**   -   Leadership Qualities (**Common sense**)
ii) **Left dot**   -   Managerial qualities (**Intelligence**)
iii) **Centre dot**   -   Intuitional qualities (**Wisdom**)

"Rain" shall be considered as "White Blood" and "Ocean" shall considered as composed of various minerals, vitamins, proteins. In the early Universe the ocean shall be considered as highly acidic with low PH value (Dark blue ozone liquid). During the course of expanding Universe the acidity gradually became variant in three geological period and ocean water considered become alkalic with higher PH value. The word "OZONE" might be dialectically pronounced as "OCEAN".

- Author

IV.   PREVIOUS PUBLICATION

The philosophy of origin of first life and human, the philosophy of model Cosmo Universe, the philosophy of fundamental neutrino particles have already been published in various international journals mentioned below. Hence this article shall be considered as **extended version** of the previous articles already published by the same author.

[1] Cosmo Super Star – IJSRP, April issue, 2013
[2] Super Scientist of Climate control – IJSER, May issue, 2013
[3] AKKIE MARS CODE – IJSER, June issue, 2013
[4] KARITHIRI (Dark flame) The Centromere of Cosmo Universe – IJIRD, May issue, 2013
[5] MA-AYYAN of MARS – IJIRD, June issue, 2013
[6] MARS TRIBE – IJSER, June issue, 2013
[7] MARS MATHEMATICS – IJERD, June issue, 2013
[8] MARS (EZHEM) The mother of All Planets – IJSER, June issue, 2013
[9] The Mystery of Crop Circle – IJOART, May issue, 2013
[10] Origin of First Language – IJIRD, June issue, 2013
[11] MARS TRISOMY HUMAN – IJOART, June issue, 2013
[12] MARS ANGEL – IJSTR, June issue, 2013
[13] Three principles of Akkie Management (AJIBM, August issue, 2013)
[14] Prehistoric Triphthong Alphabet (IJIRD, July issue, 2013)
[15] Prehistoric Akkie Music (IJST, July issue, 2013)
[16] Barack Obama is Tamil Based Indian? (IJSER, August issue, 2013)
[17] Philosophy of MARS Radiation (IJSER, August 2013)
[18] Etymology of word **"J"** (IJSER, September 2013)
[19] NOAH is Dravidian? (IJOART, August 2013)
[20] Philosophy of Dark Cell (Soul)? (IJSER, September 2013)
[21] Darwin Sir is Wrong?! (IJSER, October issue, 2013)
[22] Prehistoric Pyramids are RF Antenna?!... (IJSER, October issue, 2013)
[23] HUMAN IS A ROAM FREE CELL PHONE?!... (IJIRD, September issue, 2013)
[24] NEUTRINOS EXIST IN EARTH ATMOSPHERE?!... (IJERD, October issue, 2013)
[25] EARLY UNIVERSE WAS HIGHLY FROZEN?!... (IJOART, October issue, 2013)
[26] UNIVERSE IS LIKE SPACE SHIP?!... (AJER, October issue, 2013)
[27] ANCIENT EGYPT IS DRAVIDA NAD?!... (IJSER, November issue, 2013)
[28] ROSETTA STONE IS PREHISTORIC "THAMEE STONE" ?!... (IJSER, November issue, 2013)
[29] The Supernatural "CNO" HUMAN?... (IJOART, December issue, 2013)
[30] 3G HUMAN ANCESTOR?... (AJER, December issue, 2013)
[31] 3G Evolution?... (IJIRD, December issue, 2013)
[32] God Created Human?... (IJERD, December issue, 2013)
[33] Prehistoric "J" – Element?... (IJSER, January issue, 2014)
[34] 3G Mobile phone Induces Cancer?... (IJERD, December issue, 2013)
[35] "J" Shall Mean "JOULE"?... (IRJES, December issue, 2013)
[36] "J"- HOUSE IS A HEAVEN?... (IJIRD, January issue, 2014)
[37] The Supersonic JET FLIGHT-2014?... (IJSER, January issue, 2014)
[38] "J"-RADIATION IS MOTHER OF HYDROGEN?... (AJER, January issue, 2014)
[39] PEACE BEGINS WITH "J"?... (IJERD, January issue, 2014)
[40] THE VIRGIN LIGHT?... (IJCRAR, January issue 2014)
[41] THE VEILED MOTHER?... (IJERD, January issue 2014)
[42] GOD HAS NO LUNGS?... (IJERD, February issue 2014)
[43] Matters are made of Light or Atom?!... (IJERD, February issue 2014)

[44]   THE NUCLEAR "MUKKULAM"?... (IJSER, February issue 2014)
[45]   WHITE REVOLUTION 2014-15?... (IJERD, February issue 2014)
[46]   STAR TWINKLES!?... (IJERD, March issue 2014)
[47]   "E-LANKA" THE TAMIL CONTINENT?... (IJERD, March issue 2014)
[48]   HELLO NAMESTE?... (IJSER, March issue 2014)
[49]   MOTHERHOOD MEANS DELIVERING CHILD?... (AJER, March issue 2014)
[50]   E–ACHI, IAS?... (AJER, March issue 2014)
[51]   THE ALTERNATIVE MEDICINE?... (AJER, April issue 2014)
[52]   GANJA IS ILLEGAL PLANT?... (IJERD, April issue 2014)
[53]   THE ENDOS?... (IJERD, April issue 2014)
[54]   THE "TRI-TRONIC" UNIVERSE?... (AJER, May issue 2014)
[55]   Varied Plasma Level have impact on "GENETIC VALUE"?... (AJER, May issue 2014)
[56]   JALLIKATTU IS DRAVIDIAN VETERAN SPORT?... (AJER, May issue 2014)
[57]   Human Equivalent of Cosmo?... (IJSER, May issue 2014)
[58]   THAI-e ETHIA!... (AJER, May issue 2014)
[59]   THE PHILOSOPHY OF "DALIT"?... (AJER, June issue 2014)
[60]   THE IMPACT OF HIGHER QUALIFICATION?... (AJER, June issue 2014)
[61]   THE CRYSTAL UNIVERSE?... (AJER July 2014 issue)

REFERENCE

[1]   Intensive Internet "e-book" study through, Google search and wikipedia
[2]   M.Arulmani, "3G Akkanna Man", Annai Publications, Cholapuram, 2011
[3]   M. Arulmani; V.R. Hemalatha, "Tamil the Law of Universe", Annai Publications, Cholapuram, 2012
[4]   Harold Koontz, Heinz Weihriah, "Essentials of management", Tata McGraw-Hill publications, 2005
[5]   M. Arulmani; V.R. Hemalatha, "First Music and First Music Alphabet", Annai Publications, Cholapuram, 2012
[6]   King James Version, "Holy Bible"
[7]   S.A. Perumal, "Human Evolution History"
[8]   "English Dictionary", Oxford Publications
[9]   Sho. Devaneyapavanar, "Tamil first mother language", Chennai, 2009
[10]   Tamilannal, "Tholkoppiar", Chennai, 2007
[11]   "Tamil to English Dictionary", Suravin Publication, 2009
[12]   "Text Material for E5 to E6 upgradaton", BSNL Publication, 2012
[13]   A. Nakkiran, "Dravidian mother", Chennai, 2007
[14]   Dr. M. Karunanidhi, "Thirukkural Translation", 2010
[15]   "Manorama Tell me why periodicals", M.M. Publication Ltd., Kottayam, 2009
[16]   V.R. Hemalatha, "A Global level peace tourism to Veilankanni", Annai Publications, Cholapuram, 2007
[17]   Prof. Ganapathi Pillai, "Sri Lankan Tamil History", 2004
[18]   Dr. K.K. Pillai, "South Indian History", 2006
[19]   M. Varadharajan, "Language History", Chennai, 2009
[20]   Fr. Y.S. Yagoo, "Western Sun", 2008
[21]   Gopal Chettiar, "Adi Dravidian Origin History", 2004
[22]   M. Arulmani; V.R. Hemalatha, "Ezhem Nadu My Dream" - (2 Parts), Annai Publications, Cholapuram, 2010
[23]   M. Arulmani; V.R. Hemalatha, "The Super Scientist of Climate Control", Annai Publications, Cholapuram, 2013, pp 1-3

Research Paper   Open Access

Influence of globalization phenomenon on rural agriculture (Case study: Kashmar County)

Mahdi Jahani, Hamid Jafari, Seyed Mahdi Golmohammadi tavalaee
Assistant Professor of Geography and rural Planning department, Islamic Azad University, Mashhad, Iran
Assistant Professor of Geography and rural Planning department, Islamic Azad University, Mashhad, Iran
PhD Scholar Department of Geography &rural Planning, Islamic Azad University, Mashhad, Iran
(corresponding author)

Abstract: - Globalization have effected on rural economic. Countries that production of agriculture effect to national economic, therefore have understand influence of globalization. In recent years, globalization has been led to decreasing geographical boundaries between countries. Policies of globalization with products of less developed countries have withdrawn from the competition. Effects of this issue have disabled less developed countries in production, competitiveness and employment, and then have been led to Poverty, inequality and unemployment. There are different products in Iran due to having various climates. Kashmar Farmers active for producing such as grape, saffron, almonds and pomegranate. The effects of international marks influence studied farmers. This paper has been concluded from analyzing of seven villages in Kashmar County at 2014. Findings show, there is oriented relation between globalization and rural agriculture inequality.

I.   INTRODUCTION

Globalization process have effected on economic, social and cultural relations between countries. Also effect in developing countries. Since the rural population in developing countries are responsible for an important role in the economy, should be addressed to investigate the extent and relationship to existing problems were identified and examined. Probably the lack of rural development in developing countries and global issues linked to globalization, therefore, special attention must be paid to this problem. In this respect, should be identified the obscure and unknown aspects of the problem, then solutions to resolve problems which may be identified and presents.

The plan is to study agriculture such as seed 'Globalization' is a big problem in every sense of the term. It is, first and foremost, a problem in a material sense, insofar as it's associated syndrome of processes creates highly uneven geographical and social outcomes. … It is also a problem in a rhetorical or discursive sense, in that its meaning and significance are deeply and widely contests. 'Globalization' has evolved into a catch-all term, used by many to bundle together all the goods and buds of contemporary society.

Economies of the world are being increasingly integrated as new technology and communication has brought people together. We often hear the phrase that the 'world has become a global village' - which itself signifies how much has changed in the world in the past few decades. American businessmen are investing their time in studying the culture of the Middle East, so that they can negotiate with their counterparts in a better way (Khaje nori, 1996:85). Young graduates in India are being taught how the Americans roll their R's, so as to make a seamless conversation with their clients in many of the call-centers! The phenomenon that is globalization has brought new dimensions to this world, and people are mingling with each other like never before. The social, economic, and political changes that globalization has brought have been accompanied by some challenges. We will not approach its negative effects as a cynic, but as a student or an observer, so that we are free of any kind of prejudice and bias, and understand the topic in a better way. In recent year one of the most important concepts is "globalization". Although in its simplistic sense globalization refers to the widening, deepening and speeding up of global interconnectedness, such a definition begs further elaboration. …

Globalization can be located on a continuum with the local, national and regional. At one end of the continuum lie social and economic relations and networks which are organized on a local and/or national basis; at the other end lie social and economic relations and networks which crystallize on the wider scale of regional and global interactions. Globalization can be taken to refer to those spatio-temporal processes of change which underpin a transformation in the organization of human affairs by linking together and expanding human activity across regions and continents.

Without reference to such expansive spatial connections, there can be no clear or coherent formulation of this term. … A satisfactory definition of globalization must capture each of these elements: extensity (stretching), intensity, velocity and impact (Taylor, 1997).

II.   THE METHOD OF RESEARCH

This research is applied and the research method is "descriptive – analytical". The method of data collected is field and questionnaire. In order to was used from libraries resource, organizations internet and papers (eshraqi, 2001:45). Also, the studied area is villages of Kashmar County. Therefore the sample size is 381. Totally there are 58 number villages in studied area. Also, based on census in 2012 the population of Kashmar County is 157149 people. Also, there are 61187 people in studied area. On the other hand we used from Cochran formulate. So at first step were classified villages based on their populations. Thus, are deleted six number villages due to having fewer than 100 people. Table 1 shows sample villages.

Table 1: villages selected

Classification	Numerous villages	Selected villages	Villages
fewer than 100	6	-	-
100-499	15	2	Qaracheh , Koche nama
500-999	13	2	Tunder , Nay
1000-2499	19	2	Sarhozak , Mushak
2500-4999	5	1	Rezq abad
TOTAL	58	7	7

Source: researcher studied

Therefore, has been used Cochran formulate. The results are:

$$n = \frac{NZ^2 pq}{Nd^2 + Z^2 pd}$$

Thus 381.

$$n = \frac{NZ^2 pq}{Nd^2 + Z^2 pd} = \frac{18650 \times (1.96)^2 \times 0.5 \times 0.5}{18650 \times (0.05)^2 \times (1.96 \times 0.5 \times 0.05)} = \frac{17911}{47} = 381$$

sample size is

Table 2: detail of sample villages

Sort	Sample villages	Population	Numerous questionnaire
1	Koche nama	420	21
2	Qaracheh	42	23
3	Nay	715	36
4	Tunder	771	38
5	Sarhozak	1063	53
6	Mushak	1537	77
7	Rezq abad	2590	133
TOTAL	7	7558	381

Source: researcher studied

III.   GLOBALIZATION AND AGRICULTURE

To globalize means to make worldwide in scope or application. We live in a global ecosystem; in this, we have no choice. Increasingly, all nations of the world share a global culture, a consequence of past choices. And, the economy has become increasingly global as well. However, within the global ecosystem are boundaries, which give form and structure to natural systems. Within the global culture are boundaries, which

define different human values and perspectives of reality. And within the global economy are boundaries, which allow nations to reflect the differences in their natural ecosystems and social cultures in the structure and functioning of their economies.

The World Trade Organization (WTO) appears committed to removing all "barriers" to international trade, to achieve "free trade," and thus, to removing all "economic boundaries" among nations. Once the economic boundaries are removed, cultural boundaries will become further blurred, and ecological boundaries will be left open to economic exploitation. Cultural and ecological diversity are considered obstacles to economic progress. A truly global economy will allow greater geographic specialization, greater standardization of processes and products, and thus, will allow global corporations to achieve even greater economies of scale.
In a global agricultural economy, small farms will be replaced by large farms, which in turn will be controlled by giant multinational corporations. Small farmers quite simply will not be able to compete in a "free market" global economy. Many small farmers of the world rely on horticultural crops for their viability. Thus, the implications of globalization may be even more dramatic for horticulture than for most other agricultural sectors. But even more important, ecological and cultural boundaries are essential to the long run sustainability of agriculture. Thus, if all economic boundaries are removed, human life on earth, at least as we know it, will not be sustainable.

Over the past decade, globalization has become a major public issue. Most of the recent controversy has centered on the World Trade Organization (WTO). The WTO was established in 1994, with authority to oversee international trade, administer free trade agreements, and settle trade disputes among member nations, replacing the General Agreement on Tariff and Trade (GATT). However under the WTO, authority was greatly expanded to cover trade in services as well as merchandise – including protection of intellectual property rights. And, intellectual property rights have been interpreted to include the genetic code of living organisms. Also, the WTO has far greater authority over trade in agricultural commodities than had existed under the GATT. The implicit, if not explicit, objective in forming the WTO was to reduce and eventually remove all restraints to trade, in order to achieve a single "global free market."

In earlier times, cultural and political boundaries tended to coincide with natural boundaries – oceans, mountains, rivers, and ridges. However during the industrial era, economic and political considerations have taken priority over natural boundaries in defining our social relationships. Wars have resulted in redrawing of national boundaries along lines that have little relationship to either topography or culture. Towns and cities have expanded their boundaries with little regard for the best long run use of the land they have covered with highways, buildings, and parking lots. And with the trend toward a single "global community," the remaining social and cultural boundaries that still define different groups of people, with diverse social, ethical, and moral values, are being largely ignored.
"Globalization," as a concept, is far broader in meaning than is the concept of a "global free market." To "globalize," according to Webster's dictionary, means "to make worldwide in scope or application." The objective of the WTO is to create a single geographic market that is worldwide in scope, with a single set of trading rules that are worldwide in application. However, we cannot change the global economy without simultaneously affecting global ecology and global society. This is the crux of the current WTO controversy. What are the implications of a "global free market," not just for the world economy, but also for the world community and for the world itself?

A key determinant of agricultural comparative advantage differences across countries is relative factor endowments, which can change substantially as economies grow at varying rates. Differing technologies also can have an influence on the supply side of the market, and those differences can persist for long periods if governments under-invest in agricultural R&D. As for differences in tastes on the demand side, international diffusion tends to ensure they are far less important than factor endowment differences over the very long term. Nonetheless, changes in the preferred mix of foods away from starchy staples and towards livestock and horticultural products as consumers move from low-income to high-income status can influence comparative advantages within the farm sector.

Global agricultural trade has grown much slower than trade in other products. Prior to the 1960s, farm products accounted for more than 30 per cent of all merchandise trade globally, but since the beginning of this century their share has averaged less than 9 per cent. Since agriculture's share of global GDP has also fallen, a more appropriate indicator of the changing extent to which agriculture is globalized is the share of agricultural and food production or consumption that is traded internationally. Table 2 provides estimates of that for various regions, based on a sample of 75 countries that account for all but 1/10 of the world's population and agricultural GDP. Those numbers suggest that agriculture's tradability has increased considerably since the 1960s, rising from about one-ninth to about one-sixth of global production or consumption. However, a glance at the regional data reveals that most of that change is due to increased intra-European trade behind the EU's common external trade barrier, apart from some growth (from low bases) since the 1970s in agricultural imports by Asia and Latin America.

IV.   GLOBALIZATION EFFECTS ON RURAL AGRICULTURE

Globalization involves the movement of people, goods, ideas and information across national boundaries. It has been defined as 'the intensification of worldwide social relations which link distant localities in such a way that local happenings are shaped by events occurring many miles away and vice versa'. (Dollfuss, 1990: 64). Globalization is not new. The Roman Empire, based on militarism, political refinement and technology was in its day, global in its influence. So was the Arab Empire that followed and that brought together the latest in scientific thought. The social, artistic and commercial affects that spread – originally from Italy - during the Renaissance beginning what historians call 'the early modern period' was also an example of globalization. Today it is the globalization of production that is most influential in influencing and molding relationships. This is based on the integration of economic activities – and economies - on a world scale which is being spearheaded by multinational companies (Berman, 2005: 113). The encyclopedia Britannica dictionary defines modernization as the "transformation of a society from a rural and agrarian condition to a secular, urban, and industrial one". Modernization is mostly associated to "industrialization". This is because when there is industrialization there is division of labor and specialization. In addition, when there is division of labor and specialization, it signifies presence of modernization. Modernization is a situation whereby there is a fall in the traditional values of the people. It is also a situation whereby there is an increase in similarities between different cultural groups.

One of those theorists of Marxism who tried to trace the origin of globalization is Wallenstein. According to Wallenstein, "globalization does not constitute a new phenomenon", Wallenstein (1998:32) is the process, completed in the 20th century by which the capitalist world system spread across the actual globe, which since its development, the world system had maintained some of it features over several centuries. So according to him, globalization is the "ideological celebration of so-called globalization is in reality the swan song of our historical system". He focuses on the economic sphere. He believes the world has being going social compression since the beginning of the sixteenth century. He says the world is experiencing acceleration globalization, which is cultural and reflexive in character to an extent that it can be regarded as an accomplishment. He traces the origins of globalization starting from the human societies. He argued that the defining characteristic of all social system is the division of labor in economics of exchange. Wallenstein makes readers to understand that there are only two ways in which societies are organized. That is the mini and the world systems. The mini system he said refers where there is division of labor and economic exchange occurs only within discrete group like the traditional and isolated hunter-gathering societies. He believes those societies were rare and are now virtually in non- existence. While Giddens talks of 'time-space distanciation', Wallenstein talks of 'time-space realities'.

The origins of globalization are analyzed according to Giddens under four dimensions. That is, "capitalism, military order, surveillance, and industrialization" Giddens (1990:70-78). He believes that the liberation of time and space is an entirely modernizing development and is a prerequisite for globalization. Thus, modernization according to Giddens is a direct consequence of modernization. Giddens says, 'The concept of globalization is best understood as expressing the fundamental aspects of time-space distanciation' Giddens (1990, 1991). In addition, time- space distanciation was believed by Giddens to be the first step towards the process of globalization. For Giddens, it has come with the advent of modernization. In addition, when there is time space distanciation and disembodying (that is the lifting of social relations out of the local environment), there is the development of complex relationships between local activities and interaction across distances. He believes globalization is directly allied to the development of modern societies to the industrialization and the accumulation of material resources, and is a continuation of modernity rather than a break with it. The contemporary period Giddens terms it high modernity, by which he means modernity has now moved into a global stage. Society has become a 'world society' and social institutions that have become global confront the individual. People everywhere cannot avoid coming into contact with the global through 20th century brand marketing, imagery and fashions. He defines three factors in the 20th century that in his opinion, have resulted in contemporary globalization (Jamshidi, 2011:6).

According to Robert Chamber's idea poor is the important issue in rural areas. According to 2001 report that has been prepared by (PRUS) about (IFDA), estimated that more the 75% rural population had 1$ each day. Globalization effect on poor of villages. The basic purpose of economic boundaries is to promote "free trade" within the boundaries of communities and to carry out "selective trade" among those communities that are separated by economic boundaries. Economic diversity, as defined by economic boundaries, is necessary for division of labor and specialization. If all national economies were to lose their distinctiveness, becoming as one, all potential gains from trade among nations would disappear. Historically, economic diversity among nations also has been considered a necessity to ensure choice and opportunity – to ensure health, growth, resilience, and long run security of the global economy. Humanity has not been willing to put all of its "economic eggs in one basket (Taherkhani, 2005:99) . Some of researcher believe globalization have benefit for

rural people. Although, these relations will be better while creating relation by international level (Davan, 2010:195).

Such claims are based on economic theories of trade that historically have made "free trade" something of a "sacred tenet" of economics. This is true particularly among the more conservative of economists, whose views are now in vogue. Contemporary "free trade theory" has its foundation in the early 1800s, primarily in the writing of British economist, David Ricardo. Ricardo showed that when two individuals choose to trade, each is better off after the trade than before. People have different tastes and preferences, and thus, each person values the same things somewhat differently. So, if I value something you now own more highly than I value something I own, and you value the thing that I own more highly than you value the thing you own, we will both gain by trading. I will get something that I value more than the thing I now own and so will you (Yasuri, 2008:55).

Was and Zegar believe globalization have oriented affect on native agricultures. Also it changes traditional rural to global rural. The important problems of Poland rural are, finding appropriate market in world (Was and Zegar, 2002:88).

In a global agricultural economy, large farms will continue to displace smaller farm in the global marketplace. Increasingly, the larger farms will be controlled by giant multinational corporations. Many small farms depend on sales of internationally traded commodities to provide cash farm income, in developed as well as less-developed countries. The most important aspect of their farming operation may be its non-cash contributions to their quality of life. In less-developed countries, the major non-cash contribution of farms may be food, clothing, and shelter, while in other countries it may be a healthy environment, privacy and security, and an independent life-style. In both cases, however, the economic viability of the farm may depend on cash income from sales of internationally trade commodities. Under globalization and corporate colonialism, small independent family farms quite simply will not have access to markets for internationally traded commodities. Essentially all such commodities will be produced under comprehensive contracts offered by corporations linked to one of the "global food clusters." Only the larger farming operations will be able to secure such contracts, and in many countries, such operations may be corporately owned and operated.

In general, regardless of the region of the world or the segment of agriculture considered, the vast majority of all farms are still small farms, with many still serving local markets. However, the vast majority of total agricultural output is accounted for by a small proportion of larger, specialized commercial operations, oriented toward serving global markets. And increasingly, these large, export-oriented agricultural operations are controlled, if not owned outright, by giant multinational corporations.

V.   AGRICULTURE & IRAN

In Iran agriculture have important role between three sectors. More than 5 million professions are in agricultural sector. Indeed, they prepared a lot of parts of society food (Rahmani, 1998:51). The agricultural sector as structural have important role in economic, cultural and political condition (Qoreishi zade, 1999:13). Iran is developing country, so has two special factors:
1-   Sharp growth of population
2-   Gradual increase in per capita income

They are led to increasing demand of agriculture produce (Shultz, 1989:120). The agriculture contribution in gross domestic product(GDP)from 21.3% to 24.5% in terms of 1991-2002 is indicated to important role of this sector in the national economics Essential indices of Agriculture sector is separated to three main issues.1-Macro indices including :value added, investment, employment, international trade and productivity.2-Agricultural production indices including :crop production, horticulture production, animal production and aquatic production.3-indices of fundamental resources production including :water, soil, forest, pasture and genetic resources.

Iran ranks 1st in fruit production in the Middle East and North Africa. 2.7 million hectares of orchards are being harvested in Iran with an annual production this year of 16.5 million tons. Per capita production of fruit in the globe is 80 kilograms while in Iran it is 200 kg according to official FAO statistics. Last Iranian calendar year Iran produced 4.5 million tons of citrus fruits and 3 million tons of apples. Iran has been ranked between 8th and 10th in global fruit production in different years. 50 kinds of fruits are grown in Iran. Last year Iran exported 2$ billion worth of fruit to countries in the region and the European Union which is 46 percent more than the year before. Iran is one of the major leading producer and exporters of dried fruit such as all kinds of pistachios, Sultana raisins, Golden raisins, Sun-Dried raisins, Malayer Raisins, Kashmar Raisins, all kinds of Iranian Dates and with its modern facilities is ready to provide its customers with all these products. Also Iran due to weather, Four Seasons, able to export all kinds of flowers especially fresh cut flowers in all seasons is cultivated.

Agriculture in Iran. The rural economy, for millennia the economic and social basis for all Persian governments, is characterized by a series of ecological and economic restraints that have hampered its

development. While the natural limitations of the country have effects on the extent of agriculturally usable land and the kinds of crops grown, the socioeconomic structure of Iran and its historical foundations are important for the organization of agricultural production and for economic development. Of special importance for the understanding of the historical development of Iranian agriculture is the theory of rent-capitalism (*Rentenkapitalismus*) developed by the Austrian geographer.

Growth rate of this sector in mentioned years was fluctuable, so it was between 10.1% in 2001 and -8.6% in 1999.targetable subsidies in direction to increasing of production ,establishment of constant income fund Regarding to existence potential of this sector ,accessing to markets of Middle Asia and Middle East countries ,also new situation of global economic growth of export of agricultural products and entrance to global and regional markets can be reached to express and development of this sector and national economic. For this way**.**Animal production situation is changed in past decade positively, so its production is increased from 5390000 tons in 1991 to 8107000 tons in 2001 that is indicated to 3.8% annual growth in the mentioned term. Production capacities of animal products sub-sector is 820 million commercial poultry,2440000 honeybee colonies,598 dairy factories,134 livestock slaughter-houses,112 meat processing manufactories,551 Pelt, Pickle and Leather processing firms,214 feedstuffs manufactories. Also, its export contribution from Agriculture sector is 11.7%.

The ranking of agriculture production in Iran is 1 to 10. The percentage of garden production is 15 and farmer production is 7. In 2007 active population were 20476000. 3678000 of them were in agriculture sector. The ranking of Iran after American and china is third (Motiee, 2012:29).

VI.   AGRICULTURE IN KASHMAR

The Kashmar topographic basin is oriented in an approximately east–west direction and is about 100 km long and as much as 25 km wide. The city of Kashmar is located at the eastern end of the valley, with a population between 70 000 and 180 000. In recent decades, Kashmar Valley has been known for its commercialized growth of grapes, cultivation of pistachio and production of raisins. The development of Kashmar city can also be seen by an increase in the overall footprint of the city. The figures of increased agriculture and urban development suggest an increasing water demand. After 2000 no suitable Land sat data are available for further assessment of the recent changes in agriculture. However, analysis of ENVISAT's MERIS (Medium Resolution Spectrometer) multispectral measurements still show a slight increase in the vegetation cover of the spring season, as defined by the change in the value of normalized difference vegetation index (NDVI) (Karzan , 1987:276). The increasing demand in water is also reflected in the ground water level data. Groundwater level measurements of several piezometric wells in Kashmar Valley show a groundwater level decline by about 12 m from 1988 to 2004(Hashemi ,2006:117). Using a linear regression, we estimate an annual groundwater level decline of about 70 cm yr^{-1} in the Kashmar area. A comparison of the groundwater level decline to precipitation data suggests that climate change has only a minor influence. The precipitation archive at the Kashmar synoptic station suggests a large variance but may imply a slight decrease of about 57 mm yr^{-1} in the annual precipitation rate from 1998 to 2006 and a mean temperature increase of about 1.3 °C within this period. Therefore, a combination of the growing use of intensive agriculture in the valley since 1972, the prospering city, the increased temperature and the slight net decrease in annual precipitation rate may explain the increased demand for groundwater. As we will show below, the effects of increased water extraction may include substantial land displacement controlled by basement structures, which can be indirectly inferred by remotely sensed satellite data.

Kashmar is known by agriculture produce. Agriculture produce in Kashmar are effected some factors such as soil, canopy and climate. The important factor is soil. According soil, production divide two section. Irrigated and dry.

The total agricultural land to grow crops and gardens allocated 2405 acres that this year crop of 257 acres of wasteland has been called. Peoples of the region dehydration reason to know, of course expert Agriculture Furthermore, the weakening of the soil provided in addition to have. Lands 3860 hectares of villages as examples that this amounts to 2,765 acres, only 1,095 acres are barren and unused Let go remains to be established. These lands usually wheat, barley, watermelon dedicated.

One of the important rural economic sectors is fruit trees. The important of factor in order to garden producing is geographical condition. Rain, Temperature and other factors is important. Long and very steep downhill terrain that is not suitable for the construction of gardens and fruit orchard operations.

According to Table agricultural land, 7099 hectares of agricultural land in rural sample declared that the 1,600 hectares of barren and 5499 hectares are active. Based on letters of Agriculture Khorasan Razavi province, in 1391 the total cultivated land city of Kashmar, 24,530 hectares were announced, the 1771 acres equal to 2/7 percent of the sample villages. Kashmar land garden area of 9553 hectares in the same year reported that 745 hectares of 7/7 percent of the sample villages.

Total area	Dative land	Active Land	dry	Irrigated	garden	farming	Sample	April
887	300	587	400	187	65	122	Tunder	**1**
385	-	385	18	367	85	282	Rezq abad	**2**
800	100	700	-	700	200	500	Sarhozak	**3**
692	350	342	65	277	105	172	Qaracheh	**4**
1025	300	725	400	325	110	215	Koche nama	**5**
1530	350	1180	900	280	75	205	Mushak	**6**
1780	200	1580	1200	380	105	275	Nay	**7**
7099	1600	5499	2983	2516	745	177	7	**Total**

Appropriate agriculture is led to effective economic in rural area. We know very well that the production and sale of agricultural products are exclusive and only available in some countries is the production or trade.
Kuznets and many other agricultural economists believe the following can help the process of economic development.
- Excess supply of food and industrial raw materials
- Contribute to the balance of payments by exporting surplus
 -Creating jobs for the materials and labor supply
- Financing (Shafii, 1365: 141).

Saffron is the most important production in area. It is using for export to other countries. Although, Saffron is called *"zafaran"* in Spanish and is a spice that has a special place in history, always being considered very valuable. In fact, at one point it was even used as currency. In ancient Greece women used it as a cosmetic; the Roman Emperor Nero had the streets covered with it for his parades; Phoenicians made veils of it for their brides and Buddhists used it to dye their robes. In normal humidity of saffron is 2% but, Spanish has increased to 13% of the water content due to some benefits. The next production that is affected economic is grape. This production has the main role in export of Kashmar.
Therefore, for analyzing data at first were divided 3 periods. Before the Islamic Revolution, after the war, and in recent years. After that, was analyzed descriptive data. At finally, by using, distribution diagram and Pierson & Spearman Correlation test was measured influence of rural agriculture from globalization phenomenon.

VII.   CORRELATION TEST

If "P" is Coefficient correlation between globalization and rural inequality agriculture, the hypotheses will be following:
H0: P=0
H1: P $\neq$ 0

Finding shows the meaningful level is 0.05 (α =0.05) by analyzing coefficient correlation and sample size. So, in this level H0 are deleted. Therefore, there is oriented relation between globalization and rural agriculture inequality. Table 2 shows the results. Indeed, globalization has been led to rural agriculture inequality in this area.

Table2: factors of correlation test between globalization and rural agriculture inequality

Test	Pierson		Spearman	
Variable	r	P	Rs	-P
Globalization score **rural agriculture inequality score**	0.810	0.000	0.612	0.000

VIII.   RESULTS

According to finding, there are effects of globalizations on studied area. Also, these effects was analyzed in 3 three aspect. They are economic, industry and agriculture. After Islamic revolution, farmer use from mechanical machines more than other time. Therefore there is relation between rural agriculture and globalization due to should be purchased from foreign market. Although, these relation isn't bad, but was led to appearing unemployment in developing countries (studied area).unemployment was led to migration to cities

and increasing poverty in villages.
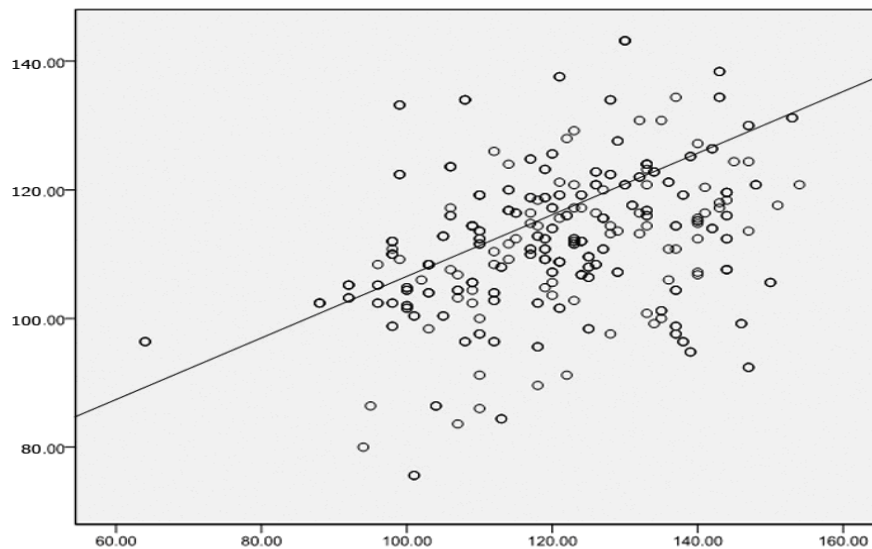
Globalization

In last decades, the rural resident produced their needs themselves. Unfortunately, with globalization effect rural industry was weak. Therefore, this phenomenon created unemployment and inequality in villages.
In general the debates on globalization often involve a clash of counterfactuals. On one side those who are against the pace of business-as-usual global trade and investment are making a plea for doing something about the jobs and entrepreneurial opportunities for the poor and for small enterprises that are being wiped out, and against the monopolistic practices of giant multinational companies and the environmental damages caused by the economic expansion. So their counterfactual is the world of more social justice and less dominant trading and investment companies, which gives some more breathing space to the poor producers and workers.

8.1. Suggestion
- Rural agriculture in global phenomena will be need to special attention from governance. There isn't relation between planners and farmers. Thus should be created relation between governance and farmers. In this case study also should be paid attention.
- In this area agriculture change to irrigate method. Thus, if we want their agriculture have special place in world, would be paid attention to dry method. In studied area there are 1600 hectares arid lands and 2983 dry lands, therefore. Should be paid attention to this matter.
- There isn't support of governance from agriculture. So, we suggest that are created organization for cooperating of people. Therefore would be created appropriate relation between people and governance.
- There isn't modern technique in studied area .it is one of the other problem. Farmers are using traditional method .thus it is necessary create relation between farmers and academic centers.
-   One of the main problems is the lake of water in studied area. Researcher believed, using from appropriate irrigation method, appropriate selecting variety of plant are suitable ways for improving agriculture place. There is modern technique in 5 farms samples (Koche Nama, Rezq abad, Sarhozak).
-there are various climates in this region. So, there is disasters climate in studied area. Thus farmers need support governance while facing damages. So, are suggested that governance support farmers in appropriate time.
- Seeds of production import other countries (for example Mexican). So, they need special climate that there isn't in Kashmar area. There isn't adaption with Iran climate. Thus, are suggested that using native seeds for adapting Iran climate.
- Researcher believes that agriculture production is as triangle. It means, one side is water and soil, one side is climate and other side is human power. Third part is very important due to there isn't efficient manpower familiarity with technology and new technology. Therefore, are proposed the has been educated people in this field to promoting agriculture in studied area.

- Another agricultural problems in the process of globalization in recent years has lowered the quality of rural farmers to increase their production efficiency, but the quality is a bit ignorant. It is suggested that the correct and scientific solutions to increase production while maintaining the quality of education given to farmers.
- In addition to accurate and timely management of water resources and irrigation management, efficient use and proper soil production appears necessary. In order to, is recommended before they become serious problems of soil. Farmers will be trained in the proper use and management of soil.
- Recommended management systems cover a rural agricultural production and raising farmers feel their products can be seen and are assessed.
- Marketing and selling agricultural village in the international arena requires a management plan is calculated. Rural agriculture will own the actual rights. Fee they will be encouraged farmers at the right time. Farming villages, missiles, view of the fact that 6 months after their fees have not received complaints that may contain wheat.

RESOURCE

[1] Bby, Earl (2003) Research Methods in the Social Sciences, translated by Reza Fazel, the publishing, printing

[2] Berman, Marshall (2006) Experience of Modernity, translated Mradfrhadpvr, Tehran Releases New Project, Fourth Edition.

[3] Behforuz, F. (1996), philosophy, scientific research methodology of Geography, Tehran University Press.

[4] Todaro, Michael (1384) Economic development in the Third World, translated by GH erudite Tehran thirteenth printing, publishing mountainside.

[5] Jamshidi. Masoumeh (2012) .globalization effects on rural communities. first conferences   rural development

[6] Khajeh nori (1996). Research method. Tehran publisher. Iran

[7] Dulfus (2013). Global space, globalization phenomenon. Papily publisher. Iran

[8] Rahimi. Behnam (2012). Global effects on social equal. Iran

[9] Garib. Hussein (2002) globalization and challenge in Islamic republic of Iran.

[10] Mehregan. Mohammad (2002) search in applied. vol(1)

[11] Harovi (2008). Short history of neoliberals. First publish.

[12] Rahmani (1999) Analysis of the capacity constraints and agricultural development in Iran, Jihad magazine.

[13] Jasbryng, S., millions, S. (1996), "Agricultural Geography", translated by S. Dehghanian, Ferdowsi University of Mashhad Press.

[14] Razzaghi, E. (1998) Introduction to the Iranian economy, spreading straw, Tehran

[15] Saidi, A. (2006), scope, and objectives of the foundation;s rural geography, Journal of Geography, No. 240.

[16] Taherkhani, M. (2009) The effects of globalization on rural communities (evidence and experience) Rural Development Conference Proceedings, Tehran Institute of Financial Management and Planning.

[17] Yasury, M. (2007) An Introduction ¬ rural economy with emphasis on agriculture, publisher Astan Quds Razavi.

[18] Hashemi, SH et al (2009), "Geography city of Kashmar," Sun Publications Sepulchre.

[19] Mostofi Hamdullah (1890) Nz • hh Alqlvb Gay effort Lestrange, Tehran, world of books.

[20] Bardhan.p.(2005)Globalization and rural poverty. University of California at Bereley.

[21] Chen,S. Datt,and Ravallion,M.(2004) A program for calculating paverty Measures from grouped Data.

[22] Taylor.P. (*1997*) Izations of the word :Americanization , modernization and lobalizoction. Conference Paper Globalization Critical Perspectives Conference, university of Birmingham. March.

[23] UNESCO(*1997*)Adult Education in a polavizing word . Paris, unesco.

[24] Was .J.Zegar *2002* trade liberalization and growth,p.*83*
    www.atkearney.ir

Research Paper	Open Access

Individual Attitude toward Recycling of Municipal Solid Waste in Lagos, Nigeria.

Tunmise A. Otitoju
(Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak, Malaysia)

Abstract: - Attitudes of the waste generators in the community appears to be critical as their points of understanding in waste recycling eventually play a significant role in providing answers to municipal solid waste management problems in Lagos State. Individual involvement has a direct bearing on an effective recycling practice. This study investigates factors influencing individual waste recycling performance and their likelihood to participation in Lagos State. This paper presents the results of the quantitative survey administered among 201 individuals in Lagos State. The result shows that gender is significant towards waste recycling participation in Lagos. Result also shows that the lack of knowledge is the major limiting factors preventing individuals from waste recycling in Lagos State. The result also shows a significant difference between waste recyclers and non-waste recyclers on their requirements for participation towards regular awareness, workshop & exhibition likewise also showing an insignificant difference on individual requirements towards the provision of facilities, regular collection, incentives, and legislation in waste recycling.

Keywords: - *Attitude, Critical, Individual involvement, Performance, Waste recycling*

I.   INTRODUCTION

Municipal solid waste has become an important concern in Nigeria. Piles of wastes are often found by roads, rivers and many other open spaces in cities, and this is causing significant health and environmental problems. While the Nigerian population is increasing by about 2.8% per annum, the rate of urban growth is as high as 5.5% per annum [1]. Nigeria is already heavily populated, having a higher population than any other country in Africa [2], of which an estimated 10% live below the national poverty line [3]. This is increasing the difficulties associated with providing an effective solid waste management system. As the urban population grows at an alarming rate, land use becomes increasingly complex and the wastes generated increase in volume and variety [4]. The amount of waste generated has increased in both quantity and diversity without adequate investment in collection, transport, treatment and disposal facilities. These problems are further complicated by political, economic and social factors.

In Nigeria, Waste Management has proven to be a huge challenge for local and national authorities in recent years due to inefficient MSW management strategies. The Federal Government of Nigeria has implemented various laws and regulations in an attempt to tackle this problem, however, insufficient funds are available at the local level to invest in either training or the technical resources that are needed to tackle waste problems [2]. In addition, solid waste management in Nigeria is hampered by a lack of data at all levels from the ward, district and municipality, and where available, is generally unreliable, scattered and unorganized [5, 6]. As a result, planning of solid waste management has remained a difficult task.

Although, waste recycling has been recognized in Lagos as an effective strategy towards waste diversion from landfills but yet only few practice it because individual "felt needs" and attitudes are not emphasized. Nonetheless, it is difficult to develop an effective strategy towards waste recycling if the waste generators needs are not considered. The success of any recycling activity depends highly on their participation. An individual behavior changes would occur when the individual is aware of the problem or need that gives individuals an initial reason or incentive to follow a particular course of action.

II. MUNCICIPAL SOLID WASTE MANAGEMENT IN LAGOS

Lagos is the most populous city in Nigeria and one of the most industrialized in the country even though it is the smallest in terms of land area hence enormous pressure is put on the environment due to huge amounts of solid waste generated in the state. An estimated 4 million tons of municipal solid waste was generated in Lagos in 1995 [7]. In Lagos, the main governmental agencies that have been entrusted with the responsibility of keeping the environment clean are the Lagos State Waste Management Authority (LAWMA), Lagos State Environmental Protection Agency (LASEPA), the Local Government Councils (LGCs) and the Ministry of Environment and Physical Planning (MEPP). Treatment of Lagos waste is achieved by open incineration, which pollutes the environment.

The problems and issues of solid waste management in Lagos are of immediate importance. However, it has been discovered that most individuals are struggling with how to manage their waste. Waste is accumulating day-in day-out, as it is often noted that there is no waste management system. In Lagos, the methods of solid waste disposal include dumping of refuse to gutters, drains, roadside, unauthorized dumping sites and stream channels during raining season and burning of wastes on unapproved dumping sites during the dry season [8]. In Lagos, MSW management is easy and does not involve ISWM approach as the waste is collected by the various agencies, transported to the designated landfill sites, and concurrently burnt openly to reduce the volume. This creates pollution problems for the environment through the release of air pollutants and harmful gases into the atmosphere. Lagos does not have an integrated waste management plan, and the margins of the present waste disposal methods are clear. Open burning contributes to atmospheric pollution and leaves residues to be disposed off in landfills. Incineration, which refers to the controlled burning of wastes at a high temperature, sterilizes and stabilizes the waste in addition to reducing its volume up to ten-fold, and may be used as disposal option when landfilling is not possible and the waste composition is highly combustible. An appropriate technology, infrastructure, and skilled workforce are required to operate and maintain the plant [9]. Some of the municipal managers are looking to the development of municipal incinerators around the periphery of their cities as a first solution in many countries [10]. Incineration produces ash, metal and non-combustibles while composting yields residue like glass, ferrous, material, and plastics [11]. This eventually ends up in a landfill [12].

Landfill is the physical facility used for the disposal of solid waste and residuals on the surface of the earth [13]. Landfilling is the ultimate waste disposal method that can deal with all materials in the waste stream [14]. Solid waste disposed in a landfill usually is subjected to a series of complex biochemical and physical processes that lead to the production of both liquid and gaseous emissions [15]. This particular option of waste disposal is suitable when the land is available at an affordable price and adequate workforce and technical resources are available to operate and manage the site [16]. However, if properly designed and operated, landfill gas provides a source of energy that can be used for several energy producing purposes and thereby generates revenue. These requirements can easily be met by Lagos. The benefits of utilizing landfill gas recovery, especially for electricity production which would supplement the existing inadequate supply from the national grid, cannot be over emphasized. According to [17], 50% of the waste streams in Lagos are made are Biodegradable wastes which could easily be diverted away from the landfill enabling a lesser volume. The bio-waste could effectively be used for resource recovery by composting, headway for which is being made in all of European Countries. Consequently, as in Japan [18], Lagos must now address the solid waste problem by implementing programs that promote waste reduction, reuse and recycling of useful materials.

III. CURRENT MSW RECYCLING IN LAGOS

It is wasteful to throw away anything that could be made use of, particularly when there is a desperate need for it elsewhere [19]. Waste recycling is an interesting approach to achieve an efficient, integrated manner of management of municipal solid waste. However, MSW recycling is restricted to well segregated materials. The study of [20] revealed that most of the secondary raw materials scavenged from wastes are not recycled by industries in the state. This is partly due to the fact that most of the industries do not actively promote take-back recycling as practiced in developed countries such as in Japan [18]. However, if the raw materials scavenged from wastes are recycled, it is expected that there will be a reduction in the energy associated costs by industries during production because recycling provides easily obtainable manufacturing feedstock [21, 22].

According to [20], municipal solid waste recycling in Lagos is at an early phase, just like in Thailand [23] and also in Malaysia. Despite its existence in Lagos to be precised, recycling and resource recovery as forms of Municipal solid waste diversion have not received adequate attention from the governments and the waste management authorities in the past and at present. MSW recycling in Lagos is carried out by the informal sector. Often times, some individual stores unlimited amount of recyclables such as cans, bottles, plastics, newspapers at their residents hoping to sell it to itinerant buyers, or to house-to house collectors of which only few lucky individuals get their recyclable materials sold to these itinerant buyers. As soon as they get frustrated of these piles of waste, they open burnt them at their resident thereby causing air pollution and also open dump

some materials like cans, glass, etc. This recyclables have significant potentials for recovery if there is effective waste recycling (collection) strategy in Lagos.

Most recycling in Lagos appears to be carried out by segregation from mixed waste as waste streams is mixed with high contents of organic waste such as food & yard waste. Such sorting is carried out by the informal sector most dominated by the scavengers with the use of carts for collections, both from street bins and at the dumpsite. Scavengers normally have no formal education, vocational training or access to appropriate equipment and do not normally have alternative employment opportunities in the formal sector. The scavengers and other informal sector recyclers generally sell their recovered materials to middlemen, who in turn sell to small and large scale processing and manufacturing industries. For instance, collected glass is processed and recycled locally as cullet for use in the glass industry; whole/complete glass bottles are cleaned and reused as syrup, drinks and juice containers; the base of broken bottles are sold to small scale industries that cut and polish the glass to manufacture items such as ash trays and candle holders [24].

Also, there is no officially known material recovery facility (MRF) in the state. Presently, only paper, plastics, glass and metals, have high market values in the City. These are separated from wastes either at the source or at landfill sites by scavengers and then sold to the market [25]. Over time, scavengers have increased in quantity as that is the only available means of their survival. There are usually 1–30 scavengers sorting recyclable materials at each waste disposal site in the state [25]. However, the number of scavengers at each disposal site also depends on how large the solid waste dumpsite is.

IV. DEMOGRAPHIC AND ATTITUDINAL INFLUENCE ON WASTE RECYCLING

Many studies in the last two decades on socio-demographic variables and environmental perception have helped in understanding people's views, and thinking about the environment. They have attempted to predict environmental awareness and attitudes of people based on their socio-demographic characteristics. For instance, [8] analysis on the effect of demographic variables on willingness to take part in recycling programme and produced various results. The results show that, place of resident has no significant effect on willingness to recycle. Gender of respondents has no significant effect on willingness to recycle as well as age though those in the middle age group were more willing to recycle than older and young respondents. Educational level has no significant effect on willingness to recycle. Household size significantly affects willingness to recycle with respondents in the middle-sized families of (5-7) or more willing to participate in recycling programme. Employment status significantly affects willingness to recycle with civil servants willing to recycle more. Income has no significant effect on willingness to recycle but respondents in medium-income group were more willing to recycle. Tenants were not willing to recycle than house owners likewise the type of housing (commercial, institutional and residential) has no significant effect on willingness to recycle.

[26] reported that age, education and gender have shown strong and consistent relationship with environmentalism. Some others have also explored the influence of education, income, age, and gender on public awareness and attitude toward environmental quality issues. [27] reported that environmental concerns among residents of Gaborone vary according to education and income levels, while age and gender do not seem to have any significant influence on the concerned variation. Gender is a variable that has received consistent attention among researchers [28, 29, and 30]. [26] found that women were significantly more likely than men to be concerned with environmental problems. Females have been consistently shown to have higher environmentally conscious attitudes than men. However, in other studies such as [31] gender was not a significant predictor of environmental concerns and attitudes as other socio-demographic variables. [32] Compared the mean attitude scores on the pretest with gender, the result obtained shows that girls score significantly higher moral attitude scores than boys; there was no significant difference in the ecologic attitude scores of boys and girls.

The profile of recyclers and their reasons for doing so might be expected to be the opposite to those of the non-recyclers. [33] Cite environmental concerns as the main reason for participation, with convenience being next in importance. They also state that the more mature, the more affluent, the better-educated and home-owners are more likely to be recyclers. [34] Identified the three main reasons for non-participation in the use of recycling centres in Glasgow to be a perception that the centres were too far away, apathy and a lack of interest in recycling. Further investigation by [34] of the first cause (distance) revealed that those giving this reason lived no farther away than the recyclers, implying that one of the other reasons was more likely to be the cause but the respondents felt uncomfortable admitting it. A similar survey of recycling centres by [35] found that the chief reason given by the respondents for not recycling was a lack of local facilities, even though the survey was carried out next to local recycling centres. [33] found in their survey that the commonest reasons given for not recycling before implementation of the schemes were inconvenience/lack of time, distance to recycling centres and storage/handling problems. [36] Found inconveniences and a lack of facilities as the main barriers to their participation in waste recycling in Glasgow. A survey into the British public's attitudes to the environment by

[37] found that the most likely reason for not recycling was the inadequacy of local facilities, followed by the facilities being too far away and a lack of storage space, a point echoed by over a quarter of respondents in [38] study. The effort involved in recycling was cited by [39] survey as the commonest reason for not recycling, and that access to better facilities would encourage more non-recyclers to participate. An [40] survey identified a lack of time as the barrier to recycling among non-recyclers (though other reasons for non-participation were not sought).

       Some other literature suggests that technical factors influencing the system are related to lack of technical skills among personnel within municipalities and government authorities [41], deficient infrastructure [42], poor roads and vehicles [43], insufficient technologies and reliable data [44].

V.   RESEARCH METHODOLOGY

       Data for this study were collected between December 2013 to April 2014 by means of a questionnaire survey mailed to 300 individuals residing in Lagos. 67% response rate was recovered. This was done in order to produce a quantitative data. The questionnaire was made of open-ended questions in order to ensure the respondents not only agree or disagree to a particular question but also provide their opinions as precisely as possible in their own words. The initial part of the questionnaire addresses the demographic traits of the respondents such as age, gender, race and education level.

       According to [45], in order to support recycling projects, it is important to understand who recyclers are, how they recycle and the possible limitations towards waste recycling. To that respect, the questionnaire also probes into assessing their level of participation. This also includes their level of acceptance, knowledge on recycling and individual rating of the existing efforts from the MSWM authorities. The responses received were coded and entered into the Statistical Package for Social Sciences (SPSS) database. The results from the processed data were thus displayed using statistical tables for interpretation and discussion.

VI.   FINDINGS AND DISCUSSIONS

6.1 Waste Recycling Awareness in Lagos, Nigeria

       According to [46], the efficiency on the waste recycling practices depends on the awareness of citizens in the city. A question was designed in order to delve into the level of awareness of respondents. To the question "Have you heard about waste recycling?" The responses obtained were analyzed and the results shows that 89.6% (180) of the respondents indicated that they have heard of waste recycling, while 10.4% (21) have never heard of waste recycling. The result indicated that the respondents had adequate awareness on the current waste recycling scenario.

       A further test was conducted to find out the source of waste recycling information. Out of the 180 respondents that have heard of waste recycling in the city, the result shows that major news about waste recycling was sourced through Education from schools (45.8%). However, Municipal leaflet only constitutes 2.5% of the responses, indicating that the existing information/news by the municipality needs to be reviewed with focus on waste recycling. 3.8% of the respondents have heard about waste segregation through friends/neighbors still pointing to the fact that publicity through the municipality leaflet still needs to be given adequate attention. There is possibility of transferring knowledge from a neighbor/friend to other neighbours or friends if the knowledge is well received and practiced by the former neighbor in the city. The fact that majority of the respondents have heard of this initiative/activity does not guarantee maximum turnout of people practicing or willing to practice this act. It is interesting to note that not all the residents in the city have access to learning from schools as can be seen in (Table I) that majority of respondents had received the news through this media. So inorder to strengthen the communication of the news to the whole populace at large, media such as T.V, Municipal leaflet, Internet, Radio must be effectively utilized. This awareness has to be regularly communicated to the public thus serving as a source of reminder to the public.

Table I: Communication media on waste segregation

Media	Percentages (%)
Education from school	45.8
Municipal leaflet	2.5
Radio/Television	20.3
Newspaper & articles	18.6
Neighbours/Friends	3.8
Others (internet, conference, etc)	8.9

       However, it is necessary to make the public aware of waste recycling practices through liable communication channel and active participation in the system. In practice, system efficiency is directly

proportional to the number of participating citizens for waste segregation. Moreover, it is difficult to have an effective waste recycling system in the city when the waste generators who are also the stakeholders are not informed about the practices and benefits.

One of the most important aspects of public participation is to get each and every individual to cooperate in the daily waste management activities. These activities include waste separation, proper storage and placement of individual waste in containers, discipline in the use of public collection points, placement of waste bags in the collection points at the right day of collection, participation in composting activities, etc. These aspects can be enhanced with the help of continuous education campaigns through a reliable media for easy access and must be transparent.

6.2 Participation in Waste Recycling in Lagos, Nigeria

According to [47], awareness "does not necessarily translate into concern or taking personal action". While information is necessary to inform the audience about an issue and its possible solution, it does not increase the sense of personal responsibility towards this issue. When people receive and understand the information about their environment, then can effectively work towards reducing environmental degradation [48].

Inorder to know who the recyclers are in the sample, a general question was asked "do you practice waste recycling". It was revealed that 37.8% (76) of the respondents are currently practicing waste recycling while 62.2% (125) do not practice waste recycling. The level of individual participation in waste sorting is very low in Lagos. This low participation in waste recycling in the sample area could allude to a low level of awareness of environmental issues and low environmental education (formal and informal) which may cultivate into apathy towards waste recycling.

However, a further test was carried out to see how the respondents carry out waste recycling at their residents. Since there was no limit on the number of different responses for multiple choices, percentages (see Table II) were calculated rather than the total number of respondents. Higher response rate was received from individuals separating paper items at the residence.

Table II: Waste recyclers methods of separation

Limitations	*Percentage (%)*
Backyard composting	13.9
Glass separation	10.4
Paper separation	28.7
Metal separation	24.3
Plastic separation	22.8

6.2.1 Barriers to participation in waste recycling

An attitudinal question towards waste recycling was asked from the non-recyclers. To the questions "why don't you recycle at your residence?" Since there was no limit on the number of different responses for multiple choices, percentages (see Table III) were calculated rather than the total number of respondents.

It is apparent that "No idea" on waste recycling appeared as the major constraints towards waste recycling in Lagos. This is because most respondents have limited knowledge on waste recycling. They felt that the process and benefits are not well communicated to them.

According to [49], "It is widely agreed that education is the most effective means that society possesses for confronting the challenges of the future. Indeed, education will shape the world of tomorrow. Progress increasingly depends upon the products of educated minds: upon research, invention, innovation and adaptation. Of course, educated minds and instincts are needed not only in laboratories and research institutes, but in every stage of life. Indeed, access to education is the sine qua non for effective participation in the life of the modern world at all levels. Education, to be certain, is not the whole answer to every problem. But education, in its broadest sense, must be a vital part of all efforts to imagine and create new relations among people and to foster greater respect for the needs of the environment."

As pointed out by [49], education is a powerful tool that should be used towards building a more sustainable society. Through education it is possible to build a society that is better informed, has critical views and has wiser and more responsible people. Better educated people will not solve the problems of the world, but it will provide the means and the determination to address them. According to [50], the way humans respond and co-operate on waste management issues is influenced by their education. Therefore, the public's education is an essential element of the success of any waste recycling initiative. Individuals need to be given the necessary knowledge in the scheme inorder to ensure maximum participation.

20% of the non-recyclers have no interest to practice this activity. When this knowledge and the benefits of waste recycling are not well received by the public, this could thus lead to the public displaying a no

interest towards the practice. Inconveniencies such as distance to the bins, lack of facilities, no recycling centres, irregular collection of wastes, and no benefits can also cause individuals showing no interest in waste recycling but felt uncomfortable admitting it.

Table III: constraints towards waste segregation practice

Limitations	Percentage (%)
No facility	17.1
Inconveniencies	2.9
No collectors	7.1
No interest	20.0
Not aware	14.3
No idea	25.7
No space	2.9
No time	10.0

According to [51, 52], Lack of access to recycling facilities is represented as a major reason for households in developing countries not to participate in waste recycling. [53, 54, 52] noted that the advocates for increasing recycling and waste diversion behaviors in developing nations call for governments and municipalities to improve access to facilities and increase educational programs as methods to improve waste management.

6.2.2   Requirements for Participation in waste Recycling
For the assessment of the recent efforts done by LASEPA, LAWMA, LGCs and MEPP, majority of the responses were not favorable, with most of the respondents (91.1%) felt that the councils had not done enough to encourage and develop waste recycling initiatives effectively in the state. These points to the fact that the state municipal councils have not done enough in respect to waste recycling. In respect to their requirements towards efficient participation, though there was no limit on the numbers of different responses for multiple choices, percentages (see Table IV) were calculated rather than the total number of respondents. Majority of the respondents suggested the Provision of Infrastructures such as Provision of bins to their residents coupled with regular collection. The benefit of facility to local residents can influence attitudes [55]. However, citizen's attitudes depend on knowledge about a facility [56].

It is difficult to achieve an effective waste recycling initiative even though the necessary bins are provided without a regular collection strategy. Some residents might separate their recyclables but when it is not timely or occasionally collected, the waste generators gets discouraged. Providing the necessary bins would serve as an incentive to them thus encouraging the non-recyclers. According to [57], Some reasons such as "lack of facilities" or "distance of facilities too far from home" are also clear proof that most individuals are not aware that they can do their bit in recycling by simply putting the recyclables and non recyclables in separate bags and placing them in the ordinary rubbish bins available at home which will then be collected by the council or appointed agents. Therefore, the location of the recycling station is essential, public attitudes and knowledge about waste recycling in general are of interest for the functioning of the whole system

22.6% of the respondents suggested the regular distribution of information to the masses. They believe information has a significant impact on the masses. They felt if they are not regularly distributed, this would discourage the public from the practice. Some respondents also stress that often times when they receive information through communication media, they don't receive information of its significance to them. This means that the public are not really aware of the social, economic and environmental benefits of waste recycling pointing to the fact that they only see waste recycling strategy as revenue to the government/municipal agents. It is important for Lagos state to harness the channel of recycling communication to the public. Since not all the inhabitants in Lagos can speak nor write. So in order to have an efficient waste recycling practice in Lagos state, such promotion has to be transparent (using a simple language known to all). Waste management is for all, so there must be no room for compromise or being biased during its promotion thus the general public should be given equal priority/treatment. According to [46], she noted that when citizens receive information about the benefits of recycling, how to sort the waste and they participate in the designing of the programs, they are more likely to participate in recycling campaigns. The initiation of such program is essential to rapidly educate the public and facilitate the development of environmentally friendly community waste behavior. To be successful, useful programs should be designed to engage their target audiences in not only increasing their environmental knowledge but their environmental skills, attitudes and behavior as well. Many studies have identified wide and sustainable involvement of the public in source recycling programs as a fundamental factor to their success [58, 59, 60, and 13].

17.5% of the respondents suggested the need for regular workshop and exhibition to encourage them to participate. This point to the fact that knowledge on how to practice wastes recycling/composting is essential for a successful practice. If the residence have heard about this scheme but do not know what to do with the materials at that particular time, this would often time lead to a waste of time and resources. So for recycling activity to be effective, a regular workshop and seminar needs to be put into place. Likewise the exhibition of the end products of the recoverable generated from waste recycling needs to be displayed to the public to see. This would thus have a significant impact towards motivating them. However, when individual begin to see benefits in what they do (that is social, economic and environmental), they are often encouraged to do more.

11.8% of the respondents suggests incentives be given to motivate the public to participate. When promoting waste recycling, it is important to provide incentives for the public. Individual would only derive joy and pleasure in an activity when they get the necessary satisfaction from it. MSWM organizations should emphasize these benefits when promoting waste behavior changes.

Enforcing the citizens to practice waste recycling received the lowest response rate. In a City such as Lagos where waste recycling is still at its peak, it would be difficult to impose laws without providing the necessary enabling facilities for the citizens. The success of waste recycling strategy depends actively on the level of public acceptance with time. Waste recycling initiative must not be seen as a strategy that can lead to an immediate positive outcome but as an initiative that is expected to change dynamically with time when they are properly implemented. However [61] argues that an individual behavior changes occur when the individual is aware of the problem or need that gives individuals an initial reason or incentive to follow a particular course of action.

Table IV: Motivating factors to participate in waste segregation

Requirements to participate	Percentage (%)
Provision of Infrastructure (bins, collections)	24.2
More awareness/campaign be provided	22.6
More Workshop & Exhibition	17.5
Regular collection of separated waste	13.6
Give/Increase Incentives	11.8
Legislation be enforced	10.4

6.3 Influential factors on waste recycling in Lagos
The following factors were tested for this study;

6.3.1. There is no significant relationship between Age, Race and Education to participation in waste recycling.

A Pearson correlation was used to determine whether demographic factors can influence waste recycling participation in Lagos. As can be seen in (Table V), Age, Race and Education show no significant relationship towards waste recycling in Lagos state. This shows that waste recycling in Lagos can be done irrespective of individuals age, race and education as it doesn't require any formal education before it can be carried out efficiently. This is in support of [8] who found age, education as insignificant factors towards waste recycling.

6.3.2. There is a significant relationship between Gender to participation in waste recycling.

Gender shows a significant relationship towards waste recycling practice in Lagos. This was supported by the fact that the highest participation among recyclers in the study was noticed among female (56.6%) while (43.4%) was seen among male. This shows that women tend to participate more actively in Waste recycling than men as they are environmental friendly. This is in support of, [26], studies who found women more likely concern than men with environmental problems. This study is not in support of [8] that gender is insignificant towards participation in waste recycling [31] that gender is not predictor of environmental concerns.

Table V: Correlation test of age, sex, race and education to participation in waste segregation

Variables	Pearson's Correlation (r)	Sig.(P)
Age	0.072	0.483
Gender	-0.218	0.002**
Race	0.112	0.115
Education	-0.075	0.293

**. Correlation is significant at the 0.01 level (2-tailed)

6.3.3   There is generally no significant difference between waste recyclers and non-waste recyclers on their requirements for participation in waste recycling.

The difference between waste recyclers and non-waste recyclers on their requirements for participation was determined by conducting an Independent t-test. The result shows an insignificant value of P>0.05 for all requirements except for awareness, workshop & exhibition. This shows that there is no difference in their requirements for participation towards the provision of infrastructural facilities, regular collection of separated waste, provision of incentives and Enforcement.

As can be seen in the table, there is no significant difference in their perception towards the provision of infrastructures (Regular collections and facilities), incentives and enforcement of the practice among recyclers and non-recyclers. However, significant difference is noted between recyclers and non-recyclers on their view towards awareness, workshop and exhibition. Non recyclers perceived that lack of knowledge on recycling methods was a major constraint that could prevent individuals from participating in waste recycling. Therefore it is expected that they need to get recycling knowledge from regular awareness, workshops and exhibitions. On other hands, most of the recyclers did not require these two variables to participate as they are already practicing and have obtained the basic knowledge on waste recycling.

Table V: difference between recyclers and non-recyclers on their requirements for participation

Requirements	(t)	Sig.(P)
Provision of Infrastructure (bins, collections)	-0.863	0.389
More awareness/campaign be provided	2.203	0.029**
More Workshop & Exhibition	2.625	0.009**
Give/Increase Incentives	-0.390	0.697
Legislation be enforced	0.319	0.750

**Significant at P<0.05 level

VII.   CONCLUSION

Individual participation has a direct bearing on efficient MSW Recycling. Yet, Lagos municipal authorities have failed to mobilize the community and educate citizens on the rudiments of proper practices of segregating waste in their own bins at the household, shop. In the absence of a basic facility of collection of waste particularly the recoverable from source, citizens would be prone to dumping waste on the streets, open spaces, drains, and water bodies in the vicinity creating insanitary conditions. There are many initiatives in place to raise awareness of waste recycling to motivate the audience to participate or increase efforts. Awareness creation in the form of education and technical training for staff is also important in making recycling a success. Improving the publics' general knowledge and awareness concerning these issues is of prime importance to the diversion of waste from landfills. Creating a sustainable society requires "a critical mass to take up sustainable lifestyles before the rest will follow" [62]. However, Efforts are also needed to involve the public in the policy-formation, development of plans, and implementation of waste management programs. Public support is essential for the success of such decisions.

The availability of an effective recycling infrastructure that enables the public to recycle their waste is clearly a crucial part of any recycling initiative but so too are the many other factors which motivate individuals to make use of that infrastructure. Given that individual recycling in Lagos is purely a voluntary activity, understanding these other motivational factors (Facilities, regular collection, incentives) is essential if recycling practice is ever to attain its full potential and become a part of everyday individual routine in the state. Knowledge of the reasons why people never recycle or, at best, only occasionally would enable scheme administrators to tailor the schemes more towards those individuals who do not participate fully. As [63] says: "the role of the Local Authority and actions of the public are paramount to the success of sustainable waste policies". [33] Noted that the key link in increasing recycling rates is the individual. Governments and municipalities can increase participation by improving access to waste diversion facilities.

It is also important to note that Lagos State needs to develop an efficient waste recycling initiative. An initiative where stakeholders' identifications and roles are identified would ensure an effective practice. This study recommends five (5) lists of stakeholders for an effective waste recycling strategy (See Table VI).

Table VI: Stakeholders and their roles in waste segregation

No	Stakeholders	Roles
1	Individual	Separating their waste.
2	Residential committee	Carrying out environmental education programs to enhance public awareness on waste separation and recycling.
3	Service Providers	Providing facilities for waste recycling activity such as waste

		containers, buy-back centres, recycling centres, etc.
4	Recycling sectors (informal & formal)	Recovering recyclable materials from public.
5	Environmental Sanitation Department	Collecting and transporting separated waste, operating of the material recovery facility (MRF).

This guideline can be used to determine the necessary stakeholders that should be involved for an effective waste recycling initiative in Lagos State. However more needs to be done in the area of Incentives whether Lagos residents wants their separated waste materials be exchanged for money or other items.

VIII.   ACKNOWLEDGEMENTS

REFERENCES

[1] UDBN (Urban Development Bank of Nigeria), *Solid Waste Sector Appraisal Report*. 1998.
[2] T. C. Ogwueleka, (2009) Municipal solid waste characteristics and management in Nigeria. *Iran journal of Environment, Health, Science and Engineering,* 6(3), 2009, 173-180.
[3] World Bank, *Restoring urban infrastructure and services in Nigeria*. Accessed 15/08/2010 from: http://www.worldbank.org/afr/findings/english/find62.htm. 1996
[4] G.E.D. Omuta, Camouflage, contravention or connivance: towards a n examination of development control in Bendel State, Nigeria. *Third World Planning Review, 3(1)*, 1987, 135–153.
[5] World Bank, *Data by country,* 2002. Website http://www.worldbank.org/data/countrydata/ countrydata.Html (Retrieved June 11, 2003).
[6] World Bank, *Thailand Environmental Monitor 2003.* A joint publication of the Pollution Control Department, Royal Thai Government. The World Bank, US Asia Environmental Partnership.
[7] U.S Ugwuh, The state of solid waste management in Nigeria. *Waste Management, 20*, 2009, 2787-2790.
[8] J.J. Momoh, D.H. Oladebeye, *Assessment of awareness, attitude and willingness of people to participate in household solid waste recycling programme in Ado-Ekiti, Nigeria*, 5(1), 2010, 93-105.
[9] F. S. Wang, A. J. Richardson and F. A Roddick, *Swim-a computer model for solid waste integrated management*, Computer Environ. Urban, 1996.
[10] N. B. Chang, Y.H. Chang and H. W. Chen, Fair fund distribution for a municipal incinerator using GIS-based fuzzy Analytic Hierarchy Process, *Journal of Environmental Management, 90(1)*, 2009, 441-454.
[11] C. Ezeigwe, Appropriate solid waste disposal methods for developing countries. *NSE Technical Transactions, 32 (2)*, 1995, 33–34.
[12] J. Landry, D. Bertola, The global plan for the management of waste in the Canton of Geneva. In: Barrage, A., Edelmann, X. (Eds.), Recovery, Recycling, Re-integration (R '99) Congress Proceedings*, EMPA, Switzerland, 1*, 1999, 39–90.
[13] G. Tchobanoglous, H. Theisen & S. A. Vigil, Integrated solid waste management, engineering principles and management issues (New York: Mc Graw-hill international edition, 1993.
[14] R. Waite, H*ousehold waste recycling* (London: Earthscan, 1995).
[15] A. Omar, A. Q. Hani, Municipal solid waste landfill citing using intelligent system. *Waste Management, 26,* 2006, 299-306.
[16] T. V. Ramachandra, Management of solid waste, centre for ecological science. Indian institute of science, Bangalore, India. 2006.
[17]   J.O. Olubori, The city of Lagos: Solid waste management. *International solid waste association (ISWA) conference*, Vienna, Austria. 2013
[18] U. Kazuhiro, H. Koizumi, Reducing household waste: Japan learns from Germany, *Environment: science and Policy for sustainable Development, 43 (9)*, 2001, 20-32
[19] D. Mathew, *Recycling putrescible/household waste*. In: barrage, a., Edelman, x. (eds.), recovery, recycling, re-integration (r '99) congress proceedings, vol. 1. EMPA, Switzerland, 1999, 363–366.
[20] O.O. Adebayo, T.A. Ojetayo, *Beneficial uses of Lagos state municipal solid waste*. Mechanical engineering department, university of Lagos, Nigeria, 2001, 22–27 (Unpublished B.sc Thesis).
[21] T. Mumma, Construction: *Reducing the embodied energy of buildings*. Home energy magazine online. 1995.

[22] S.H. Gheewala, P.H. Nielsen, *Beyond energy efficiency – application of LCA and integrated environmental assessment*. In: proceedings of the second regional conference on energy technology towards a clean environment, Phuket, Thailand. 2003.

[23] S. Danteravanich, C. Siriwong, *Solid waste management in southern Thailand.* In: proceeding of the thirteenth international conference of solid waste technology & management, Philadelphia, USA. 1997.

[24] C.R. Cheeseman, A. Imam, B. Mohammed & D.C. Wilson, Solid waste management in Abuja, Nigeria. Waste Management, 28, 2008, 468–472

[25] O. F. Kofoworola, Recovery and recycling practices in municipal solid waste management in Lagos, Nigeria. *Waste Management, 27(9)*, 2007, 1139-1143.

[26] M. Raudsepp, Some socio-demographic and socio-psychological predictors of environmentalism. *TRAMES, 5(4),* 2001, 355-367.

[27] R. Chanda, Correlates and dimensions of environmental quality concern among residents of an African Subtropical City: Gaborone, Botswana. *Journal of Environmental Education, 30(2)*, 1992, 31-39.

[28] R. E. Jones & R. E. Dunlap, The social bases of environmental concern. Have they changed over time? *Rural Sociology, 57(1)*, 1992, 134-144.

[29] T. A. Arcury & E. H. Christianson, Rural-Urban differences in environmental knowledge and actions. *Journal of Environmental Education, 25(1)*, 1993, 19-25.

[30] J. Petts, Effective waste management: Understanding and dealing with public concerns. *Waste Management & Research, 12(3)*, 1994, 207-222.

[31] K. D. Van Liere & R. E. Dunlap, Environmental concern: Does it make a difference how it's measured? *Environment and Behaviour, 13*, 1981, 651-676.

[32] P.F.J. Eagles, R. Demare, Factors influencing children's environmental attitudes. *Journal of Environmental Education, 30(4),* 1999, 33-37.

[33] D. Perrin, J. Barton, Issues associated with transforming household attitudes and opinions into materials recovery: a review of two kerbside recycling schemes. *Resource Conservation & Recycling, 33*, 2001, 61–74.

[34] V. Belton, D.V. Crowe, R. Matthews & S. Scott, A survey of public attitudes to recycling in Glasgow. *Waste Management Res., 12*, 1994, 351–67.

[35] S. McDonald, R. Ball, Public participation in plastics recycling schemes. *Resource Conservation & Recycling, 22*, 1998, 123– 41.

[36] C. Coggins, Who is the recycler? *Journal of Waste Management Resource Recovery, 1(2)*, 1994, 69–75.

[37] Department for Environment, Food and Rural Affairs (DEFRA). *Survey of public attitudes to quality of life and the environment*, 2001. Available at: http://www.defra.gov.uk/environment/statistics/pubatt/index.htm; 2002 [accessed 6/10/03].

[38] N. Mee, P.S. Clewes, P.S. Phillips & A.D. Read, Effective implementation of a marketing communications strategy for kerbside recycling; a case study from Rushcliffe (UK). *Resource Conservation & Recycling, 41(1)*, 2004, 1–26.

[39] S. Burnley, J. Parfitt, Public *attitudes to waste and waste management*. The Open University, UK: Department of Environmental and Mechanical Engineering, 2000.

[40] Environment Agency. *Household waste survey,* 2002. Available at: http://www.environment-agency.gov.uk/subjects/waste/232021/239537/296229/?lang= e&region; 2002 [accessed 16/5/03].

[41] T. Hazra, and S. Goel, Solid waste management in Kolkata, India: Practices and challenges. *Waste Management, 29*, 2009, 470-478.

[42] M. R. A. Moghadam, N. Mokhtarani & B. Mokhtarani, Municipal solid waste management in Rasht City. *Iran Journal of Waste Management, 29*, 2009, 485–489.

[43] R.K. Henry, Z. Yongsheng, D. Jun, Municipal solid waste management challenges in developing countries – Kenyan case study. *Journal of Waste Management, 26*, 2006, 92–100.

[44] B. Mrayyan, M. R. Hamdi, Management approaches to integrated solid waste in industrialized zones in Jordan: a case of Zarqa City. *Journal of Waste Management, 26*, 2006, 195–205.

[45] A. D. Read, A Weekly doorstep recycling collection, I had no idea we could overcoming the Local barriers to Participation. *International Journal of Resource Conservation & Recycling, 26*, 1999, 217-249.

[46] G. A. Lilliana, G. Maas & H. William, Solid waste management challenges for cities in developing countries. *Waste Management, 33*, 2013, 220–232

[47] J. Genovese, *Behaviour Change for Combating Climate Change,* 2008. [available online] [accessed 12th May 2011] available on World Wide Web via http://learningfundamentals.com.au/wp-content/uploads/behaviour-change-for-combating-climate-change.pdf

[48] World Bank, *Solid Waste Ecological Enhancement Project (SWEEP),* Sector Assessment Report. (Manila, Philippines, 1998).

[49]   UNESCO, *"Education for Sustainable Development"*. 2001. [Online]. Available: http://www.unesco.org/education/esd/english/education/role.shtml [2002, December 31]. [United Nations Educational, Scientific and Cultural Organization].

[50]   P. Agamuthu, K. M. Khidzir, & F. S. Hamid, Drivers of Sustainable Waste Management in Asia. *Waste Management & Research, 27*, 2009, 625–633.

[51]   V. Corral-Verdugo, Situational and Personal Determinants of Waste Control Practices in Northern Mexico: A Study of Reuse and Recycling Behaviors. *Resource, Conservation and Recycling, 39(3)*, 2003, 265- 281.

[52]   A. M. Troschinetz, J. R. Mihelcic, Sustainable Recycling of Municipal Solid Waste in Developing Countries. *Waste Management, 29(2)*, 2009, 915-923.

[53]   J. Gutberlet, *Recovering Resources-Recycling Citizenship: Urban Poverty Reduction in Latin America. (*Aldershot, England: Ashgate, 2008).

[54]   N.Matete, C. Trois, Towards zero waste in emerging countries – A South African experience. *Journal of Waste Management, 28*, 2008, 1480–1492.

[55]   M. L. Lima, *Individual and social determinants of attitudes towards the construction of waste incinerator: two case studies*, The 1996 Annual Meeting of the Society for Risk Analysis-Europe, The Centre for Environmental Strategy (University of Surrey, Guildford: Surrey, 1996).

[56]   B. Rahardyan, T. Matsuto, Y. Kakuto, & Tanaka, Resident's Concerns and Attitudes towards Solid Waste Management Facilities in Japan. *Journal of Waste Management, 24*, 2004, 437-445.

[57]   C.M. Petersen, P.O. Berg, Use of Recycling Stations in Borlänge, Sweden – Volume Weights and Attitudes. *Journal of Waste Management, 24*, 2004, 911-918.

[58]   S. S. Chung, C.S. Poon, A comparison of waste-reduction practices and new environmental paradigm of rural and urban Chinese citizens. *Journal of Environment Management, 62*, 2001, 13–19.

[59]   D.H. Folz, Municipal recycling performance: a public sector environment success story. Public Administration Review, 59(4), 1999, 336–345.

[60]   D.J. Lober, Municipal solid waste policy and public participation in household source reduction. *Waste Management Resources, 14*, 1996, 125–143.

[61]   F. Fahy, A. Davies, Home improvements: household waste minimization and action research. *Resources Conservation and Recycling, 52(1)*, 2007, 13–27.

[62]   L. Whitmarsh, I. Lorenzoni & S. O'Neil*, Engaging the public in climate change: Behavior change and communication* (London: Earthscan, 2012).

[63]   JL. Price, The landfill directive and the challenge ahead: demands and pressures on the UK householder. *Resource Conservation and Recycling, 32(3–4)*, 2001, 333–348.

Research Paper   Open Access

Conceptual effectiveness criteria in Design Processes of tall buildings

[1.]Mohammad Amin Khojasteh Ghamari, [2.]Salman Hasanvand,
[3.]Shiva Sadat Hosseini Tabrizi

[1.]*Instructor, department of architecture, university college of Roshdieh,Tabriz.Iran*
[2.]*Department of Art and Architecture, Science and Research branch, Islamic Azad University, Tehran, Iran*
[3.]*M.S.C. Architecture, East Azarbaijan Science and Research Branch,Islamic Azad University,Tabriz.Iran*

Abstract: - Nowadays high-rise buildings are of the important approaches of the major world cities. High population growth and expense of land and urban horizontal development problems can be, as reasons for the move to be making vertical and high-rise development. The approach of the past 50 years the country has also been considered as an important element in the larger cities. Firstly, the expression of urban growth was then introduced as the need for high-rise buildings of the history of these buildings have been over the world and Iran Sublime advantages and disadvantages from the perspective of experts examined the terms and provisions of these projects has been evaluated. While the definition of dense urban areas and their characteristics high-rise building as one of the solutions to improve quality conditions in these areas are introduced and an approach to improve the laws and regulations in these areas is investigated the problems and challenges facing these projects in dense urban areas have been identified. Methodology is descriptive-analytical which the firs pay to definitions of key topic, also discus design theory, modeling constructions, structure, and sustainable city success and achieve high standards by architecture and urban planning experts and then will consider effective criteria in tall buildings design. Eventually to regarding criteria and also it will analysis design alternatives and give strategies on improvement of design and construction style in high-rise buildings.

Keywords: - *high-rise building, design criteria, modeling, structure of design.*

I.   INTRODUCTION

The twentieth century experienced an unprecedented demographic shift. The world population more than doubled in the last 40 years. A 2004 United Nations report predicts that by 2050 the world population is expected to exceed 9 billion, and by 2010 the world's urban population for the first time will surpass the rural one. Across the globe, low-density urban sprawl is the solution to population growth. There is mounting consensus among the scientific community that urban sprawl has significant negative social, economic and environmental implications.

Four billion additional people will need housing and work places in just a few decades. An immediate way to address population growth is for cities to support high-density buildings, Particularly high-rises. Over the past century, high-rises have successfully and increasingly responded to this need. We calculate that housing for 4 billion people will require constructing close to 4 million 40-storey high rise buildings (each with 1,050 occupants in 350 units). Yet most high-rises perform poorly in terms of lifecycle cost, environmental impact and social benefit. According to Yeang, in a 50-year lifecycle of a high-rise, energy costs contribute 34% of the total cost. Close to 50% of energy use in high-rises comes from artificial illumination. Kaplan indicates that a typical high-rise building is made of poor quality materials and is aesthetically mundane. Successful high-rise designs need to use a minimum of nonrenewable energy, produce limited pollution, and minimize their carbon footprint, without diminishing the comfort, health, functional needs, and safety of the people who inhabit them. To

respond to these mounting environmental, economic, and social pressures, the Architecture, Engineering, and Construction (AEC) industry needs to revise traditional high rise design and analysis methods. Recent advances in computer-based methods promise vastly improved design processes, but current teams are ill equipped to take advantage of these new opportunities. To help them understand the reasons behind current inefficiencies and develop and implement more integrated design and analysis methods we must first document and measure existing conceptual high-rise design processes in terms of quantifiable metrics on which to base and compare the performance of prospective improvements. Little research has been carried out in this area; the goal of this paper is to fill the gap. Through literature review and industry-based case studies, this paper develops a definition and relevant metrics describing conceptual high-rise design processes, and applies this definition and metrics to a set of contemporary case studies and survey data. We find that conceptual design teams generally operate with low project goal clarity, and generate very few formal design options and analyses that neglect environmental and life-cycle economic considerations. We conclude with a discussion about the potential causes and costs of today's greatly underperforming high-rise design processes.

In this section, we look to design theory for a theoretical definition of high-rise design processes; to process modeling for a method to describe and measure these processes; and to high rise specific literature for classification and key design criteria.

II. BRIEF EARLY HISTORY OF TALL BUILDINGS

Many 19th century American architects went to Paris for training and education and brought back with them ideas that influenced their architecture. In Paris, the Eiffel Tower, at 300m (984 ft) in 1889, was surely a catalyst for new heights with its remarkable architectural qualities and became known as an engineering masterpiece. The U.S. also exported cultural and architectural ideas and developments to Europe that included the skyscraper, a clearly American innovation with its beginning in Chicago. The steel-framed structure of the 10-story Home Insurance Building is generally recognized as the first skyscraper, built in Chicago in 1885. A series of tall buildings, relatively large at the time of their construction, were built at the turn of the century. These include the Wainwright Building of 1890 in St. Louis, the Guaranty Building of 1895 in Buffalo, New York, and the Reliance Building of 1895 in Chicago. This trend continued in New York with the Flat Iron Building of 1903, continuing to the

Chrysler Building of 1930 and the Empire State Building of 1931. Following a pause in construction during the Great Depression and World War II years, tall building construction re-appeared in Chicago in the 1960s. Enormous progress was made in the development of tall buildings after World War II, first in the U.S., followed much later by some Pacific Rim countries, parts of Europe, and the Middle East. Although technology has advanced and the architectural style of tall buildings has evolved, the architectural planning concept of vertically stacking a series of floors and achieving spatial efficiencies by increasing the net-to-gross floor area has remained almost the same. Despite architecturally ambitious thinking, as well as technical and structural advancement, the primary focus remained on economic viability and technological and constructional limitations. Beginning with the last decade of the 20th century, this has changed, however, in favor of sustainability, innovative façade treatment, free-form massing, and iconic architectural vocabulary.

III. DESIGN THEORY

Akin formulates conceptual design as a five-step process: 1) identifying a set of requirements; 2) prioritizing among these requirements; 3) developing preliminary solutions; 4) evaluating solutions; and 5) establishing final design requirements, preferences and evaluation criteria. Haymaker and Chachere further formalize these distinctions in the MACDADI (Multi-Attribute Decision Assistance for Design Initiatives) framework, which includes: 1) *organizations* – a project's stakeholders, designers, gatekeepers and decision makers; 2) *goals* – these organizations' constraints, objectives, and preferences; 3) *options* – design options and methods to generate them; 4) *analyses* – the methods, timing, and types of analyses performed; and 5) *decisions* – rationale and process for making decisions. This paper is structured using these MACDADI distinctions.

Design is an unbounded process; there are infinite numbers of organizations, goals, options, analyses, and decisions that a team potentially can consider. Simon in his behavioral theory of bounded rationality describes people as partially rational when making decisions, due to computational limitations in gathering and processing information. Woodbury and Burrow also argue that designers typically consider a very small number of alternatives in their work as a result of cognitive limits. As a result, designers often make decisions without fully understanding their implications. To develop solutions, designers first establish a design space. Krishna Murti defines a design space as the sum of the problem space, solution space, and design process. A **problem space** includes only the candidate solutions that satisfy the established design requirements. A **solution space** includes all candidate solutions for a given design problem. A **design process** consists of methods used to develop candidate solutions from requirements. The extent of the design space is highly dependent on the designer's

interpretation of the design problem, the choice of design criteria (project goals and constraints), and the employed design process. Two prevailing strategies emerge to describe the design process: breadth first, depth next or depth first, little breadth. The breadth first strategy entails generating multiple design options first, and then analyzing them to determine which ones meet the sought requirements. Depth first strategy entails generating a single option and analyzing it in depth. Goldschmidt argues in favor of the depth versus breadth strategy, in which both known architects and novice students deliberately choose a limited design space to conduct their exploration. The goal is refining and enriching a "strong idea" supported by well-developed design rationale. In contrast, Akin argues that in solving problems expert designers prefer the breadth first, depth next strategy. As a result, multiple alternatives help reveal new directions for further exploration. Each strategy has significant implications in the way teams generate designs. Currently there is no consensus about which strategy performs best, although in light of rapidly evolving project teams, goals, options, and analyses, many researchers argue that the sheer quantity of options generated by a breadth first search enables designers to find more successful solutions in terms of multi-criteria and multidisciplinary performance. Design theory helps us understand design processes, but it does not help us understand how to specifically represent and measure them. A widely accepted method for this kind of Representation and analysis is process modeling.

IV.   PROCESS MODELING

There are three general applications for process models: a) *descriptive:* for describing what Happens during a process; b) *prescriptive:* for describing a desired process; and c) *explanatory:* for describing the rationale of a process. Faroese presents a comprehensive overview of AEC-specific process models, including IRMA (Information Reference Model for AEC, BPM - Building Project Model), ICON (Information / Integration for Construction), and GRM (Generic Reference Model). Most of these are based on EXPRESS-G modeling language, which provides a foundation for graphically representing process models. Other significant process modeling languages relevant to this paper are: IDEF0, used to model decisions, actions, and activities of an organization or system; Narratives, which model information and the sources, nature, and status of the dependencies between information; and Value Stream Mapping [18], which describe the flow of actors, activities, task duration, and information that produce value in a given process. With these process-modeling languages, we can describe design processes but not establish process measurement metrics. To address this problem various techniques have been proposed; for example, to evaluate BIM (Building Information Model) users practices and processes, to measure benefits from VDC (Virtual Design and Construction) use and factors that contribute to its successful implementation, or to simulate the impact of improvements to the engineering design process. In spite of the wealth of existing process modeling languages, none can describe and measure design processes in terms of all the distinctions included in the MACDADI framework. This paper later synthesizes a process model and metrics to describe high-rise design team size and composition, the clarity of their goal definitions, the number of design options they generate and analyze, the prevailing objectives used in their decision making, the conceptual design duration, and the discipline-specific time invested.

V.   HIGH-RISE CLASSIFICATION AND KEY DESIGN CRITERIA

In the late 19th century a wave of innovations in the building industry led to the development of the first high-rises in Chicago and New York. The elevator, the steel frame, and later the curtain wall and HVAC, along with the demand for new office space on expensive and limited land, made the development of high-rises possible and necessary. Despite the success of high rises, the AEC industry lacks a consistent definition of the building type. The American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE) defines high-rises as buildings in which the height is over three times the width , whereas structural engineers define high-rises as buildings influenced primarily by wind loads. High-rises can be categorized according to their function, structural system type, and environmental control strategies. From a functional standpoint, there are four types: residential, commercial, hospitality, and mixed-use. This section briefly describes what is currently known about the organizations, goals, options, and analyses of high-rise design processes.

VI.   ORGANIZATIONS

In high-rise design the developer is often the main decision maker. The developer outlines the architectural program and the budget constraints, and may specify a desired design language and construction start date. Future tenants are often involved at the conceptual design stage, and many cities require a design to be approved by neighbors. Gatekeepers such as city planning and building departments determine building height and construction limitations.

Design firms involved in the design process include architects, structural and mechanical engineers; later design phases include other consultants such as landscape, egress or LEED. The majority of design firms are single disciplinary, offering either architectural or engineering services, and are typically organized in a

hierarchy. A design director makes high-level design decisions that help determine the design space and therefore guide the design team, and represents the firm in client review meetings. Any decisions made at such meetings are then conveyed verbally or through sketches to the senior design and technical architects who oversee the design process. Most of the drawings and calculations are done by mid level and intern architects. The coordination between engineering and architectural drawings is generally done by the senior technical architect.

VII. GOALS (DESIGN CRITERIA)

Several key design criteria must be considered when designing a high-rise. The Floor-Area- Ratio (FAR) is calculated by dividing the gross floor area allowed on a site by the net area of the site. FAR helps designers determine the maximum allowable building height. Building area efficiency is calculated as a subtraction of the building's non-sealable area (core, circulation corridors, etc.) from its gross area. Generally, this number must be at least 75% and represents the net saleable or rentable area. The *lease span,* defined as the distance from the unit's inner wall to the exterior glazing, varies according to the building function. For residential high-rises, a maximum lease span of 10m is recommended given the daylight factor considerations. Office buildings with an open plan allow for deeper spans of up to 14m or more when atriums are provided. In the case of modular office layout a building depth of over 13m is considered excessive.

The main criterion in choosing a load-bearing system is the lateral stiffness for resisting the wind and earthquake forces, which is governed by the total height. Additional criteria include building height-to-width aspect ratio, floor-to-floor height, interior layout, exterior wall, foundation systems, fire safety, construction methods, and budget constraints. The criteria in choosing the foundation type are the gravity loads, quality of the site's subsoil, water table level, and wind loads. Wind loads lead to significant vibration in the upper floors, which provides additional stresses on the bed soils. The foundation piles often determine the location of the structural grid and therefore may affect the overall building efficiency. Fire safety is another important criterion. The core design needs to satisfy the number and size of escape stairwells by determining the building occupancy, as well as address the smoke extraction. Budget constraints often influence the structural material choice. Multiple design criteria exist to help improve environmental control strategies of high-rises. High level concepts include maximizing reliance on natural ventilation and daylight illumination, while depending upon the season and geographical location minimizing or maximizing the heat gain from direct sunlight along the building's perimeter areas.

VIII. OPTIONS

Facades have a significant influence on the aesthetics and symbolism of high-rises. Two main types can be distinguished: curtain wall (butt glazed, conventional mullion system, composite - glass and cladding), and facades as expression of structure (reinforced concrete, prefabricated panels, exoskeleton, etc.). Circulation patterns influence the building's efficiency. They are determined by the configuration, number, and positioning of the service core(s). A typical core includes elevators, fire-protected stairs, electrical / cable closet, riser ducts, and sometimes washrooms. The core positioning will determine the floor plan configuration, given the maximum allowable distance from the outermost point of the corridor to the escape stair(s). When designing cores an important consideration is the *elevator cab aspect ratio*. The preferred range is between 1:2 and 1:3 for maximizing loading and unloading efficiency. The Council on Tall Buildings and Urban Habitat (CTBUH) defines three major structural systems: steel, reinforced concrete, and composite. The choice of structural system determines the building aspect ratio limitations. Until recently, a 6:1 aspect ratio was a constraint. Currently, there are precedents for 10:1 or higher. Floor heights in residential high-rises are generally smaller than in commercial, and range between 2.5-3.5m. In commercial high-rises, floor heights range between 3.3-4.5m. To maximize efficiency, interior layouts may often seek a minimal presence of structural elements, which help choose alternative strategies (exoskeleton, concrete tube, etc.). Generally, the architect's choice of exterior wall system will impact the structural solution. Until recently, the rule of thumb in curtain wall-based high-rises was to vertically divide the façade into 1.5m increments due to ease of assembly, cost savings, and flexible planning. Today, geometrically complex high-rise designs demand variability in the exterior wall panel sizes and novel structural solutions. Engineers can choose among multiple foundation types depending on the building design and soil properties. Examples include cast-in-place telescoping piles, caissons, slab-pile, piled-raft, mat foundation, etc. Cost often can determine the design's final choice of material. For example, reinforced concrete is preferred in the developing world, given its cheaper cost and lower construction skill requirements than for steel structures.

Two types of high-rises can be distinguished according to employed environmental control strategies. First relies entirely on mechanical systems and is a net energy consumer. The second type responds to the climate and site context. The Chartered Institution of Building Services Engineers CIBSE distinguishes four

types of natural ventilation systems: a) **cross ventilation**, with windows on both sides; b) **single-sided ventilation**, with all the windows on one side; c) **stack ventilation**, in which fresh air is drawn through windows and hot air is exhausted through the roof; d) **mechanically assisted**, to increase the airflow in any of the first three systems. In high-rises stack ventilation is the preferred strategy given that the building's height helps create a chimney effect. However, a good understanding of the environmental conditions is important, as, for example, in hot and dry climates the stack effect may not function during the day. Light shelves or reflectors can be used to diminish the energy use in high-rises. Their performance is subject to optimal orientation, determined by the building orientation and geometry. Joachim presents an extensive study of how daylight is affected by the high-rise geometry and the floor plan proportions as related to the core design. He concludes that triangular footprints perform best by having the least amount of dark spaces within a 10m span, followed by the square and circular configurations. This study, however, is limited to centrally located cores. Yeang [4] stresses the importance of peripheral core location on east and west facades used as thermal "buffer-zones," leading to important reductions in air-conditioning loads and operation costs. Additional benefits include access to daylight and natural ventilation into the core area, making the building safer in case of power failure, and eliminating the requirement for mechanical fire-fighting pressurization ducts.

Considering their height and external surface area, high-rises are well suited to take advantage of emerging energy generation technologies. Integrating photovoltaic cells (PVs) into the building's exterior wall or louver system, for example, may become feasible after understanding the local climate and context. This knowledge helps choose optimal building orientation and location of PVs (i.e., non-shaded sections of the building). Similarly, given substantial wind velocities at high altitudes, high-rises can be volumetrically shaped to maximize the performance of integrated wind turbines (i.e., Zero Energy Tower in Guangdong, China by SOM). Other technologies include geothermal energy and thermal storage, evaporative cooling systems for arid climates, etc.

IX.   ANALYSES AND DECISIONS

Designing high-rise buildings is a complex process as illustrated by the criteria discussed above. As a result, many prototypes have been developed in academia and practice to address aspects of the design processes as heuristic rules that automate some of these processes and help designers make decisions more efficiently. Danaher argues that by not being well defined the conceptual design is reserved only to senior, experienced designers. He proposes the use of knowledge-based expert systems in facilitating the access of junior designers to expert knowledge, in which the system guides them towards good solutions. Several such systems surveyed by Danaher are Hi-Rise, Tallex, Conceptual, Predes, and Archie.

Tall building pioneer in sustainable city success and achieve high standards as well as the buildings are proposed:

Shape

The shape of a tall building determines its cost effectiveness, and value efficiency at least as much as (and usually more so) than its height. The key efficiency ratios in the cost and value of a tower, wall: floor and net: gross, are both directly affected by geometry. This means that a 70-storey tower may cost less per square meter than a 30-storey building.

Shape is critical in cost terms, not least because it has a significant influence on the two key elements, structure and façades (and their effect on time as well as cost).

Façades

There is an intense — and sometimes political — relationship between high-rise aesthetics and performance, which is no more evident than in their façades. The form and envelope of a tower create its identity, and its external walls play a critical role in its passage through the town planning process. But they also have to satisfy a number of performance criteria, all of which exist in a certain tension. Our façades team is lead by Steve Mudie, based in London and First Vice President Jim McDonnell, based in New York, and is able to advise on any global project. We have a unique mix of technical and commercial expertise in this respect.

Structure

Tall buildings need to overcome particular difficulties such as severe wind loads and increased dead loads. Design solutions must also take due consideration of the typically Grade-A nature of tall buildings and the requirement to create an iconic structure. A number of structural forms may need to be analyzed early in the design stage to establish whether a core, tube, outrigger, mega brace, bundled tube — or a combination of these — may be most appropriate, together with which materials are best.

Schedule

Optimizing a design for efficiencies can shorten the construction program, easing the financing costs and reducing the risk of price rises during the construction phase. Greater savings can be made through phasing of works to allow phased opening (and thus earlier income streams), and to allow works that would normally be carried out sequentially to be carried out concurrently. Maximizing build ability requires the early planning and programming of the construction project, with detailed consideration of alternative methodologies. Importantly, this should be reinforced through on-going constructability reviews through Tishman which has in-house expertise across all these areas.

X. BUILDING INFORMATION MODELING (BIM)

Building Information Modeling (BIM) and other virtual construction services are a critical part of executing tall and super tall buildings. Using these techniques means more efficiencies and accuracy in pre-construction planning and strategies, and equally important, during construction. In addition to innovative methods for coordination of structural and mechanical engineering, our project teams now take advantage of extracting information from the model to facilitate estimating, procurement, clash detection and field management. Furthermore, elements of a project's 3-D model are used to identify and avoid safety hazards. Through continuous syncing of information in cloud-based servers, the model is updated and available to all project team members in real time. This enhances our overall productivity, provides instant clarification and offers important cost savings in high-rise construction.

1. Procurement strategy
Two key features of tall buildings tend to dictate the procurement strategy to be adopted: Firstly, the critical path for the construction of the whole project flows through a single structure, as opposed to two or more shorter buildings with the same total floor area. The resultant extended construction period pushes up not only the contractors' preliminaries costs, but also the developer's financing costs. Therefore, any solution which offers shorter construction times means an overall lower project cost. Secondly, the iterative nature of building one floor repeatedly on top of another gives huge opportunity for repetition of floor layouts and the incorporation of pre-fabricated construction techniques into the design. Ultimately, a procurement strategy which allows an early start on site, phased completion and occupation all helps to drive up value.

2. Environmental strategy
The property industry is becoming increasingly aware of the costs and benefits of building "green." Knowledge in this area is advancing rapidly, and the higher visibility, status, and design quality of tower buildings means that they are often the forefront of research and implementation of sustainable strategies. The adoption of LEED-type methods are helping to develop the efficiency of individual buildings as "products", though there are many aspects of sustainability that are not included in these methods. Davis Langdon's research in sustainability feeds directly into our advice to clients, and is used to direct industry organizations and government legislation. When we address sustainability, we are looking not just at the energy efficiency of buildings, but also their relationship to infrastructure and their long-term financial viability.

3. Vertical transportation
One of the key considerations in the design of a vertical transportation system in tall buildings is to reach the optimum balance between the quality and quantity of lift service provided (usually expressed in terms of waiting times) against the capital cost of the lifts themselves and the loss of revenue-earning, tenantable space taken up by the provision of lift cores and plant rooms. This becomes even more critical as buildings become taller than 50–60 storeys'.
The public Square office tower attached to the residential tower and the lightness of the structure relative to the coverage area of glass used in the field of building frontage possible view of the structural of the Sydney Opera Sydney is. Environmental issues and sustainable development, and materials recovered from the other issues that have been raised today with more objectivity. Office project residential building in Sydney piano for an overview of the glass surface to form a continuous layer that has used ¬ creates relatively invisible eastern facade of the glass it artistic expression towers a gridding beautiful a space of your URBAN piano it describes a moving sculpture . The product of this cooperation specializing in glass bottle networking groups, building structures and the design of each of the glass network as a binder with each clamp, special to the clamps top or bottom rows of the structure of nearly building, backed on each of these sensor networks are placed in sensitive to dislocation movement and possibly warn those of glass in the building, repair and replacement parts so it can take action .composite steel and concrete columns at the corners of a triangular -shaped building plan are transferred . In the turrets, towers and other structures that foster self- employed structural engineer with the product of joint cooperation with the Department of Computer Simulations of three- dimensional building is that ultimately led to build.

XI.　　CONCLUSION

High-rise buildings within the urban fabric of the building were a secondary issue .new attention to the manner and style of the drainage density was noted in the hinterland tall. Valves are required to evacuate the density of tall building and vehicle traffic creates other major issues were noted It will be interesting of the New York skyscrapers sits of the metro area large and connects suburb.

Position office tower residential Philip Sidney Street along the main street of the city demonstrated it by making other tall buildings in urban areas , unlike the rules are somewhat Construction Engineering , which allows the similarity in different parts of the climatic conditions of social, cultural etc. The desired range is also continuing to high-rise building in the city and fits the general culture prevailing in the region .urban, architectural styles and periods are double neighboring and other issues of importance.

The connection is obvious as the Sydney Harbour Tower is designed in such a way that the shadow of the tower to a height of approximately 90 meters to the botanical gardens around it does not In fact; interactive communication tower with respect to the Botanical Garden has a special form. Architectural issues in designing terraced towers are crucial for Commerce Bank Tower in Frankfurt, the possibility of watching the city from different directions at different altitudes and building permit the site also allows transparency created using glass in various categories based view provides a visual communications. The way that employees in various classes, such as a collection of visual communication with each other the buildings are employed in different classes according to the type of unity.

tall building in various fields indicate the importance in today's world of high rise buildings papers in different fields such as systems and concepts, structures, tall buildings , high-rise office buildings , innovation in the field of tall building design , modular systems , do Reviews and buy aesthetic design of tall buildings , vertical social behavior of urban residents in tall buildings , saving energy costs immunization against fire, wind, earthquake and seismic monitoring in the field were presented , all of which indicate entailed a variety of specialties the design and implementation of the towers . As it observed, through case studies and a survey, that design organization during the conceptual design of high-rise building treat goals informally and search through a relatively narrow part of the design space. Design theory and our own experience suggest that significant better performing buildings are remaining undiscovered. Deficiencies in current conceptual design process lead to solutions with mediocre day lighting, and excessive thermal loads and energy demands, thus making the cost of operating or retrofitting traditional high-rises prohibitive. The lack of a comprehensive and systematic method of defining multi-stakeholder multidisciplinary goals, meaning their evolution, and generating and choosing among design options that respond to identified goals is a major impediment to more successful design.

REFERENCE

[1]　**"American Society of Heating, Refrigeration and Air-conditioning Engineers"** (ASRAE), (1989). Handbook on fundamentals.

[2]　Chartered Institution of Building Services Engineers. (1997). "**Natural Ventilation in Non-Domestic**

[3]　Council on Tall Buildings and Urban Habitat, (2000). **"Architecture of Tall Buildings"**. pp. 95, 102-106.

[4]　Eisele, J., Kloft, E., (2002). **"High-rise Manual - Typology and Design, Construction and Technology Birkhauser - Publishers for Architecture"** .

[5]　David.C.W.Kwok(2009). **"Construction Planning for High-Rise Residential Building"**;Gammon Guiding Construction(Macau)Ltd.

[6]　Haymaker, J., Chachere, J. (2007). **"Coordinating goals, preferences, options, and analyses for the Degree of urban sprawl in Switzerland:** Quantitative analysis 1940–1950.

[7]　Laemee,B.Jean(1983). **"A Planning and Scheduling High-Rise Building Construction"** the center for building studies.

[8]　McElfish, J. (2007). **"Ten Things Wrong With Sprawl"**. Environmental Law Institute report.

[9]　Schueller, W. (1986). **"High-rise buildings structures"**. 2nd edition, Robert E. Krieger Publication

[10]　United Nations, (2004). **"World population to grow from 6.5 billion to 9.1 billion by 2050"**. Accessedathttp://www.un.org/esa/population/publications/WPP2004/2004_Revision_press_release_Final .pdf 13th EG-ICE Revised Selected Papers. Lecture Notes in Computer Science, Vol. 4200/2006.

[11]　Yeang, K. (1996). **"The Skyscraper Bioclimatically Considered – a design primer"**. Academy Editions.

Research Paper   Open Access

THE KACHCHA THEEVU?... *(A New theory on " Islands")*

M.Arulmani, V.R.Hema Latha,
B.E. (Engineer)
M.A., M.Sc., M.Phil. (Biologist)

Abstract: - This Scientific research article focus that in geological term "**PLASMA LAND MASS**", also called as "**e-LAND**" shall be considered as the land origin where **first Human origin** started living on the "**Earth Planet**". In proto Indo Europe language the plasma land of Earth shall be called as "**Kachcha theevu**". In **Dravidian language** the land of Kachcha theevu shall also be called as "**KARI NADU**" called in short as "**K-NADU**". Kari Nadu shall mean land of medically enriched "**FISH-CURRY**" containing basic minerals and vitamins.

In the history of geological evolution there are thousands of "**Islands**" such as Madagascar, Sri Lanka, British isle, Greenland exist all over the world. This article emphasize that "**Kachcha theevu**" shall be considered as the "**SOUL**" of all Islands and Continental Nations. Based on human historical culture the logo of Kachcha Theevu shall be indicated as below. Kachcha shall mean "**GOD**".

(Kachcha Logo)

This article further emphasize that clear understanding about the philosophy of Kachcha theevu shall pave path for formation of **new theories** about geological origin of various land origin as well as Human origin on the Earth planet.
Kachcha Theevu shall be considered as the fundamental "ENERGY SOURCE" of Earth resource like crude oil, coal, coke, natural gas, including fish. The closure of "OCEANIC DUCT" of Kachcha Theevu shall mean exhaust of all oil fields of Earthly nations.

-   *Author*
-

Key Words:	
b) Philosophy of "**Plasma clay soil**"	d) Philosophy of "**Ezhem**"
c) Philosophy of "**Theevu**"	e) Philosophy of "**e-Son**"
	f) Philosophy of "**Blue eye Iris**"

I.   INTRODUCTION

Based on Big Bang Standard modal theory it is understood that the entire Universe was formed about **13.7 Billion years** ago form the Molecular cloud of **star dust**. But global level scientist still could not clarify for the following.

i) First land origin on Earth was rock (or) clay?...
ii) The name of first Island origin?...
iii) The name of first main land origin?...
iv) The Land origin where first Human dwell?...

v) How mountains were formed on the Earth?...
vi) Egyptian pyramids are natural or human made?...
vii) When Blue eye Iris human originated?...

viii) The mystery of Bermuda triangle?...   ix) The source of energy for human heart?...

In this article it is focused that Kachcha theevu shall be considered as the "Embryo" of continental nation of "Mother Earth" just like embryo of "INFANT" developed within Mother's womb. "Kachcha theevu is like "Thai-e land", and all Islands and continental nations are like "Kutties".

- Author

II.   HYPOTHESIS AND NARRATION

a)   Philosophy of "Thee"?...

It is hypothesized that "**J-Radiation**" emanated near "**White hole region**" of Universe shall be considered as the "**Soul**" and **energy provider** for existence of all matters such as various planets, stars, Elements, Atoms, Molecule etc. In proto Indo Europe language the **J-Radiation** shall be called as "**THEE**". Thee shall be defined within the following scope.
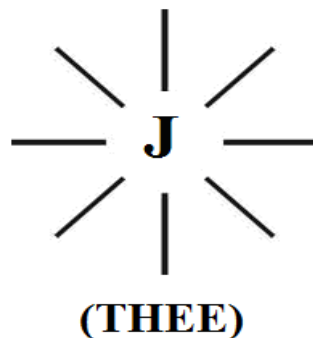
(THEE)

i)   **Thee** shall mean composed of THREE-IN-ONE fundamental particles Photon, Electron, Proton having **optic, Electric, Magnetic** parameter and charge properties having **Zero mass**.
ii)   **Thee** shall be considered evolved near white hole region due to impact of "**ACCRETION**" of Dark Matter cells due to growth of **downward gravity**.
iii) **Thee** shall be considered exist under **Highly Endothermic, Zero entropy** environment and considered free form **UV, RF, IR** interferences.

b)   Philosophy of MARS PLANET?...

It is hypothesized that "**MARS PLANET**" (also called as **EZHEM** or **e-NADU**) shall be considered as "**Mother of all planets**" in the whole Universe. The mother planet shall also be called as **White star** composed of exclusively Photon, Electron, Proton ions and free from "**Atoms**". Further MARS consider exist under "**RAIN**" environment rather than **Sea water, Ocean water**. The Rain shall be considered composed of only charged ions of **Photon, Electron, Proton** having **Zero PH value**, and free from atoms like Hydrogen, Carbon, Nitrogen, Ozone, Oxygen etc.

c)   MARS Planet contains water?...

No... No... No... "**WATER**" considered differs from "**RAIN**". Mars Soil considered exist under the environment of Rain rather then water having high acidic value. Water, sea, ocean consider having different "**Salinity potential gradient**" exist only on **Earth planet** having increased alkalic value.
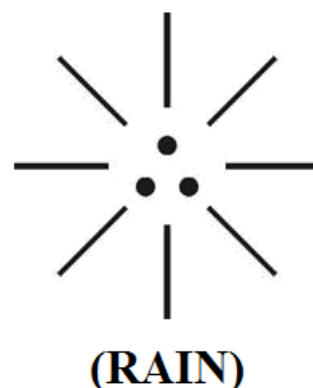
(RAIN)

It is focused that the rainfall on the earth shall be considered as "**pure water**" (having PH value 7.0). Further it is hypothesized that during expanding Universe the shape and angle of rainfall considered varies due to impact of growth of **downward gravity** in three geological evolutionary periods. The Philosophy of angle of rainfall to the vertical axis of gravity, the distinguished shape of rainfall shall be described as below.

(i)

(0° angle in prehistoric time)

(ii)

(30° angle in ancient time)

(iii)

(60° angle in modern time)

d) Philosophy of Kachcha Theevu?...

It is hypothesized that in the early universe the **Earth planet** shall be considered surrounded and submerged by "**SEA WATER**" (low salinity level). The Kachcha Theevu shall be considered as "**land mass**" descended form mars planet.

MARS
(Mother Earth)

(ENDOS)

Transformation &
Plasma barrier

ANCIENT INDIA
(Single Super Continent)

(INDOS)

KACHCHA THEEVU
(Earth Soul)
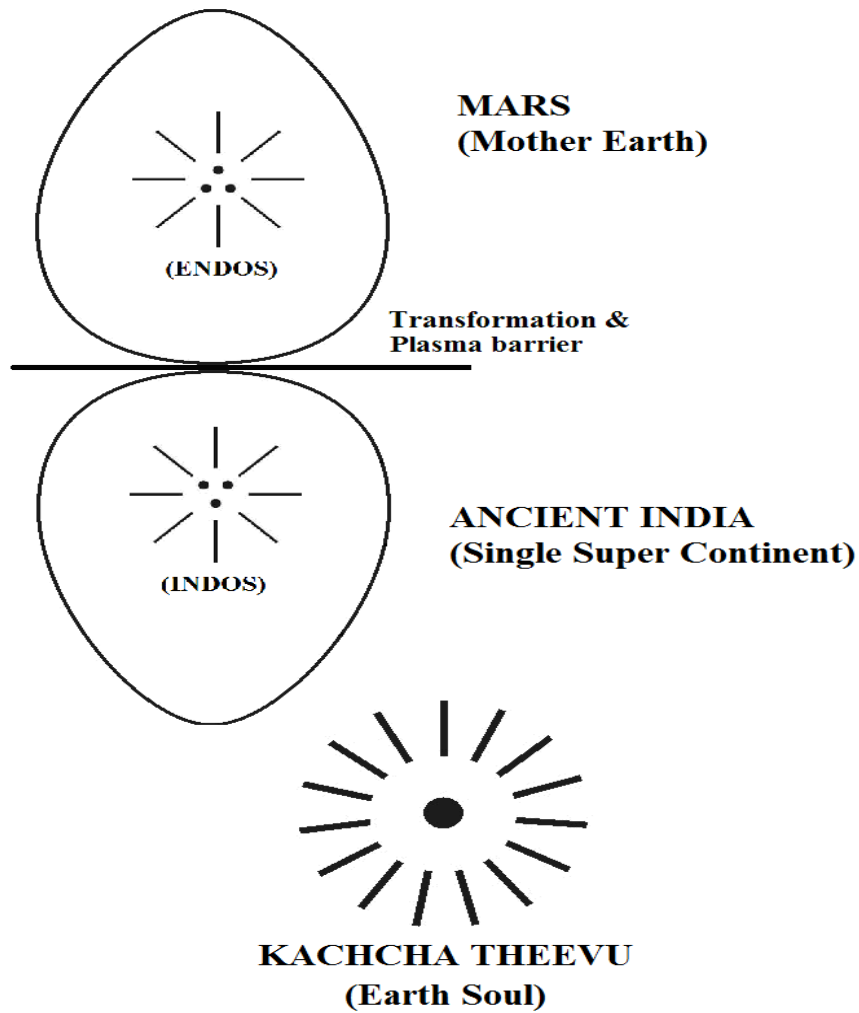
The **Mars land mass** formed on the Earth planet shall be called as "**J-PLASMA**" look like white clay soil matter composed of only **photon, Electron, Proton** ions and free form Hydrogen and other atoms. The prehistoric time "**ETHIA**" shall be considered as **SINGLE SUPER CONTINENT** evolved after formation of Kachcha Theevu on the Earth Planet. The super continent mass on earth planet shall be considered as strong binding to crust of techtonic plates of Earth planets just like "**TOOTH IS ATTACHED TO GUM**". The philosophy of Mars Planet, Kachcha Theevu, Super Continent Ethia shall be hypothetically represented as below.

It is further focused that the ancient Ethia super continent (also called later as **INDO** continent) Considered contains only **three Sea** with low salinity. During the course of expanding Universe water source like Arctic, Antarctic, Atlantic, Pacific (having high salinity level) might be formed due to natural process of "**Osmosis**" and "**Reverse Osmosis**". The formation of huge mountains like **Himalya, Alps** on the Earth planet might be formed due to impact of "**salinity potential gradient**" within various regions of water, sea, oceans over earth planet.

(Three Sea)
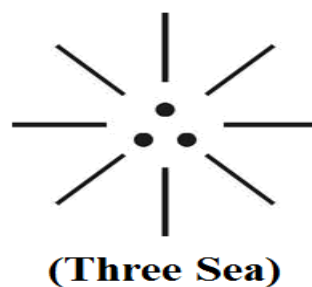
i)   Right dot   - **Bengal Sea**
ii)   Left dot   - **Arabic Sea**
iii)   Centre dot   - **Indo sea** (Called as sea rather than ocean)

e)   Philosophy of Islands?...

Case study shows that there are about 45,000 islands exists in different regions of earth planet. The islands are considered as formed due to impact of techtonic plates forces of earth crust.

It is hypothesized that **Island** shall be considered as Land Mass clay like soil (**Plasma Soil**) derived from **Mars Planet** during geological evolutions in the early universe. In modern English the Plasma Soil shall be called as "**Marsh Land**". It is focused that the prehistoric **Mars land mass** shall be considered containing only fundamental ions Photon, Electron, Proton and free from Hydrogen and other atoms In proto Indo Europe Language the "**Plasma land**" region shall be called as "**THEEVU**" (or) "**e-LAND**". Theevu shall mean soil made up of "**THEE**" (Photon, Electron, Proton).

THEEVU ➔ *Thee + eevu.*

(e-Land)
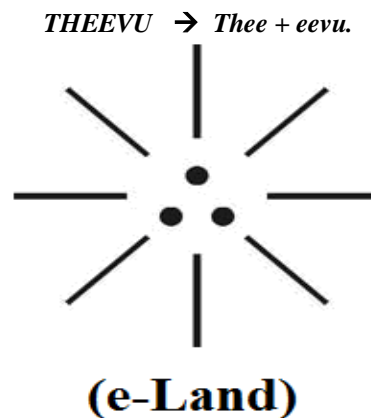
It is hypothesized that "Kachcha Theevu" shall mean Land mass made up of "**THEE**". "**KACHCHABI**" shall mean "**GOD**".

f)   Philosophy of Bermuda triangle mystery?...

Case study shows that the Bermuda triangle is an area in the western Atlantic ocean where many ships and planes have been reportedly missing due to downward force. In 2013 study the world wide fund for nature identified the worlds ten most dangerous waters for shipping but Bermuda triangle was not among them. Further there are so many theories behind about the mystery of Bermuda triangle including KUSCHE theory, Charles Berlitz theory.

It is hypothesized that the prehistoric three seas Indo, Bengal, Arabic surrounded to Kachcha theevu shall be considered as the three fundamental "**base oceanic ducts**" of global seas and oceans having three salinity level of water. It is further focused that in the prehistoric time the seas surrounded to Kachcha theevu shall be considered as **highly acidic** and during three geological period the ocean contains different layer level of water with different PH value, say bottom most water contains only acidity, middle level contains pure water, top layer contains alkalic water. The Philosophy of prehistoric Kachcha theevu shall be described as below.

(Variant Salinity Potential)
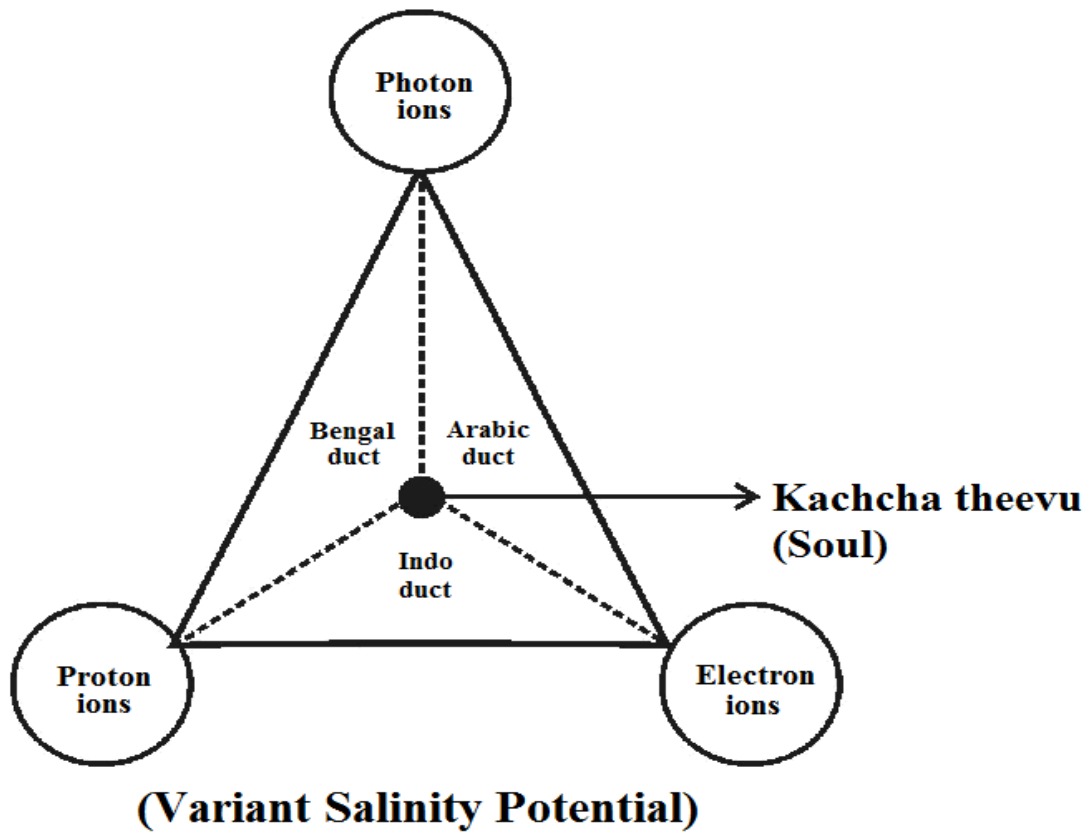
It is focused that Kachcha theevu shall be considered as the point of **strongest downward gravity** for attaining equilibrium of salinity of various seas having different PH level. It is further focused that global scientists claim that the natural resources of earth is expected to be exhausted in another 100 years. However It is hypothesized that the resources of the earth shall be continue to be formed through oceanic duct as long as seas and oceans exists on the earth.

g)   Etymology of Island?...
Case study shows that the etymology of word island derived from igland, iland, eiland. It is hypothesized that the etymology of word island might be derived from proto Indo Europe language word "e" pronounced as "i". It is focused that the Philosophy of "e", "i" shall be considered involved nature behavior and mathematics and other scientific calculations. "e", "i" shall be considered as godly constants in the behavior of **nature universe**.

(i)

("e")
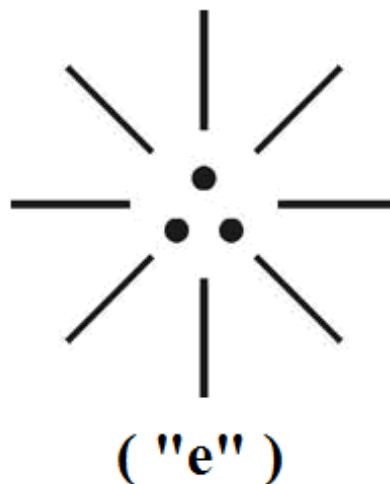
(ii)

(Virgin Island)

(iii)
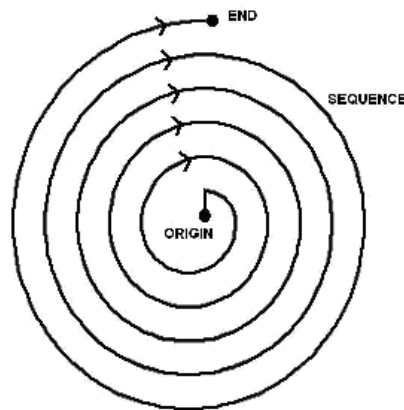
(Evolved Islands)

h)   *Philosophy of formation of Sri Lanka?...*

Case study shows that there is no clear theories about formation of **Sri Lanka**. Sri Lanka is considered as oceanic island. It is hypothesized that the ancient Sri Lanka (also called as Ezhem, e-Nadu) shall be considered as "**kutty**" of mother Ethia (ancient super continent).

(i)
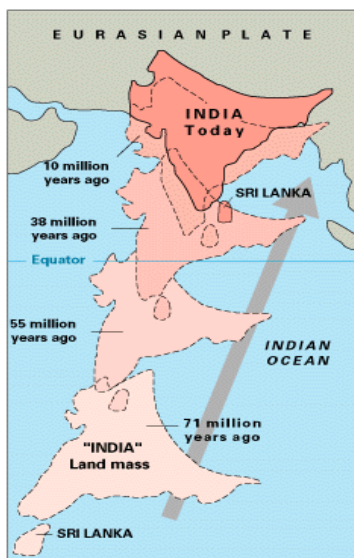
(Evolution of Sri Lanka)

(ii)

(Kutties of Ethia)

(iii)

(Pet Kutty of Ethia)

i) Philosophy of Blue Iris human?...

It is hypothesized that the Ancient population lived in Kachcha Theevu shall be considered containing eye of "**Blue-Iris**" called family name "**Thai-e**" populations. During expending universe different colored eye Iris population might be evolved in three geological periods due to variant "**CNO Cycle**" environment.

THAI–e
(Blue iris)

j) Adam, Eve lived in Kachcha Theevu?...

It is hypothesized that **Adam, Eve** belong to "**Angel family**" who might have lived in **MARS PLANET** (mother of Earth Planet). It is hypothesized that the origin of first human might have derived energy for heart beat (also called as **SOUL**) from **J-RADIATION** consists of **THREE-IN-ONE** fundamental ions of PHOTON, ELECTRON, PROTON. They might have descended to Earth planet after consuming **forbidden fruit** and become "**Human family**" with distinguished genetic structure. It is further hypothesized that during living on Earth Planet Adam, Eve might have changed their names as "**MARAN**", **MARI-e**" for **numerological reasons**. Maran, Mari-e shall mean human descended from "**MARS PLANET**" (also called as EZHEM (or) e-NADU)
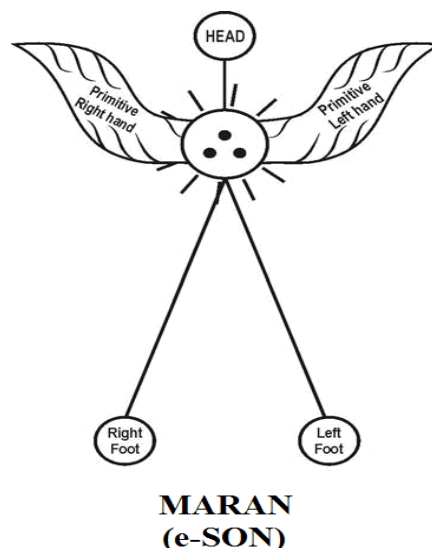

MARAN
(e-SON)

"Maran, Mari-e shall mean dark populations of Kachcha theevu (K-Nadu). Rajan, Patchan, Velan, Ammu, Ram, Seethai shall mean, loving children of Maran, Mari-e"

- Author

k) Maran, Mari-e constructed pyramids?...

It is hypothesized that Maran, Mari-e shall be considered expert in Astrophysics, Astronomy and formulated the relative position of **MARS, SUN, EARTH, MOON** and considered Material Universe having shape like "**TRIPOD**" structure with Sun, Earth, Moon as base and mars as Vertex. They were able to control the relative position of Various planets by "**e-Logics**" code called (**Akkie code**). The "**Egyptian pyramids**" shall be considered as constructed by them as "**Ground based Antennas**" for remote control of various planets. Further the stone structures of pyramids shall also be considered as "**level Indicators**" of ocean level above Earth surface in the early universe. In proto Indo Europe language e-Logic shall be called as "KANNI THAMIL". It is focused that the first language spoken on the earth planet shall be called as Kachcha Thamil, Kanni Thamil (natural virgin language).

(i)

(e-LOGIC)

(ii)

(RELATIVE POSITION)
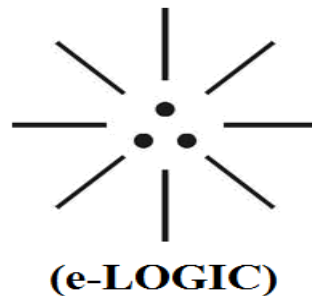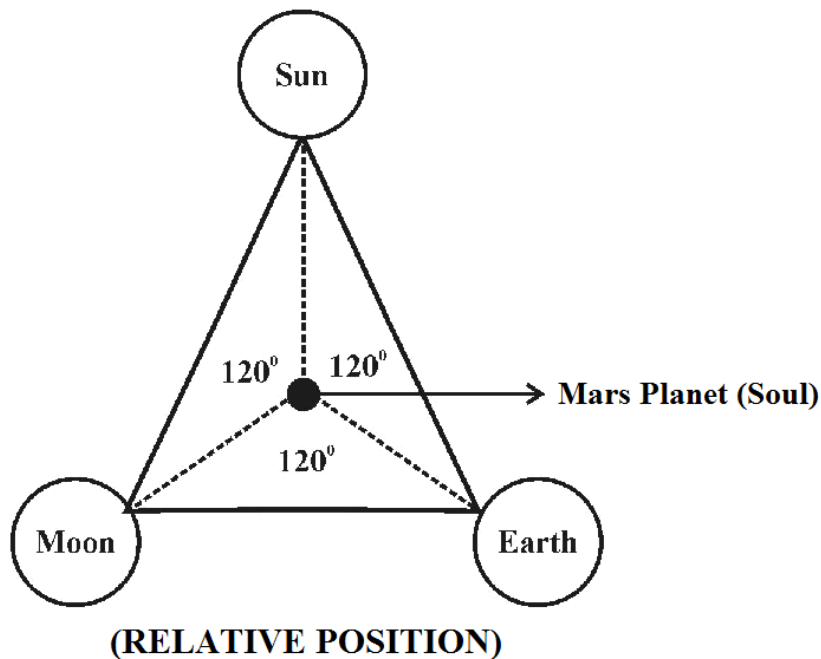
III.   CONCLUSION:

It is focused that the Ancient world exist like a single super continent (Ancient India). In proto Indo Europe language the single continent shall be called as "**ETHIA**". Ethia shall mean **supreme mother** of continental Nations derived from land mass of "**Kachcha Theevu**". The Philosophy of (international maritime boundary line) might be derived from the Philosophy of Ethian in ancient time.

"Ancient Ethians (also called as proto Dravidians) use to communicate through "e-logics" rather than writing letters (KADITHAM)"

- Author

IV. PREVIOUS PUBLICATION:

The philosophy of origin of first life and human, the philosophy of model Cosmo Universe, the philosophy of fundamental neutrino particles have already been published in various international journals mentioned below. Hence this article shall be considered as **extended version** of the previous articles already published by the same author.

[1]   Cosmo Super Star – IJSRP, April issue, 2013
[2]   Super Scientist of Climate control – IJSER, May issue, 2013
[3]   AKKIE MARS CODE – IJSER, June issue, 2013
[4]   KARITHIRI (Dark flame) The Centromere of Cosmo Universe – IJIRD, May issue, 2013
[5]   MA-AYYAN of MARS – IJIRD, June issue, 2013
[6]   MARS TRIBE – IJSER, June issue, 2013
[7]   MARS MATHEMATICS – IJERD, June issue, 2013
[8]   MARS (EZHEM) The mother of All Planets – IJSER, June issue, 2013
[9]   The Mystery of Crop Circle – IJOART, May issue, 2013
[10] Origin of First Language – IJIRD, June issue, 2013
[11] MARS TRISOMY HUMAN – IJOART, June issue, 2013
[12] MARS ANGEL – IJSTR, June issue, 2013
[13] Three principles of Akkie Management (AJIBM, August issue, 2013)
[14] Prehistoric Triphthong Alphabet (IJIRD, July issue, 2013)
[15] Prehistoric Akkie Music (IJST, July issue, 2013)
[16] Barack Obama is Tamil Based Indian? (IJSER, August issue, 2013)
[17] Philosophy of MARS Radiation (IJSER, August 2013)
[18] Etymology of word **"J"** (IJSER, September 2013)
[19] NOAH is Dravidian? (IJOART, August 2013)
[20] Philosophy of Dark Cell (Soul)? (IJSER, September 2013)
[21] Darwin Sir is Wrong?! (IJSER, October issue, 2013)
[22] Prehistoric Pyramids are RF Antenna?!... (IJSER, October issue, 2013)
[23] HUMAN IS A ROAM FREE CELL PHONE?!... (IJIRD, September issue, 2013)
[24] NEUTRINOS EXIST IN EARTH ATMOSPHERE?!... (IJERD, October issue, 2013)
[25] EARLY UNIVERSE WAS HIGHLY FROZEN?!... (IJOART, October issue, 2013)
[26] UNIVERSE IS LIKE SPACE SHIP?!... (AJER, October issue, 2013)
[27] ANCIENT EGYPT IS DRAVIDA NAD?!... (IJSER, November issue, 2013)
[28] ROSETTA STONE IS PREHISTORIC "THAMEE STONE" ?!... (IJSER, November issue, 2013)
[29] The Supernatural "CNO" HUMAN?... (IJOART, December issue, 2013)
[30] 3G HUMAN ANCESTOR?... (AJER, December issue, 2013)
[31] 3G Evolution?... (IJIRD, December issue, 2013)
[32] God Created Human?... (IJERD, December issue, 2013)
[33] Prehistoric "J" – Element?... (IJSER, January issue, 2014)
[34] 3G Mobile phone Induces Cancer?... (IJERD, December issue, 2013)
[35] "J" Shall Mean "JOULE"?... (IRJES, December issue, 2013)
[36] "J"- HOUSE IS A HEAVEN?... (IJIRD, January issue, 2014)
[37] The Supersonic JET FLIGHT-2014?... (IJSER, January issue, 2014)
[38] "J"-RADIATION IS MOTHER OF HYDROGEN?... (AJER, January issue, 2014)
[39] PEACE BEGINS WITH "J"?... (IJERD, January issue, 2014)
[40] THE VIRGIN LIGHT?... (IJCRAR, January issue 2014)
[41] THE VEILED MOTHER?... (IJERD, January issue 2014)
[42] GOD HAS NO LUNGS?... (IJERD, February issue 2014)
[43] Matters are made of Light or Atom?!... (IJERD, February issue 2014)
[44] THE NUCLEAR "MUKKULAM"?... (IJSER, February issue 2014)
[45] WHITE REVOLUTION 2014-15?... (IJERD, February issue 2014)
[46] STAR TWINKLES!?... (IJERD, March issue 2014)
[47] "E-LANKA" THE TAMIL CONTINENT?... (IJERD, March issue 2014)
[48] HELLO NAMESTE?... (IJSER, March issue 2014)
[49] MOTHERHOOD MEANS DELIVERING CHILD?... (AJER, March issue 2014)
[50] E–ACHI, IAS?... (AJER, March issue 2014)
[51] THE ALTERNATIVE MEDICINE?... (AJER, April issue 2014)
[52] GANJA IS ILLEGAL PLANT?... (IJERD, April issue 2014)
[53] THE ENDOS?... (IJERD, April issue 2014)
[54] THE "TRI-TRONIC" UNIVERSE?... (AJER, May issue 2014)

[55] Varied Plasma Level have impact on "GENETIC VALUE"?... (AJER, May issue 2014)
[56] JALLIKATTU IS DRAVIDIAN VETERAN SPORT?... (AJER, May issue 2014)
[57] Human Equivalent of Cosmo?... (IJSER, May issue 2014)
[58] THAI-e ETHIA!... (AJER, May issue 2014)
[59] THE PHILOSOPHY OF "DALIT"?... (AJER, June issue 2014)
[60] THE IMPACT OF HIGHER QUALIFICATION?... (AJER, June issue 2014)
[61] THE CRYSTAL UNIVERSE?... (AJER July 2014 issue)
[62] THE GLOBAL POLITICS?... (AJER July 2014 issue)

REFERENCE

[1]   Intensive Internet "e-book" study through, Google search and wikipedia
[2]   M.Arulmani, "3G Akkanna Man", Annai Publications, Cholapuram, 2011
[3]   M. Arulmani; V.R. Hemalatha, "Tamil the Law of Universe", Annai Publications, Cholapuram, 2012
[4]   Harold Koontz, Heinz Weihriah, "Essentials of management", Tata McGraw-Hill publications, 2005
[5]   M. Arulmani; V.R. Hemalatha, "First Music and First Music Alphabet", Annai Publications, Cholapuram, 2012
[6]   King James Version, "Holy Bible"
[7]   S.A. Perumal, "Human Evolution History"
[8]   "English Dictionary", Oxford Publications
[9]   Sho. Devaneyapavanar, "Tamil first mother language", Chennai, 2009
[10] Tamilannal, "Tholkoppiar", Chennai, 2007
[11] "Tamil to English Dictionary", Suravin Publication, 2009
[12] "Text Material for E5 to E6 upgradaton", BSNL Publication, 2012
[13] A. Nakkiran, "Dravidian mother", Chennai, 2007
[14] Dr. M. Karunanidhi, "Thirukkural Translation", 2010
[15] "Manorama Tell me why periodicals", M.M. Publication Ltd., Kottayam, 2009
[16] V.R. Hemalatha, "A Global level peace tourism to Veilankanni", Annai Publications, Cholapuram, 2007
[17] Prof. Ganapathi Pillai, "Sri Lankan Tamil History", 2004
[18] Dr. K.K. Pillai, "South Indian History", 2006
[19] M. Varadharajan, "Language History", Chennai, 2009
[20] Fr. Y.S. Yagoo, "Western Sun", 2008
[21] Gopal Chettiar, "Adi Dravidian Origin History", 2004
[22] M. Arulmani; V.R. Hemalatha, "Ezhem Nadu My Dream" - (2 Parts), Annai Publications, Cholapuram, 2010
[23] M. Arulmani; V.R. Hemalatha, "The Super Scientist of Climate Control", Annai Publications, Cholapuram, 2013, pp 1-3

Research Paper   Open Access

Spatial Distribution of Solid Waste Collection Points Using GIS Approach In Urban Katsina, Katsina State, Nigeria

L. A. S. Danbuzu, A. I. Tanko, U.A. Ibrahim and M. Ahmed
Department of Geography Bayero University Kano, Nigeria

Abstract: - The advancement of technology today, helps in the depiction of reality for a particular phenomenon. The use of Geographical Information Systems (GIS) as part of the organization helps in development, especially when it comes to analysis and the distribution of facilities within a given area. This paper attempted to map out and analyze the spatial distribution of Solid Waste Collection Points in Urban Katsina using GIS approach. The objectives used in achieving the aim are: To make an inventory for the solid waste collection points in Urban Katsina and to examine the type and patterns of the distribution. Data related to the list of the collection points were sourced from Katsina State Environmental Protection Agency (SEPA) and field survey; and GPS was then used for taking the coordinates (latitude and longitude) of the each solid waste collection point in the study area. Arc GIS 9.3 (version) was used to analyze the result showing that there are 741 collection points in Urban Katsina, from which only 96 (12.96%) are Legal (authorized) while all the other 645 (87.04%) are Illegal (Unauthorized). The paper also revealed that the amount of illegal disposal increases as you move from low to high density settlement areas, while the reverse is the case for refuse hips size. Meanwhile, areas with high population density have more legal collection points than areas with medium population density, with high clusters of illegal collection points around the medium density populated areas. The nearest neighbor analysis shows that both the legal and the illegal collection points, are R- values of 0.67, 0.64 and 0.89 respectively. The study concludes that there is clustering and randomness of the collection points' distribution. Therefore, the study recommends for more authorized collection points in the medium population density areas. And population should also be use as a criterion for facility allocation. Moreover, there is need for institutionalization of the use of GIS in waste management.

Keywords: *- Solid Waste, Collection Points, GIS, Distribution, Nearest Neighbor analysis.*

I.   INTRODUCTION

Solid Waste consists of everyday items that is used and then thrown away such as, product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, paint, and batteries. Wastes come from homes, schools, hospitals, and businesses (EPA, 2011). Man, in an attempt to satisfy his daily needs, engages in the production of goods and services. In the process waste is generated (Beede and Bloom, 1995). Virtually all aspects of man's productive activities involve the generation of waste (Muhammad, 2007). The way these wastes are handled, stored, collected and disposed of that can pose risk to the environment and to public health.

Solid waste generation is experiencing a rapid increase all over the world as a result of continuous economic growth, urbanization and industrialization. It is estimated that in 2006 the total amount of *municipal solid waste* (MSW) generated globally reached 2.02 billion tones, representing a 7% annual increase since 2003. It is further estimated that between 2007 and 2011, global generation of municipal waste will rise by 37.3%, equivalent to roughly 8% increase per year (Global Waste Management Market Report 2007).

Waste management is a global environmental issue; solid waste management in urban areas is one of major problems facing city planners all over the world. The problem is especially severe in most developing countries where poor planning and lack of adequate resources contribute to the poor state of municipal solid waste management (Obirih-Operah, and Post, 2002; Mato, 1999; Doan, 1998; Mwanthi *et al*, 1997). Solid waste management according to Ibrahim (2002) is the scientific way or established procedure and sanctioned legislation for the collection, transportation and disposal of waste products which is economically feasible and

environmentally viable. Warnless (2009) noted that waste management differs for developed and developing nations, urban and rural areas, for residential and industrial producers.

Urban Katsina, the capital of Katsina State, has been experiencing a population growth, since the creation of the state in 1987. As such there is increase in residential, commercial, industrial and institutional land uses leading to urban expansion. The simultaneous increase in population and settlement expansion of Urban Katsina has a direct effect on the increase in solid waste generation. According to Katsina Waste Management and Pollution Control (2004), 80% of waste generation in Katsina Metropolis is from household, commercial, institutional, construction and demolition wastes account for only 15%. The Katsina State Environmental Protection Agency (SEPA) has created designated refuse collection centers for community storage and evacuation. Despite of this, refuse litters the entire landscape. This made the Katsina State Department of Waste Management and Pollution Control (2004) to confess that there is improper allocation and distribution of solid waste collection points in urban Katsina, leading to negative setbacks which should be addressed. These are:

a. A lot of undesignated refuse dumps have been created especially on our main roads, making the area clumsy and create an eyesore. And improper waste disposal is another issue of concern and should be addressed.

b. Our drainages, gutters and other water passages were turn to be refuse collection centers thus causing flood during the rainy season and a vectors breading places sometimes lead to unpleasant odor due to stagnant of the water.

Zakariya'u (2010) also confirmed that the proliferation of illegal waste collection sites and indiscriminate dumping of refuse at any available space has now become a common scene. Moreover, the Katsina Waste Management and Pollution Control (2004) admitted that there is no available map showing the distribution of the refuse collection points in Urban Katsina. Thus, the map produced at the end of this study will be of vital importance to both planners and managers.

II   GIS AND SOLID WASTE MANAGEMENT

Technological development in computer science has introduced Geographic Information System (GIS) as an innovative tool in solid waste management including landfill process (Kontos *et al*., 2003). GIS combines spatial data (maps, aerial photographs, Satellite images, etc) with non spatial data including both the quantitative and qualitative. The role of Geographic Information Systems (GIS) in solid waste management is very large as many aspects of its planning and operations are highly dependent on spatial data. In general, GIS plays a key role in maintaining account data to facilitate collection operations; customer service; analyzing optimal locations for transfer stations; planning routes for vehicles transporting waste from residential, commercial and industrial customers to transfer stations and from transfer stations to landfills; locating new landfills and monitoring the landfill. GIS is a tool that not only reduces time and cost of the site selection, but also provide a digital data bank for future monitoring program of the site. It has taken an initiative to setup a GIS like ArcInfo, ArcView 3.2a and ArcGIS etc as key components for managing its information (Keir, 1997). Technological development in computer science has introduced geographic information (GIS) as an innovative tool in landfill.

According to Burrough, (1998), Geographic Information System (GIS) is a powerful set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world for a particular set of purposes. Smith *et al* (1987) argued that GIS is a database system in which most of the data are spatially indexed and upon which a set of procedures operated in order to answer queries about spatial entities in the database. It is a decision support system that involves the integration of s ati 1 referenced data in a problem solving environment. While Environmental Systems Research Institute (ESRI) California (1990), defined GIS as an organized collection of computer hardware, software and personnel to efficiently capture, store, update, manipulate, analyze and display all forms of geographically referenced information. GIS software allows law enforcement agencies to produce more versatile electronic maps by combining their crime databases of reported crime locations with digitized maps of the target areas (Sahu and Peeyush, 2011).

Thirumalai *et al.* (2010) developed an engineered design of solid waste collection using GIS with a vehicle tracking system and final disposal by composting with investment costs. The GIS was used to analyze existing maps and data, to digitize the existing ward boundaries and to enter data about the wards and disposal sites. The proposed GIS model for solid waste disposal would give information on the planning of bins, vehicles and the optimal route. In the case of disposal, composting would be a successful strategy to accelerate the decomposition and stabilization of the biodegradable components of waste in MSW.

GIS technology has also been documented in the United States. Montgomery County, Maryland has been using GIS since 1996 to enable users from different disciplines to access, share, and manage various data types for many purposes including solid waste management (Chen, 2004). The Geographical Information System (GIS) can provide an opportunity to integrate field parameters with population and other relevant data or

other associated features, which will help in selection of suitable disposal site. The technology can also provide ways for decision making during planning especially when it comes to solid waste collection and disposing.

III.   AIM AND OBJECTIVES

The main aim of this study is to map out and analyse the spatial distribution of solid waste collection points in Urban Katsina using GIS approach.

The objectives through which the aim of the research was achieved are as follows:
  i.   To make an inventory for the solid waste collection points in the study area
 ii.   To examine the type and patterns of the solid waste collection points

IV.   STUDY AREA

Urban Katsina is the capital of Katsina state; it is located between latitude 12^0 45^1N and13^0 15^1N, and Longitude 7^0 30^1 and 8^0 00E (fig 2). The location is at the extreme part of Northern Nigeria, some 30Km from the Nigeria-Niger border. The town and its immediate environs form the present study area. Urban Katsina comprises of two Local Government Areas, i.e. Katsina and (some parts of) Batagarawa Local Government Areas (Zayyana, 2010).
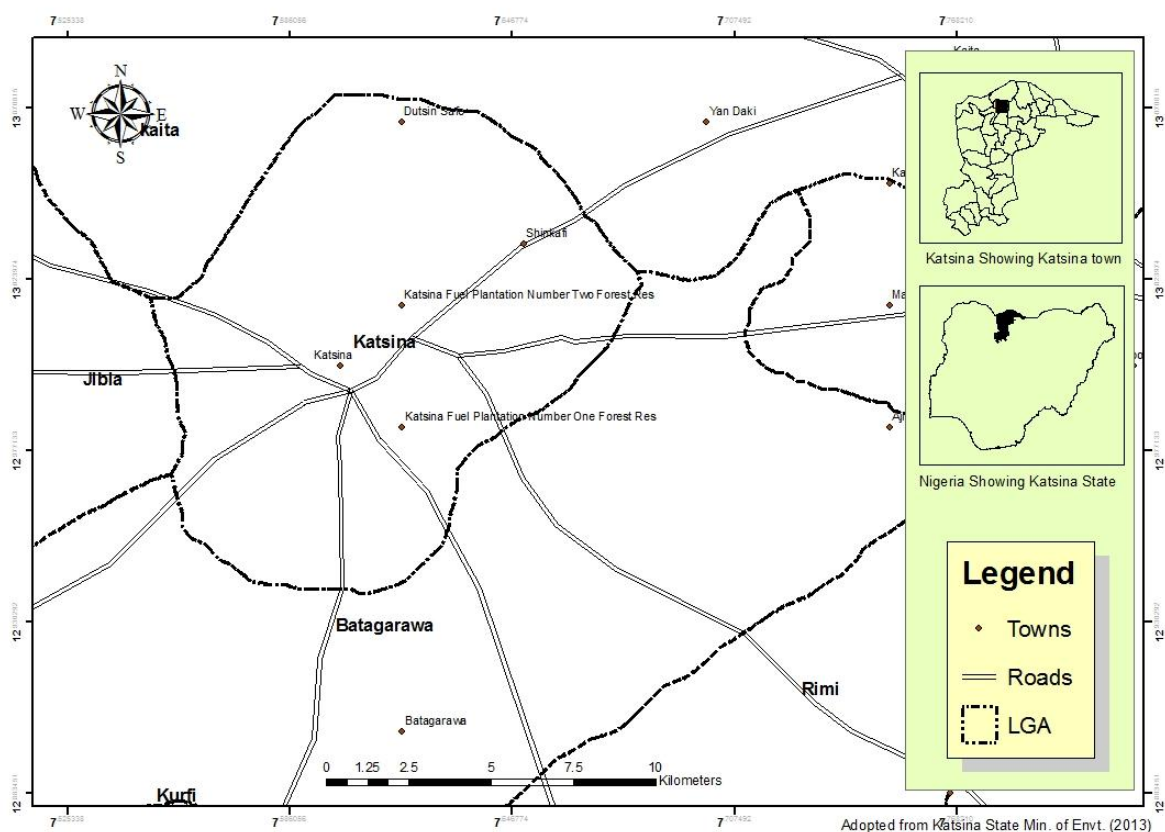
Figure 1: Showing Urban Katsina

Land use in the study area is dominated by urban activities, such as residential, institutional, commercial and industrial land uses, with few areas (mostly undeveloped) devoted farming activities. In addition to the major urban land uses mentioned above, other land uses such as livestock production and gathering are also carried out in the area. Residential area cover most part of the study area, different land uses such as commercial, institutional and educational can also be seen within the residential areas. *Sabuwar Unguwa* extension is the major area functioning as industrial layout. Industries such as steel rolling, packaging, beverages processing etc, are found in this area. Commercial activities happened to be growing very fast in the area.
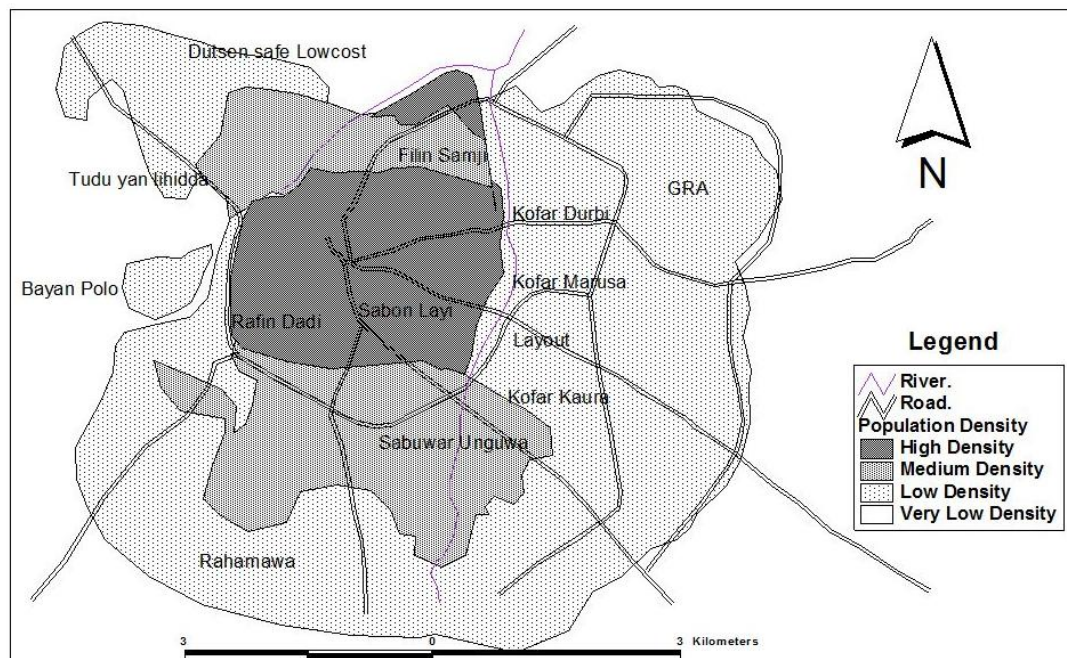
Figure 2: Urban Katsina Showing the Population Density

V. MATERIALS AND METHODS

Research tools
Global Positioning System (Garmin 76csx GPS model), Digital Camera, Google Earth Imagery, and GIS software (ArcGIS 9.3 version).

Method of data collection and Analysis
Ground Positioning System (GPS) was used to take the co-ordinates of the solid waste collection points, through which a database was created and used to record the coordinates, legality, locations and addresses of the collection points. A digital camera was also used to take pictures of some selected solid wastes collection points so as to show their type/nature.

Geo-Referencing and Digitization
Urban Katsina was zoomed and extracted from satellite imagery, Google Earth imagery specifically. The extracted image was then imported to Geographic Information System (GIS) software, specifically ArcGIS 9.3, and then geo-referenced and digitized to produce a digital maps. Population density map was produced base on field experience and satellite imagery observation. Land uses and housing pattern were used as guide.

Distribution of the Solid Waste Collection Points
The coordinates of the solid waste collection points taken during the fieldwork were imported into the ArcGIS 9.3 as text file, then converted to shape file to show the spatial distribution on the digital maps as well as the satellite imageries too. Points (dots) were used to show the solid waste collection points; the types of collection points as well as the legality were shown using different symbols (points) in terms of shape and color variations.

VI.   RESULT AND DISCUSSIONS

Solid Waste Distribution

The Solid Waste Collection points in Urban Katsina irrespective of whether legal (authorized) or illegal (unauthorized) have been located and numbered to come up with their total number as 741 distributed across 78 areas (locations) in the area.
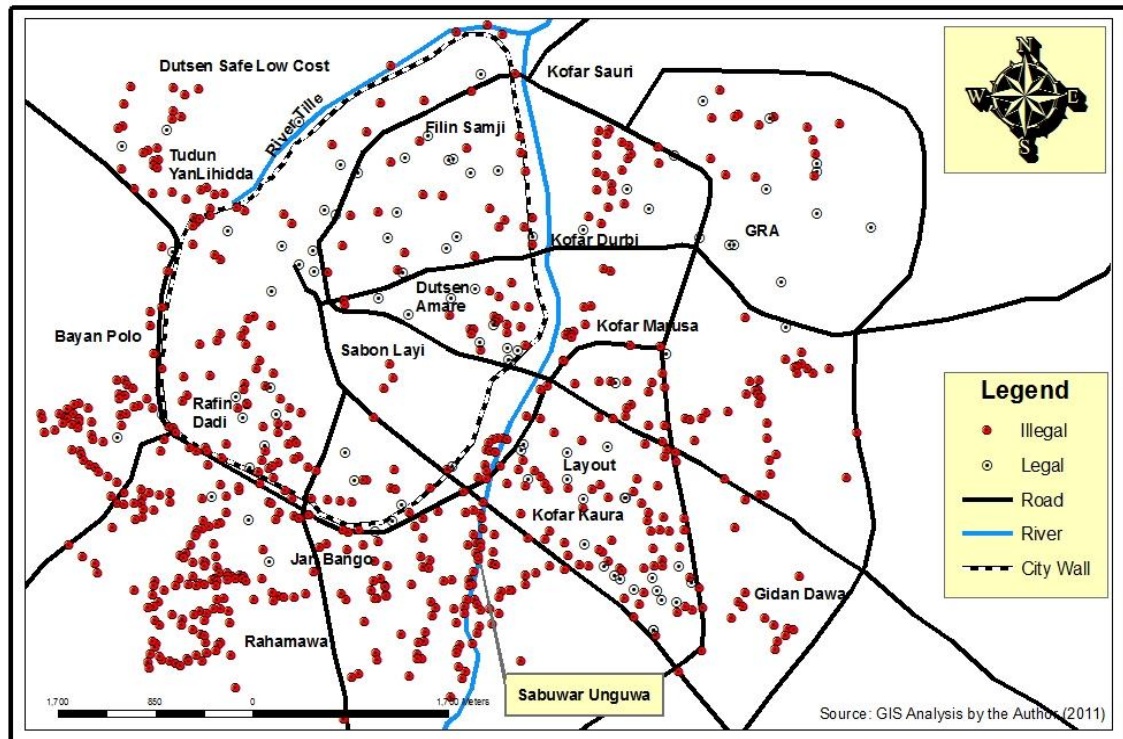
Figure 3: Showing the Distribution of Legal and illegal Solid Waste Collection Centers in Urban Katsina

The Spatial Distribution of the legal and the illegal collection points is shown below on figure 4, the illegal collection points are more concentrated in the low-medium density populated part of the Urban Katsina. The high population density areas have fewer collection points but larger hips of refuse as no space is provided for indiscriminate waste disposal all over the landscape as in the case of the low and medium density settlement areas (observed during the field work). The illegal (unauthorized) solid waste collection points can also be found along the old city wall as well as along water channels most especially the two major rivers – River Ginzo and River Tille.

From the analysis in the city wall there are reasonable distributions of legal than the illegal dumpsites even though, to some extend at the South-western part of the old-city there are few number of illegal dumpsites especially at the *Rafin Dadi* area while at the Eastern part of the city wall particularly along the *Dutsen Amare* area. While outside the old-city, at the South western part where there are clustering of illegal dumpsite in the area, these includes; part of *Rahamawa* and *JanBango*. Furthermore, at the South eastern part, areas like *Kofar Kaura, Gidan Dawa* and part of layout which are situated at the eastern part of the area, *Kofar Durbi* and part of GRA at the North eastern part of the area are having fewer illegal collection points.

The settlement pattern of Urban Katsina has been characterized into two categories base on population density. The first category is the high to medium density settlements which include the *Cikin Birni* (Old City) and their peripheral areas respectively. While the second category is the low density settlements of Government Reservation Areas (GRA), *Kofar Marusa* Low Cost and the New Layout among others outside the city wall. The *Cikin Birni* which is the old city and the most densely populated area in the metropolis consists of buildings closely packed together thus providing no space for indiscriminate waste disposal all over the landscape unlike in the case of the low and medium density settlement areas.

Moreover, the characteristics of solid waste collection points between high density and medium to low density areas is different in the sense that most of the collection points within former are over used, as large volumes of refuse hips were observed during fieldwork (2011) at both the authorized and the unauthorized

disposal sites, most especially around the core *Cikin Birni* (Old City). *Sabuwar Unguwa* being a medium density urban extension and the major area functioning as industrial layout with industries such as steel rolling, packaging, beverages processing etc accommodates 73 solid waste collection points of the study area of which all are unauthorized as not even a single one is provided by the respective agency -- The State Environmental Protection Agency (SEPA), and this is the highest number across the whole locations making up to 9.85% of the entire 741 collection points.

Out of the 741 Solid Waste Collection Points only 96 (12.96%) are legal (authorized), while all the other 645 (87.04%) are illegal (unauthorized). The State Environmental Protection Agency (SEPA) classified them into that (legal and illegal) base on the nature of their provision. The collection points provided jointly or completely by the agency are termed as legal ones, while the collection points (sites) where people are just disposing their household refuse without authority from SEPA are illegal. The former are of two categories – A three sided walled site built on a squarely shaped piece of land called Refuse Collection Center (RCC) and a moveable metal container called Roll-on Roll-up (*Roro*). While the later are unauthorized sites like open space, water channels, roadside, uncompleted buildings among others (see plate 1, 2 and 3).

The 95 legal (authorized) solid waste collection points in the study area are made up of two types of collection facilities: Roll-on Roll-up (*Roro*) and Refuse Collection Centers (RCC) as stated earlier, the former are 28 (29.47%), while the later are 67 (70.53%) as shown on table 4 above. The Refuse Collection Centers (RCC) is more evenly distributed within the city wall than Roll-on Roll-up (*Roro*). The later is made available adequately at areas like Government Reservation Area (GRA), Layout, Kofar Kaura, Dutsen Safe Low Cost and the likes (see figure 4).

The State Environmental Protection Agency (SEPA) stated that the Roll-on Roll-up (*Roro*) are normally fixed at places that are not appropriate for the Refuse Collection Centers (RCC) such as roadside, near shops or other form of public activity area. However, it can also be found very close to the Refuse Collection Centers (RCC) serving as its extension when necessary.
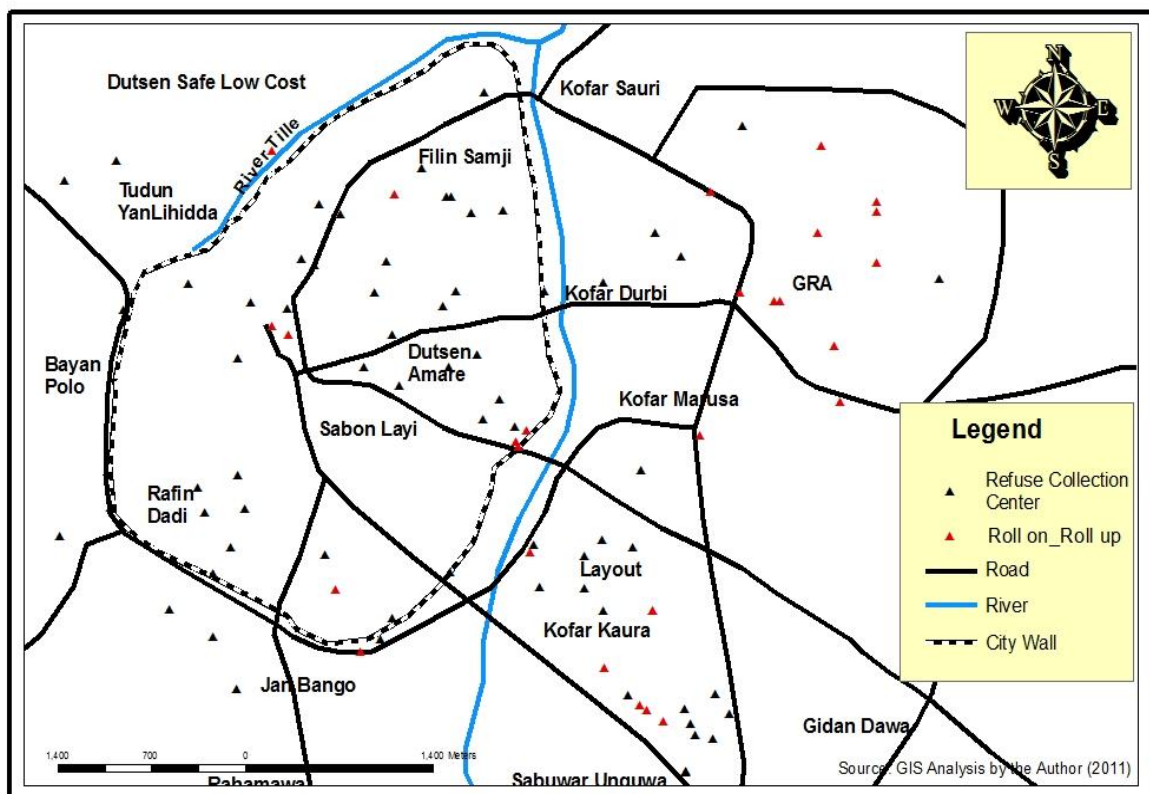

Figure 4: Showing the Distribution of Legal Solid Waste Collection Points by Type

In addition to the State Environmental Protection Agency (SEPA) that is responsible for managing entire waste of not only urban Katsina, but Katsina State, there are also 4 private waste management agencies that alongside with SEPA manages the solid waste in Urban Katsina. These are:

1. Immaculate Company; responsible for provision of household refuse storing facility as well as transporting the refuse to dispose at collection its clients. This company is responsible for managing the entire household refuse generated at Barhim Housing Estate, behind Katsina State Secretariat, and some part of Umaru Musa Yar'Adua University.
2. Express Environmental Services; operates similar services as Immaculate Company above, but for the Federal College of Education and Diamond Bank branches in urban Katsina.
3. Tri-Dynamic Waste Management Company; operates similar services as Express Environmental Services above for its respective clients. These include: Federal Medical Center and the Administrative Blocks of Umaru Musa Yar'Adua University. The company also operates special services such as general when invited among others.
4. Annur Cleaners; operation is mainly special services such as general cleaning, soak-away evacuation, spraying, fumigation, etc.
   The State Environmental Protection Agency (SEPA) had set up some criteria for selecting site to fix a legal (authorized) collection points, these are:

❖ The population of the area must be taken into consideration before fixing a solid waste collection point in an area so as to avoid underuse by fixing a multiple collection points in a very low population density area. Because it is but a waste of resource as there are likely other shareable collection points in the neighboring areas;

❖ The community leaders of the area which comprises the elders and traditional leaders must be contacted by the State Environmental Protection Agency (SEPA) and then ask them to make a formal request for solid waste collection point in their area from the agency, or in some cases require that the community should make the request from their local government; and

❖ The site must also be owned by the government.

Plate 1: Roll-On Roll-Up (Roro) at Unguwar Yari, CPS Junction


Plate 2: A Refuse Collection Center (RCC) at Kofar Yandaka, near Kofar Yandaka Gate

Plate 3: Roll-On Roll-Up (Roro) at Kofar Soro, near Magajin Gari's Office

Spatial patterns using Nearest Neighbor Analysis of the Solid Waste Collection Points

        The spatial patterns were performed using the nearest neighbor analysis in the ArcGIS. The analysis were done using 3 different stages, these are the general collection points (both legal and illegal). The general distribution from the analysis shows that (figure 5) there is clustering with the R-value of 0.67 and showing the Z-score of -17.24, while the scale were ranges within the critical value of -2.58 and the significant level of 0.01. The result indicates that there is less than 1% likelihood that this clustered pattern could be the result of random chance.
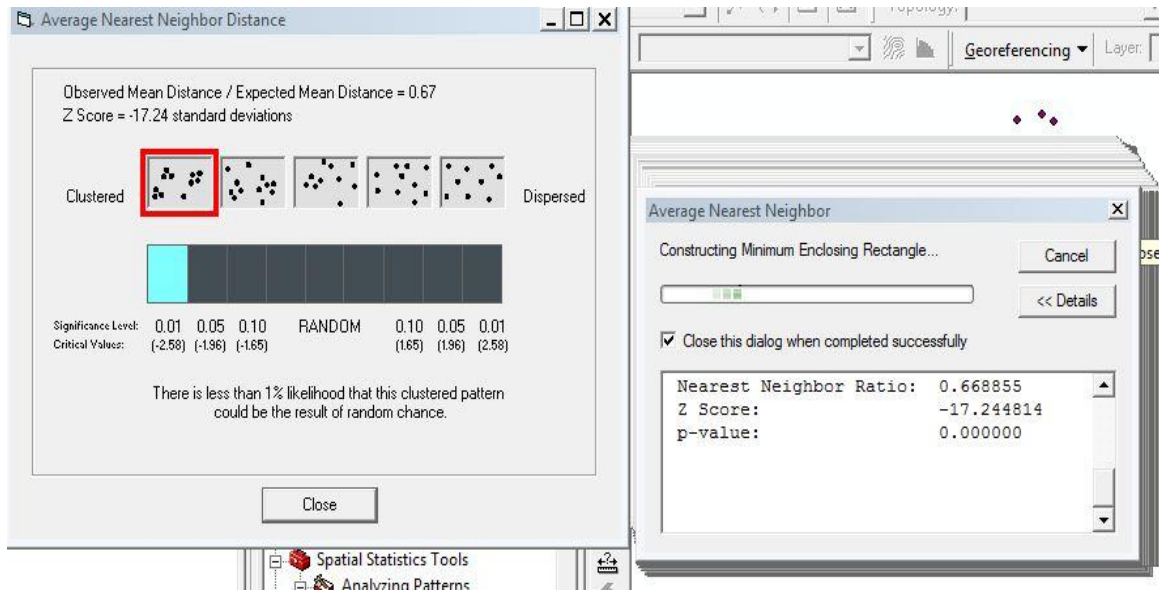
Figure 5: Showing the nearest neighbor analysis of the Collection Points

        The distribution of the illegal solid waste collection centers (Figure 6) shows that there is clustering with the R-value of 0.64 from the nearest neighbor analysis with the Z score of -17.62 while the critical values of -2.58. The significant level of 0.01 and there is less than 1% likelihood that this clustered pattern is as the result of random chance.
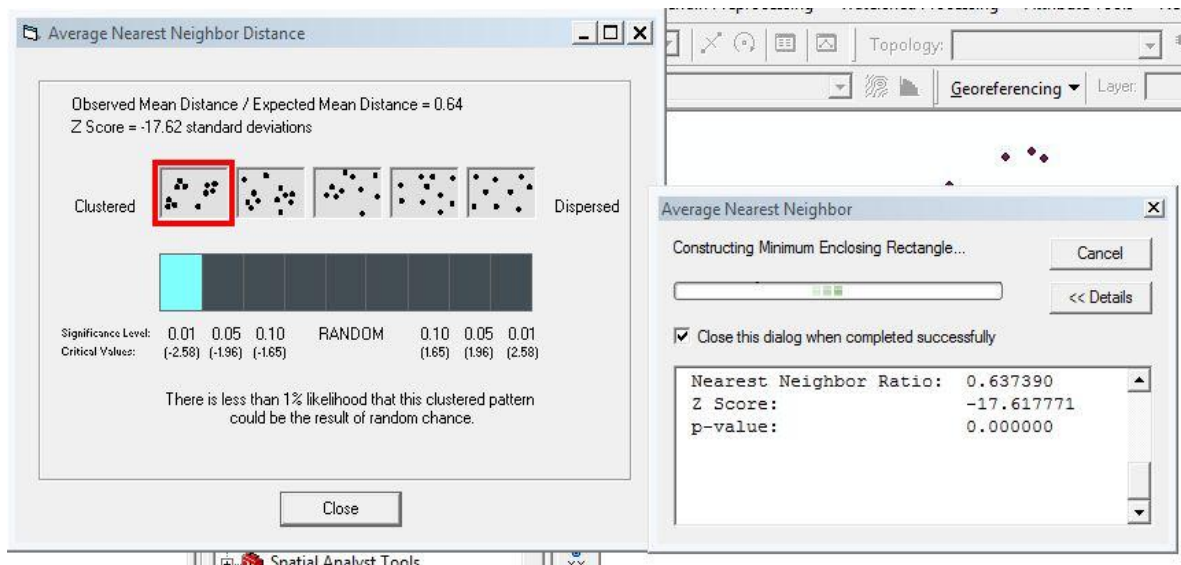
Figure 6: Showing the nearest neighbor analysis of the Illegal Collection Points

        The distribution of legal Collection Points in the area (Figure 7) shows that the R-value of the nearest neighbor analysis of 0.89 with the Z scores of -2.03 which is an indication of weak random, that is it's not properly clustered, however the critical values of -1.65 from the scale and with the significant level of 0.05. There is less than 5% likelihood that this clustered pattern is as a result of random chance.
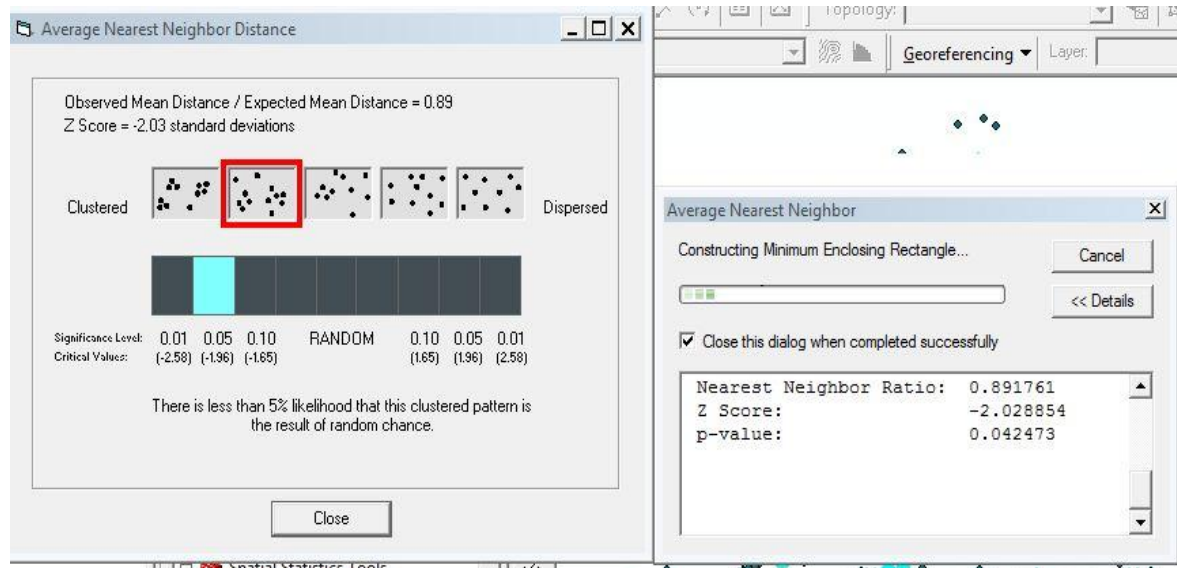
Figure 7: Showing the nearest neighbor analysis of the Legal Collection Points

Conclusion and Recommendations

The use of Geographic Information System in analyzing a spatial analysis especially when representing the real world phenomenon, helps in the integrating and simplifying the interpretation of a distribution of a facilities especially the visual analysis and interpretations. GIS play a significant role in Solid Waste Management System; it helps the Managers in database creation and the stakeholders to know the exact areas where there is need more attention rather than concentrating on a particular area.

This paper attempted to analyze the distributions of the Solid Waste Collection Points in the Urban Katsina. The result shows that areas with the highly density population are more served with the Solid Waste facilities, while there are concentration of illegal dumpsites in the Medium density populated areas and volumes and hips of solid waste are more in the old-city.

Solid waste for both legal and illegal are more clustered, and the illegal alone is showing a clustering in the distribution when analyzing it using Nearest neighborhood analysis while the distribution of the Legal dumpsite in the area shows a closely to randomness in the area, this to say population is not considered during the distribution of Solid waste collection facilities. Therefore, the study recommend for;

➤ Considering population as a criterion for the allocation of the Collection centers.
➤ GIS for solid waste collection needs to be institutionalized. It needs to be introduced to the Contractors, municipal and city councils officials in order to ease information management for both spatial and non-spatial data.
➤ GIS can be used as a planning tool for solid waste management. On the other hand, the spatial and non-spatial data should be updated from time to time in order to support decision making.

REFERENCE

[1] Chakraborty D. Sahoo Rabi N. (2007): *Fundamentals of Geographic Information System* published by Vinod Vasishtha for Viva books Private Limited, 4737/23 New Delhi
[2] Chen , Lian. (2004): *An Enterprise Geodatabase: Montgomery County.* Maryland: ESRI 2004 Users Conference, Paper Number 1674.
[3] Doan, P.L. (1998): *Institutionalization of Household Waste Collection*: Habitat International. 22, 27-39.
[4] ESRI (2001): *Getting to Know Arc GIS Desktop.* Redlands: ESRI.
[5] Global Waste Management Market Report (2007): *Global Waste Management Market Assessment.* Accessed 1/12/2011 from http://keynote.co.uk/market-inteligence/view/
[6] Ibrahim, A. M. (2002): *Introduction to environmental problems and management*. Kano: WADEC.
[7] Keir, A. (1997): *The Role of GIS in the Privatization of Malaysia Solid Waste Management,* 6th ERSI South Asia Users Conference, 8-10 September, Penang, Malaysia.
[8] Kontos, T. H. D. (2003): *Siting MSW Landfills in Lesvos Island with a GIS-Based Methodology:* waste Management and Research, 21 (3), 262-277.
[9] Lambi, C. M. *et al.* (2001): *The February 2000 floods in Downtown Yaoundé.* Reading in Geography. Bamenda: Unique Printers.

[10] Lukman, S. (1998): *Solid Waste Disposal in Bonny Camp and Ikeja Military Cantonment Lagos.* Unpublished B.Sc Project, Department of Geography, NDA Kaduna.

[11] Mato, R. A. M. (1999): *Environmental Implications Involving the Establishment of Sanitary Landfills in Municipalities in Tanzania:* The case study of Tanga municipality. Resource, conservation and recycling. 25 1-16.

[12] Muhammd, A. M. (2007): *An Analysis of Solid Waste Generation and Management in the Federal Capital City Phase I, Abuja, Nigeria.* A Ph.D Thesis submitted to the Department of Geography, Bayero Univeristy, Kano.

[13] Mwanthi, M. A., Nyabola, l. O. and Tenambergen, E. D. (1997): *The Present and Future Status of Municipal Solid Waste Management in Nairobi.* International Journal for Environmental Health Research, 7, 345-353.

[14] Obirih-Opereh, N. and Post, J. (2002): *Quality aassessment of public and private Modes of Solid Waste Collection in Accra, Ghana.* Habitat International, 26, 95-112.

[15] Sahoo R and Peeyush S. (2011) *Effective crime control using GIS.* www.gisdeve*lopment.net*

[16] Smith T.R., Menon, S., Starr, J.E., (1987): *Requirement and Principles for the implementation and construction of large scale geographic information system*. *International Journal of   Geographic Information System*

[17] Thirumalai E. K., Mohaideen J. A., Srinivasan S, and Sundaram V. L. K.(2010*): Optimum Municipal Solid Waste Collection Using Geographical Information System and Vehicle   Tracking   for Pallavapuram Municipality*. **F**irst published on April 14, 2010

[18] Warnless (2009): *Solid Waste Management*. Accessed 04-20-2010 from http://www.warnless.com/org

[19] Waste Management and Pollution Control (2004): *Annual progress report*. From January to December, 2004.

[20] WikiAnswers (2011): *Why do we need to find bulk density of solid waste?* Accessed 3/13/2011 from http;//wikianswers.com/Q/

[21] Zakariya'u, M. M. (2010): *Problem of Solid Waste Management in Funtua Town.* An M.Sc research proposal Submitted to the Department of Geography, Bayero University, Kano.

[22] Zayyana, Y. I. (2010): *Some Aspects of Urban Farming in Urban Katsina, Katsina State.* An Unpublish M.Sc Thesis Submitted to the Department of Geography, Bayero University, Kano.

Gain Enhancement in Microstrip Patch Antennas Using Metallic Rings

Arvind Kumar[1], Mithilesh Kumar[2]

[1,2]*Electronics Engineering Department, University College of Engineering, Rajasthan Technical University Kota, Rajasthan, India)*

Abstract : This paper presents a novel approach for gain enhancement in microstrip patch antennas using metallic rings. The design forces conversion of the surface wave energy into the space wave energy by scattering of surface waves. The scattering of surface waves created by introducing the metallic ring around the metal patch at a distance of d_1 from the circumference of the metal patch and width of metallic ring is d_2. If another metallic ring is introduced it is at distance of d_3 from the circumference of the first metallic ring and width of it is d_4. Initial values of the metallic rings width d_2 and d_4 are one-quarter of free pace wavelength $(d_2=d_4=4\lambda_0/16)$ and spacing between metal rings and metal patch d_1 and d_3 are one-sixteen of free space wavelength $(d_1=d_3=\lambda_0/16)$ are selected. Using CST Microwave studio, the results of the patch antenna without metallic rings and patch surrounded by metallic rings are simulated and measured results validates proposed design concept. This microstrip patch antenna operates at the 5.8 GHz frequency suitable for WLAN applications. By this metallic rings approach there is enhancement in the gain of microstrip patch antenna about 6.7 dB as compared to conventional one (without metallic rings).

Keywords : Gain; Microstrip Patch Antennas; Return Loss; Surface waves.

I. INTRODUCTION

Microstrip patch antennas is most widely used in recent wireless communications devices because of some advantageous features such as small size and light weight, cost effective, compact and planner structure, easy interconnection with solid-state devices. The microstrip patch antennas have some drawbacks like somewhat lower gain limited to 4-8dB, surface wave losses [1] when substrate thickness >1mm and narrow bandwidth. Several techniques are introduced to improve these disadvantages. The performance of microstrip patch antennas in terms of gain and directivity is degraded by surface wave losses, dielectric losses and conductor losses. Over the years a lot of work is carried out to overcome these three types of losses dielectric and conductor losses is minimized by using better quality of the substrate and conducting materials. Surface wave losses is reduced by using high impedance surfaces such as electromagnetic [2] and photonic band gap structures [3] that allow and forbid the electromagnetic waves in certain frequency band. Some other methods that reduces the surface wave losses are by using hybrid substrates [4], by using superstrates [5], surface mounting horn [6] etc. but disadvantageous features of these techniques is fabrication difficulties because these techniques requires a large number of holes and vias. In this paper we introduce a novel approach for gain enhancement in microstrip patch antennas by suppressing surface wave propagation in the lateral directions. Metallic rings are placed coplanar to radiation patch so microstrip patch antenna design by metallic rings approach for gain enhancement is very simple in construction as compared to previous gain enhancement techniques.

II. PROPOSED ANTENNA DESIGN

When electromagnetic waves incident on the interface that have small dimensions as compared to incident wave then EM waves are scattered from that interface [7-9], scattered energy radiate in all directions and some of in the directions of incident wave if this energy combined with incident wave either in phase or out of phase causes constructive or destructive interferences and rest of scattered energy that is not combined is may

feedback to microstrip cavity and patch reradiate this energy. If this concept is applied to design of microstrip patch antennas by placing metallic rings around the radiation patch to scatter the surface waves. Scattered energy is converted into the space wave energy and enhances the gain of microstrip patch antennas. The geometry of proposed design is shown in the Fig. 1. It is shown that radiation patch on the top of grounded dielectric substrate and it is surrounded by two metallic rings. Metallic rings are in the same plane as
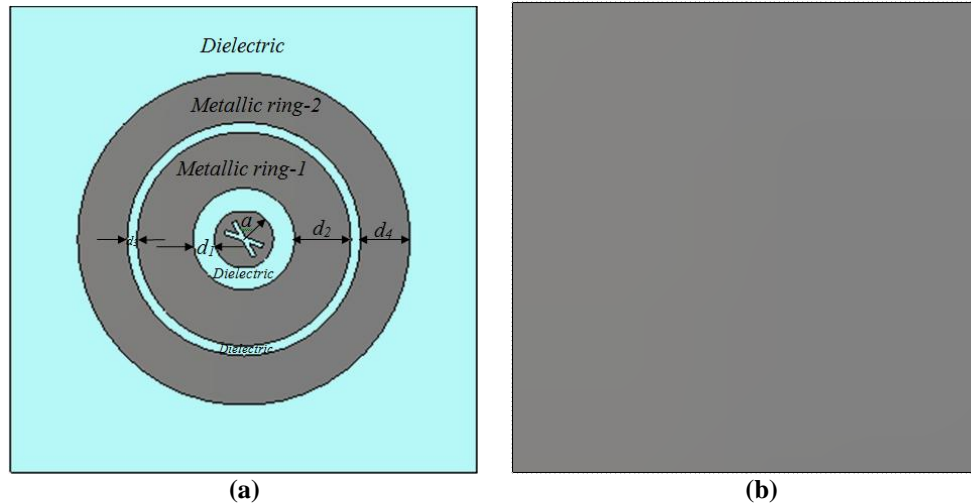
Figure 1. (a) Top view (b) Bottom view of proposed antenna, substrate and ground plane size is 100×100 mm^2 and a=6.3mm.
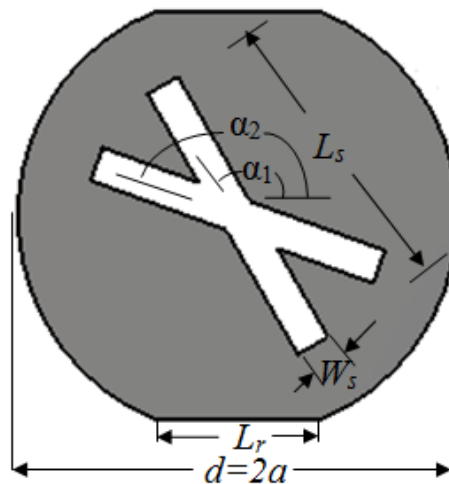
Figure 2. Geometry of circular microstrip patch antenna. Design frequency 5.8 GHz and L_s=8.6 mm, W_s=1 mm α_1=60°, α_2=120°, L_r=4.62 mm, d=12.6mm.

radiation patch and thickness of metallic rings is also same as radiation patch is 0.01mm. The shape of metallic rings depends upon the shape of microstrip patch (circular, square, rectangular etc.). First metallic ring is at d_1 distance from the circumference of metal patch and having width d_2. Second metallic ring is at d_3 distance from the circumference of first metallic ring and having width d_4. Initial values of the metallic rings width d_2 and d_4 are one-quarter of free pace wavelength (d_2=d_4=$4\lambda_0/16$) and spacing between metal rings and metal patch d_1 and d_3 are one-sixteen of free space wavelength (d_1=d_3=$\lambda_0/16$) are selected. Values of d_1, d_2, d_3, d_4 are optimized accordingly that satisfy the maximum gain as a criterion. Optimized values d_1=$1.425\lambda_0/16$, d_2=$3.716\lambda_0/16$, d_3=$0.652\lambda_0/16$ and d_4=$3.283\lambda_0/16$ that are used in simulation and fabrication of proposed design. A parametric variation is illustrated in the end of this paper to find out the optimized values.

III. GAIN AND BANDWIDTH

In this microstrip patch antenna design, a circular microstrip patch [10] designed on FR-4 substrate (relative permittivity of ε_r=4.1) with thickness 1.5 mm. Geometry of circular patch shown in Fig. 2. There are two diagonal slots that provide good impedance matching. The proposed design is simulated using CST Microwave studio [12] and results for both antennas are shown in the same graph for comparison. The S_{11} characteristic is shown in Fig. 3. Dashed line is for antenna-1 (circular patch without metallic rings) and solid line for antenna-2 (circular patch with metallic rings). E-plane radiation pattern of gain for both antennas is shown in Fig. 4, dashed line for circular microstrip patch without metallic rings and solid line for circular microstrip patch with metallic rings at design frequency 5.8 GHz. From Fig. 4 it is observed that antenna-2 (patch with metallic rings) have more directional radiation pattern as compared to antenna-1 (patch without
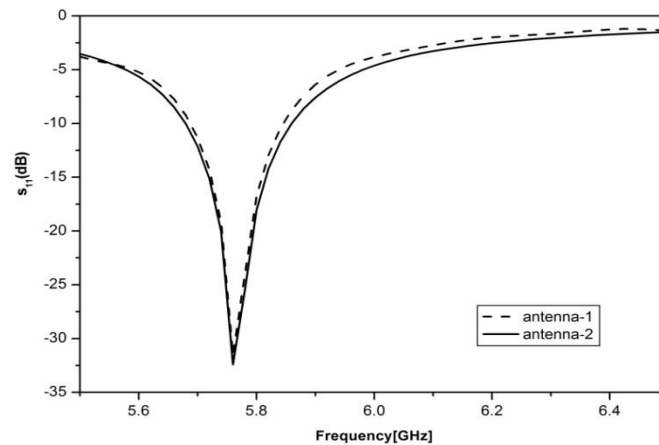
Figure 3. Simulated results of S_{11} of circular patch without metallic ring (dashed line) and with metallic ring (solid line).
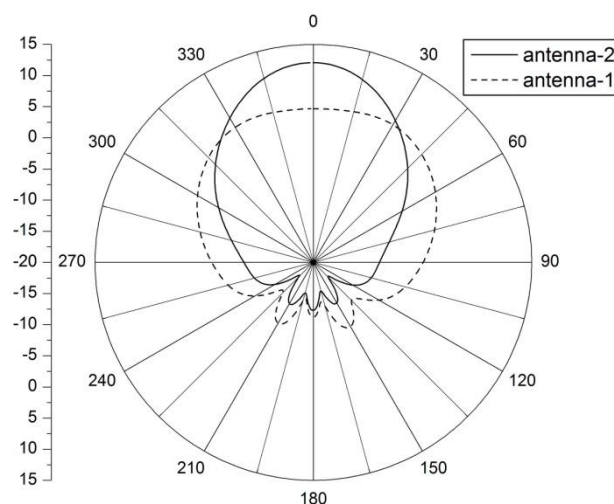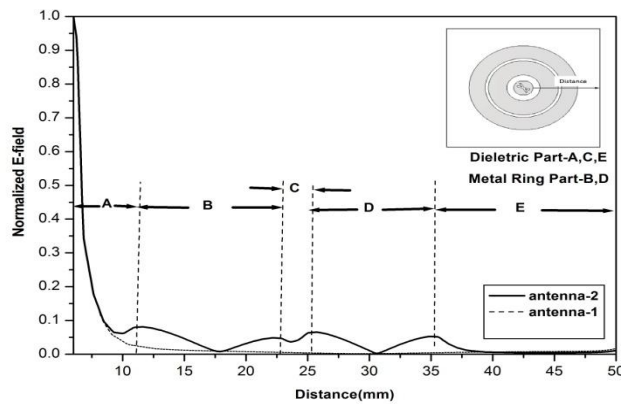

Figure 4. Radiation pattern (in decibels) for circular patch without metallic rings (dashed line) and circular patch with metallic rings (solid line).

metallic rings). Circular patch without metallic rings attain 5.5 dB gain at 5.8 GHz and circular patch with metallic rings attains 12.2 dB gain at same frequency 5.8 GHz. Proposed design also have same radiation pattern of gain in H-plane. So there is enhancement of gain in both E and H planes about 6.7 dB at 5.8 GHz by using metallic rings. Fig. 5 shows electric field intensity on the top surface of both antennas and it can be observed that field intensity in antenna-2 is higher as compared to the antenna-1 due to metallic rings. The normalized E-field intensity in the substrate for both antennas from the
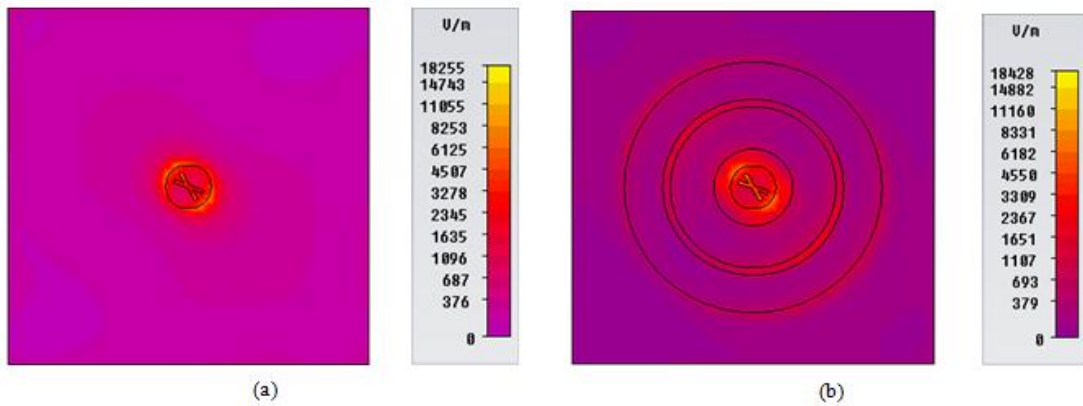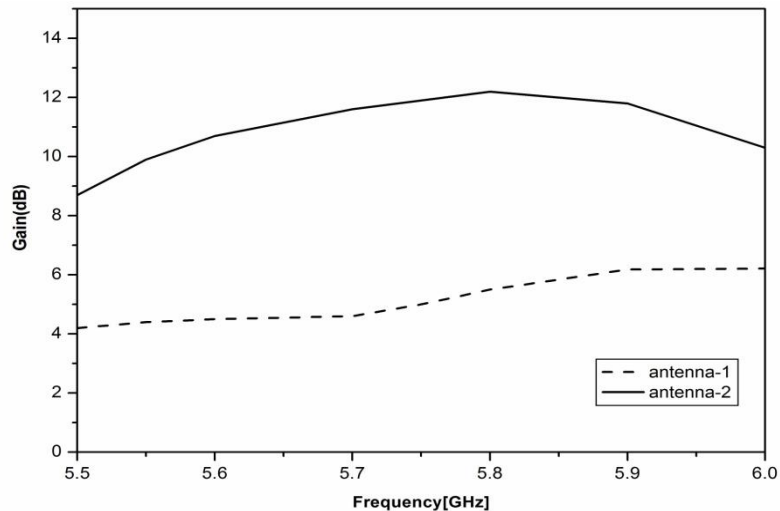
Figure 5. Electric field intensity on the top surface of the circular microstrip patch, metallic rings and substrate. (a) antenna-1 (without metallic rings) (b) antenna-2 (circular patch surrounded by metallic rings).

Figure 6. E-field normalized magnitude in the substrate for circular patch without metallic rings (dashed line) and with metallic rings (solid line).

edge of the radiation patch to the end of the substrate is shown in Fig. 6. Dashed line is for patch without metallic rings and solid line for patch surrounded by metallic rings. It can be observed that the field intensity on surface of antenna-2 and in the metallic ring part is higher than the field intensity in the antenna-1 or without metallic ring part and as seen from the graph field intensity is maximum in the radiation patch and it decreases as move away from it, but it gets peak at the edges of metallic rings this shows the EM-waves are scattered from the metallic ring and surface wave is converted into space waves and this is the reason of gain enhancement.

Figure 7. Frequency response graph of the gain for circular patch without metallic rings (dashed line) and with metallic rings (solid line).

Electric field intensity of antenna-2 is eight to nine times higher as compare to antenna-1and from the several simulations it is observed that whenever there is higher field intensity, antenna exhibits higher gain. Frequency response graph of the gain is shown in the Fig. 7, circular patch without metallic rings is shown by dashed line and for circular patch with metallic rings is shown by solid line and the antenna-2 (patch with metallic rings) achieves average gain of 10.88 dB in the frequency range of 5.5–6 GHz and in the same frequency range circular patch without metallic ring have average of 5.2 dB gain. Hence patch with metallic ring have higher average gain as compared to patch without metallic ring. In order to validate proposed design concept, proposed antenna was fabricated and photograph of fabricated antenna is shown in Fig. 8. Measured results of S_{11} is shown in Fig. 9, simulated and measured results are shown in the same graph for comparison and there is marginal shift in resonant frequency 5.75 GHz to 5.78 GHz in measured results in comparison of simulated results, so there is good agreement between measured and simulated results.
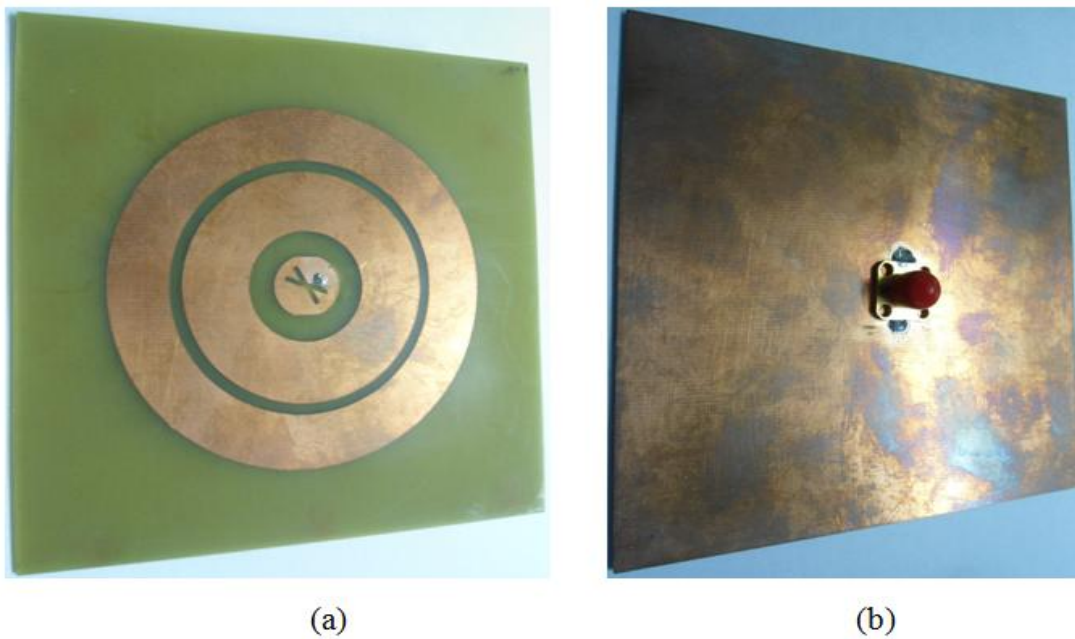

(a)   (b)

Figure 8. Photograph of fabricated antenna (a) Front (b) Back view

(a)   (b)
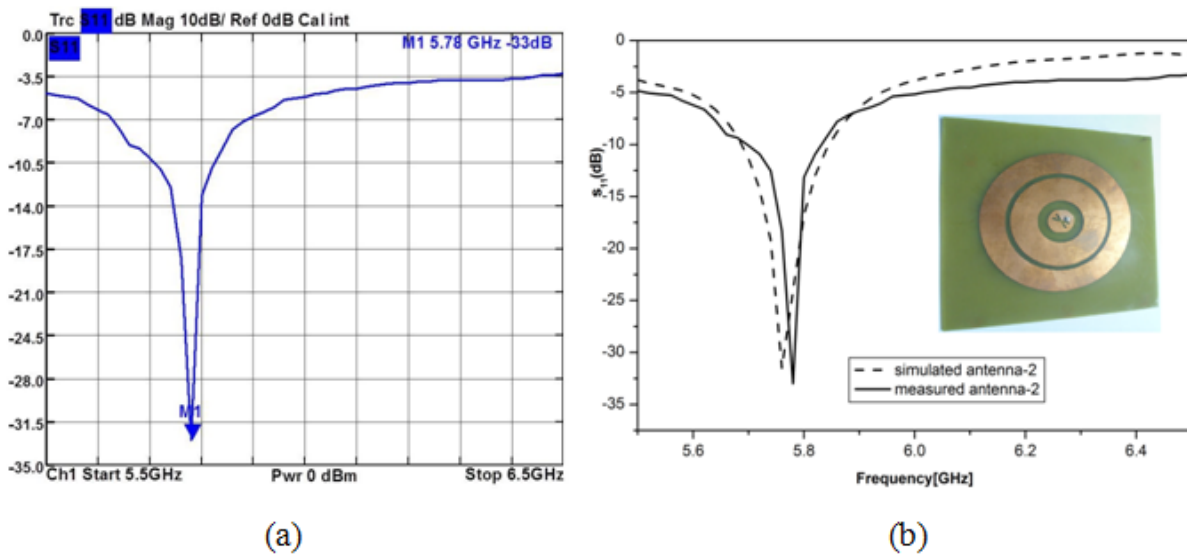
Figure 9. Measured results (a) VNA screen output (b) Comparison of measured and simulated results

IV. MAXIMUM GAIN

The parametric variation in the metallic ring width d_2 and d_4, and its spacing d_1 and d_3 were performed to determine the optimal values of d_1, d_2 and d_3, d_4 using the maximum gain as a criterion. The gain was calculated first for values of d_1 and d_2 from $0.0625\lambda_0$ to $0.25 \lambda_0$ in steps of $0.0625\lambda_0$. Fig. 10 depicts the maximum gain as a function of d_1 and d_2 and graph shows that gain was calculated as function of d_1 for different values of d_2. From the Fig. 10 it is observed that the maximum gain is achieved when d_2 equals four times of the one by sixteen of free space wavelength and it flat for all values of d_1 so choose the minimum value of d_1, d_1 equals to one by sixteen of free space wavelength. So optimal values are $d_1=\lambda_0/16$ and $d_2=4\lambda_0/16$ that shows maximum gain. Values of d_1 and d_2 can be optimized accordingly that satisfy maximum gain as criteria.
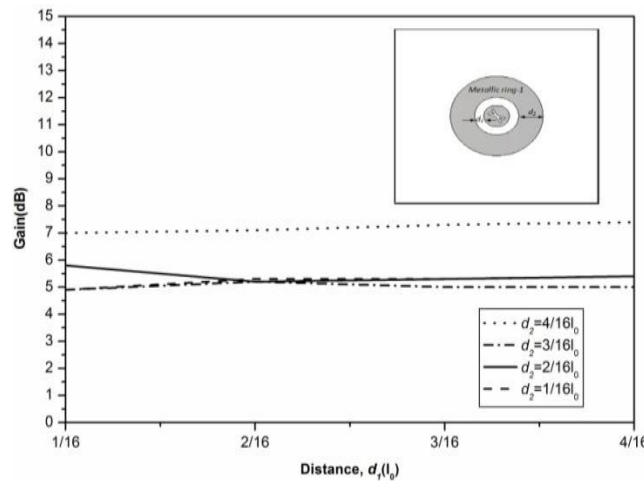

Figure 10. Maximum gain for as a function of d_1 and d_2 (d_1 and d_2 are function of free space wavelength $\lambda_0=l_0$).
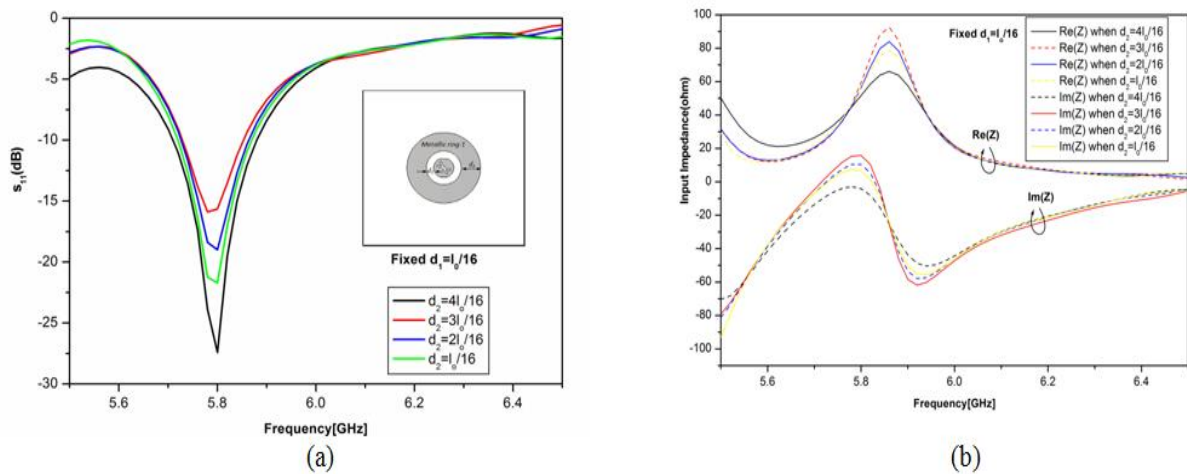

Figure 11. (a) S_{11} Graph (b) Impedance Graph for fixed value of d_1 and variation in d_2 (d_1 and d_2 are function of free space wavelength $\lambda_0=l_0$).

Fig. 11(a) shows S_{11} graph for fixed value of d_1 and variation in d_2 from $0.0625\lambda_0$ to $0.25 \lambda_0$ in steps of $0.0625\lambda_0$. Fig. 11(b) shows input impedance graph for fixed value of d_1 and variation in d_2 from $0.0625\lambda_0$ to $0.25 \lambda_0$ in steps of $0.0625\lambda_0$. So fixed d_1 and d_2 at $d_1=\lambda_0/16$ and $d_2=4\lambda_0/16$ and another metal ring is placed around the first metal ring at distance of d_3 and width d_4 and to find the optimal values of d_3 and d_4 a parametric variation is performed satisfying maximum gain as a criteria. The gain was calculated for values of d_3 and d_4 from $0.0625\lambda_0$ to $0.25 \lambda_0$ in steps of $0.0625\lambda_0$. Fig. 12 shows the maximum gain as a function of d_3 and d_4 and fixed d_1 and d_2 at $d_1=\lambda_0/16$ and $d_2=4\lambda_0/16$, graph shows that gain was calculated as function of d_3 for different values of d_4. From the Fig. 12 it is observed that the maximum gain is achieved when d_4 equals three times of the one by sixteen of free space wavelength and it almost flat for all values of d_3 so choose the minimum value of d_3, d_3 equals to one by sixteen of free space wavelength. So optimal values are $d_3=\lambda_0/16$ and $d_4=3\lambda_0/16$ that shows maximum gain. Values of d_3 and d_4 can be optimized accordingly that satisfy maximum gain as criteria.
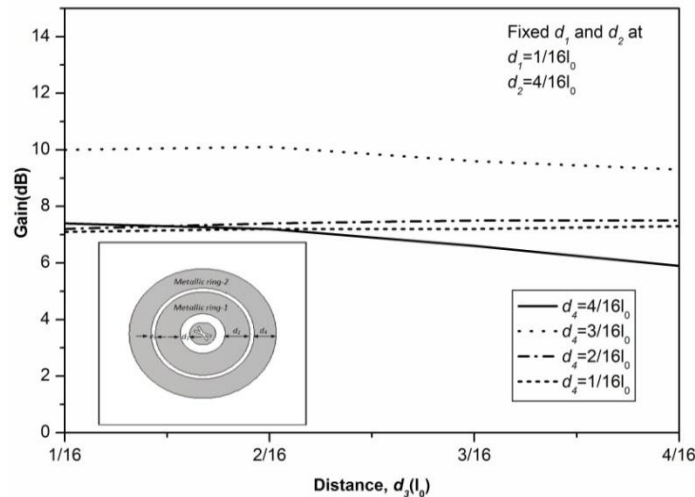
Figure 12. Maximum gain for as a function of d_3 and d_4 (d_3 and d_4 are function of free space wavelength $\lambda_0 = l_0$).
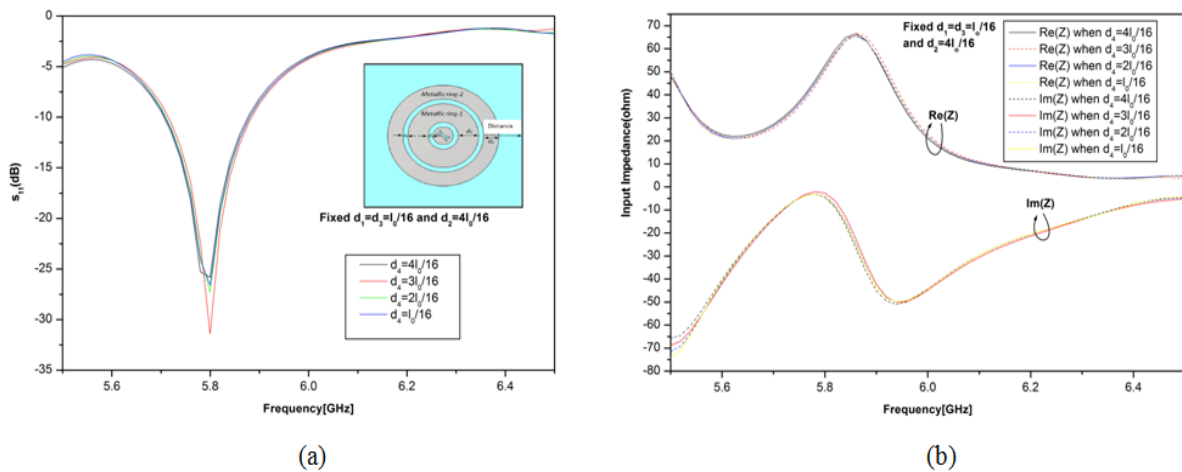

| (a) | (b) |

Figure 13. (a) S_{11} Graph (b) Impedance Graph for fixed value of d_1, d_2, d_3 and variation in d_4 (d_1, d_2, d_3 and d_4 are function of free space wavelength $\lambda_0 = l_0$).

Fig. 13(a) shows S_{11} graph for fixed value of d_1, d_2, d_3 and variation in d_4 from $0.0625\lambda_0$ to 0.25 λ_0 in steps of $0.0625\lambda_0$. Fig. 13(b) shows impedance graph for fixed value of d_1, d_2, d_3 and variation in d_4 from $0.0625\lambda_0$ to 0.25 λ_0 in steps of $0.0625\lambda_0$.

So optimal values are found metal rings width are $d_2 = 4\lambda_0/16$, $d_4 = 3\lambda_0/16$ and spacing is $d_1 = d_3 = \lambda_0/16$. It is observed from several simulations that by reducing d_1, and d_3 maximum of 13 dB gain is obtained from two metal rings around the metal patch. Gain is also increases by increasing number of metallic rings there is no limitations for number of rings and shape of ring its shape square, circular depends on the shape of patch but its function is to reduce the surface waves. As we know that surface waves are decreases exponentially in the substrate, so by increasing number of rings more than two or three there is no impact on the maximum gain. Microstrip patch antenna design by metallic ring approach is very simple in construction as compared with the state of art.

V.   CONCLUSION

We conclude that a patch with metallic ring causes the enhancement in the gain as compared with the patch without metallic ring. From the graphs presented in this paper it is observed that there is enhancement of 6.7 dB in the gain when patch is surrounded by metallic ring as compared with the patch without metallic ring. Analysis of the fields in the substrate shows that surface wave are scattered from metallic ring and convert into the space waves. A parametric study illustrated that shows the maximum gain was obtained when d_1, d_3 are near one by sixteen of the free-space wavelength and d_2 is near four times one-sixteen of free space wavelength d_4 are near three times one-sixteen of free space wavelength.

REFERENCES

[1]   R. B. Waterhouse, Microstrip Patch Antennas—A Designer's Guide. Boston, MA: Kluwer Academic Publishers, 2003, ch. 4.

[2]   D. Sievenpiper, L. Zhang, R.F. Jimenez Broas, N. G. Alexopoulos, and E. Yablonovitch, "High-impedance electromagnetic surfaces with a forbidden frequency band", IEEE Trans. Microwave Theory Techn., vol. 47, pp. 2059-2074, Nov. 1999.

[3]   Gonzola and De Maagt and sorola "Enhanced patch-antenna performance by suppressing surface waves using photonic-bandgap substrates" IEEE Trans. Microwave Theory Techn., vol. 47, pp. 2131-2138, Nov. 1999.

[4]   A. Rivera-Albino and C.A. Balanis "Gain Enhancement in Microstrip Patch Antennas Using Hybrid Substrates" IEEE Antennas and Wireless Propagation Letters, vol. 12, pp. 476-479, April 2013.

[5]   Hussein Attia and Leila Yousefi "High-Gain Patch Antennas Loaded With High Characteristic Impedance Superstrates" IEEE Antennas And Wireless Propagation Letters, vol. 10, pp.858-861, August 2011.

[6]   P. Kumar, D. Batra, and A. K. Shrivastav, "High gain microstrip antenna capacitive coupled to a square ring with surface mounted conical horn," Int. J. Electron. Commun. Technol., vol. 1, no. 1, pp. 7–9, Dec. 2010.

[7]   Yong H. Cho., Cheolsig Pyo and Jaeick Choi "Gain Enhancement of Microstrip Patch Antenna Using Parasitic Metallic Bar" IEEE AP-S. vol. I, pp. 728 -731, 2003.

[8]   C. S. Lee. V. Nalbandian and F. Schwcring. "Gain enhancement of a thick microstrip antenna by suppressing surface waves," IEEE AP-S. vol. I, pp. 460 -463, 1994.

[9]   C. Balanis, Advanced Engineering Electromagnetics, 2nd ed. NewYork, NY, USA: Wiley, 2012.

[10]   H. Boutayeb, T. Djerafi, and K. Wu, "Gain enhancement of a circularly polarized microstrip patch antenna surrounded by a circular mushroom-like substrate," in Proc. EuMC, Sep. 2010, pp. 257–260.

[11]   F. Tinoco-S., D. C. Nascimento, R. Schildberg, and J. C. da S. Lacava "Analysis and Design of Rectangular Microstrip Antennas for Educational Purposes" IEEE Antennas and Propagation Magazine, vol. 53, No.1, February 2011.

[12]   CST. Computer simulation technology microwave studio 2011. [Online]. Available: http://www.cst.com

A Novel Harmonic-Based Phase-Shifted Control Method to Regulate The Transferred Power

[1,]G.Kaladhar , [2,]Y.Narayana Rao , [3,] G.Gopala Rao

ABSTRACT: *over a wide range of load the power is regulated with high efficiency by inductively coupled power transfer system. In this paper a novel harmonic based phase-shifted control method is proposed. With this method, the resonant inverter output voltage is employed to regulate the output power. By changing the phase-shifted angle of inverter the output power is regulated. The switching frequency is much lower than the fundamental frequency which is different from conventional approaches; therefore the switching losses are very less. The principle of operation, switching strategy and the effect of dead time has all been presented. Experimental results says that the proposed power regulate method can achieve improvement at the light load condition.*

Index Terms: *Inductively coupled power transfer(ICPT), Phase-shifted control, Harmonic, power regulation, Efficiency.*

NOMENCLATURE

L_p	Total inductance of primary winding
L_s	Total inductance of secondary winding
M	Mutual inductance
C_p	Resonant capacitor on primary side
C_s	Resonant capacitor on secondary side
R_p	Total resistance of primary winding
R_s	Total resistance of secondary winding
R_L	Load resistance
R_e	Equivalent resistance of load
Z_{pk}	Self impedance of kth order harmonic component on primary side
Z_{sk}	Self impedance of kth order harmonic component on secondary side
Z_r	Reflected impedance of the secondary circuit seen by the primary side
S_1 - S_4	switching components
D_1- D_4	freewheeling diodes

D_5- D_8 diodes

C_f Filter capacitance

V_{dc} Voltage of dc input source

V_{inv} Inverter output voltage

V_{pk} Root mean square value of the kth-order harmonic component

V_{Rek} Voltage of equivalent resistance of the
               k^{th}-order harmonic component

I_p Inverter output current

I_{pk} Inverter output current of the kth-order harmonic component

I_{sk} Secondary winding current of the kth-order harmonic component

f_r Resonant frequency

f_s Switching frequency

ω_s Switching angular frequency

ω_r Resonant angular frequency

$\propto$ Phase shifted angle

t_d Delay time of inverter

P_{out} Output power on load
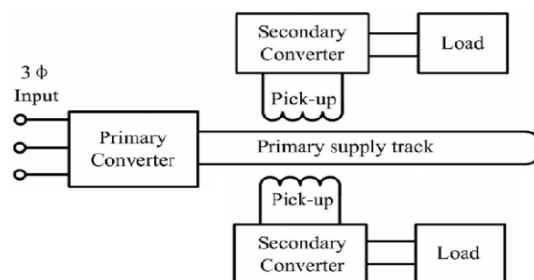η Transfer efficiency

Fig.1. Basic ICPT system with multiple loads.

I.   INTRODUCTION

The term inductively coupled transformer (ICPT) in general can be used to describe the power transfer between two objects that are physically un- connected. The use of contactless power is sometimes the only way of transferring power between the source and load. There are so many applications of this technology, high-power applications and low power applications. Low power applications are wireless charging of cell phones, laptops, TVs, desktops, and also in biomedical applications where as high power applications are people movers, industrial transport, automation, mining, military and aviation. but unlike low power transfer applications where the air gap between the load and source is very small and power transfer efficiency is comparatively small, in case of high power transfer the air gaps are larger and efficiency of power transfer is intended to be high as the amount of power transfer is large.ICPT system utilizes varying magnetic field at a certain frequency to couple power across an air gap to one or more secondary load systems without direct physical contact .ICPT is safe, reliable ,and flexible and environmental friendly due to electrical isolation of the

system. The movable contactless power transfer (MCPT) system is an alternative proposal for the supply of rail transit system .The MCPT system contains the ground part and vehicle part; the primary windings are powered by converter located on the ground and the secondary windings pickup the power and transfer it to load. For high power applications, it is necessary to regulate the output power of ICPT system with the load change.

The output power is regulated by changing input dc voltage but this method is simple but increases the power losses, size and cost of the power primary converter. Phase-shifted angle variation method is used to regulate the fundamental output voltage in full bridge inverter. While comparing different control methods i.e. voltage control, duty cycle control, frequency control, and phase angle control, phase angle control gives the optimal scheme under the uniform load condition.The objective of this paper is to analyze the variation of output powers in different compensation systems, first the fundamental principle of ICPT system is analysed.Then, and a harmonic model equivalent circuit for ICPT with series capacitor on both sides is built. After that, the harmonic-based phase-shifted control (HPSC) method is derived. Comparative analyses and experiments for the proposed and conventional methods are investigated. The compensation capacitance values are find out using the equations given in Table-A for different compensation topologies.

II. FUNDAMENTAL PRINCIPLE

The basic circuit diagram of ICPT system shown in fig.1. It contains a set of coils near and along the rail known as primary winding, one or more secondary winding coils beneath the vehicle. The primary converter converts three phase 50HZ ac voltage into DC voltage, then the inverter outputs high frequency ac to primary winding coil and set of high frequency magnetic field. The high frequency voltage is induced in secondary winding coils which couple with magnetic field. The secondary converter converts ac voltage to DC voltage through Diode Bridge for the load R_L.Which is a motor or inverter.In order to increase the transferred power as well as efficiency, compensation capacitors are used in the ICPT system. Basically there are four types of compensation topologies; those are series-series compensation (SS), series- parallel compensation (SP), parallel-series compensation (PS), parallel-parallel compensation (PP) as shown in following fig (a), fig (b), fig(c) and fig (d) respectively.Compensation capacitors are also used to reduce the apparent power of primary converter. If both primary and secondary compensation capacitors are connected serially, then no need to vary the capacitance with the load or the mutual inductance between primary winding and secondary winding. On the other hand the SS topology has one more advantage is that; the reflected impedance of the secondary winding on to the primary winding has only a real reflected component and no reactive component. In the conventional method, the power is transferred by fundamental component, and harmonic components are usually neglected. So, the conventional phase-shifted control is called fundamental-based phase-shifted control (FPSC) in this paper.
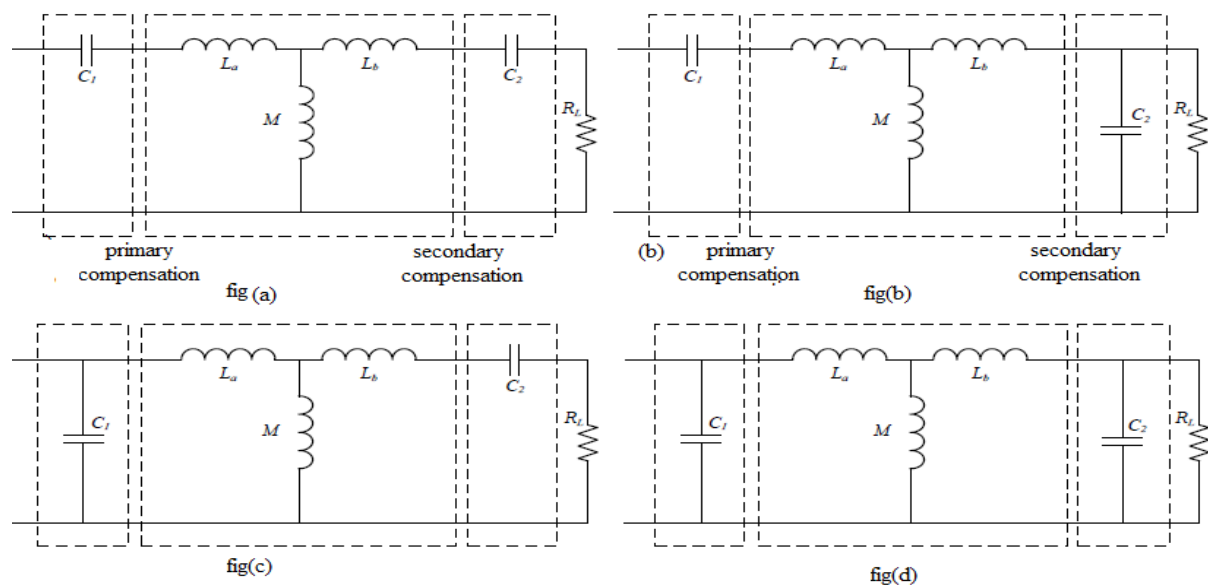

Fig.4. Compensation topologies (a) SS (b) SP (c) PS (d) PP.

TABLE-A

Topology	C_2	C_1
SS	$C_2 = \dfrac{1}{\omega_i^2(L_b + M)}$	$C_1 = \dfrac{1}{\omega_i^2(L_b + M)}$
SP	$C_2 = \dfrac{1}{\omega_i^2(L_b + M)}$	$C_1 = \dfrac{(L_b + M)^2 c_2}{(L_a + M)(L_b + M) - M^2}$
PS	$C_2 = \dfrac{1}{\omega_i^2(L_b + M)}$	$C_1 = \dfrac{(L_a + M)(L_b + M)^2 C_2^2 R_L^2}{M^4 + (L_a + M)(L_b + M)R_L^2}$
PP	$C_2 = \dfrac{1}{\omega_i^2(L_b + M)}$	$C_1 = \dfrac{(L_b + M)^2((L_a + M)(L_b + M) - M^2)C_2}{((L_b + M)(L_a + M) - M^2)^2 + M^4 R_L^2(L_b + M)C_2}$

To analyze the harmonic components, fast Fourier transform (FFT) of the inverter output voltage is carried out at first. Here, the dead time of inverter is not considered, the root-mean-square (RMS) value of the kth –order harmonic component of inverter output voltage is given by

$$V_{PK} = \frac{2\sqrt{2}}{k\pi}\ \cos\frac{k\alpha}{2} \quad (k = 1,3,5,7 \ldots\ldots). \quad (1)$$

The fundamental model equivalent circuit of ICPT system is presented in [21]. Similarly, the *k*th-

order harmonic model is built in this paper to analyze the effect of the harmonic components as well as the fundamental to the transferred power. The harmonic model equivalent circuit with series capacitors on both sides is shown in Fig.2.

As indicated in Fig.2, the primary current I_{PK} and secondary current I_{SK} can be expressed as

$$\begin{bmatrix} I_{PK} \\ I_{SK} \end{bmatrix} = \frac{v_{pK}}{Z_{pK}Z_{sK} + (K\omega_S M)^2}\begin{bmatrix} Z_{sk} \\ jk\omega_s M \end{bmatrix} \quad (2)$$

Where

$$\omega_s = 2\pi f_s \quad (3)$$

$$R_e = \frac{8}{\pi^2}R_L \quad (4)$$

$$Z_{pk} = jk\omega_s L_p + \frac{1}{jk\omega_s C_P} + R_p \quad (5)$$

$$Z_{sk} = jk\omega_s L_s + \frac{1}{jk\omega_s C_s} + R_s + R_e. \quad (6)$$

The *k*th-order harmonic component P_{ok} in output power is expressed as

$$P_{ok} = I_{sk}^2 R_e = \frac{8\cos^2(\frac{k\alpha}{2})}{k^2\pi^2}\frac{V_{dc}^2(K\omega_s M)^2 R_e}{|Z_{pk}Z_{sk} + (k\omega_s M)^2|^2}. \quad (7)$$

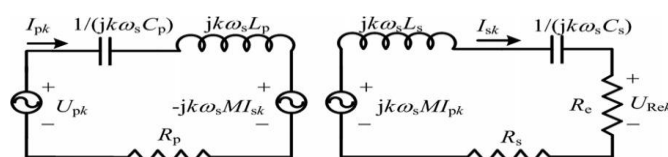Fig.2. Harmonic model equivalent circuit of ICPT with series compensation.

III.   THE HARMONIC BASED PHASE-SHIFTED CONTROL

A.   The Harmonic Based Phase-Shifted Control

To transfer power in FPSC, the harmonic component of inverter output voltage is used by changing switching frequency. Where as in HPSC, to regulate output power accurately phase shifted control is used. The following are the steps to analyze the HPSC

Step-1: Harmonic components of inverter output voltage must be found out.

Step-2: Normalized value has to be introduced

We know that,

$$V_{pk} = \frac{2\sqrt{2}}{k\pi} V_{dc} \cos \frac{k\alpha}{2} \quad \text{(K=1,3,5,............)} \qquad (8)$$

At, $\alpha = 0$

$$V_{p1} = \frac{2\sqrt{2}}{\pi} \, Vdc \qquad (9)$$

Therefore, Normalized value of k_{th} order harmonic RMS value, at phase shifted angle 'α' is
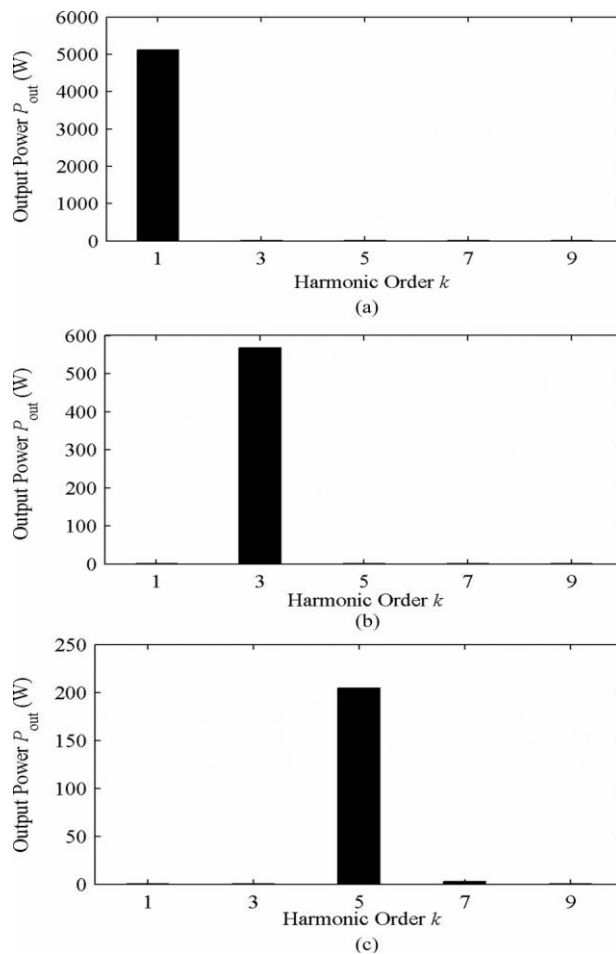
$$G_k = \frac{Vpk}{Vp1} \qquad (10)$$

Fig.3 output power with different harmonic components under f_r = 42kHz: (a) 42kHz,(b)14kHz, and (c)8.4kHz.

$$G_k = \frac{1}{k}\cos\frac{k\alpha}{2} \quad (k=1, 3, 5 \ldots) \quad\quad\quad (11)$$

Where

G_k= Normalized RMS harmonic voltage

To illustrate this method, Fig.6 shows key waveforms of the third-order harmonic-based control method. Furthermore, a half switching period in Fig.6 is subdivided into six stages and their simplified paths in different stages are shown in Fig.8.
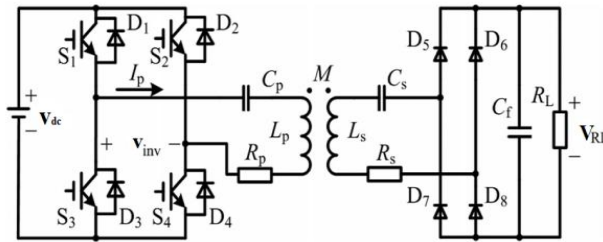

Fig.5. circuit topology of ICPT with series compensation.

Region1 [t_0 to t_1]: S_3 turns OFF at t_0. from t_0 to t_1 the power is oscillating freely through S_2, Lp, Zr, Rp, Cp, and D_1. V_inv is equal to 0 during this stage.
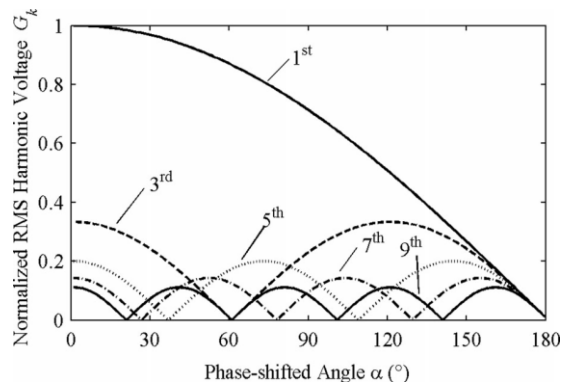

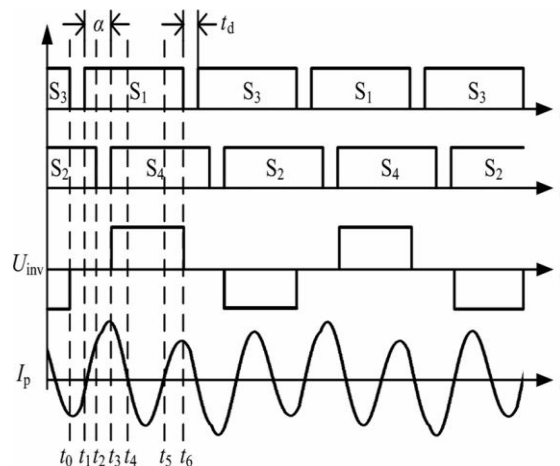Fig.7. Normalized Value of Fundamental and Harmonic Components at Different Phase-Shifted Angle.

Fig.6. key waveforms of HPSC with third order harmonic.

Region2 [t_1 tot_2]: At t_1, S1 turns ON at zero voltage switching (ZVS) when D_1conducts. The power is oscillating freely through S_1, C_p, R_p, Zr, L_p , and D_2.

Region3 [t_2 tot_3]: At t_2, S_2 turns OFF at zero voltage switching (ZVS) when D_2conducts

Region4 [t_3 tot_4]:S_4turns ON at t_3, and D_2turns OFF at the same time. The conduction current through S_4 is same with the turning OFF current of D_2.the power is transferred from input dc source to load through S_1, C_p, R_p, Zr, L_p, and S_4.$V_{inv}$is equal to V_{dc} during this stage.

Region5[t_4 tot_5]:Inverter output current $I_p$crosses zero and changes its direction at t_4.the power is circulated from load to input dc source through D_4, L_p, Zr, R_p, C_p,and D_1.this stage finishes when I_p reaches zero.

Region6 [t_5 tot_6]:After current I_p crosses zero and changes its direction at t_5,the power is transferred from input dc source to load through S_1, C_p, R_p, Zr, L_p,and

S_4 during this stage. This stage ends when S_1turnsOFF at t_6. The other half period current directions are similar as explained above. The current I_p circulates three times during one switching period, which means lower switching losses compared with FPSC.
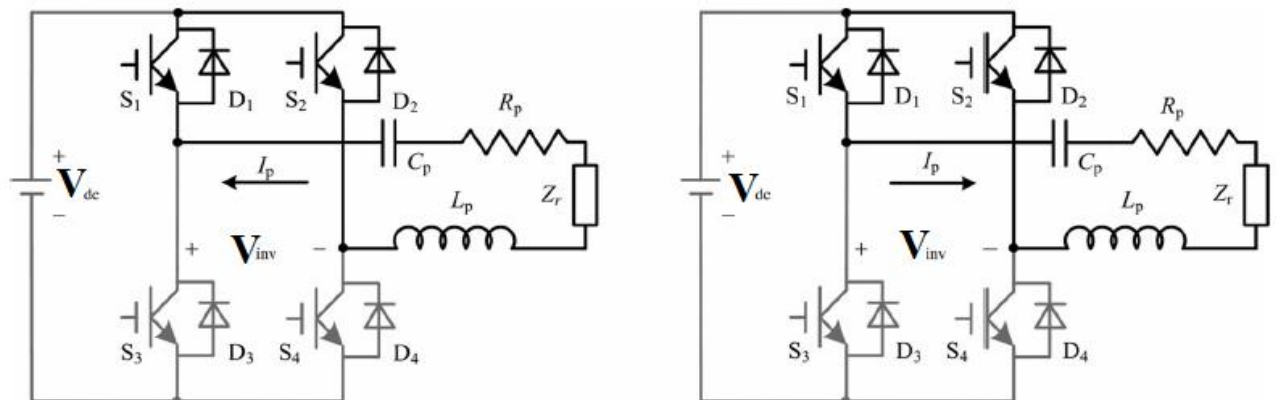
Switching Strategy for Harmonic Components:
From Fig.7, it is evident that several harmonic components meet the demand of low output power. The switching strategy for different order harmonic is discussed as follows.First, α_{1k} is defined as the switching phase-shifted angle from fundamental to the kth-order harmonic component. When fundamental component is at resonance, the kth-order harmonic component could be employed to transfer the same power if the phase-shifted angle is greater than α_{1k}. The maximum value of G_k is 1/k, so from the relationship $G_1=1/k$, α_{1k} can be expressed as

$$\alpha_{1k} = \frac{360°}{\pi} arccos \frac{1}{k} \ (k = 1,3,5,7 \dots .). \quad (12)$$

Similarly, α_{1k} is defined as switching phase-shifted angle from the kth-order harmonic to (k+2)[th]-order harmonic. When the kth-order harmonic is at resonance, if the phase-shifted angle is greater than α_k, then (k+2)[th]-order harmonic can be used to transfer same capacity of power. It means the reasonable phase-shifted angle range

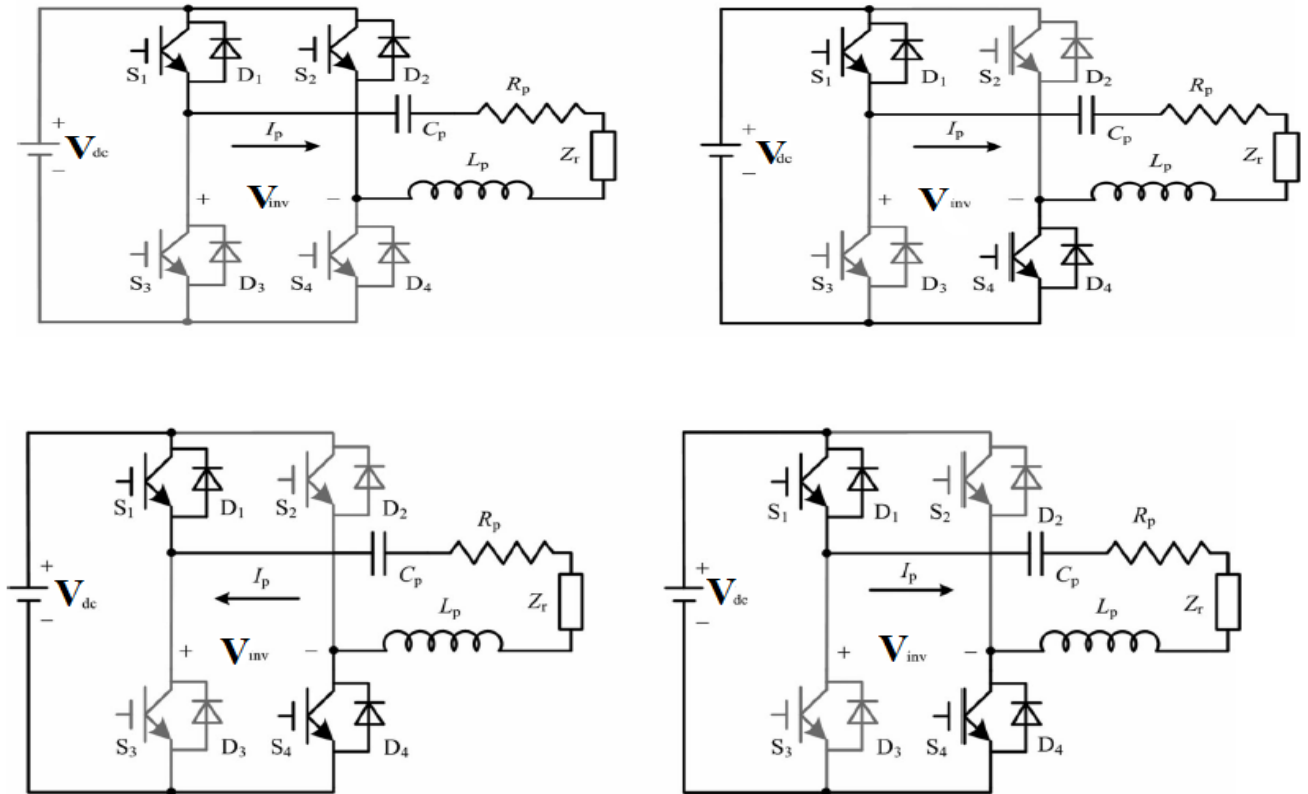$$\alpha_K = \frac{360°}{K\pi} arccos \frac{k}{k+2} \ (k = 1,3,5,7 \dots .) \quad (13)$$

Fig.8. simplified paths of HPSC with third-order in half switching period.

of kth- order harmonic can be 0 to α_k. From the relationship $G_k=1/(k+2)$, α_k can be expressed as

The switching phase-shifted angles for fundamental and harmonic components are shown in Table II. Generally, by ignore the components which are not at resonance, the normalized value of output power is

$$G_{Pk} = G_k^2 = \frac{1}{k^2} \cos^2 \frac{k\alpha}{2} \quad (k=1,3,5,7.....). \qquad (14)$$

TABLE –I

SIMULATION AND EXPERIMENTAL PARAMETERS

symbol	value	symbol	value
$V_{dc}(v)$	90	$R_P(\Omega)$	0.1
$L_P(\mu H)$	39	$R_L(\Omega)$	20
$L_S(\mu H)$	149	$C_P(\mu F)$	0.36
$M(\mu H)$	16	$C_S(\mu F)$	0.09
$R_S(\Omega)$	0.2	$f_r(kHz)$	42

Effect of Dead Time
The dead time is necessary to avoid current passing directly through any bridge arm of an inverter. Because it will bring some effect to duty width, it must be considered especially for high frequency switching.

TABLE-II

SWITCHING PHASE SHIFTED ANGLES FOR FUNDAMENTAL AND HARMONIC

Harmonic Order	$\alpha_{1k}(°)$	$\alpha_k(°)$
1	0	141.1
3	141.1	35.4
5	156.9	17.8
7	163.6	11.1
9	167.2	7.8
k	$\dfrac{360°}{\pi} arccos \dfrac{1}{k}$	$\dfrac{360°}{k\pi} arccos \dfrac{k}{k+2}$

For example the effective duty width will be decreased from 50% to 41.6% if dead time is $2\mu s$ and switching frequency is 40 kHz, which results in decreased in maximum output power. Here $\propto_{kd}$ is defined as equilent phase-shifted angle of dead time for k_{th} order harmonic in HPSC, and it is expressed as

$$\propto_{kd} = \frac{t_d f_r}{k} 360 \ (k = 1,3,5,7 \dots .).\qquad(15)$$

Considering the dead time effect, the equations with phase shifted angle $\propto$ will be updated. Taking V_{pk} as an example,(1) is updated as

$$v'_{pk} = \frac{2\sqrt{2}}{k\pi} v_{dc} \cos\frac{k(\alpha+\propto_{kd})}{2} \ (k = 1,3,5,7 \dots \dots).\quad(16)$$

Besides, the switching phase-shifted angle will be up dated as

$$\propto'_{1k} = \frac{360°}{\pi} arccos \frac{1}{k} - t_d f_r 360 \ (k = 1,3,5,7 \dots .).\qquad(17)$$

$$\propto'_k = \frac{360°}{k\pi} arccos \frac{k}{k+2} - t_d f_r 360 \ (k = 1,3,5,7 \dots .).\qquad(18)$$

It is evident that the phase shifted angle for the maximum value of $v'_{pk} \ (k = 3,5,7 \dots)$ is $\frac{360}{k} - \propto_{kd}$ instead of zero. The lost phase-shifted angle range due to the dead time can be replaced by $\frac{360}{k} - \propto_{kd} \sim \frac{360}{k}$.

IV. EXPERIMENTAL RESULTS
A. Experimental setup
In order to verify the validity of HPSC power regulation method, experiments have been implemented on a prototype of movable contactless power supply system for rail transit system. The prototype consists of a contactless transformer and two converters. The contactless transformer contains long primary winding and short secondary winding. The former is fixed on ground along the track, and the latter is fixed on the movable vehicle. The converter topology adopted is same as that in fig.5 where the dc voltage V_{dc} is obtained from a three phase diode rectifier. The load is purely resistive. The third and fifth order harmonics are chosen for experiment in this paper. The dead time is set as $2\mu s$.the equivalent phase shifted angle of dead time is $30^0,10^0$, and 6^0 for FPSC, third-order harmonic in HPSC, and fifth-order harmonic in HPSC respectively. The SIMULINK diagram of FPSC or HPSC is shown in fig.13

B. Power Regulation Comparison
Fig.9 shows the voltage measured on load at a given phase shifted angle for three kinds of control methods.

It is known that the curves in fig.9. are very similar with those in fig.7 because the V_{RL} is nearly proportional to V_{pk}. It can be seen that the higher the harmonic order is, the lower the maximum output power is. It is apparently consistent with aforementioned analyses.
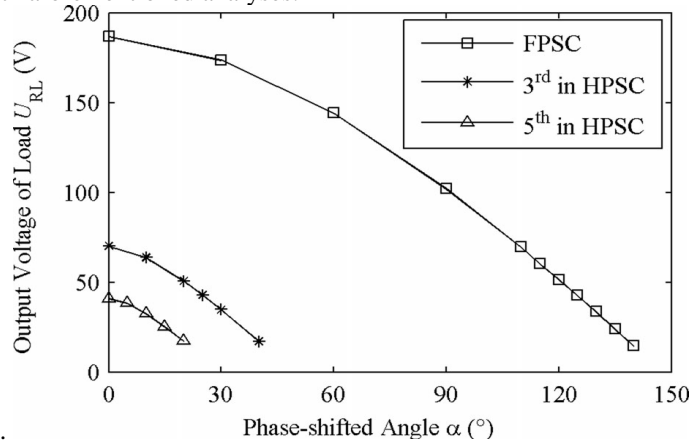

Fig.9. output voltage at different phase-shifted angles with different methods.

The phase shifted angle range is output power for FPSC,the third order harmonic and fifth order harmonic in HPSC is compared. According to the analysis in section III,output power is lower with higher harmonic order, so the reasonable range $1/7^2 \sim 1/5^2$ of normalized output power of the fifth order harmonic in HPSC is selected. According to (14), the start phase shifted angle for the selected normalized power range can be obtained from (19) and the end phase shifted angle is obtained from (20).Then the phase shifted angle range can be calculated

$$G_{PK} = 1/5^2 \ (k = 1,3,5) \qquad (19)$$

$$G_{PK} = 1/7^2 \ (k = 1,3,5) \qquad (20)$$
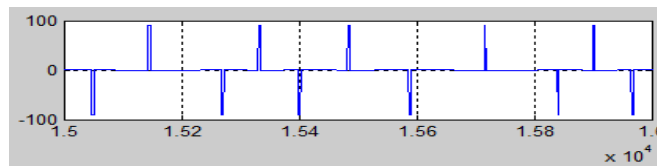
(a)
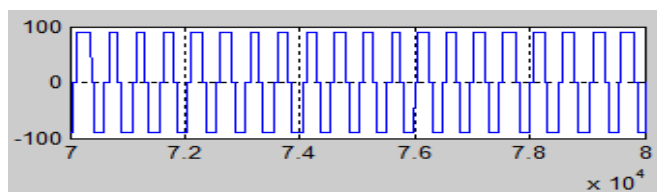
(b)
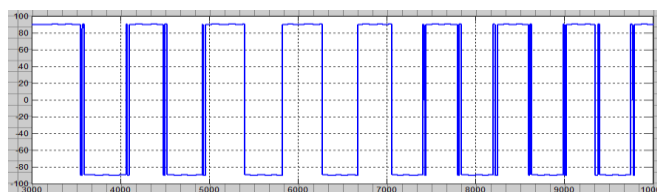
(c)
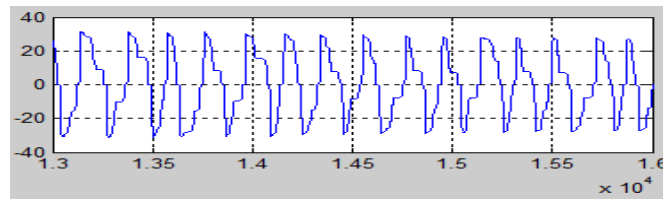
(d)
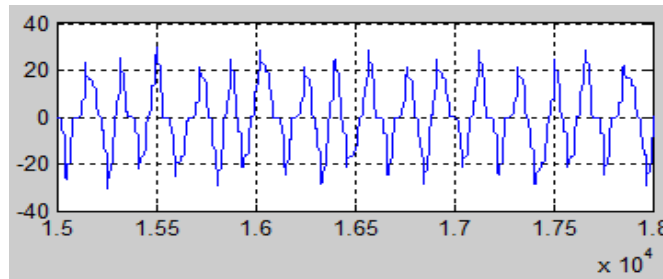
(e)
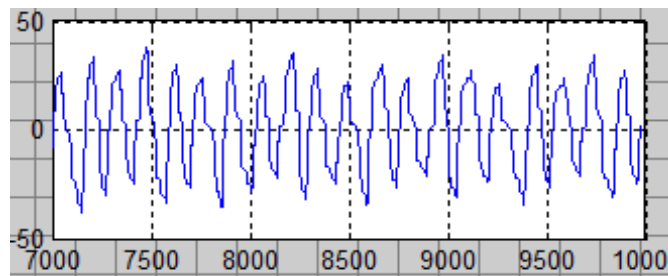
(f)

Fig. 10. Waveforms of inverter output voltage using diff-erent control methods (a) FPSC.(b)third-order harmonic in HPSC. (c) Fifth order harmonic in HPSC. And current using different control methods (d) FPSC. (e) third-order harmonic in HPSC. (f) Fifth order harmonic in HPSC.

A comparison of phase shifted angle range during the same range of normalized output power is shown in table III. From this table it can be known that phase shifted angle range is wider if higher order harmonic is used. The wider phase shifted angle range means higher power regulation accuracy due to the limited digital bits in digital processor.

(a)

(b)
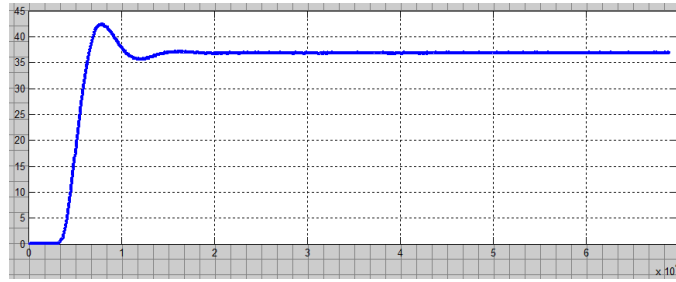
(c)

Fig.11. Waveforms of the rectifier output voltage using different control methods. (a) FPSC. (b) Third-order harmonic in HPSC. (c) Fifth-order harmonic in HPSC.

C. Efficiency Comparison

In order to verify the improvement of system efficiency from HPSC to usual FPSC, experiments for FPSC, the third order harmonic in HPSC, and the fifth order harmonic in HPSC at their power range have all been tested. Here the input power of three phase ac power and load power are measured, and then the normalized value

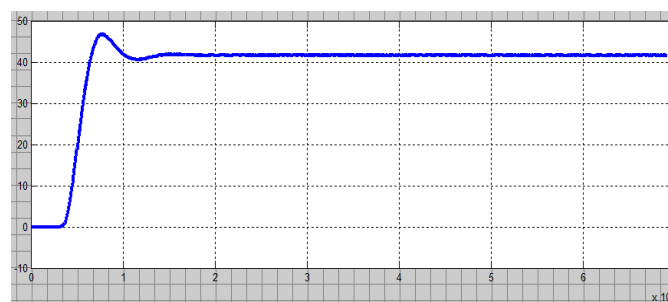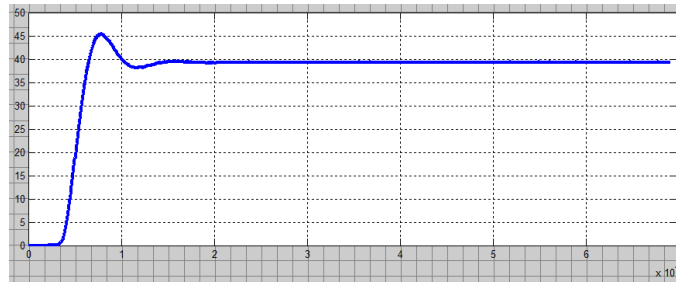G_P of output power is expressed as (20).the base value P_{0max} is the maximum value of output power at actual zero phase shifted angle using FPSC.The P_{0max} here is 1.77kW.

$$G_p = \frac{P_{out}}{P_{0max}} \qquad (21)$$

Fig.12. shows the efficiency at light load with these three methods. It can be seen that 1) the system efficiency increased with higher output power; 2) system efficiency using HPSC is higher than that of FPSC at the same output power; 3) efficiency of fifth order harmonic in FPSC is higher than that of the third order harmonic in HPSC; and 4) the suitable G_P for HPSC is about less than15% in fact.
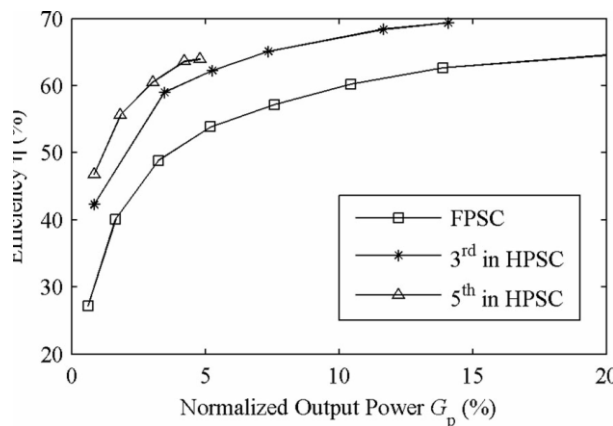
Fig.12. System efficiency with different methods at light load.

D. Comparison under same output power

To compare the proposed HPSC and the conventional FPSC under the same output power, the following experiment is implemented. The output power here is about 88W and G_P is around 5%. Detailed experiment data is shown in table IV. As can be seen from this table the fifth order harmonic in HPSC improves efficiency of system with 10.09% compared to FPSC.It can be inferred that higher efficiency improvement will be reached at lighter load. Fig.10 shows the waveforms of inverter output voltage V_{inv} inverter output current I_P ,and voltage on load V_{RL} with FPSC, the third order harmonic in HPSC,and the fifth order harmonic in HPSC, respectively.fig shows the phase shifted angle is greater at light load for FPSC, which results in great switching losses remarkably. FFT analysis to the inverter output current I_P is carried out to compare the current spectrum, which is shown in fig.14 as can be seen from this figure we have the followings.

Switching frequency adopted by HPSC is much lower than resonant frequency resulting that the low-order harmonic of inverter output voltage takes high proportion.
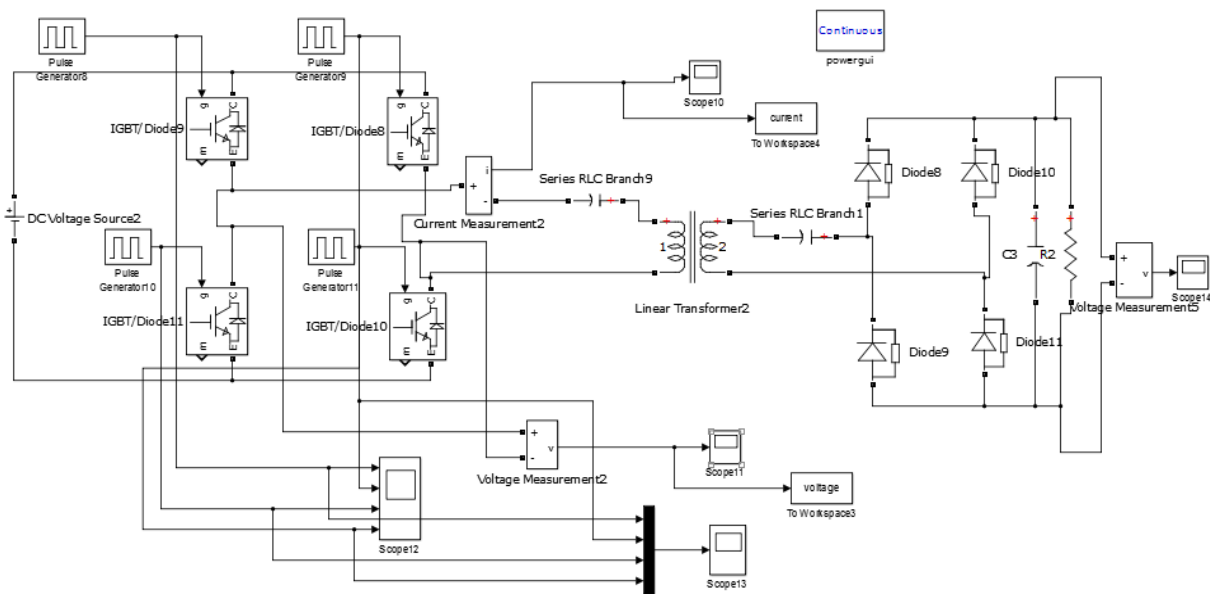
Fig.13. SIMULINK diagram of FPSC or HPSC.

TABLE –III

COMPARISON OF PHASE-SHIFTED ANGLE RANGE UNDER THE SAME RANGE OF NORMALIZED OUTPUT POWER ($1/7^2 \sim 1/5^2$).

Method	Start phase-shifted angle($^\circ$)	End Phase-Shifted angle($^\circ$)	Phase-shifted angle Range($^\circ$)
FPSC	156.9	163.6	6.7
Third-order harmonic in HPSC	35.4	43.1	7.7
Fifth-order harmonic in HPSC	0	17.8	17.8

The amplitude of inverter output current at resonant frequency is almost of the same. The reason is that the power is transferred mainly at the resonant frequency.

1) Low frequency harmonics using HPSC is greater than that of FPSC, whereas high frequency harmonics is lower. This is because the

TABLE-IV

EXPERIMENTAL DATA WITH CONTROL METHODS

Method	f_s(kHz)	$\alpha(°)$	V_{RL}(v)	η(%)
FPSC	42.0	125	41.58	53.85
Third-order harmonic in HPSC	14.0	25	39.26	62.27
Fifth-order harmonic in HPSC	8.4	0	36.8	63.94

2) If high order harmonic is employed to transfer power for HPSC, there will be more harmonic current components near the resonant frequency. Because the quality factor Q of resonant circuit is not infinite, so the harmonics components far from the resonant frequency are mostly filtered, but those near the resonant

3) frequency do not decay seriously.

Fig.14. FFT analysis of an inverter output current using different control methods.(a)FPSC.(b)Third-order harmonic in HPSC.(c) Fifth-order harmonic in HPSC.
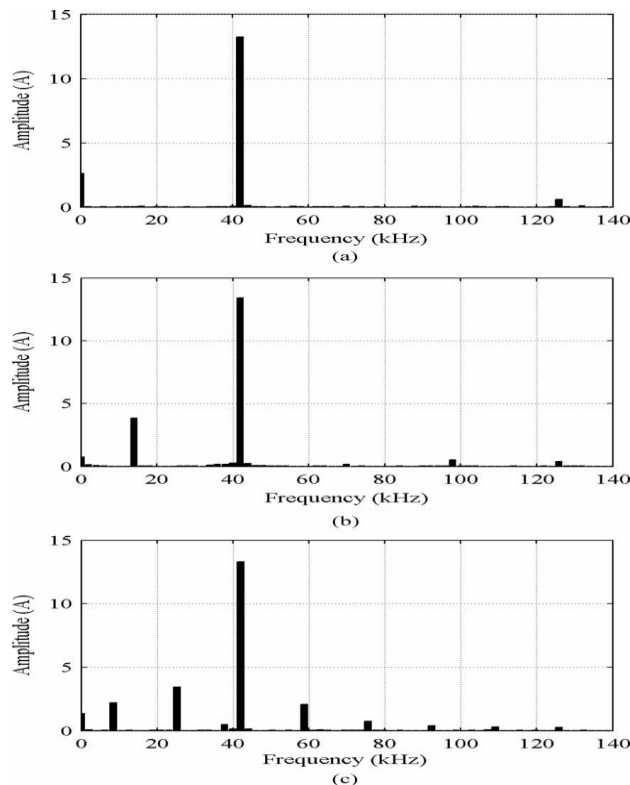
V.CONCLUSION

In this method the switching frequency is set to be much lower than the resonant frequency, but the frequency of selected harmonic component is the same with the resonant frequency. The phase shifted angle of the inverter is controlled to regulate the power. The efficiency increases more than 10% at the light load condition. Analysis and experimental results shows that the proposed method can improve system efficiency compared with the traditional fundamental based phase shifted control. Furthermore improves the power regulation and reduced switching frequency has been achieved simultaneously. Results of the investigation demonstrate that the proposed control method for the resonant converter can effectively improves the converter performance at the light load condition. Because of the characteristics of HPSC that harmonic component is adopted, there is a limited range of normalized output power using HPSC, which is less than11.1% in theory.

REFERENCES

[1]   [1] A. K. Swain, M. J. Neath, U. K. Madawala, and D. J. Thrimawithana "A dynamic multivariable state-space model for bidirectional inductive power transfer systems," *IEEE Trans. Power Electron.*, vol. 27, no. 11, pp. 4772–4780, Nov. 2012.
[2]   [2] H.Matsumoto, Y. Neba, K. Ishizaka, and R. Itoh, "Model for a three-phase contactless power transfer system," *IEEE Trans. Power Electron.*, vol. 26, no. 9, pp. 2676–2687, Sep. 2011.
[3]   [3] Y. Ota, T. Takura, F. Sato, H.Matsuki, T. Sato, and T. Nonaka, "Impedance matching method about multiple contactless power feeding system for portable electronic devices," *IEEE Trans.Magn.*, vol. 47, no. 10, p. 4235—4237, Oct. 2011.
[4]   [4] S. Hasanzadeh, S. Vaez-Zadeh, and A.H. Isfahani, "Optimization of a contactless power transfer system for electric vehicles," *IEEE Trans. Veh. Technol.*, vol. 61, no. 8, pp. 3566–3573, Oct. 2012.[5] G. A. J. Elliot, S. Raabe, G. A. Covic, and J. T. Boys, "Multiphase pickupsfor large lateral tolerance contactless power-transfer systems," *IEEE Trans. Ind. Electron.*, vol. 57, no. 5, pp. 1590–1598, May 2010.
[5]   [6] J. Kuipers, H. Bruning, S. Bakker, and H. Rijnaarts, "Near field resonant inductive coupling to power electronic devices dispersed in water," *Sens. Actuators A: Phys.*, vol. 178, pp. 217–222, May 2012.
[6]   [7] S. Raabe and G. A. Covic, "Practical design considerations for contactless power transfer quadrature pick-ups," *IEEE Trans. Ind. Electron.*, vol. 60, no. 1, pp. 400–409, Jan. 2013.
[7]   [8] K. W. Klontz, D. M. Divan, D. W. Novotny, and R. D. Lorenz, "Contactless power delivery system for mining applications," *IEEE Trans. Ind. Appl.*, vol. 31, no. 1, pp. 27–35, Jan./Feb. 1995.
[8]   [9] D. J. Hartland, "Electric contact systems – Passing power to the trains," in *Proc. 5th IET Prof. Develop. Course REIS*, London, U.K., 2011, pp. 60–68.
[9]   [10] J. Huh, S. W. Lee,W. Y. Lee, G. H. Cho, and C. T. Rim, "Narrow-width inductive power transfer system for online electrical vehicles," *IEEE Trans.Power Electron.*, vol. 26, no. 12, pp. 3666–3679, Dec. 2011.
[10]   [11] G. A. Covic, J. T. Boys, M. L. G. Kissin, and H. G. Lu, "A three-phase inductive power transfer system for roadway-powered vehicles," *IEEE Trans. Ind. Electron.*, vol. 54, no. 6, pp. 3370–3378, Dec. 2007.
[11]   [12] M. Bauer, P. Becker, and Q. Zheng, "Inductive power supply (IPSR_) for the transrapid," presented at the Magn. Levitated Syst. Linear Drives,Dresden, Germany, 2006.
[12]   [13] (Jun. 2012).[Online].Available:http://www.railwaygazette.com/news/urban-rail/si-ngle-view/view/primove-induction-powered-tram-trialproves-
[13]   a-success.html
[14]   [14] H. H. Wu, G. A. Covic, J. T. Boys, and D. J. Robertson, "A series-tuned indctive-power-transfer pickup with a controllable AC-voltage output," *IEEE Trans. Power Electron.*, vol. 26, no. 1, pp. 98–109, Jan. 2011.
[15]   [15] G. B. Koo, G. W. Moon, and M. J. Youn, "Analysis and design of phase shift full bridge converter with series-connected two transformers," *IEEE*
[16]   [16] H. L. Li, A. P. Hu, and G. A. Covic, "FPGA controlled high frequency resonant converter for contactless power transfer," in *Proc. IEEE PowerElectron. Spec. Conf. 2008*, Rhodes, Greece, 2008, pp. 3642–3647.
[17]   [17] C. S. Tang, Y. Sun, Y. G. Su, S. K. Nguang, and A. P. Hu, "Determining multiple steady-state ZCS operating points of a switch-mode contactless power transfer system," *IEEE Trans. Power Electron.*, vol. 24, no. 2, pp. 416–425, Feb. 2009.
[18]   [18] W. P. Choi, W. C. Ho, X. Liu, and S. Y. R. Hui, "Comparative study on power conversion methods for wireless battery charging platform,"in *Proc. EPEPower Electron. Motion Control Conf.*, Ohrid, Republic of Macedonia, 2010, pp. S15-9–S15-16.
[19]   [19] J. L. Villa, J. Sallan,A. Llombart, and J.F. Sanz, "Design of a high frequency inductively coupled power transfer system for electric vehicle battery charge," *Appl. Energy*, vol. 86, no. 3, pp. 355–363, Mar. 2009.
[20]   [20] C. S. Wang, G. A. Covic, and O. H. Stielau, "Power transfer capabilityand bifurcation phenomena of loosely coupled inductive power transfersystems," *IEEE Trans. Ind. Electron.*, vol. 51, no. 1, pp. 148–157, Feb.2004.
[21]   [21] H. Cai, L. M. Shi, and R. H. Zhang, "A novel control method of resonant inverter for movable contactless power supply system of maglev,"presented at the *Int. Conf. Electr. Mach. Syst.*, Beijing, China, 2011.
[22]   [22] Hua cai, Liming shi, *Member,IEEE,* and Yaohua Li, " Harmonic –Based Phase-Shifted Control Of Inductively Coupled Power Transfer," *IEEE Trans. Power Electron,* vol.29, no.2, pp. 0885-8993,Feb.2014.

Mr. Gaddala Kaladhar received his B.Tech degree in Electrical and Electronics Engineering from Narasaraopeta Engineering College, Narasaraopeta. Master degree (M.Tech) also from same college. Presently he has been working as Assistant professor in Electrical department since eight years in St. Ann's College of Engineering & Technology, Chirala and pursuing Ph.D from SV University College of Engineering and Technology, SV University, Tirupati.

Mr.Y.Narayana Rao received his B.Tech degree in Electrical and Electronics Engineering from Chundi Ranganayakulu Engineering College, Chilakaluripeta. Master degree (M.Tech) from College of Engineering JNTU, Hyderabad. Presently he has been working as Associate professor in Electrical department since eight years in St.Ann's College of Engineering & Technology, Chirala.

Mr.G.Gopala Rao received his B.Tech degree in Electrical & Electronics Engineering from St.Ann's College of Engineering & Technology, Chirala.

Effect of Pavement Conditions on Rolling Resistance

Mr.Dipanjan Mukherjee
*M.Tech CIVIL ENGINEERING (Pursuing),NATIONAL INSTITUTE OF TECHNOLOGY Silchar,Assam,INDIA;
B.Tech West Bengal University of Technology, West Bengal,INDIA,*

ABSTRACT: *Rolling resistance is the force acting on a vehicle over a full journey. It is generated by the hysteresis of tyre and pavement. Rolling resistance, sometimes called **rolling friction** or **rolling drag**, is the force resisting the motion when a body (such as a ball, tire, or wheel) rolls on a surface. It is mainly caused by non-elastic effects; that is, not all the energy needed for deformation (or movement) of the wheel, roadbed, etc. is recovered when the pressure is removed. A hysteresis phenomenon can be observed when viscoelastic materials undergo a load-then-unload process. A typical hysteresis curve of viscoelastic material can be found. The shadow area enclosed by the hysteresis loop represents energy loss. A characteristic of a deformable material such that the energy of deformation is greater than the energy of recovery. The rubber compound in a tire exhibits hysteresis. As the tire rotates under the weight of the vehicle, it experiences repeated cycles of deformation and recovery, and it dissipates the hysteresis energy loss as heat. Hysteresis is the main cause of energy loss associated with rolling resistance and is attributed to the viscoelastic characteristics of the rubber. Materials that have a large hysteresis effect, such as rubber, which bounce back slowly, exhibit more rolling resistance than materials with a small hysteresis effect that bounce back more quickly and more completely, such as steel or silica. Low rolling resistance tires typically incorporate silica in place of carbon black in their tread compounds to reduce low-frequency hysteresis without compromising traction. Note that railroads also have hysteresis in the roadbed structure. Like the fuel consumption, rolling resistance also has a significant relationship with velocity. experiment has shown that, for a 32-tonn goods vehicle, rolling resistance contributes about 70% of total drag when driven at 50km/h and about 37% at 100km/h. An important issue which should not be overlooked is that rolling resistance is affected by the characteristics of the pavement surface. Rolling resistance varies between different pavement surfaces. Hard and smooth surfaces produce lower rolling resistance than soft and rough surfaces. Rolling resistance is affected by both tyre and ambient temperature.*

KYE WORDS: *Literature Study, Primary Causes Of Rolling Resistance, Rolling Resistance Coefficent, Factor Influencing Rolling Resistance, Minor Factors Under Considerasion.*

I.   INTODUCTION

Rolling resistance is the force acting on a vehicle over a full journey. It is generated by the hysteresis of tyre and pavement. Rolling resistance, sometimes called **rolling friction** or **rolling drag**, is the force resisting the motion when a body (such as a ball, tire, or wheel) rolls on a surface. It is mainly caused by non-elastic effects; that is, not all the energy needed for deformation (or movement) of the wheel, roadbed, etc. is recovered when the pressure is removed. Two forms of this are hysteresis losses (see below), and permanent (plastic) deformation of the object or the surface (e.g. soil). Another cause of rolling resistance lies in the slippage between the wheel and the surface, which dissipates energy. Note that only the last of these effects involves friction, therefore the name "rolling friction" is to an extent a misnomer. In the broad sense, specific "rolling resistance" (for vehicles) is the force per unit vehicle weight required to move the vehicle on level ground at a constant slow speed where aerodynamic drag (air resistance) is insignificant and also where there are no traction (motor) forces or brakes applied. In other words the vehicle would be coasting if it were not for the force to maintain constant speed. An example of such usage for railroads is This broad sense includes wheel bearing resistance, the energy dissipated by vibration and oscillation of both the roadbed and the vehicle, and sliding of the wheel on the roadbed surface (pavement or a rail).
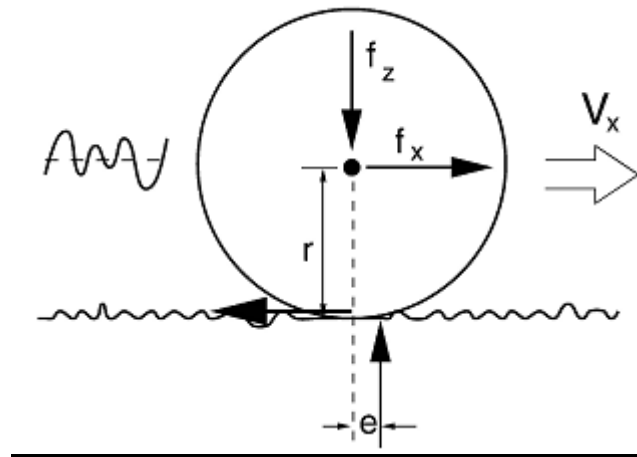
II.   LITERATURE STUDY :-

Figure 1 Tyre Rolling Resistance (Miege & Popov, 2005)

a single tyre rolling on a pavement surface with a constant velocity Vx. The radius of the tyre is r. fz is a vertical load generated by the weight of a vehicle. fx is a drag force generated by the engine to push the tyre forward. As can be shown, the sequence under the drag force fx ends up as a rotation of the tyre, and this rotation pushes the tread into a tyre/pavement interface, which has been named as the contact zone. Tread and pavement compress each other into a contact zone. The deformation is found to occur in both tyre and pavement. Meanwhile, the rotation pushes another part of the tread out of the trailing edge of the contact zone. Then, both pavement and tyre are decompressed after the tread goes out of the contact zone. The stress applied on the contact zone is uneven. Normally, the front edge experiences a bigger pressure compared to the trailing edge. Due to the uneven distribution of stresses on the contact zone, the counterforce fc, which is generated by the pavement, is not in the centre of the contact zone, but, shifts forward by a short distance e. When multiplied by the distance e of the counterforce fc it represents a resistance moment, which has been named as the rolling resistance moment. To keep the balance of the moment, another moment needs to act on the tyre and it is a product of the tyre radius r and a horizontal force fr. The horizontal force fr is the rolling resistance of the tyre (Wong, 2001).

A hysteresis phenomenon can be observed when viscoelastic materials undergo a load-then-unload process. A typical hysteresis curve of viscoelastic material can be found in Figure 2 The shadow area enclosed by the hysteresis loop represents energy loss. The dissipated energy can be calculated by using the following equation:

$E_h = \int \sigma \, d\xi$ where E_h = the dissipated energy, σ = stress, ξ = strain.
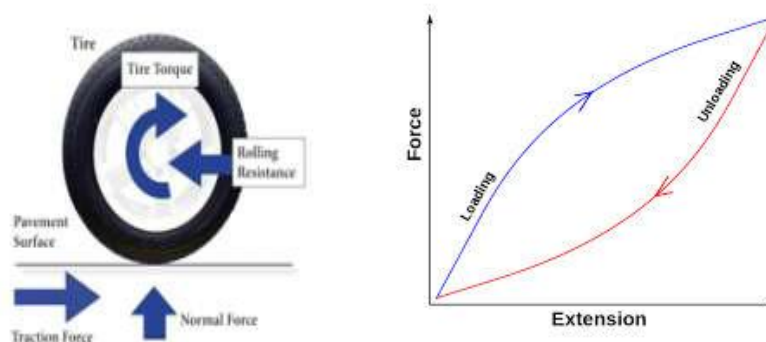

Figure 2 Rolling resistance & Hysteresis Loop

Rubber compounds of a tyre, at a regular temperature, display viscoelastic characteristics (Nokian Tyres plc., 1999), i.e. the hysteresis phenomena can be observed when a rubber compound undergoes repeated strain. A rolling tyre deforms when it contacts the pavement surface and recovers when it leaves the contact area. Therefore, rubber compounds of the tyre rapidly repeat the process of straining when the tyre is rolling on pavement. This process consumes energy which ends up as heat. Rolling resistance is not only caused by the deformation of the tyre. Bendtsen (2004) summarized three main mechanisms influencing rolling

resistance:

[1] The macro deformation of tyre

[2] The micro deformation in the contact area between tyre and pavement

[3] The slippage friction in the contact area between tyre and pavement\Sandberg (1997) also indicated that road surface texture needs to be considered in the rolling resistance calculation or simulation. Benbow et al (2007) stated that stiffness, texture and temperature have a quantifiable influence on rolling resistance.

PRIMARY CAUSES OF ROLLING RESISTANCE : A characteristic of a deformable material such that the energy of deformation is greater than the energy of recovery. The rubber compound in a tire exhibits hysteresis. As the tire rotates under the weight of the vehicle, it experiences repeated cycles of deformation and recovery, and it dissipates the hysteresis energy loss as heat. Hysteresis is the main cause of energy loss associated with rolling resistance and is attributed to the viscoelastic characteristics of the rubber.

-- National Academy of Sciences

This main principle is illustrated in the figure of the rolling cylinders. If two equal cylinders are pressed together then the contact surface is flat. In the absence of surface friction, contact stresses are normal (i.e. perpendicular) to the contact surface. Consider a particle that enters the contact area at the right side, travels through the contact patch and leaves at the left side. Initially its vertical deformation is increasing, which is resisted by the hysteresis effect. Therefore an additional pressure is generated to avoid interpenetration of the two surfaces. Later its vertical deformation is decreasing. This is again resisted by the hysteresis effect. In this case this decreases the pressure that is needed to keep the two bodies separate.

The resulting pressure distribution is asymmetrical and is shifted to the right. The line of action of the (aggregate) vertical no longer passes through the centers of the cylinders. This means that a moment occurs that tends to retard the rolling motion.

Materials that have a large hysteresis effect, such as rubber, which bounce back slowly, exhibit more rolling resistance than materials with a small hysteresis effect that bounce back more quickly and more completely, such as steel or silica. Low rolling resistance tires typically incorporate silica in place of carbon black in their tread compounds to reduce low-frequency hysteresis without compromising traction. Note that railroads also have hysteresis in the roadbed structure.

III.   ROLLING RESISTANCE COEFFICENT:-

The "rolling resistance coefficient", is defined by the following equation:

$$F = C_{rr} N$$

Where

F is the rolling resistance force

C_{rr} is the dimensionless **rolling resistance coefficient** or **coefficient of rolling friction** (**CRF**), and

N is the normal force, the force perpendicular to the surface on which the wheel is rolling.

Table1 : Rolling resistance coefficient due to effects of pavement surface

Road surface	Rolling resistance coefficient
Car tyre	
Concrete, asphalt	0.013
Rolled gravel	0.02
Tarmacadam	0.025
Unpaved Road	0.05
Field	0.1-0.35
Truck tyres	
Concrete, asphalt	0.006-0.01

IV. FACTORS INFLUENCING ROLLING RESISTANCE

Vehicle Velocity

Like the fuel consumption, rolling resistance also has a significant relationship with velocity. experiment has shown that, for a 32-tonn goods vehicle, rolling resistance contributes about 70% of total drag when driven at 50km/h and about 37% at 100km/h, aerodynamic drag contributing the remainder (Gyenes & Mitchell, 1994). The results from the experiment indicate that the main factor determining vehicle fuel consumption is speed. Ejsmont (1990) stated that the relationship between rolling resistance and velocity could be described as

$$F_r = C_1 + C_2V$$

Where, C_1, C_2 = Constants.
    V = Velocity of vehicle.

Temperature : Rolling resistance is affected by both tyre and ambient temperature. The temperature of tyre will be presented first then followed up by ambient temperature. Descornet (1990) measured rolling resistance by using a "quarter-car"trailer which had been designed and tested at the Belgian Road Research Centre. A mutual dependency between RRC and temperature can be found, i.e. RRC values reduced if the tyre had a higher temperature, as shown in Figure. This is logical since a warmed tyre becomes soft and thus, less energy is needed to deform the tyre, which means less energy is consumed in the rolling process. There would also be reduced stress concentration at tyre-pavement contacts and therefore less pavement deformation.
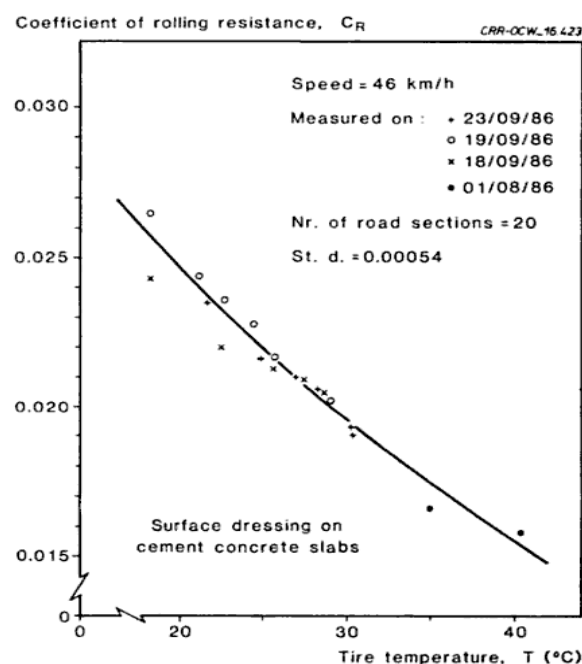
Figure 3 Rolling resistance coefficent Vs Tyre temperature (Descornet, 1990)

(a) rolling loss

(b) inflation pressure

Figure 4 Measurement during tyre warm-up (Popov,Cole,Cebon,Winkler, 2002)

Figure 5 Rolling resistance coefficent Vs Pavement surface condition (Descornet, 1990)

Figure 6 Pavement surface influence on rolling resistance (DeRaad, 1977)

Pavement Surface : An important issue which should not be overlooked is that rolling resistance is affected by the characteristics of the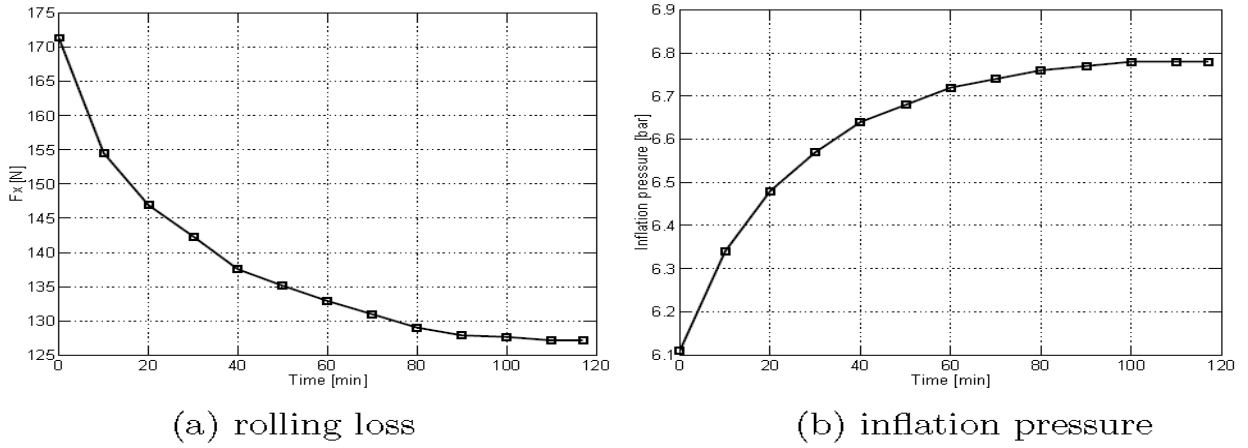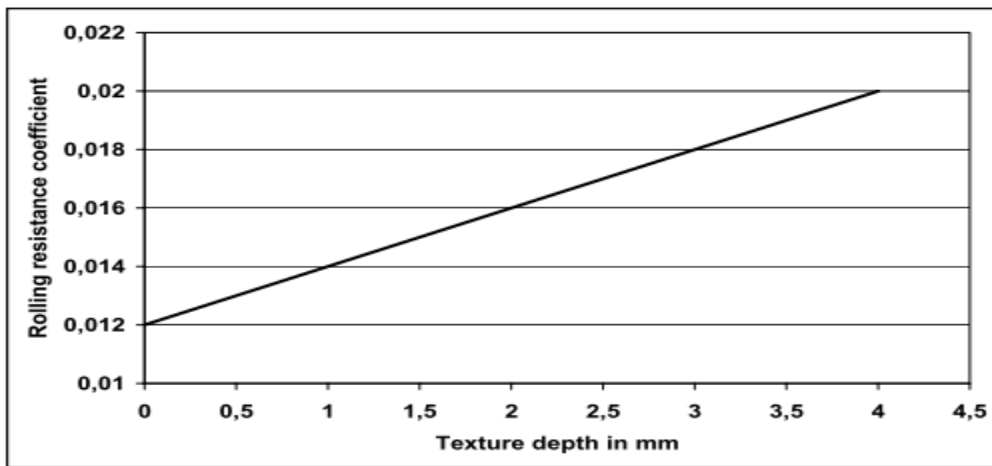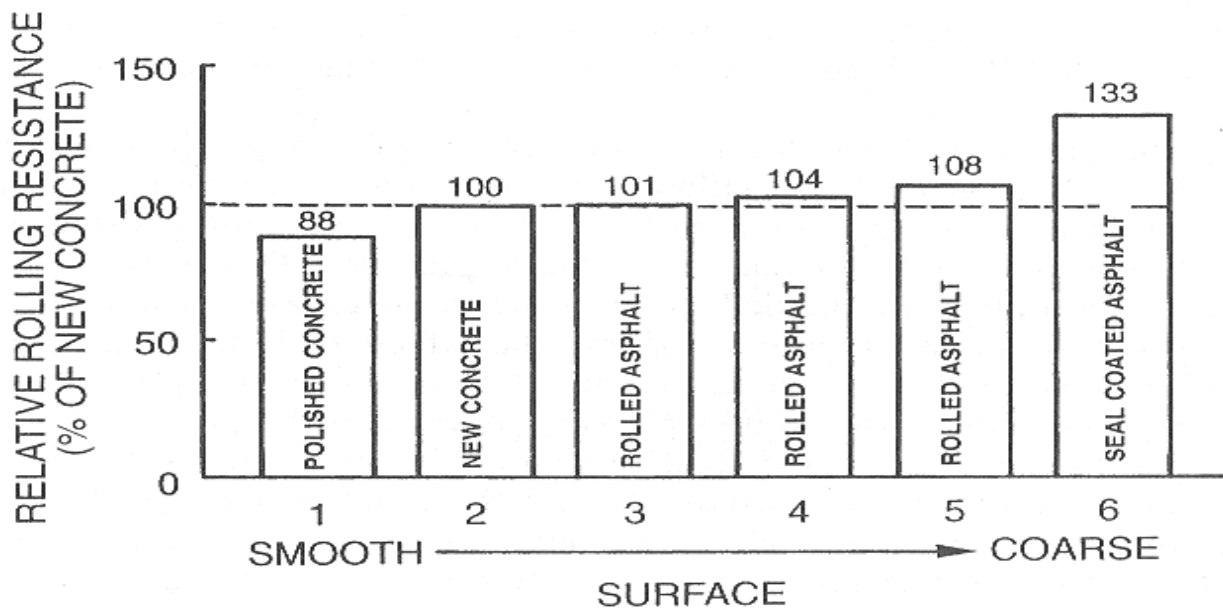 pavement surface. Rolling resistance varies between different pavement surfaces. Hard and smooth surfaces produce lower rolling resistance than soft and rough surfaces. The materials and surface characteristics also affect the rolling resistance (DeRaad, 1977). Figure shows a comparison of relative rolling resistance over a range of pavement surface types. The rolling resistance generated by a new concrete pavement has been defined as a standard value; 100%. The polished concrete pavement achieves the lowest rolling resistance; 88% of new concrete. The polished asphalt is a little higher than the standard, at 101%. The rolled asphalt pavements, number 4 and number 5, are 104% and 108%. The seal coated asphalt has the highest value, 133%. (Shown in above Fig.). Since the frictional characteristics of a pavement surface are influenced by pavement texture (Thom, 2008), pavement texture influences rolling resistance as well. Descornet (1990) stated a linear relationship between rolling resistance coefficient and texture depth by measuring a reference tyre of a trailer, as shown in Figure 2-13. The results show that the rolling

resistance coefficient increases by 0.002 as the depth of pavement texture increases by 1mm.

At Mairepav'03 Symposium in July 2003 in Portugal, A. Woodside, University of Ulster, Northern Ireland, presented a paper about rolling resistance of surface materials affected by surface type, tyre load and inflation pressure

Tyre characteristics	Tyre Operating Conditions	Environmental Conditions	Road Surface Characteristics
Construction: - cross ply - bias-belted - radial *Tread:* - compound - pattern - depth - fragmentation	Inflation pressure Load Speed Slip angle Camber angle Driving/braking force Wheel/axle configuration	Temperature Water Snow Ice	Micro-texture Macro-texture Mega-texture Unevenness

Table 2 - Factors affecting rolling resistance Based on Woodside paper Mairepav'03

OTHER MINOR FACTORS UNDER CONSIDERASION: Several factors affect the magnitude of rolling resistance a tire generates: (http://en.wikipedia.org/wiki/Rolling_resistance)
- Wheel radius, forward speed, surface adhesion, and relative micro-sliding.
- Material - different fillers and polymers in tire composition can improve traction while reducing hysteresis. The replacement of some carbon black with higher-priced silica–silage is one common way of reducing rolling resistance.
- Dimensions - rolling resistance in tires is related to the flex of sidewalls and the contact area of the tire For example, at the same pressure, wider bicycle tires flex less in sidewalls as they roll and thus have lower rolling resistance (although higher air resistance)

- Extent of inflation - Lower pressure in tires results in more flexing of sidewalls and higher rolling resistance. This energy conversion in the sidewalls increases resistance and can also lead to overheating and may have played a part in the infamous Ford Explorer rollover accidents.
- Over inflating tires (such a bicycle tires) may not lower the overall rolling resistance as the tire may skip and hop over the road surface. Traction is sacrificed, and overall rolling friction may not be reduced as the wheel rotational speed changes and slippage increases.
- Sidewall deflection is not a direct measurement of rolling friction. A high quality tire with a high quality (and supple) casing will allow for more flex per energy loss than a cheap tire with a stiff sidewall. Again, on a bicycle, a quality tire with a supple casing will still roll easier than a cheap tire with a stiff casing. Similarly, as noted by Goodyear truck tires, a tire with a "fuel saving" casing will benefit the fuel economy through many tread lives, while a tire with a "fuel saving" tread design will only benefit until the tread wears down.
- In tires, tread thickness and shape has much to do with rolling resistance. The thicker and more contoured the tread, the higher the rolling resistance. Thus, the "fastest" bicycle tires have very little tread and heavy duty trucks get the best fuel economy as the tire tread wears out.
- Diameter effects seem to be negligible provided the pavement is hard and the range of diameters is limited.
- Virtually all world speed records have been set on relatively narrow wheels, probably because of their aerodynamic advantage at high speed, which is much less important at normal speeds.
- Temperature: with both solid and pneumatic tires, rolling resistance has been found to decrease as temperature increases (within a range of temperatures: i.e. there is an upper limit to this effect). For a rise in temperature from 30°C to 70°C the rolling resistance decreased by 20-25%.

V. CONCLUSION:-

The rolling resistance depends both on how the tyre is designed (tyre factors) and on different characteristics in the road pavement. Many different **tyre factors** influence the rolling resistance:
- Different shape of the tyre gives different rolling resistance at higher speeds.
- Higher air pressure in the tyre reduces rolling resistance.
- Higher vehicle load gives higher rolling resistance.
- The tyre manufacturers can change the composition of the tyres to achieve a lower rolling resistance.
- A higher ambient temperature reduces rolling resistance.

The type of road pavement and its surface also influence the rolling resistance. Different **surface characteristics** (pavement texture) provides a major contribution to the rolling resistance as does the **structural behaviour** as both bearing capacity and viscoelastic behaviour can influence the rolling resistance. . A hysteresis phenomenon can be observed when viscoelastic materials undergo a load-then-unload process. A typical hysteresis curve of viscoelastic material can be found. The shadow area enclosed by the hysteresis loop represents energy loss. A characteristic of a deformable material such that the energy of deformation is greater than the energy of recovery. The rubber compound in a tire exhibits hysteresis. As the tire rotates under the weight of the vehicle, it experiences repeated cycles of deformation and recovery, and it dissipates the hysteresis energy loss as heat. Hysteresis is the main cause of energy loss associated with rolling resistance and is attributed to the viscoelastic characteristics of the rubber. Materials that have a large hysteresis effect, such as rubber, which bounce back slowly, exhibit more rolling resistance than materials with a small hysteresis effect that bounce back more quickly and more completely, such as steel or silica. Low rolling resistance tires typically incorporate silica in place of carbon black in their tread compounds to reduce low-frequency hysteresis without compromising traction. Note that railroads also have hysteresis in the roadbed structure. Like the fuel consumption, rolling resistance also has a significant relationship with velocity

REFERENCES

[1]   1.Environmental Impacts and Fuel Efficiency of Road Pavements; Industry report March 2004; PREPARED BY - JOINT
[2]   EAPA/EUROBITUME TASK GROUP FUEL EFFICIENCY; eurobitume ;EAPA.
[3]   2.THE INFLUENCE OF PAVEMENT STIFFNESS ON VEHICLE FUELCONSUMPTION – Tao Lu; The University of
[4]   Nottingham, September 2010.
[5]   3.Synthesis of the Effects of Pavement Properties on Tire Rolling Resistance NCAT, AUBURN UNIVERSITY, RESEARCH
[6]   SYNOPSIS–NCAT REPORT 11-05.
[7]   4.A1 Paper Plc. (2006). Small Fleet Performance Management Tool (SFPMT) helps A1 Paper improve efficient. Department
[8]   for Transport.
[9]   5.Ang-Olson, J., & Schroeer, W. (2002). Energy efficiency strategies for freight trucking: Potential impact on fuel use and
[10]   greenhouse gas emissions. Transportation Research Record (1815), 11-18.
[11]   6.Bang, J. R. (1990). Reduction in Automobile Fuel Consumption. OECD/IEA Informal Expert Panel on Low Consumption

[12]   Low Emission Automobile, Proceedings of an Expert Panel, Rome , 14-15.
[13]   7.Bamberger, R. (2005). Automobile and Light Truck Fuel Economy: The CAFE Standards. CRS Issue Brief for Congress.
[14]   8.Benbow, E., Iaquinta, J., Lodge, R., & Wright, A. (2007). Investigation of the Effects of Pavement Stiffness of Fuel
[15]   Consumption. TRL Limited.
[16]   9. http://en.wikipedia.org/wiki/Rolling_resistance
[17]   10.FUEL CONSUMPTION & ENERGY DISSIPATION THROUGH ROAD PAVEMENT CHARACTERISTIC- Dipanjan
         Mukherjee; ISRJ,June,14

Research　　　　　　　　　　　　　　　　　　　　　　　　Open Access

Performance of Vacuum Insulation Panels in Building Energy Conservation

[1,]Steven J. Herek, [2,]Emmanuel C. Nsofor

[1]*Department of Mechanical Engineering & Energy Processes, Southern Illinois University, Carbondale, IL 62901, USA*

ABSTRACT: *In this study, building energy simulations were performed to explore the application of Vacuum Insulation Panels (VIPs) for building insulation. The simulations were done to compare the use of traditional building insulation to the use of VIPs in relevant areas of a building. Also, the study was extended to investigate the outcome if the same building is located in different geographical areas and climates. The results show that in moderate to cold climates VIPs can account for an overall building energy savings of up to 10%. In warmer months, particularly in the warmer climates, the savings were found to be insignificant. This implies that in hot climates the energy savings is not much. For winter months in colder climates energy savings were found to be in the range of 10% to 16%. Thus VIPs have the potential to save energy in moderate to cold climates, especially during the coldest months of the year and can be a valuable application for green buildings located in areas that have more of such weather conditions.*

KEYWORDS:-*Building energy conservation, green buildings, thermal energy transfer, vacuum insulation panels*

I.　INTRODUCTION

Conservation of energy has become very important as energy costs continue to rise. Consequently, building energy conservation has emerged as a key area of research and development. The operation of buildings in the United States alone uses almost forty percent of the nation's annual energy supply [1]. Related information on Europe's annual energy supply also show that building space heating and cooling demands about the same percentage of energy consumption. Many materials and applications have been used to insulate buildings. There have been some improvements in recent years as new materials are emerging with some having better insulating properties but with higher cost. A recent example is Vacuum Insulation Panels (VIPs). This is an effort to implement vacuumed space in thermal boundary walls for substantial insulation. Studies have shown that for the same thickness, the thermal resistance of an evacuated insulation is up to ten times better than conventional insulation materials such as fiberglass, polyurethane and polystyrene.

Related research on VIPs include Kaynaki [2] which reported a study to determine optimum thickness of building insulation and its effect on energy consumption. Xiao et al. [3] explored the influence of wall insulation thickness on building energy consumption. Other than climate, building type, and indoor heat gain, external wall insulation were found to have about the most influence on energy consumption in buildings in the study. The results show that the increase in insulation thickness helps reduce building energy consumption. Friess et al. [4] investigated the impact of building insulation on building energy consumption. The study showed that with appropriate external wall insulation alone energy savings can be up to 30%. Korolija et al. [5] used EnergyPlus to explore how to select an appropriate HVAC system and provided guidelines for selecting HVAC systems for UK office buildings. Bojic et al. [6] investigated possibilities for decreasing the energy used in a Serbian home that was not thermally insulated and found that the single best refurbishment procedure was insulating the external walls. Hens and Wouters [7] and Petersson [8] studied the effect of insulating roofs and ceilings on building energy consumption and found that energy consumption was greatly reduced with improved ceiling insulation.Johnasson [9] did a literature survey on VIPs and recommended promising areas for future applications. Fricke et al. [10] investigated the thermal properties and some applications of VIPs and concluded that understanding thermal transport in VIPs is necessary for its further applications. Brunner and Simmler [11]

studied application of VIPs to buildings and also, compared the findings to laboratory simulations.

A VIP flat roof construction was studied for three years. The results were used in predicting the service life of VIPs. Alam et al. [12] explored VIPs' use in building construction by reviewing their contemporary developments and possible future directions. Conclusions from the study and future directions included needing to develop ways for VIPs to last longer and lower market prices.Tseng and Chu [13] studied the effects of adding polyethylene (PE) in polystyrene (PS) foaming material on the cell structure and heat transfer of VIPs. Results from the study show that adding 2 to 5% PE altered the cell structure and reduced the heat transfer through the VIP whereas adding more than 5% did not improve the heat transfer performance further. Kwon et al. [14] studied three thermal transport mechanisms of a number of filling materials for VIPs with special emphasis on the solid conduction. The results show that due to the relatively long thermal path, solid conductivities of the fiber and staggered beam insulation are lower than those of foam and powder. The study also found that fiber and staggered beam structures demonstrate promise as filling materials for VIPs. In this present study, a typical residential building constructed with traditional building insulation materials was interfaced with the EnergyPlus program. Computer simulations were performed to study the energy demand by the building. Thereafter, simulations were also performed for the same building to study how the effect of applying VIPs as a building construction material to relevant areas of the building will affect the energy consumption. Areas investigated included external wall insulation and ceiling. The results of the energy demand by the building for the two different cases were compared. The study was extended using the same building to study the comparison for different geographical areas and climates of this country, namely the northeast, the northwest, the southeast, the southwest and the mid-region (mid-west). The results of the study were summarized and discussed. Based on these, recommendations were made for the best applications of VIPs.

II.   THERMAL ENERGY TRANSFER THROUGH THE VIP

Vacuum Insulation Panels can be described as an evacuated open porous material located inside a multilayer envelope [12]. A vacuum within the core eliminates convection heat transfer and reduces conduction heat transfer. Figure 1 is a schematic of the VIP. It is composed of three parts, namely, an inner core, the barrier envelope, and
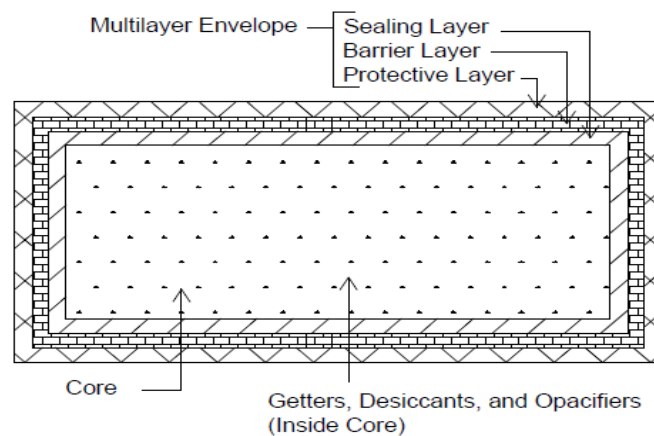
Figure 1: Schematic of a VIP

getters. The inner core is made of low conductivity porous material that has the purpose of maintaining the physical support of the panel under vacuum conditions. The porous cells in the material are connected thus forming a network that makes it possible for all the gases to be evacuated. The barrier envelope is composed of non-permeable thick metal sheets of multiple layers. The functions of the multiple layers are for protection and sealing, with a barrier in between. Getters are chemicals within the VIP that collect gasses that do slip through the membrane. Compared to most common building insulators such as, fiberglass, mineral wool, VIPs have a potential to have up to eight times higher thermal resistance to heat transfer [11]. Performance of conventional insulators is limited by gas conduction inside the porous materials.Thermal energy transfer through the VIP is by solid conduction, radiation and gaseous conduction. The structure and material properties of the core control solid conduction. Thermal radiation energy transfer is dependent on the structure and optical properties of the core.

The gas conduction also depends on the gas pressure. Collision between the gas particles limits efficient heat transfer at a high pressure where the mean free path of the gas molecules is much smaller than the size of the pores. Gas conduction is also determined by the thermal conductivity of the non-convective gas. The effective thermal conductivity k_{eff} of the VIP can be written as:

$$k_{eff} = k_s + k_r + k_g \tag{1}$$

In this equation, k stands for thermal conductivity and the subscripts s, r, and g stand for solid, radiation and gas respectively.

The theory of gaseous thermal conduction is based on the concept of temperature jump or discontinuity. For two parallel plane surfaces at temperatures T_1 and T_2, separated by a small distance L, Kwon [14] gives the energy flux q_g between the surfaces as:

$$q_g = \frac{k_g}{L + 2\beta}(T_1 - T_2) \tag{2}$$

In this expression, β is described by the equation,

$$\beta = \left(\frac{9\gamma - 5}{2\gamma + 1}\right)\left(\frac{2 - \alpha}{\alpha}\right)\lambda \tag{3}$$

where, γ is the specific ratio of the gas, α is the thermal accommodation coefficient and λ is the mean free path for the gas. VIP is a thin material and so the heat transfer through the central core can be modeled as a one-dimensional plane parallel medium. The radiant energy transfer is given by the expression [15]

$$q_r = -\frac{16\,\sigma\,T_m^3}{3\,\sigma_e\,(\nabla T)} \tag{4}$$

where, σ is Stefan Boltzmann constant, T is absolute temperature, T_m is the mean of the boundary temperatures and σ_e is Rosseland mean extinction coefficient defined as:

$$\frac{1}{\sigma_e} = \int_0^\infty \left(\frac{1}{\sigma_{e_\lambda}}\right)\frac{\partial e_{\lambda_b}}{\partial e_b}\,d\lambda \tag{5}$$

In this expression, e_b is total emissive power of a blackbody, $e_{\lambda b}$ is the spectral emissive power and λ is the wavelength of the thermal radiation. It is also important to include the heat transfer at the edges of the VIP due to conduction. The barrier material for the edges are required to have low water vapor and gas permeability and should surround the evacuated core completely. Schwab et al. [16] gave the expression for the overall or effective thermal transmittance U_{eff} for the barrier laminate that completely covers the evacuated core of the VIP as:

$$U_{eff} = U_{cop} + \frac{L_p}{A_s}\psi_{vip,edge} + \frac{1}{A_s}\sum_{i=1}^N \chi_{vip,corner,i} \tag{6}$$

where L_p is the perimeter of the panel or circumference, N is the number of corners, A_s is the surface area of the panel, $\psi_{vip,edge}$ is the linear thermal transmittance of the edge and $\chi_{vip,corner}$ is the corner thermal transmittance. For this equation, Tenpierik and Cauberg [17] stated that the center of panel thermal transmittance U_{cop} for

conventional insulation materials including their environment can be expressed as:

$$U_{cop} = \left[\frac{t}{k_{cop}} + \frac{1}{h_i} + \frac{1}{h_o} \right]^{-1}$$

(7)

where t is the thickness of the panel, k_{cop} is the thermal conductivity of the panel, h is the heat transfer coefficient and the subscripts i and o stand for inside and outside respectively. Usually, the third term on the right hand side of equation (6) can be neglected by assuming that the corner thermal bridge effect is small compared to the effect of the thermal edge.

III. BUILDING DESCRIPTION AND PROCEDURE

The house used for this study was designed for 2000 square feet, (about 186 square meters), which is typical for today's average family residential building. Figure 2 illustrates the floor plan for the building used in this study. The building has three bedrooms, including a large master suite, two bathrooms, an average sized
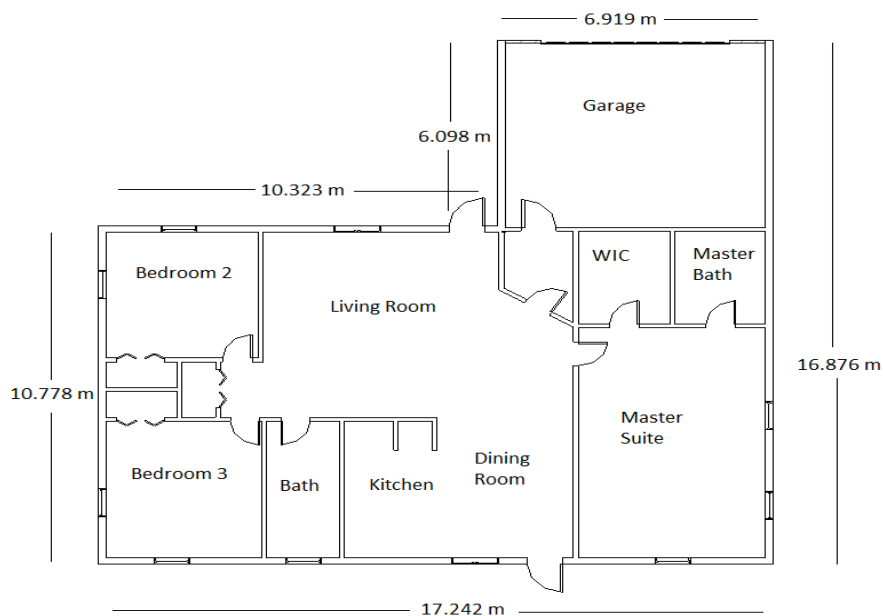
Figure 2: House Floor Plan

kitchen, a dining room and a large living room. Also included in the building are, a two car garage and a typical attic space. All aspects of the construction are considered to be very typical. Exterior and interior wall studs were designed with 16-inch spacing on center. Exterior walls are composed of wood siding, a layer of insulation, and plasterboard from exterior to interior. Interior walls are considered to have just plasterboard on both sides. The roof consists of a few layers from exterior to interior, asphalt shingles, and plywood. The ceiling is composed of a layer of insulation and plasterboard from the exterior to interior. The windows used consist of three layers with exterior layers made of 3mm thick glass, and the interior consisting of 6 mm of air. Exterior doors are also basic and made of wood. The garage door is made of a material similar to the steel siding. Energy for the garage was not modeled because typically, the garage is not served by the HVAC system in most family residential buildings.All of the equipment in the house that uses electricity were divided into three groups, namely, lighting, heating and cooling, and others. An electric heat pump system was implemented for the building. The heating and cooling was run on the same schedule not only to ensure that temperatures were always within a comfortable range but also to maintain the same standard for the different regions studied. The set point used for heating was 20°C (68°F) and that for cooling was 24°C (75.2°F). Other equipment/appliances implemented in the model included a hot water heater, four ceiling fans, one vacuum

cleaner, a clothes dryer, a clothes washer, one video game system, one HD receiver, a Blu-ray player, three cell phones,
two computers, one tablet, two clock radios, one stereo player, two TVs, one coffee making machine, a microwave oven, a dishwasher, and a refrigerator/ freezer combo. Tables 1 and 2 show the relevant properties for the materials implemented in this study. While Table 1 shows the R-values for the building materials, Table 2 shows the thicknesses and relevant thermal properties for the fiberglass batting and the VIP used.

Table 1: R-values for Typical Building Insulation Materials [14]

R-Values for Typical Building Insulation Materials		
Material	$m^2 \cdot K/(W \cdot in)$	$ft^2 \cdot °F \cdot h/(BTU \cdot in)$
Fiberglass Blanket	0.55-0.76	R-3.1 – R-4.3
Rockwool Blanket	0.52-0.68	R-3 – R-3.85
Blown in Fiberglass	0.44-0.65	R-2.5 – R-3.7
Blown in Cellulose	0.52-0.67	R-3 – R-3.8
Spray Foam Open Cell	0.63	R-3.6
Spray Foam Closed Cell	0.97-1.14	R-5.5 – R-7
Foam Board	0.63-0.95	R-3.6 – R-5.4
VIPs	5.28-8.8	R-30 – R-50

Table 2: EnergyPlus Data for Fiberglass Batting and VIPs

Material	Thickness (m)	Conductivity (W/m-K)	Density (kg/m^3)	Specific Heat (J/kg-K)
Fiberglass Batting	0.066	0.04	12	840
VIPs	0.0254	0.005	190	800

The procedure adopted in the study assumed that the materials used in the building construction had uniform thicknesses. Material degradation over time was not considered. The following is a list of the steps taken in the procedure.

[1] Selection of the building and the contents.
[2] Construction of the model of the building in EnergyPlus environment. This included all of the building surfaces, fenestration, schedules, etc.
[3] Performance of simulations to fix any arising errors.
[4] Selection of the materials along with the properties necessary for the simulations.
[5] Performance of annual simulations with the working model based on the representative city and the weather data for the region being studied.
[6] Recording the results along with the associated data.
[7] Selection of a new representative city with its weather data for the new region and repeating steps 5 and 6.
[8] Continuing the steps 5 to 7 until simulations were completed for all the regions. It should be noted

here that the simulations were performed for five different regions of the United States. The study involved locating and studying the building energy demand in the following regions, namely, the Midwest, Northeast, Southeast, Southwest, and Northwest. These cities for the locations were Carbondale-Illinois, Boston-Massachusetts, Orlando-Florida, Phoenix-Arizona, and Seattle-Washington, respectively. The weather files for each city stored in the program, were used in the simulations.
Analysis of the results.

IV. RESULTS AND DISCUSSION
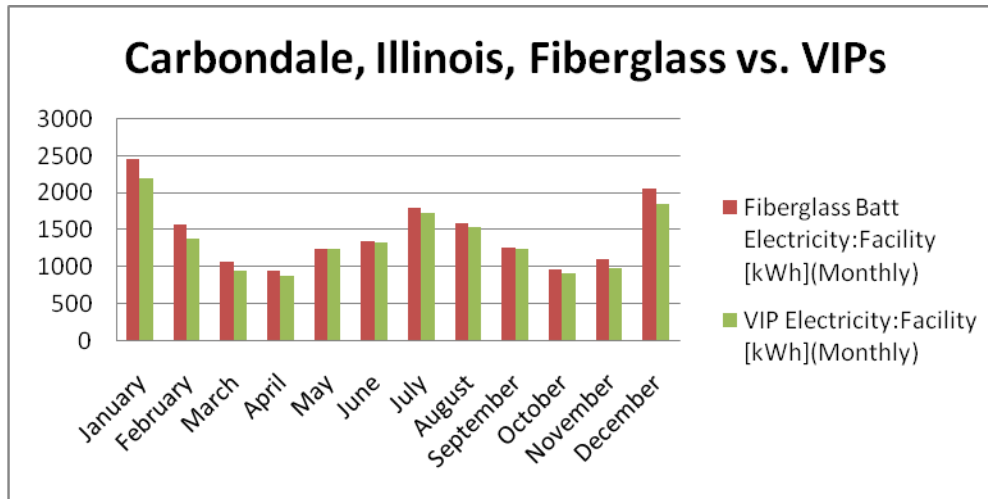
Figure 3 shows comparison of performance of fiberglass batting and the VIP in the building for Carbondale IL representing the mid-west region of the country. This illustrates the savings VIPs can provide
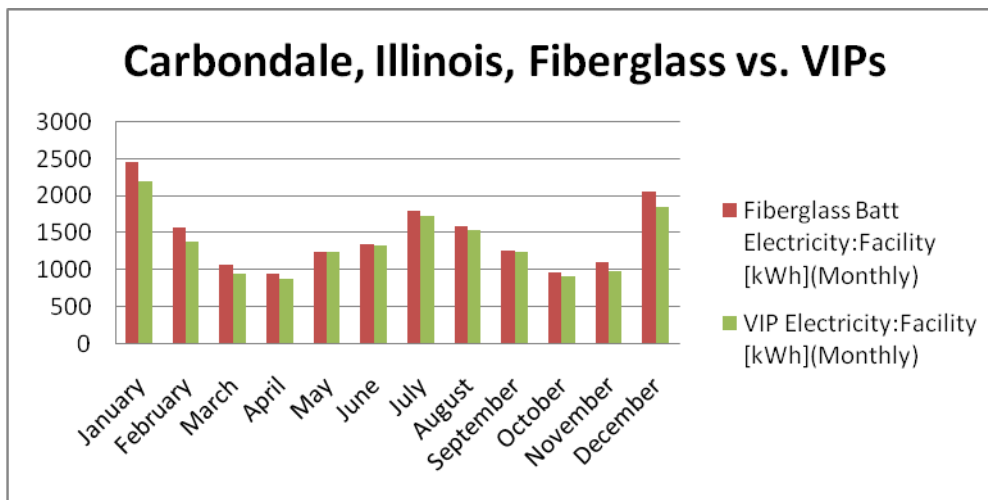
Figure 3: Results for Carbondale, Illinois, Fiberglass vs. VIPs

over fiberglass batting as wall insulation. As can be seen in the figure, electricity is saved every month. Figure 4 shows the savings broken down by month shown as percentages. The greatest savings can be seen to occur in the winter months. It can also be seen that in these colder months the electricity savings is always over 10%, peaking at 13%. This shows that VIPs are more effective during the winter months. During the summer, the hottest months, the savings are much lower than the winter savings. During the periods in-between, the savings are minimal.
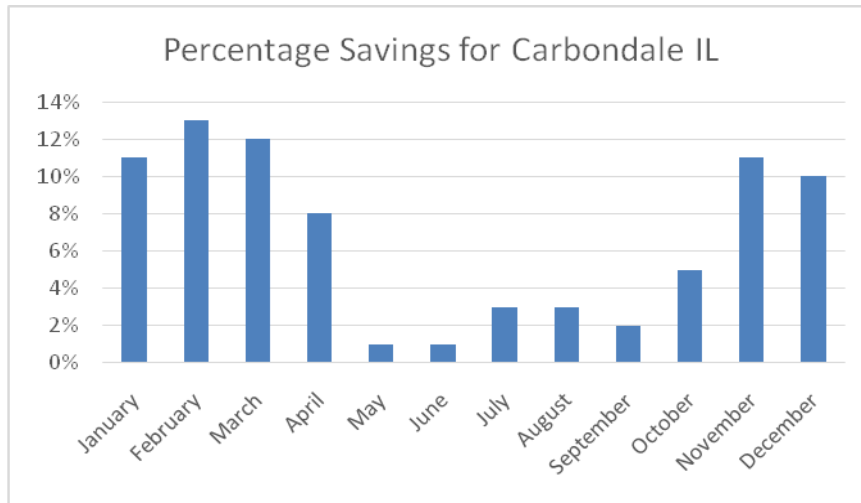
Figure 4: Percentage Savings for Carbondale, IL, Fiberglass vs. VIPs

Figure 5, compares the performance of the VIP to the fiberglass batting as wall insulation in Boston, Massachusetts. The total electricity usage showed an 8% savings with VIP over that with fiberglass batting.
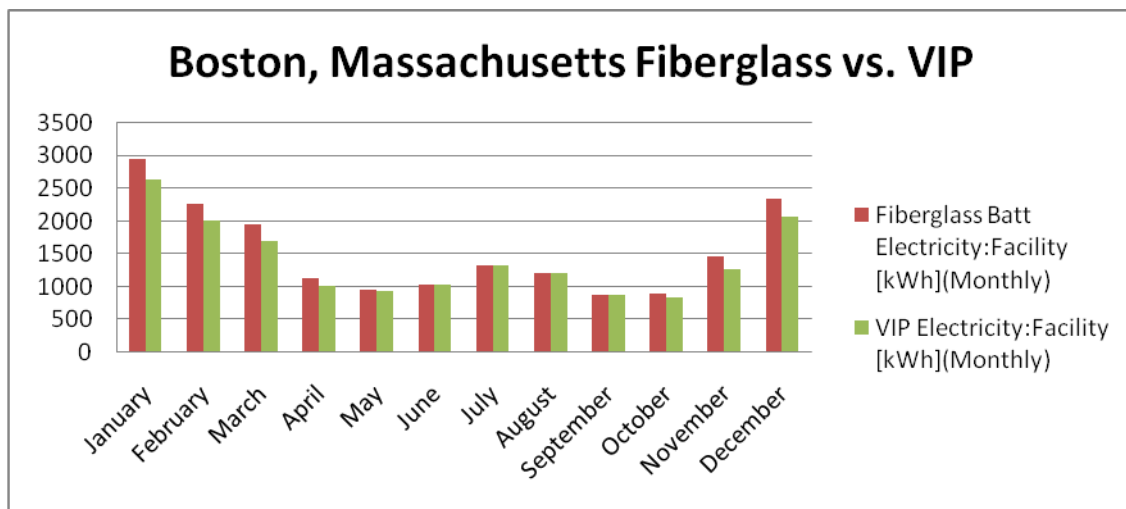
Figure 5: Results for Boston Massachusetts Fiberglass vs. VIP

The monthly energy savings when using VIPs instead of fiberglass batting are shown in figure 6. It is seen that throughout the warmer months there is virtually no savings, i.e., 1% or less for four months. For the winter, the colder months, there are significant savings. For six months out of the year, electricity usage was reduced by 10% or more.
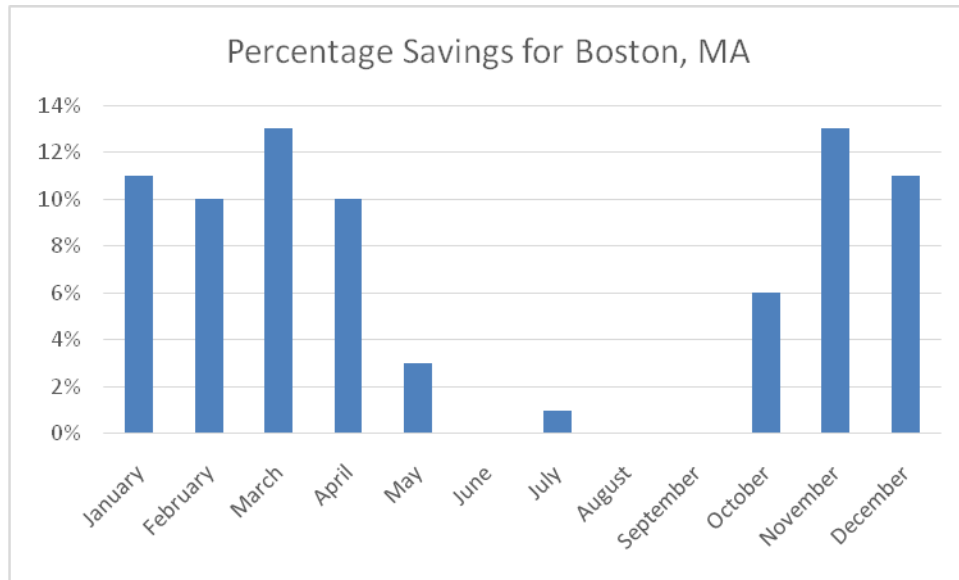
Figure 6: Percentage Savings for Boston, MA, Fiberglass vs. VIPs

Simulations were also performed for Orlando, Florida to investigate the performance of VIPs in houses located in the southeast region of the country. Figure 7 shows the results for fiberglass batting as wall insulation compared to VIP in that region.
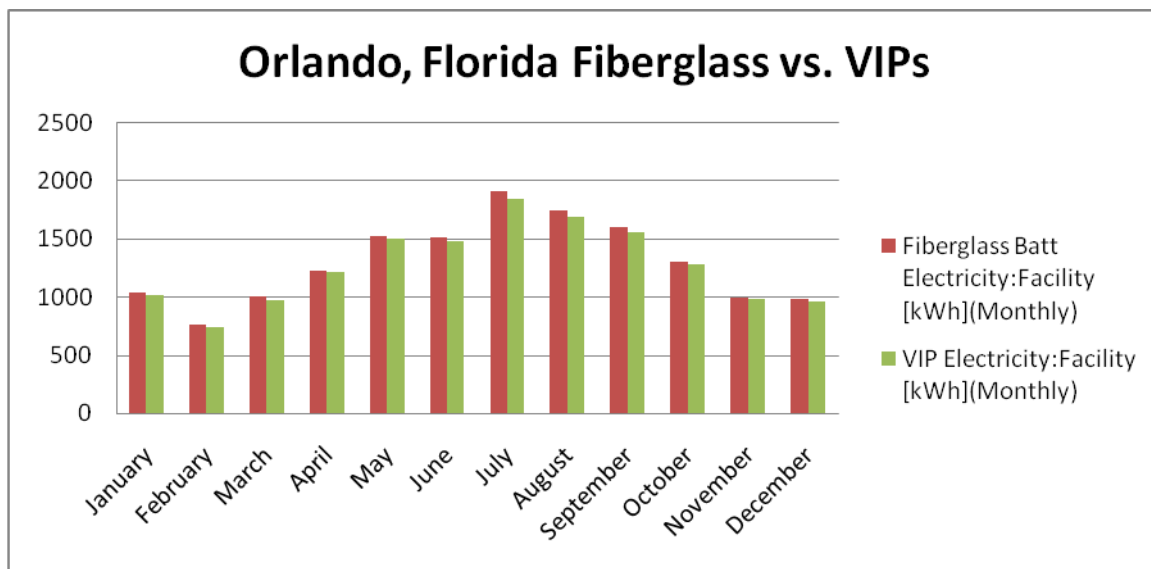
Figure 7: Results for Orlando, FL, Fiberglass vs. VIPs

In figure 8, the energy savings are broken down monthly, and shown in percentages. In a climate like Orlando, Florida, the high and low temperatures do not fluctuate as much as those in the more northern climates, and are warmer overall. The energy saved when using VIPs instead of fiberglass batting was never higher than 4% for a month. This implies that in this climate, and similar ones, VIPs do not have a large impact.
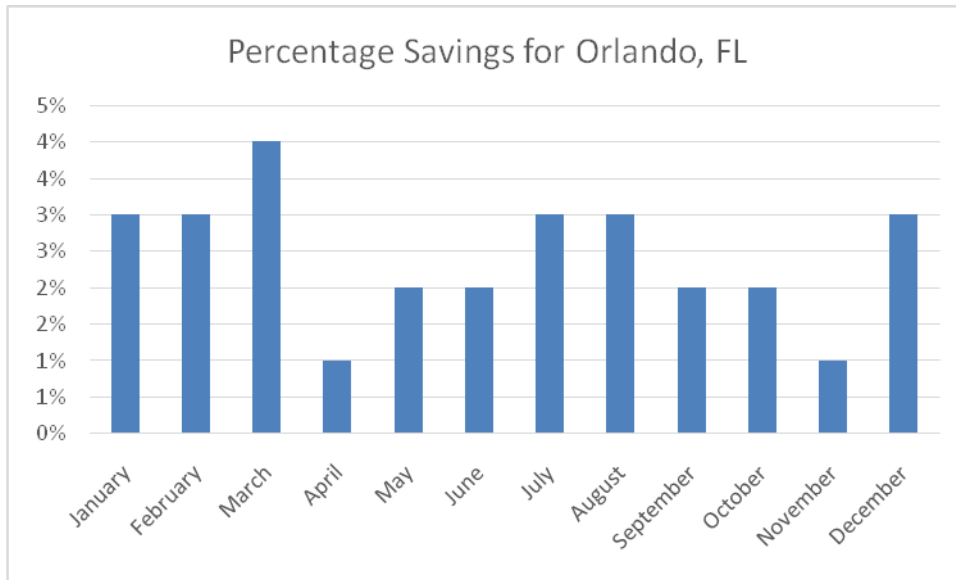
Figure 8: Percentage Savings for Orlando, FL, Fiberglass vs. VIPs

Simulations were also performed for Phoenix, Arizona to investigate the performance of VIPs in the southwestern region of the country. Figure9 shows the results for fiberglass batting versus VIPs in this
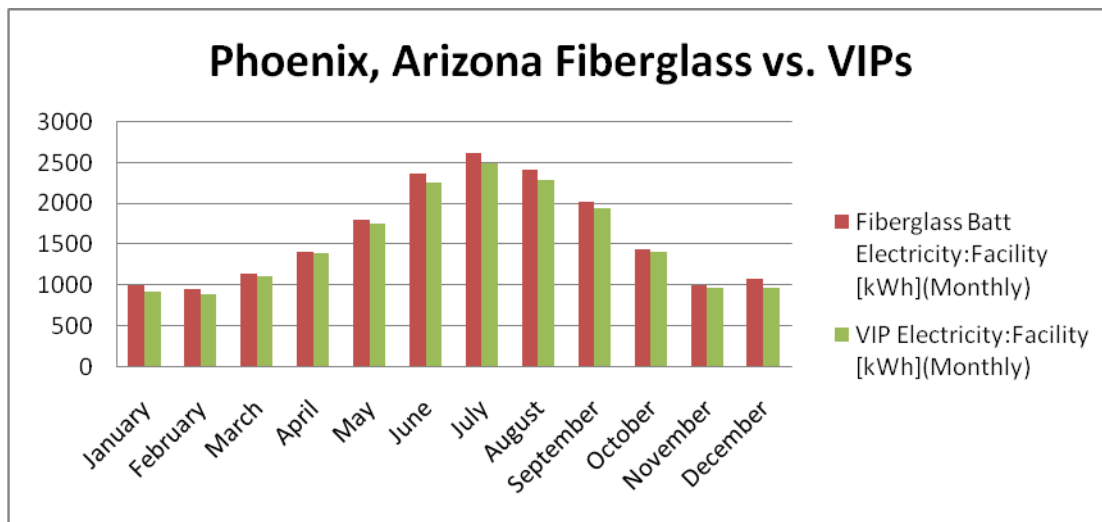
Figure 9: Results for Phoenix, Arizona, Fiberglass vs. VIPs

region. Figure 10, shows the energy savings broken down by month and reported in percentages. It can be seen that in the colder, winter months, there are some meaningful savings. In the three coldest months electricity used is reduced by 7% monthly. As for the rest of the year, savings are seen to be less significant. Overall, it can be concluded that electricity savings in Phoenix-Arizona are likely not significant enough to implement VIPs as wall insulation for the building. Simulations were also performed for Seattle, Washington
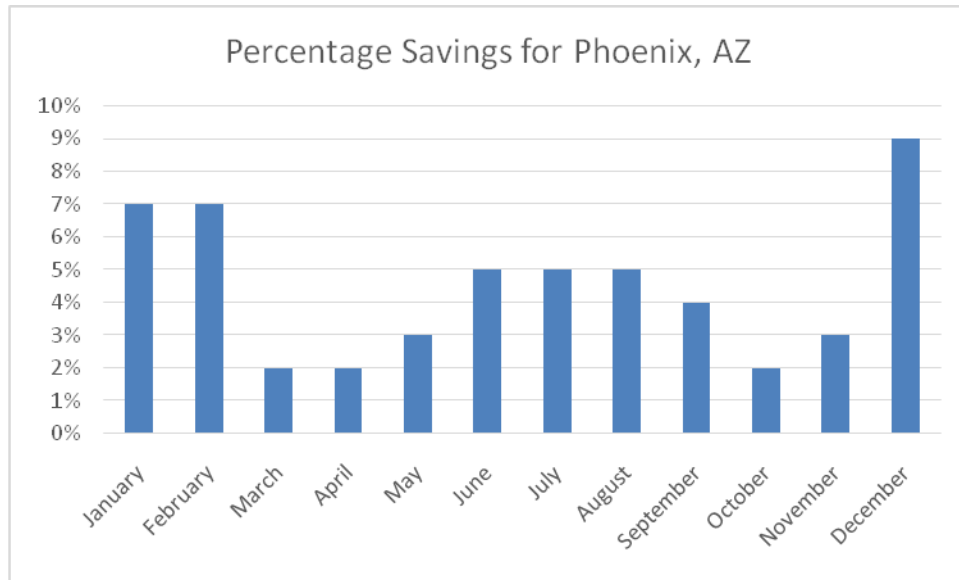
Figure 10: Percentage Savings for Phoenix, AZ, Fiberglass vs. VIPs

to investigate the performance of VIPs in houses located in the northwestern region of the country. Figure 1 shows the results for fiberglass batting as wall insulation versus VIP for this region. Monthly percentage savings for Seattle WA, are shown in figure 12. The savings in this region show to be the highest among all
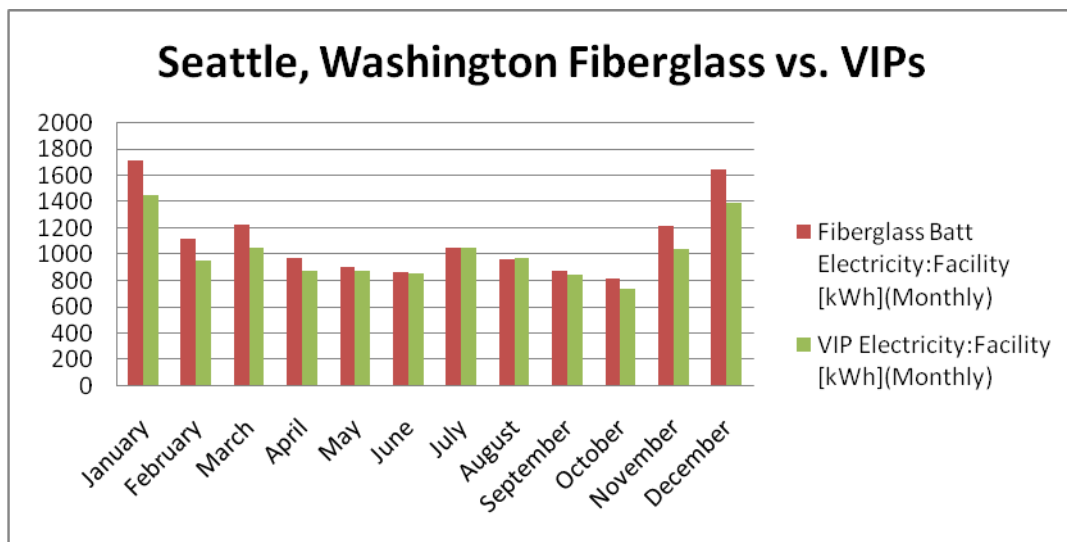
Figure 11: Results for Seattle, Washington, Fiberglass vs. VIPs

the regions studied. Monthly savings of between 14% and 16% were obtained for the months of October to April. During the warmer months (May to September), little or no savings, of between 0% and 1% were obtained. Thus the savings in the relatively colder months are seen to be quite significant.
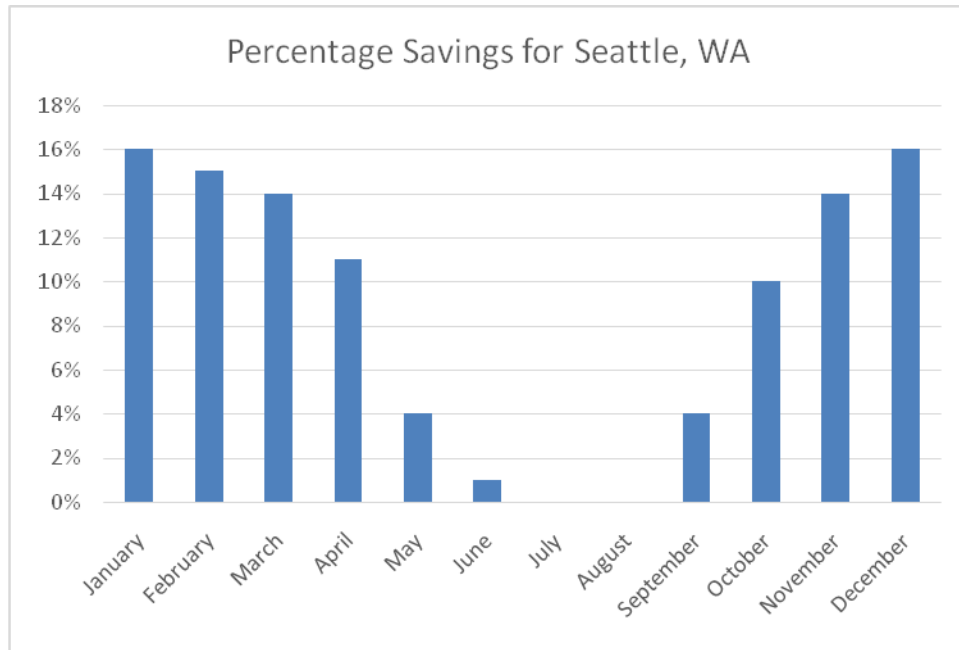
Figure 12: Percentage Savings for Phoenix, AZ, Fiberglass vs. VIPs

Simulations were also performed for each location to explore the application of VIPs as insulation in ceilings. The use of insulation in ceilings is important, as large heat loses or gains may occur there. Hence,
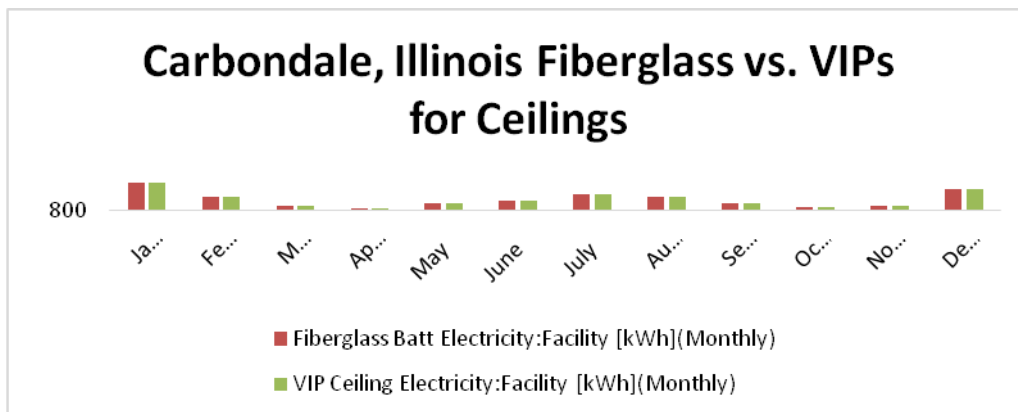
Figure 3: Results for VIPs as Insulation in Ceilings

it is important to have the right level of insulation in ceilings. Simulations were performed with fiberglass batting ceiling insulation in the building and compared to the use of VIP as ceiling insulation for all the five cities (regions) studied under wall insulation. The results for Carbondale, IL (the mid-west region) are shown in Figure 3. This data shows electricity energy use by month for both ceiling insulations. The graph clearly shows the minimal savings. Results were found to vary only slightly by location. Hence only the results for the mid-west region represented by Carbondale, IL are shown here. The savings show to be only less than half of a percent.

V.   CONCLUSIONS

In this study, computer simulations were performed on a typical family residential building to study the energy demand by the building using conventional wall and ceiling insulation materials compared to using VIP as the insulation material. The application of VIP as wall insulation showed electricity savings ranging from 2% to 10%. The lowest savings were for the southeast and the southwest regions of the country, at 2% and 4%

respectively. With this result, it is not be recommended that VIPs be used as an energy saving option for these areas at this time. It is anticipated that the cost of VIPs will come down with time as more research is done on it. The other three regions of the country, namely, the mid-west, northeast and northwest regions, showed savings of up to 7%, 8%, and 10%, respectively. Thus VIPs could be effective energy savers as wall insulation material in these areas. The simulations performed by using VIP as insulation material for the ceiling in all the cities or regions showed only very slight energy savings. Thus is not recommended that VIPs be used at this time as ceiling material in these areas.Another important trend also emerged from this study. Savings in the colder months were found to be significantly greater than those for the warmer months. Savings were also significantly greater in colder climates. During the months with the hottest temperatures in the hottest climates the savings were found to be not much, i.e. zero to one percent. During the five coldest months in the three coldest climates, VIPs showed savings of at least 10% of energy use compared to fiberglass batting. Therefore for areas where relatively long cold months in the year, VIPs could be implemented for considerable energy savings.

REFERENCES

[1] USDOE, "Buildings Energy Databook" Office of Energy Efficiency and Renewable Energy, US Department of Energy, Washington DC, 2002.
[2] O. Kaynaki, O., Review of the Economical and Optimum Thermal Insulation Thickness for Building Applications,*Renewable and Sustainable Energy Reviews*, 16, 2011, 415-425.
[3] J. Xiao,J. Liu, J. Liu, and G. Xu, G., The Influence of Wall's Insulation Thickness to Building Energy Consumption,*International Conference on Mechanic Automation and Control Engineering, MACE2010*, 2010, 4241-4244.
[4] W. Friess, K. Rakhshan, T. Hendawi, and S. Tajerzadeh, Wall Insulation Measures for Residential Villas in Dubai: A Case Study in Energy Efficiency,*Energy in Buildings*, 44, 2011. 26-32.
[5] I. Korolija,Y. Zhang,L. Marjanovic-Halburd, and V. Hanby, V., Selecting HVAC Systems for Typical UK Office Buildings,*Proceedings – 6th International Symposium on Heating, Ventilating, and Air Conditioning*, 2009, 388-392.
[6] M. Bojic, S. Djordjevic,A. Stefanovic, M. Miletic, and D. Cvetkovic, D., Decreasing Energy Consumption in Thermally Non-Insulated Old House via Refurbishment," *Energy in Buildings*, 54, 2012, 503-510.
[7] H. Hens, and P. Wouters, P., Energy Use in Use in Occupied Dwellings." *National Swedish Inst. For Building Research*. pp. 95-106.
[8] B. A. Petersson, Additional insulation of Roofs, *National Swedish Inst. For Building Research*,1983, 591-599.
[9] P. Johansson, Vacuum Insulation Panels in Buildings: Literature Review." 2012, Chalmers University.
[10] J. Fricke, H. Schwab, and U. Heinemann, Vacuum Insulation Panels – Exciting Thermal Properties and Most Challenging Applications, *International Journal of Thermophysics,*2006, 27(4), 1123-1139.
[11] S. Brunner, and H. Simmler, In Situ Performance of Vacuum Insulation Panels in a Flat Roof Construction,*Vacuum*, 82,2007, 700-707.
[12] M. Alam,H. Signh, and M. C. Limbachiya, Vacuum Insulation Panels (VIPs) for Building Construction Industry- A Review of the Contemporary Developments and Future Directions,*Applied Energy*, 88,2011, 3592-3602.
[13] P. C. Tseng, and H. S. Chu, The Effects of PE additive on the Performance of Polystyrene Vacuum Insulation Panels,*International Journal of Heat and Mass Transfer*, 52, 2009, 3084-3090.
[14] J. Kwon, C. H. Jang, H. Jung, and T. Song, Effective Thermal Conductivity of Various Filling Materials for Vacuum Insulation Panels, *International Journal of Heat and Mass Transfer*, 52, 2009, 5525-5532.
[15] J. R. Howell, R. Siegel and M. P. Menguc, *Thermal Radiation Heat Transfer*, 5th Edition, (Taylor & Frances CRC Press, Boca Raton, FL, 2011).
[16] H. Schwab, C. Stark, J. Wachtel, H. P. Ebert, and J. Fricke, Thermal Bridges in Vacuum-insulated Building Facades, *Journal of Thermal Envelope and Building Science*, 28(4),2005, 345-355.
[17] M. Tenpierik, and H. Cauberg, H., Analytical Models for Calculating Thermal Bridge Effects Caused by Thin High Barrier Envelopes around Vacuum Insulation Panels, *Journal of Building Physics*, 30, 2007, 195-215.

Research Paper   Open Access

Comparison of Blowfish and Cast-128 Algorithms Using Encryption Quality, Key Sensitivity and Correlation Coefficient Analysis

Shailaja S[1], Dr Krishnamurthy G N[2]

[1] *(Department of Computer Science and Engineering, PDA College of Engineering, Gulbarga, India,*
[2] *(Department of Information Science and Engineering, B N M Institute of Technology, Bangalore, India,*

ABSTRACT : This paper demonstrates the performance of well known block ciphers Blowfish and Cast-128, considering different aspects of security namely, Encryption quality, Key sensitivity test and Statistical analysis. Statistical analysis is conducted using images by test on the histogram of encrypted images and correlation of horizontally adjacent pixels in an encrypted image.

KEYWORDS: Avalanche, Correlation Coefficient, Decryption, Encryption, Encryption Quality, Key Sensitivity.

I.   INTRODUCTION

Blowfish [1] is a variable-length key [2], 64-bit block cipher developed by Bruce Schneier. The algorithm consists of two parts namely a key-expansion part and a data- encryption part. Key expansion converts a key of utmost 448 bits into several sub key arrays totaling 4168 bytes. Data encryption occurs via a 16-round Feistel network [1]. Each round consists of a key-dependent permutation, a key and data-dependent substitution. All operations are EX-ORs and additions on 32-bit words. CAST-128 [2], [3], [4] is a design procedure for symmetric encryption algorithm developed by Carlisle Adams and Stafford Tavares. CAST has a classical Feistel network consisting of 16 rounds and operating on 64-bit blocks of plaintext to produce 64-bit blocks of cipher text. The key size varies from 40 bits to 128 bits in 8-bit increments.

II.   ENCRYPTION QUALITY

In this Subsection Encryption Quality (EQ) [5], [6] of both Blowfish and Cast-128 are calculated for digital images. Let F and F′ denote the original image and the encrypted image respectively each of size M*N pixels with L grey levels. F(x, y), F′(x, y) ε {0... L −1} are the grey levels of the images F and F′ at position (x, y) $(0 \le x \le M-1, 0 \le y \le N-1)$. Let $H_L(F)$ denote the number of occurrences of each grey level L in the original image F. Similarly, $H_L(F')$ denotes the number of occurrences of each grey level L in the encrypted image F′. The EQ represents the average number of changes to each grey level L and is expressed mathematically as:

$$Encryption\ Quality = \frac{\sum_{L=0}^{255} \left| H_L(F') - H_L(F) \right|}{256}$$

The effect of number of rounds r on the encryption quality for Blowfish and Cast-128 is investigated. The block size and secret key lengths are both constants. The encryption quality (EQ) is computed as a function of number of rounds (r). Fig 1, 2 and 3 show the results of Encryption and Decryption. The results obtained for the image Butterfly (AV1.bmp) using both the algorithms are shown in Table I.

Figure 1: Original Image

Figure 2: Encrypted image
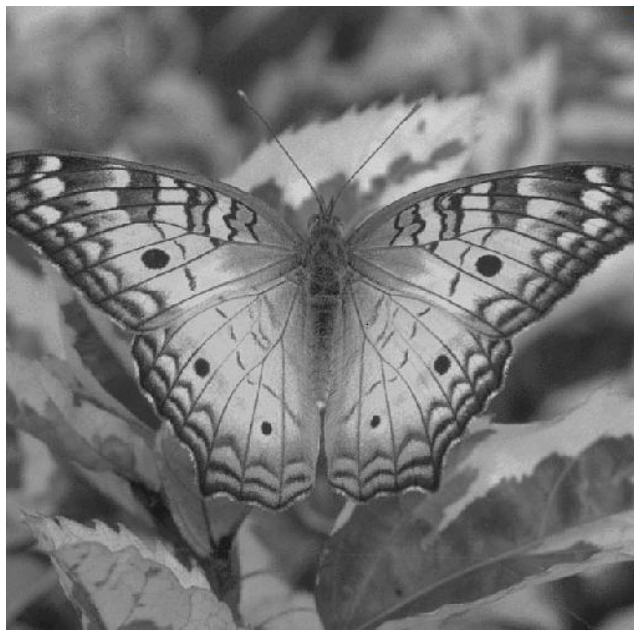
Figure 3: Decrypted Image

TABLE I: *Comparison Of Encryption Qualities Of Blowfish And Cast-128 For Different Rounds*

Number of Rounds	Algorithm Type	
	Blowfish	Cast-128
2	900.484	1149.00
4	1055.64	1151.27
6	1094.09	1151.40
8	1142.10	1154.42
10	1140.53	1149.54
12	1135.00	1150.13
14	1138.64	1148.98
16	1144.61	1150.35

KEY SENSITIVITY TEST : A 16-CHARACTER CIPHER KEY IS USED. THE KEY CONSISTS OF 128 BITS. A TYPICAL KEY SENSITIVITY TEST [5], [6], [11] HAS BEEN PERFORMED ACCORDING TO THE FOLLOWING STEPS:

[1] An image of Butterfly (AV1.bmp) is encrypted by using the test key ADF278565E262AD1F5DEC9 4A0B**F** 25B27 (Hex).
[2] Then one bit of the key which is selected randomly is changed .We have changed the key to ADF278 565E262AD1F5DEC94A0B**B**25B27.The same image is encrypted with the modified key. The character which is changed as a result of changing an arbitrary bit is shown in bold in test key and the modified key.
[3] Finally, the above two ciphered images, encrypted by the two slightly different keys are compared.

The result is that the encrypted image using Blowfish by the key K1 =ADF278565E262A D1F5DE C94A 0B **F**25B27 has 99.6126% of pixels differing from the encrypted image by the key K2 = ADF278565E2 62A D1F5DE C94A 0B**B**25 B27 in terms of pixel grey scale values although there is only one bit difference in the two keys. The above experiment is repeated with Cast-128 shows that 99.5903% of pixels differ when we compare the image encrypted image (encrypted with key K1) with that of key K2 in terms of pixel grey scale values. Table II shows the results of percentage difference of pixels (key sensitivity analysis) of Blowfish and Cast-128 for different rounds.

TABLE II: Comparison Of Key Sensitivity Of Blowfish And Cast-128 For Different Rounds

Number of Rounds	Algorithm Type	
	Blowfish	Cast-128
2	92.39	99.57
4	98.44	99.57
6	98.73	99.58
8	99.43	99.60
10	99.57	99.57
12	99.56	99.58
14	99.56	99.58
16	99.61	99.59

Avalanche Effect :A change in one bit of the plain text or one bit of the key should produce a change in many bits of the cipher text. This change in number of bits in the cipher text whenever there is a change in one bit of the plaintext or one bit of key is called Avalanche effect [1], [2], [11]. We have counted number of times Blowfish gives better avalanche, number of times Cast-128 gives better avalanche and the number of times both algorithm give same avalanche for different rounds. Table III gives avalanche effect due to change in one bit of key.

TABLE III: Comparison Of Avalanche Effect For Different Rounds Of Blowfish And Cast-128 Algorithms For One Bit Change In Key

Number of Rounds	Blowfish Algorithm	Cast-128 Algorithm	Both Algorithms
2	17482	9480	3038
4	13834	12367	3799
6	13818	12422	3760
8	13239	12874	3887
10	13085	12977	3938
12	13030	12925	4045
14	13016	13022	3962
16	13116	12927	3957

STATISTICAL ANALYSIS : STATISTICAL ANALYSIS OF THE DIGITAL IMAGES IS CARRIED OUT USING CORRELATION COEFFICIENT ANALYSIS.

Correlation of Adjacent Two Pixels

To determine the correlation between horizontally adjacent pixels [5], [6], [11] in an image, the procedure is as follows:

First, randomly select N pairs of horizontally adjacent pixels from an image. Compute their correlation coefficient using the following formulae:

$$E(x) = \frac{1}{N} \sum_{t=1}^{N} x_i,$$

$$D(x) = \frac{1}{N} \sum_{i=1}^{N} (x_i - E(x))^2,$$

$$\text{cov}(x, y) = \frac{1}{N} \sum_{i=1}^{N} (x_i - E(x))(y_i - E(y)),$$

$$r_{xy} = \frac{\text{cov}(x, y)}{\sqrt{D(x)}\sqrt{D(y)}},$$

x and y represent grey-scale values of horizontally adjacent pixels in the image. E(x) represents the mean of x values; D(x) represents the variance of x values, cov (x, y) represents covariance of x and y and r_{xy} represents correlation coefficient.   To test the correlation between two horizontally adjacent pixels we have randomly selected 1200 pixels and pixels adjacent to them from original (Butterfly.bmp) and their encrypted images. Then we have calculated their correlation coefficient using the equations.
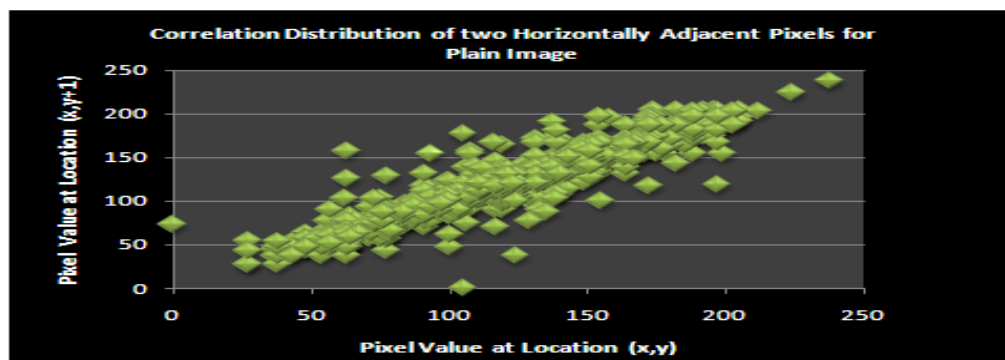
Figure 4: Correlation Distribution of Two Horizontally Adjacent Pixels for Plain Image Butterfly.bmp
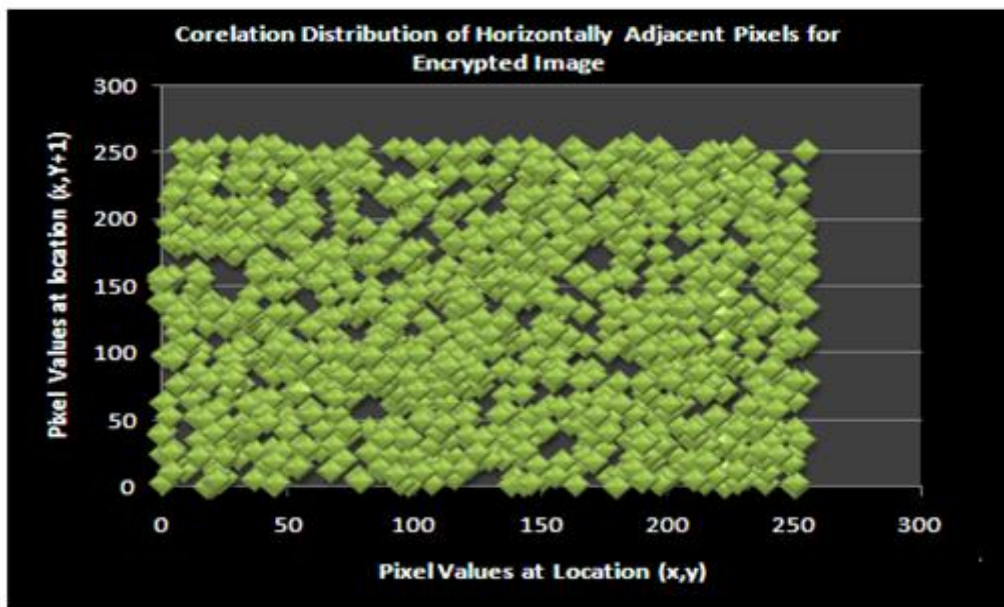
Fig.5: Correlation Distribution of Two Horizontally Adjacent Pixels for Encrypted Image Butterfly.bmp using Blowfish Algorithm.
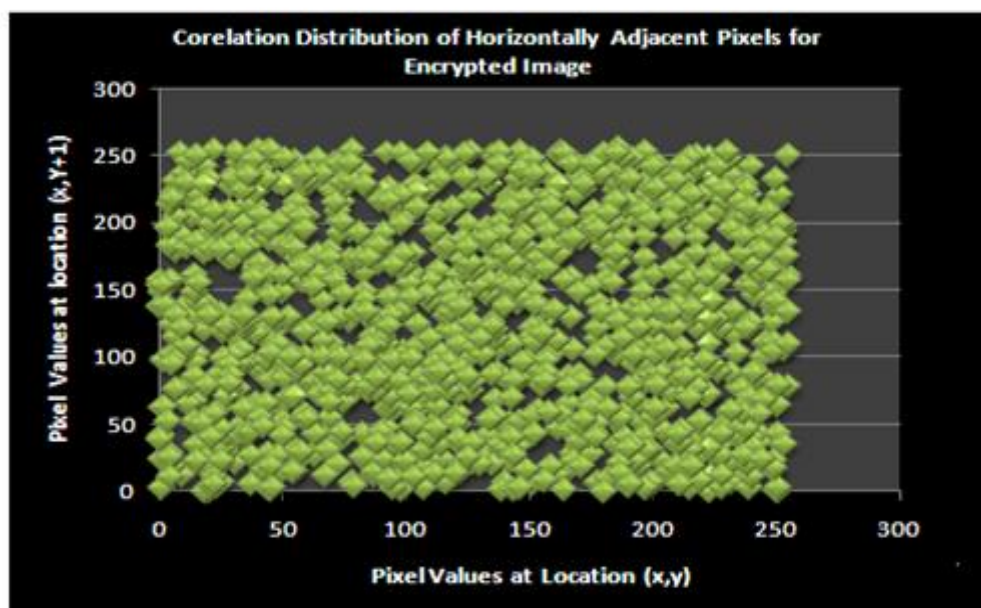
Figure 6: Correlation Distribution of Two Horizontally Adjacent Pixels for Encrypted Image Butterfly.bmp using Cast-128 Algorithm

Fig 4, 5 and 6 show the correlation distribution of two horizontally adjacent pixels in the plain image and cipher image using Blowfish and Cast-128 block ciphers. The correlation coefficient for plain image is **0.951021**. It is **0.034859** for cipher image encrypted using Blowfish and is **0.951021** for plain image and **0.00200** for cipher image encrypted using Cast-128. In cases of both original and modified algorithm the correlation coefficients for plain image with that of cipher images are far apart.

III.   CONCLUSION

The results of the tests and analysis conducted in this paper lead to conclusion that the security of Blowfish Algorithm is good as compared to Cast-128 Algorithm

REFERENCES

[1]   B. Schneier, "Description o f a New Variable-Length Key,64-Bit Block Cipher (Blowfish)", Fast Software Encryption, Cambridge Security Workshop proceedings (December 1993), Springer-Verlag, 1994, pp. 191-204.

[2]   B. Schneier, "Applied Cryptography: Protocols, Algorithms, and Source Code in C", 2nd ed., John Wiley & Sons, 1995.

[3]   W. Stallings, "Cryptography and Network Security: Principles and Practices", 2nd ed., Prentice Hall, 1999.

[4]   C.M. Adams, "Constructing symmetric ciphers using the CAST design procedure", Designs, Codes, and Cryptography, Vol. 12, No. 3, November 1997, pp. 71–104.

[5]   Hossam El-din H. Ahmed, Hamdy M. Kalash, and Osama S. Farag Allah, "Encryption Quality Analysis of RC5 Block Cipher Algorithm for Digital Images", Journal of Optical Engineering, vol. 45, 2006.

[6]   Hossam El-din H. Ahmed, Hamdy M. Kalash. And Osama S. Farang Allah, "Encryption Efficiency Analysis and Security Evaluation of RC6 Block Cipher for Digital Images", International Journal Of Computer, Information, and System Science, and Engineering volume 1 number 1 2007 ISSN 1307-2331. pp 33-38.

[7]   B.Schneier, "The Blowfish Encryption Algorithm", In Dr Dobb's Journal, pp. 38-40, April 1994.

[8]   Harley R. Myler and Arthur R. Weeks, "The Pocket Handbook of Image Processing Algorithms in C", Prentice-Hall, New Jersey, 1993.

[9]   Krishnamurthy G N, Dr. V Ramaswamy, "Encryption Quality Analysis and Security Evaluation of CAST-128 Algorithm using digital images", communicated to IAENG International Journal of Computer Science, 2008.

[10]   Krishnamurthy G.N, Dr. V Ramaswamy, "Performance Enhancement of CAST-128 algorithm by modifying its function", Proceedings of International Conference in CISSE 2007, University of Bridgeport, Bridgeport, CT, USA.

[11]   Krishnamurthy G N, Dr. V Ramaswamy "Encryption quality analysis and Security Evaluation of Blow-CASTFish using digital images", Communicated to International Journal of Computational Science 2008.

[12]   Adams C,"The CAST-128 Encryption Algorithm", RFC 2144, May 1997.

Impact Of The Granted Facilities On Jobs In Urban Tourism Development (Case Study: Melli Banking Facilities In Zahedan)

[1,]Sadegh Shahmoradzadeh Fahraji , [2,]Gholam Reza Miri , [3,]Mariam karimian Bostani

[1,]MSc student in Department of Geography and Tourism Planning, College of human science, Zahehan Branch, Islamic Azad University, Zahedan, Iran
[2,]Assistant professor in Department of Geography and Urban Planning, College of human science, Zahehan Branch, Islamic Azad University, Zahedan, Iran
[3,]Assistant professor in Department of Geography and Urban Planning, College of human science, Zahehan Branch, Islamic Azad University, Zahedan, Iran

ABSTRACT : *Due to the expansion of the banking system in recent years and the increased facilities and services to banks, to assess the effect on net employment in the economic performance of the banking system has become more important. What is important is the effectiveness of these types of facilities to create new job opportunities. One of the sectors, which have been discussed in recent year's tourism sector, is lending facility. It should be noted that most of the direct and indirect employment opportunities associated with this sector. In this regard, this study is based on the framework and describes an analytical method using field observations and questionnaire study. The library of documents, employment facility for granting Effect - creation of urban tourism development (case study: national banking facilities in Zahedan) has been used. And also the extent of this effect has been studied. And also the extent of this effect has been studied. Accordingly, the results indicate that the greatest amount of tourism facilities and cultural heritage of national banks amounted to 6 thousand 500 million dollars to pay the country's banking system. National Bank of the city of Zahedan facility dedicated to value (1824949) to 2012 in the service sector than in other sectors led tourism development and tourism boom in the city. Finally, the results obtained are presented in a series of administrative procedure.*

KEYWORDS: *Facilities jobs, Zahedan, Tourism, Bank Melli*

I.   INTRODUCTION:

Employment may be due to the importance of the practical aspects of human personality, identity and origin of the instrument is considered to reach prosperity of mankind. The dimensions of the philosophical, religious, and political psychology useful and productive work are of paramount importance. In general, in recent years , providing jobs and reducing the unemployment rate , one of the challenges in the economy as the most important objective for the management and economic programs , the organization of the country and in economic, social and culture have been considered. Optimal use of existing resources to meet human needs and demands, including increased production, income, employment and social welfare of each country is the most important development objectives. Zahedan County is comprised of three cities, Zahedan, Nosrat abad and Korin T. fifth development plan of the city of Zahedan, about 804,000 people 904,000 increase forecast by the end of the program - does. Since about 33% of the population is estimated between 15 to 30 years of employment, so the spectrum is the most important thing. Monetary and financial markets are of particular importance in the economic system and economic development literature of the important requirements is to achieve sustained growth. So that researchers develop better and more suitable for financial and monetary markets as an important instrument for development .In monetary and financial markets, sources of funding for various economic activities are. Production units from the point of view of financing working capital and new investment activities and perspectives of development of the major issues is system management .Receive a loan or credit, and transfer money from one

person to another or from one entity to another entity a major role in funding various economic activities . Credit and Loan direct and indirect employment and new job opportunities that will affect production units. Loan and credit injected into the production process as working capital in the short term due to the fixed capital stock, employment will increase. But in the long run, and credited the loan is converted into fixed capital, technological change brings with it (Samimi and et al, 2010, 3). If this change stays neutral employment and otherwise alters the employment is. So you can see from the comments, including the positive effects of proper and optimum utilization of loan and credit flows can increase investment, production, income and employment to be followed. Of course, the monetary system and financial efficiency of each country and how the existing economic units in financial management is a necessary condition and sufficient to achieve the positive economic effects of this is that in the absence of the effective part in the process in granting credits and what are the optimal uses of credits may be expected and effects plus. Among the factors affecting the performance of banking facilities in the development of enterprise financial and operating production and employment, access to sufficient liquidity facilities and enterprise of importance. Because the facilities to carry out the investment and set up economic units (which is a relatively large costs have) as well as the continuation of a productive activity and provision of raw materials for production are used.

In Iran due to the restrictions in the financial market is one of the most important financial resources and Bank resources available to corporations. On the other hand, nowadays banks in Iran as a financial resource provisioning in the established form (with fixed capital investment and facilities) and set up (with investment and provide working capital facilities) and the basic role of the Board. According to the Central Bank and the Department of labor reports, statistical Center of Iran and populist enterprise performance information more than 80 percent of the fixed capital corporations or through bank financing facilities to be funded in accordance with the rules in the deprived areas; brought share owners corporations within the limit of 10% of the Board's initial investment (Samsami & Amirjan, 2011, 133). The financial position of the bank credits in the structure of the Board is based on Microeconomics, which means at the level of the Board of bank credits, investment, employment, with raw materials and as a result the production of enterprises can be analyzed. Corporations to finance investment of resources, internal and external. Internal resources have been divided into depreciation and profits include storage and external resources include borrowing (loan و bonds) and buy the new shares. With respect to the cost of each of the funds, the decision of the Board of investment is affected (Bronson, 2005,

Expanding markets and financial institutions and consequently, a variety of products in this area has led to the process of obtaining the necessary funds for financing and the advancement of the company and individuals, at the level of a rapid and reliable way to establish trust, of the country's economic priorities and requirements will be considered. In the developed countries, have been able to provide the necessary infrastructure in this area to provide well; being that developing countries have long ago on the way, so the World Bank figures showed that today, less than 25 per cent of people in developing countries access formal financial services. This ratio in the developed markets more than 90 percent. Banks in the process of the development of financial services, a key role are responsible, whereas the banks your resources are devoted mainly to large companies, and since the services to the obtaining and small units of work, and the people is expensive, less attention has been paid to this sector. Design and apply the very validity of the measurement system is an important factor as the financial services development in a just manner in all parts of the play, the role of the Constitution. The process of granting credit facilities in the community of the system to be more patient and fronts, economic sector to better and more reliable way to financial resources, and will be able to optimize the use of resources. In the event that coincides with the growth and development of the economic sector and increasing the need for financial resources, saw the establishment of proper systems in facilitating the acceleration of the credit granting facilities and providers with many problems, nobody else in the field of the acquisition of knowledge of the existence of potential customers will face validity (Jalili, 2009, 222-221).

Are most important, considering the above-mentioned items with concerns to the region have been created due to the lack of industry and agriculture, the tourism boom is a dynamic region with the creation of a sense of the city's infrastructure and tourist boom and field can be created to provide youth employment. One of the ways to create tourism infrastructure grant facilities that if by the National Bank as the largest bank in the Middle East and the Islamic world with its 27 branch and 2 counter and 12 box and having the highest banking network in the city of Zahedan international resources for the optimal effective steps taken can be done on the economic development of the region.

II.   RESEARCH THEORY:

It seems the granting of employment facilities in urban tourism development causing a significant connection exists.

Appear to grant facilities causing employment in the tourism sector will lead to job creation.

Research objectives
[1] Study grant and loan facilities and loan applicants seeking employment caring citizen's employment
[2] Check the facilities granted to each of the sectors
[3] Check the share of each age group and gender of banking facilities
[4] Evaluation of the contribution of each of the sectors of banking facilities.

The History of research : Samimi et al (2010), in their study entitled "The effect of reinvestment on economic sectors of employment" to assess the role of the banking system during the years (2006-1973) began and concluded banking system during this year strategy steady growth in employment has not pursued because of banking facilities to the fluctuation in the rate of job creation and job destruction has resulted in many years. Farzinvash & Heidari (2011), in their study entitled" Evaluation of the indirect effects of monetary policy on bank loan supply by banks balance sheet state and private properties " found in the monetary policy indirectly through a balance of properties such as size, capital and liquidity of banks on the pathogenic impact of facilities for employment .

Nadran (2008), in a study under the title of "credit policy of value added in the industrial sector of Iran, "the effect of the credit is paid on the value added in the industrial sector. In this study the effects of fiscal and monetary policies based VAR has been examined and tested. Convergence of long-term application of modeling and correction components - an error of clear communication and credits VAT industrial sector has rendered effective. Overall, the results indicate a positive connection between bank credit and the added value of a strong and sustainable industry.Jahangard (2002), using input - output table 1991 Census indicators pre-and post -Iran tension input - output, employment sectors of the economy have been investigated. The findings suggest that areas of residential buildings, motor vehicles and apparel jobs have the highest tensile index.Baseri (2002), in an article entitled Study of Iran 's foreign trade using three input - output table for years 1986 to 1991 and 1994 have shown the application of labor and capital export and import of work of Iran's economy is based on the comparative advantage of production has moved.Valadkhani (2002), study employment sectors in the Australian economy. The two- way stretch Input - Output and mining and concludes that assumptions used in the draw method , handicrafts and business services sectors have the greatest jobs in the sectors of agriculture and hunting theory Extraction machinery and equipment they are key. Meanwhile, the costs of creating a full-time job opportunities, education and health services according to final demand sectors have been leading.Rioja & Valve (2003), in their paper investigates the effect of financial development on economic growth in 74 countries are eligible. In this study, the industrialized and developing countries during the years 1961 - 1995 , three high-income countries , middle and bottom groups. The results show the effect of financial development on economic growth in industrialized countries through productivity growth and growth in less developed countries through capital accumulation takes place.Tarahomi (2007), in an article titled key sectors of the economy from the perspective view of the employment status of the 35 sectors of the economy and employment generation has investigated and concluded of agriculture, Beverage Buildings highest make employment among the economic sectors.

III.   RESEARCH METHODOLOGY

Descriptive research analytical methods-this is based on a library of documents, studies and the field. First, information analysis was done and after that to complete the range of data, check the field for data analysis and SPSS software is used.

IV.   DISCUSSION AND CONCLUSIONS

Determine the connection between the granting of urban tourism development and job creation facilities.
For the impact of the grant component of the connection between tourism development and job creation, urban facilities 19 indicators that according to a survey done in 380 patients was investigated study that follows.

(Table 1): the relationship between job creation and development facilities in urban tourism

indicator	Percent	Number
increasing quality in the transport sector	3.00	380
Increasing Accommodation units	3.45	380
increase the number of catering units	3.72	380
revival of local culture and the protection of traditional arts	3.53	380

education and information to the people On how to deal with tourists and tourism infrastructure development	3.34	380
facilitate visas for tourists with a personal car	3.45	380
the standard residential facility and reception	3.66	380
extend the flight lines index	3.72	380
Development programs to introduce a tourist attraction	3.21	380
diversity and development program Advertising to introduce the natural and historical attractions	3.60	380
health foods, the hotels and restaurants	3.50	380
Repair of buildings and monuments and historical sites in the city	3.28	380
improve payments for conservation of ancient and historic sites	3.40	380
Infrastructure development	3.42	380
help protect natural resources	3.74	380
traditional arts, the preservation and dissemination of and ancient rituals	3.80	380
change the modernization and introduction of local culture	3.80	380
the view of urban furniture	3.10	380
improvements in roads and the quality of the way	3.42	380

Source: research results, 2014

As can be seen in the table above, check the desired index of 19 related to the index, change the modernization and introduction of local culture and traditional arts, the preservation and dissemination of and ancient rituals with an average 3.80, help protect natural resources with an average of 3.74, increase the number of catering units and extend the flight lines index with an average of 3.72, the standard residential facility and reception mean 3.66, diversity and development program Advertising to introduce the natural and historical attractions with an average 3.60, revival of local culture and the protection of traditional arts, with the average being 3.53, health foods, the hotels and restaurants 3.50 average, facilitate visas for tourists with a personal car and Increasing Accommodation units with an average of 3.45, improvements in roads and the quality of the way with an average of 3.42, improve payments for conservation of ancient and historic sites with an average of 3.40, education and information to the people On how to deal with tourists and tourism infrastructure development with an average of 3.34, Infrastructure development with an average of 3.24, the view of urban furniture with an average of 3.10, increasing quality in the transport sector with an average 3.00 that ranked the highest and the lowest, in order to have dedicated there.

(Table 2) the relationship between job creation and development facilities in urban tourism

increasing quality in the transport sector	Sperman s rho correlation Sig.(2-tailed) N	0.440 0.000 380
Increasing Accommodation units	Sperman s rho correlation Sig.(2-tailed) N	0.546 0.000 380
increase the number of catering units	Sperman s rho correlation Sig.(2-tailed) N	0.350 0.000 380
revival of local culture and the protection of traditional arts	Sperman s rho correlation Sig.(2-tailed) N	0.500 0.000 380
education and information to the people On how to deal with tourists and tourism infrastructure development	Sperman s rho correlation Sig.(2-tailed) N	0.440 0.000 380
facilitate visas for tourists with a personal car	Sperman s rho correlation Sig.(2-tailed) N	0.490 0.000 380
the standard residential facility and reception	Sperman s rho correlation Sig.(2-tailed) N	0.530 0.000 380

extend the flight lines index	Sperman s rho correlation Sig.(2-tailed) N	0.546 0.000 380
تDevelopment programs to introduce a tourist attraction	Sperman s rho correlation Sig.(2-tailed) N	0.400 0.000 380
diversity and development program Advertising to introduce the natural and historical attractions	Sperman s rho correlation Sig.(2-tailed) N	0.529 0.000 380
health foods, the hotels and restaurants	Sperman s rho correlation Sig.(2-tailed) N	0.495 0.000 380
Repair of buildings and monuments and historical sites in the city	Sperman s rho correlation Sig.(2-tailed) N	0.464 0.000 380
improve payments for conservation of ancient and historic sites	Sperman s rho correlation Sig.(2-tailed) N	0.510 0.000 380
Infrastructure development	Sperman s rho correlation Sig.(2-tailed) N	0.430 0.000 380
help protect natural resources	Sperman s rho correlation Sig.(2-tailed) N	0.570 0.000 380
traditional arts, the preservation and dissemination of and ancient rituals	Sperman s rho correlation Sig.(2-tailed) N	0.578 0.000 380
change the modernization and introduction of local culture	Sperman s rho correlation Sig.(2-tailed) N	0.578 0.000 380
the view of urban furniture	Sperman s rho correlation Sig.(2-tailed) N	0.387 0.000 380
improvements in roads and the quality of the way	Sperman s rho correlation Sig.(2-tailed) N	0.513 0.000 380

Source: research results, 2014

With regard to the impact of tourism on the development of job creation, urban facilities and a rating according to the scale to rank Spearman correlation test data used to be. Spearman correlation test represents the ability to express a variable as a function of other variables consistent. For this purpose, first to check the average and then to examine the indicators were paid, the results of the analysis of data shows the role of urban tourism facilities on the development of job creation impact. In fact, all the indicators of positive impact, expressed in the table. In fact, it can be said with a meaningful connection for sig (0.000) achieved a positive role between job creation and on the development of urban tourism facilities there.

Determine the connection between the undertaking and the granting of facilities to create employment in the tourism sector.
To analyze the impact of component connection between the granting of facilities and job creation job creation in the tourism sector 6 indicator that according to a survey done in 380 patients was investigated study that follows.

(Table 3): The relationship between lending facility job creation and job creation in the tourism sector

indicator	Percent	Number
non-agricultural income opportunities	3.53	380
job creation and foreign exchange earnings for the country	3.90	380
diverse local economy	3.88	380
Creating new opportunities	4.00	380
creating permanent jobs	3.60	380
income security	3.33	380

Source: research results, 2014

As shown in the table and the graph above can be significant, the index in the index relating to the 6 indicators, Creating new opportunities with an average of 4.00, job creation and foreign exchange earnings for the country, with an average 3.90, diverse local economy with an average of 3.88, creating permanent jobs with an average of 3.60, non-agricultural income opportunities with an average of 3.53, income security with an average of 3.33, respectively the highest and lowest ratings to Have assigned themselves.

(Table 4): The relationship between lending facility job creation and job creation in the tourism sector

non-agricultural income opportunities	Sperman s rho correlation Sig.(2-tailed) N	0.533 0.000 380
job creation and foreign exchange earnings for the country	Sperman s rho correlation Sig.(2-tailed) N	0.580 0.000 380
diverse local economy	Sperman s rho correlation Sig.(2-tailed) N	0.573 0.000 380
Creating new opportunities	Sperman s rho correlation Sig.(2-tailed) N	0.600 0.000 380
creating permanent jobs	Sperman s rho correlation Sig.(2-tailed) N	0.540 0.000 380
income security	Sperman s rho correlation Sig.(2-tailed) N	0.480 0.000 380

Source: research results, 2014

 With regard to the impact of the grant of facilities undertaking in creating employment in the tourism sector and as regards the scale of the data type of a rating. In fact, should be according to the spearman rank correlation test data from being used. For the analysis of information, first to check the average and then to examine the indicators were paid, the results of the analysis of data shows that between the undertaking and the granting of facilities to create meaningful employment in the tourism sector to positive and there is significant according to 0.000.

V.   CONCLUSION
        The importance of economic and social works, and its effective role in the development of tourism and of employment and welfare, to the point that many of the Government's policy making, he obliged and his investment focus to attract tourists, these Governments are trying to login at using your economy to the point of politics of balance ".In the meantime, the border city of Zahedan, due to the specific conditions and geopolitical environment for development of tourism. And given the main concern of the ILO that area due to the lack of industry and agriculture, the tourism boom is a dynamic region with the creation of a sense of the city infrastructures can be filed under the youth employment and make the tourism boom. One of the ways to make tourism a regulated the granting of facilities that if by Bank Melli as the largest bank in the Middle East and the Islamic world is the highest Bank in Zahedan City between network resources for the optimal effective steps taken can be done on the economic development of the region. Bank Melli Iran cultural heritage and tourism facilities most amounted to 6 thousand 500 billion Rials in the banking system has paid. It also crushed many tourism facilities Bank in the whole province is paid.

Testing hypotheses
First hypothesis: It seems the granting of employment facilities in urban tourism development causing a significant connection exists.

With regard to the impact of tourism on the development of job creation, urban facilities and a rating according to the scale to rank Spearman correlation test data used to be. Spearman correlation test represents the ability to express a variable as a function of other variables consistent. For this purpose, first to check the average and then to examine the indicators were paid, the results of the analysis of data shows the role of urban tourism facilities on the development of job creation impact. In fact, all the indicators of positive impact, expressed in the table. In fact, it can be said with a meaningful connection for sig (0.000) achieved a positive role between job creation and on the development of urban tourism facilities there.

Second hypothesis: Appear to grant facilities causing employment in the tourism sector will lead to job creation.

With regard to the impact of the grant of facilities undertaking in creating employment in the tourism sector and as regards the scale of the data type of a rating. In fact, should be according to the spearman rank correlation test data from being used. For the analysis of information, first to check the average and then to examine the indicators were paid, the results of the analysis of data shows that between the undertaking and the granting of facilities to create meaningful employment in the tourism sector to positive and there is significant according to 0.000.

Suggestions
- Appropriate financial support of tourism through the creation of financial and credit funds.
- The promotion and strengthening of the economy and the necessary financial support and legal border livelihood from tourism projects in the majority of the cross-border points and the use of natural resources and tourism.
- The use of the economic opportunities in the region to draw the Iranians outside the country for tourism investment
- Planning and Development Council in the province to develop tourism in the area.
- Financing projects and initiatives related to the tourism sector through cooperative companies guarantee fund investment cooperation.
- Improve the quantity and quality of tourist services.

REFERENCE

[1]   Basari, B, (2003), Evaluation of the factors of production, foreign trade, Proceedings of the second conference techniques - data - on planned economic and social outcomes, Statistical Centre of Iran publication & Allameh Tabataba'i University publication.
[2]   Bronson, W., (2005), Macroeconomics, Translated by Abbas Shakeri, 8th edition, Tehran: Nashre Ney publication.
[3]   Farzinvash, A & Heidari, H, (2011), to assess the indirect effects of monetary policy on bank loan supply by banks, governmental and non-governmental balance sheet characteristics, Journal of Economic Modeling Research No. 2.
[4]   Jahangard, E, (2002), identified the key tasks of industrialization, Quarterly Journal of Economic Research and Policies, Year 6, No. 21.
[5]   Jalili, M, (2010), banking and insurance systems, customer validation, Case study: the experience of Iran Credit Scoring (ICS) Company, Quarterly Journal of Pool va Eghtesad, No. 4.
[6]   Nadaran, E, (2008), the effects of credit policy on value added of the industrial sector in Iran, Journal of Economic Literature.
[7]   Papoliyazdi, M.H. Saghaei. M. (2003), Tourism and genealogy, Quarterly Journal of Geographical Research, No. 68.
[8]   Rioja, F. & N. Valev, (2003), "Finance and the Sources of Growth at Various Stages of Economic Development", Economic Inquiry, Oxford University Press
[9]   Samimi,P, Sataei,M, Tabibi, S.K. (2010), the effect of reinvestment on economic sectors of employment, Quarterly Journal of Pool va Eghtesad, No. 4.
[10]   Samsami, H, Amirjan, R, (2011), the effect of banking facilities to the value added of industry and mining, Quarterly Journal of Economic Research and Policies, Year XIX, No. 59.
[11]   Tarahomi, F, (2007), identification of key sectors of the economy from the standpoint of employment, Monthly Quarterly Journal of Economic, Issue 74-73.
[12]   Valadkhani, Abbas. (2002), Identifying Australia's High Employment Generating Industries". Discussion Paper, Queensland University of Technology, School of Economics and Finance. No. 119.

Acid-Catalyzed Transesterification Reaction of Beef Tallow For Biodiesel Production By Factor Variation

R.C. Ehiri [1, 2], I.I. Ikelle[2] and O.F. Ozoaku[2]

[1]*Department of Chemistry/Biochemistry/Molecular Biology, Fed. Univ. Ndufu-Alike, Ikwo, Nigeria*
[2]*Department of Industrial Chemistry, Ebonyi State University, Abakaliki, Nigeria*

ABSTRACT : *Biodiesel is a diesel grade fuel made by transesterification reaction of vegetable oils and animal fats with alcohol. Three variable factors that affect the yield of biodiesel namely, reaction time, reaction temperature and catalyst concentration were studied in this work. The biodiesel was produced via a batch-process acid-catalyzed transesterification reaction of beef tallow with methanol. Optimal conditions for the reaction were established in a three factor two-level (2^3) central composite design with the biodiesel pre-treatment yield as the response surface. The results show that the mean yield of biodiesel was 92.04% with a standard deviation of 5.16. An optimal biodiesel yield of 96.30% occurred at 0.5% HCl catalyst concentration and at constant conditions of 1.5h reaction time, 60^oC reaction temperature and 6:1 methanol: tallow volume ratio. Gas chromatographic analysis of the beef tallow identified palmitic, stearic and oleic acids in it while the fatty acid methyl esters in the biodiesel product were oleate and linoleate. Catalysis was the most significant factor in the transesterification process.*

KEYWORDS: *Biodiesel; Transesterification; Tallow; Factor Variation.*

I.   INTRODUCTION

Biodiesel is a mixture of mono-alkyl esters of triglyceride that can be used in compression ignition engines and as home heating oil. Current research efforts are being directed towards the use of biomass for bio-fuel production principally because the fuels are renewable, bio-degradable, non-toxic and eco-friendly[1-3]. Biodiesel has gained prominence as a suitable alternative to fossil fuel-based diesel due to environmental benefits and its direct use in compression ignition engines with little or no engine modifications.Biodiesel can be made by the process known as transesterification[4, 5]. Transesterification of vegetable oils and animal fats can be carried out by using alkali-, acid- or bio-catalysis but the alkaline-catalyzed process has short reaction time, low cost of production, gives high yield and is often commercially employed[1,6,7]. Problems associated with alkaline-catalyzed transesterification are the competing saponification reaction forming soap that occurs when the product is washed with water to remove the alkaline catalyst[4, 7, 8] and the presence of free fatty acids (FFAs) and water in the triglycerides[7-10]. The FFAs cause saponification while water leads to hydrolysis reaction and eventually reduce the yield of biodiesel[6, 8, 9].

Several feedstock oils and fats are available for the production of biodiesel. They include soybean oil, rapeseed oil, palm oil, palm kernel oil, *jatropha-curcas* oil, sunflower oil, peanut oil, rubber seed oil, waste cooking oil, canola oil and tallow[3, 4, 11-17]. Variable reaction conditions have been identified to affect the transesterification process and consequently the yield of biodiesel. These conditions include reaction temperature, catalyst type and catalyst concentration, alcohol type, alcohol: oil molar or volume ratio, reaction time, the reactor process and downstream operations, etc. [3-7, 18].In this study biodiesel was produced using acid-catalyzed transesterification reaction of beef tallow with methanol. Hydrochloric acid was used as catalyst. The objective of the study was to investigate the relationship between reaction time, reaction temperature and catalyst concentration at constant alcohol: oil volume ratio and to also determine their optimal conditions in the transesterification process and the associated maximum biodiesel yield. The Box-Wilson central composite design (CCD) and response surface methodology (RSM)[19-20] were used for the optimization analysis.

II.   MATERIALS AND METHODS

Materials: Beef tallow (BT) raw material was obtained from Meat Market in Abakpa Enugu Township. The fat samples were heated to 120°C to obtain oil-like liquid usually at the start of the production. The fatty acid composition of the oil was determined using the Hewleth Packard 6890 Gas Chromatograph. Analar grade hydrochloric acid, methyl orange indicator and methanol were supplied by May and Baker Ltd, Bagenham, England.

Experimental Design: A 2^3 (three-factor at two levels) factorial experimental design was used to determine the optimum conditions of the three variables studied. The variables were both at high and low levels. One variable, the methanol: oil volume ratio was kept constant at 6:1. Generally, a higher alcohol: oil molar or volume ratio favours high biodiesel yield[2-7, 12-18]. The response is biodiesel yield in the pre-treatment step. Table 1 shows the high, low and centre values of the variables studied.

Experimental Procedure: A preliminary titration was carried out by using the oily tallow sample, methanol and methyl orange indicator solution to find out how much of HCl catalyst of given concentration was needed for complete transesterification reaction. Transesterification reaction proper was conducted without adding indicator solution thus: 3 cm^3 of the oily tallow sample was taken in a 250 cm^3 conical flask equipped with a reflux condenser. A pre-determined volume of HCl catalyst was dissolved in 18 cm^3 of methanol to obtain HCl-methanol mixture, which was then gently added to the tallow in the reactor. The mixture was heated to selected temperature and for a specified time to produce biodiesel and glycerol. At the end of reaction the products were cooled to room temperature and transferred to a separating funnel in which biodiesel was the upper layer and glycerol the lower layer. The two layers were eventually separated by gravity or sedimentation. The volume of biodiesel produced in the pre-treatment step was recorded. Thereafter, the biodiesel was purified by washing with hot distilled water for four times. It was eventually dried for 24 hours in desiccator over anhydrous sodium carbonate. The biodiesel product was analyzed for its fatty acid methyl esters (FAMEs) composition using the Hewleth Packard 6890 Gas Chromatograph. Helium gas was used as the carrier gas. The biodiesel product yield was calculated using Eq-1

$$\text{Yield of biodiesel} = \frac{\text{Volume of product}}{\text{Volume of Beef Tallow sample}} \times 100\% \qquad \text{...Eq-1}$$

Additional experiments were carried out to study the effect of catalyst concentration on biodiesel yield at ethanol: oil volume ratio of 6:1, reaction time of 1.5h and reaction temperature of 60°C.

Table 1: High, low and centre values of the variables studied

Variable	High value	Centre value	Low value
Residence time (h)	2.5	1.5	1
Reaction temperature (^{o}C)	70	60	50
Catalyst concentration (%)	2.5	1.5	0.5

III.   RESULTS AND DISCUSSION

Free Fatty Acids Composition of Beef tallow

The free fatty acids (FFAs) in the beef tallow sample used for this study are presented in Table 2. The FFAs consists of palmitic, stearic and oleic acids.

The reaction conditions and experimental results of the transesterification process are shown in Table 3. The biodiesel yield was taken as the response variable of the experimental design. Residence time (X_1), reaction temperature (X_2) and HCl catalyst concentration (X_3) were the independent variables selected to be optimized for the transesterification of beef tallow. The results show that the mean yield of biodiesel was 92.04% with a std dev. of 5.16%. There were also two fatty acid methyl esters (FAMEs)- oleate and linoleate identified in the biodiesel product (Table 4).

Table 2: The free fatty acid composition of beef tallow

Fatty acid composition	Percentage (%)
Palmitic $C_{16:0}$	19.41749
Stearic $C_{18:0}$	35.22732
Oleic $C_{18:2}$	45.35519

Table 3: Reaction conditions and experimental results

| Run | Manipulated variables | | | | | | Response |
| | X₁ | | X₂ | | X₃ | | Yᵢ |
	Residence time(h)	Level[a]	Reaction temperature (oC)	Level[a]	Catalyst concentration (%)	Level[a]	Yield (%)
1.	1	-1	50	-1	0.5	-1	95.00
2.	1	-1	50	-1	2.5	+1	96.00
3.	1	-1	70	+1	0.5	-1	90.00
4.	1	-1	70	+1	2.5	+1	90.00
5.	2.5	+1	50	-1	0.5	-1	96.30
6.	2.5	+1	50	-1	2.5	+1	91.70
7.	2.5	+1	70	+1	0.5	-1	96.00
8.	2.5	+1	70	+1	2.5	+1	80.00
9(C).	1.5	0	60	0	1.5	0	93.33
Mean biodiesel yield							92.04
Std dev.							5.16

a -1: low value, 0: centre value (C), +1: high value.

Table 4: Fatty acid methyl esters (FAMEs) in the biodiesel product

Fatty acid methyl ester	Percentage (%)
Oleic $C_{18:1}$	52.18262
Linoleic $C_{18:2}$	47.81738

Table 5: Effect of catalyst concentration on yield

Catalyst concentration (%)	Biodiesel yield (%)
0	44.50
0.5	96.30
1.0	86.70
1.5	93.33
2.0	93.33
2.5	90.00

Effect of Catalyst Concentration on Yield

Hydrochloric acid was used as catalyst for the transesterification in this work. The effect of the catalyst on the pretreatment yield of biodiesel is presented in Table 5. The results show that an optimal biodiesel yield of 96.30% occurred at 0.5% HCl catalyst concentration (at constant conditions of 1.5h reaction time, 60°C reaction temperature and 6:1 methanol: tallow volume ratio). The data also indicated that the yield was 44.50% when no catalyst was used. Catalysis was the most significant factor in the transesterification process at 60°C reaction, 1.5h reaction time and 6:1 volume ratio of methanol to oil.

IV. CONCLUSION

The study shows that the mean pretreatment yield of biodiesel produced was 92.04% with a standard deviation of 5.16. The Box-Wilson CCD and RSM were effective in determining the relationship among the variables studied. Catalysis was the most significant factor in the transesterification reaction of beef tallow to biodiesel.

REFERENCES

[1]   Krawczyk T. (1996) Biodiesel – Alternative fuel makes inroads but hurdles remain, *INFORM*, 801-829.
[2]   Ramadhas A. S. Jayaraji S. and Muraleedharam C. (2004) Use of vegetable oils as IC engine fuels: A Review, *Renewable Energy* 29, 727-742.
[3]   Environment Australia (2003) Setting National Fuel Standards. Paper 6, National Standards for Biodiesel – Discussion Paper, pp1-102.
[4]   Ma F. and Hanna M. A. (1999) Biodiesel Production: A Review, *Bioresource Technol*. 70, 1-15.
[5]   Schuchardt U., Sercheli R. and Vargas R. M. (1998) Transesterifcation of vegetable oils: A Review, *J. Braz. Chem Soc*, 9 (1) 199-210.
[6]   Khan A K. (2002) Research into biodiesel kinetics and catalyst development. A Ph.D Thesis submitted to the Department of Chemical Engineering, The Univeristy of Queensland, Brisbane, Queensland, Australia, May,2002, pp.1-14.

[7] Freedman B., Pryde E. H. and Mounts T. I. (1984) Variables affecting the yield of fatty esters from transesterified vegetable oils, *JAOCS*, 61, 1638-1643.

[8] Wright H. J., Segur J. B., clark H. V., Coburn S. K., Langdom E. E. and Du Puis R. N. (1984) A report on ester interchange, *Oil and Soap*, 21, 145-148.

[9] Bradshaw G. B. and Meuly W. C. (1944) Preparation of detergents, *US Patent* 2, 360-844.

[10] Feuge R. O. and Grose T. (1949) Modification of vegetable oils VII. Alkali-catalyzed transesterification of peanut oil with ethanol, *JAOCS*, 26, 99-102.

[11] Kubmaraw D., Barminas J.T., Nwaigwe C. N., Kidah M. I. and Kelong D. (2007) Transesterification of some vegetable oils for use as biofuel, *JCSN*, 32 (8): 72-80.

[12] Ajiwe V. I. E., Ajibola V. O. and Martins C. M. O. A. (2001) Possible vegetable diesel fuels from rubber seed oil (*Haevea brasiliensis*) methyl esters diesel blends, *African J. Sci.*, 2: 277-289.

[13] Encinar J. M., Gonzalez J. M., Rodriquez J. J. and Tejedor A. (2002) Biodiesel Production from vegetable oils: Transesterification of (*Cynara carduneulus L.*) oil-ethanol, *Energy Fuels* 16: 443-450.

[14] Ma F., Clements L. D. and Hanna M. A. (1998) Biodiesel fuel from animal fat: Ancillary studies on transesterification of Beef Tallow, *Ind. Eng. Chem. Res.* 37: 3768-3771.

[15] Dube M.A. (2007) Acid-Catalyzed Transesterification of canola oil to Biodiesel under-single and two-phase reaction conditions, *Energy and Fuels* 21: 2450-2459.

[16] Barminas J.T. and Maina H.M. (2001) A preliminary Investigation into biodiesel (biofuel) characteristics of tallow, *Biofuel and Biomass* 5: 87-89.

[17] Darnoko D. and Cheryman M. (2000) Energy kinetics of palm oil and tallow transesterification in a batch reactor, *Energy and Fuel* 3: 1263-1267.

[18] Attanatho L., Magmee S. and Jenvanitpanjakul P. (2004) Factors Affecting the Synthesis of Biodiesel from Crude Palm Kernel Oil, The Joint Int. Conf. on "Sustainable Energy and Environment (SEE)" 1-3 December 2004, Hua Hin, Thailand, 359-361.

[19] Vincente G., Coteron A., Martinez M. and Aracil J. (1998) Application of the Factorial Design of Experiment and Response Surface Methodology to Optimize Biodiesel Production, *Industrial Crops and Production*, 8: 29-35.

[20] Ehiri R.C. and Olabanji A. (2010) Acid-Catalyzed Transesterification Reaction of Coconut Oil to Biodiesel b Factor Variation, Paper presented at the 2nd FUTO International conference on Renewable and Alternative Energy and 1st Annual Conference of the Renewable and Alternative Energy Society of Nigeria, ''Renewable Energy for Sustainable National Development'', May 16-20, 2010, Fed. Univ. of Tech. Owerri, Nigeria.