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A study of existing solar power policy framework in India for viability of the solar projects perspective

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ABSTRACT

A decade before conversion of solar energy into electricity was quite expensive compare with other renewable energy or conventional fossil fired generated power. For making solar energy as a main stream source of power generation Indian government has taken several initiatives in last 5–6 years. Presently, the deployment of the solar power project in India is governed by both central and state government under the various schemes. These schemes are mainly includes, Feed-in-Tariff (FiT), Renewable Purchase Obligation (RPO), long term Power Purchase Agreements (PPAs), Renewable Energy Certificates (REC), Accelerated Depreciation (AD) benefit and reverse bidding/auctions etc. As an effect of this competitive market environment, the tariff of solar power has come down from INR 17 or US $ 0.27[1] (year 2010) to less than INR 6 or US $ 0.092[2] (year 2015). This decremented solar tariff may achieve grid parity soon but also has raised the question of sustainability of the solar power project as well. Additionally, this multi-policy environment of both central and state government has created lots of confusion among the solar power project developers to select scheme and make their investment viable as per other power generation business. This paper summarizes various schemes under the current policy framework in terms of viability of the solar power projects in India. It also includes issues related with the sustainability of the solar power project taken under the competitive bidding process with remarkable lowered tariff than benchmarked tariff (ceiling price)in India (i.e. INR 7 or US $ 0.107).

This study will help project developers and other stakeholders to understand the issues related with viability of the project in current multi-policy environment for better planning before investing in the field of solar Power business.

Contents

Abbreviations: FiT, Feed-in-Tariff; RPO, Renewable Purchase Obligation; PPA, Purchase Agreements; REC, Renewable Energy Certificates; AD, Accelerated Depreciation; NSM, National Solar Mission; PSU, Public Sector Undertaking; RET, Renewable Energy Technology; CERC, Central Electricity Regulatory Commission; SERC, State Electricity Regulatory Commission; INR, Indian Rupees; DCR, Domestic Content Requirement; RE, Renewable Energy; MW, Megawatt; GW, Gegawatt; DISCOMs, Distribution Companies; CEA, Central Electricity Authority; IREDA, Indian Renewable Energy Development Agency; NCEF, National Clean Energy Fund; GBI, Generation Based Incentives; SECI, Solar Energy Corporation of India; MNRE, Ministry of New & Renewable Energy; ABT, Availability based Tariff; KWh, Killo Watt Hour−1; PV, Photovoltaic

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[1] In year 2010, US $ 1=INR 45.
[2] In year 2015, US $ 1=INR 65.

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1. Introduction

Since end of last decade (year 2009) India's central and state government has taken many initiatives to harness solar energy in the country and to deal with energy security and all together reducing the carbon emissions. However, it has been noticed that the impact of these programs have not so significant particular in 'solar energy' compare with other renewables like wind, biomass and small hydro plants. Contrary, India is uppermost in the world for having great potential of solar energy which is about 5000 trillion kWh per year [1]. The solar radiation incident over India is equal to 4–7 kW h per square meter per day for 250–300 sunny days [2]. With this potential India could become world leader by deploying the solar power projects nationwide for generating power. The reason behind minimal development in solar area is mainly due to low cost of fossil fired generated power and no aggressive policy framework for deployment of solar energy in India. At the end of the last decade of 2010, governing authorities has taken some major steps towards development of progressive policy framework for deploying solar energy on mass scale. The study presented here will analyze these existing policy framework for solar and its impact on viability of the solar power generation in India.

2. Motivation

Since 1950, review of five year annual plans, solar energy in India has been keenly promoted only since 2009 with specific solar policies at both National and State level government. Till 2009, the total installed capacity of solar energy in India has managed close to 6 MW only (inclusive of both grid and off grid) [3]. Gujarat is the first state in the country that has launched its solar policies in 2009. Besides Gujarat, now approximately 18 states have declared their solar energy policies to promote this sector [1]. After analyzing the tariff offered by various states, it is noticed that tariff varies from INR 7.5 to INR18.5 per unit of electricity. This variation in tariff has created ambiguity among solar project developers to take decision for selection of state to invest money in solar sector as there is no rationale among the states tariff orders. Besides, each state is offering various exemptions in wheeling charges of electricity, duties and taxes, etc to motivate the project developers to invest money in solar energy sector. This also persuades to compare the viability of the project with respect to tariff order and exemptions offered by respective states.

At central level, central government had come up in 2010 with an ambitious initiative i.e. National Solar Mission (NSM) aims to install 22 GW of capacity by 2022 [4]. Under this mission CERC a Central Electricity Regulatory Commission has announced benchmark tariff from of INR 17 per unit of electricity in year 2010 which is declined to INR 6.35 per unit of electricity in year 2015. The reason behind it is sudden fall of price of solar pv module due to rise in demand in international demand. Additionally, schemes like competitive bidding has also played major role to drop down the tariff at central level [5] which has also raised the question of sustainability of solar power project as well.

Despite of the all policy infrastructure, Solar Power Projects have not yet succeeded as a major alternative source with respect to other Renewable Energy Technologies (RET) like 'wind energy'.

With respect to all aforesaid status of solar energy in India, the authors feel that there are lot many initiatives has been announced by both the central and state governments which has created extreme competitions among each other. Further, this multi-policy environment has created lot of confusion for the project developers to take a decision for investment in solar energy project. This has motivated author to review the existing policy framework for solar power sector of India to understand its impact on the viability of the project and hence also helps to find out the ambiguity among the project developer/investor to invest in the solar power sector.

3. Existing solar policy framework review for solar power

In the journey of solar power in India, Rural Electrification Program in year 2006 was the first step taken by the Indian Government in recognizing the importance of solar power. Later, in January 2008, Generation Based Incentive (GBI) scheme was the first step by the government to encourage grid connected solar power plants. The scheme has started with Feed-in Tariff (FiT) maximum of INR 15/kW h for solar power. Presently, the FiT is come down to range of INR 3–4/kW h and combining this low price solar power with raising price of conventional power may make solar power viable [6]. It is still matter of exploration that

lowering cost of solar power making solar project really viable? Or Is it just an impact of competitive bidding process to get the project?

A research group of World Bank has analyzed the technical, economic and policy barriers of solar energy development and deployment. The group has concluded that unless aforesaid barriers are overcome a constant costly policy support for maintaining the incremental growth of solar power supplies is required [7]. Author has not mentioned any way forward to minimize the support and other strategy to enhance solar project viability. E.g. Design of solar power tariff as per the available solar resources as it varies place to place.

IDFC policy group has revealed about auctioning or reverse bidding, availability of solar resources, performance of technologies, technology risk, financial status of distribution companies, regulatory risk, infrastructure constraint and other concerns as well. A report has been concluded that despite an apparently improved policies and support structure, solar power development remains an expensive and risky for developers and lenders [5]. The study could be further extended by proposing certain guidelines to resolve the major financing constraints in India's existing solar policy framework.

Gireesh Shrimali has analyzed the effectiveness of NSM against its own targets until mid-2013 and developed quantitative metrics to assess the deployment effectiveness. Author has identified that NSM has been moderately successful in deploying solar photovoltaic (PV) and failed to deploy the other technology i.e. solar thermal. Study has stated that present policy lessons from NSM that can be applied to future policy design [8]. Besides policy efficacy, viability of the solar power project in a view of project developers needs to be determined for overall sustainability of the solar projects implemented in the current policy framework.

According to Gupta, the impingement of Solar electricity supply system has grown at very rapid pace in India during the last few years Author has briefed about various initiatives taken by national and state authorities including with incentives, packages and studied their effectiveness as well. It has been concluded that though NSM first phase could not perform up to anticipated results state level policies have succeeded to fill the gap [9].

The World Bank initiated a study to understand the "ground level" barriers for successful deployment of solar power in India. The study has tried to cover the development cycle of solar power project ranging from policy to financing aspects and the report was primarily based on the responses of the selected twenty five developers. The interview study has been based on five parameters i.e Policy and Regulations, Technology, Solar resource assessment, available. The outcome of the study has identified five critical barriers which could be addressed in the short term duration. They are basically related with (i) PPA bankability for ease in financing. (ii) minimum and maximum capacity to be developed by a single developer (iii) The Domestic Content Requirement (DCR) removal from first phase (iv) reduction of lead times faced by the developers and (v) single government or semi – government financing agency as the focal point [10].

Sharan has studied the potential of renewable energy in addressing India's energy supply and access. It also identified the challenges and provides a discursive overview of the various market and policy instruments developed to scale up renewable energy generation. Authors have concluded that the various policy-driven instruments characterized by ambitious targets have been used in order to enhance renewable energy uptake. But despite a multitude of renewable energy policies and financing mechanisms, actual implementation is lagging [11].

Karan kapoor and group of authors have detailed out the journey of solar energy in India since 1950 till date. The study has highlighted the potential barriers and challenges which could impact the ambitious mission taken up by Central and State governments. Authors have concluded with some suggestions like development of robust partnerships with developed countries for transfer of technology, acquiring accurate ground level data of solar radiation, Optimum usage of land etc [12]. The effect of the lowering the cost of solar power and impact of reverse bidding process on viability of solar project developers is needed to explore further.

Altenburg highlights the importance of rent management effectively in promoting 'green' technologies. It has studied how India's NSM has boosted solar investments by managing the necessary subsidies. Author also learnt that beside Policy strategy and implementation, some risk remained there. The example of such loop hole is the failure in enforceability of renewable energy quotas (RPOs/RECs) at the level of Indian states [13]. Further, policies like reverse auction bidding has declined overall capital cost of the project and hence cost of the generation as well. In such competitive atmosphere there might chances of lowering the quality of PV module to make financial viability and to increase the chances to win the project in bidding process. The effect of such policy loopholes of existing policy framework towards viability point of view needs to be required which is missing in this paper.

Mevin Chandel and group have studied the potential and the cost-effectiveness of a solar photovoltaic power plant for meeting the energy demand of garment zone at Jaipur (India). The analysis has been done to calculate financial performance indicators i.e. internal rate of return (IRR), net present value (NPV) and based on four financial cases of equity analysis pre-tax, post-tax analysis pre-tax analysis, and equity analysis post-tax. Financial analysis revealed that the off-site PV power generation option would be better because of land scarcity near the city [14]. It is further needs to be studied that how large scale off grid solar PV plant could be viable venture compare with grid connected with solar PV plant.

According to Morgan Bazilian, PV plant module price is the key element while deriving capital cost of the project and it has witnessed exceptional decline in module prices since 2008. Further, it has been noticed that the LCOE in the Solar PV sector may mislead and therefore it has required cautious interpretation and transparency. Author has also observed that current PV module prices considered for economic analysis is actually below its development cost and hence not sustainable. The reason behind this is that large number of numerous leading non-chinese firms in the industry have announced losses or declared bankruptcy [15] ultimately; the alteration in prices of solar PV conveys major implications for decision makers and policy designers, especially for the design of tariff and other supporting policies. The study has not explored that how the project developers shall be encouraged to invest in the sector by ensuring the returns from the project and make them viable proposition like other successful renewable energy technologies (e.g. wind).

Branker and Pathak have studied methodology for evaluation of LCOE to determine the economic feasibility of PV projects. As per the authors, PV projects are generally evaluated using the levelized cost of electricity (LCOE) generation in order to compare with other electricity generation technologies. Authors also observed that there is lack of clarity of reporting assumptions, and justifications in LCOE calculations, which produces widely varying and contradictory results [16].

A group of authors from CPI-ISB Energy and Environment Program, Indian School of Business, Hyderabad, India has analyzed the 'impact of policy on financing costs' of renewable in India. Authors have conducted financial modeling of actual renewable projects in India and derived the following insights. First, the high cost of debt and inferior terms of debt in India may raise the cost of Solar Energy or other renewable energy by 24–32% compared to the U.S. Author has been noted that an subsidy on interest-rate

reduces the overall subsidy load by 13–16%. Study also suggests that Indian policy makers needs to prioritize the establishment of low-cost, long-term debt and may observe the successful efforts by China and Brazil [17]. The methodology for provision to reduce interest rates on debt for solar power sector is missing. Further, priorities of country may vary country to country and hence it cannot be compare with developed nations.

The Council on Energy, Environment and Water (CEEW), India and The Natural Resources Defense Council (NRDC) is an international non-profit environmental organization, jointly prepared a report on 'Reenergizing India's Solar Energy Market through Financing'. This report discusses the impact on capacity addition, risk justification, and decrease in the cost of finance in an existing policy framework. The report has also discussed financial mechanisms successfully implemented in Indian states and internationally. It has concluded that a high cost of financing calls for continued innovation in policy and the introduction of financial mechanisms that would be helpful to minimize costs and also to attract the level of investment needed to build 20 GW of solar power by 2022 [18]. To overcome from financial obstruction, inventive debt schemes needs to be derived, which has not discussed in the report. Additionally, the effect of policies like reverse auction on the viability of the project needs to be studied to understand the sustainability of ambitious missions undertaken by government of the India.

Shrimali and Rohra reviewed National Solar mission in the perspective of the power sector reforms. The paper has concluded that despite of all sound policies the NSM has failed to pay enough attention to the implementation roadmap and the necessary policies and institutions are needed to achieve the desired outcome via new industrial revolution in the sector [19].

International Renewable Energy agency – IRENA has investigated the criteria and indicators used to evaluate renewable energy deployment policies. The focus is on application in lower income countries for evaluating policies in support of the deployment of renewable power. Key objectives are to explore to which the literature on such criteria and indicators considers lower income country. The analysis is divided into four basic criteria i.e. equity, efficiency, effectiveness and institutional feasibility. Apart from these criteria, a number of alternative criteria have also been identified as part of the review, such as political responsibility, source of investment and regulatory minimalism [20]. The similar study needs to done to evaluate the overall viability of the project in competitive atmosphere as well.

As per the Sonja Lüthi, Rolf Wustenhagen, Solar photovoltaic (PV) technology has expected to make an essential contribution, however comparatively high cost, its progress to date has been fundamentally driven by public policy such as Feed-in Tariffs. This paper suggests that project developers who make a decision between PV investment opportunities in different countries carefully weigh feed-in tariff-induced returns against a set of policy risks, and choose the project with the most favorable risk-return profile. The findings demonstrate that risk matters in PV policy design, and that a "price tag" can be attached to specific policy lacunas e.g time taken by an administrative processes or uncertainty induced by an approaching capacity cap [21].

Muneer a researcher from Ontario Canada has done study on optimization model and techniques to facilitate a prospective investor to arrive at an optimal investment plan in large-scale solar PV generation projects. A detailed case study considering the investment in large-scale solar PV projects in Ontario, Canada has been also discussed for practical application and usefulness of the proposed methodology and tools. Sensitivity analysis towards single policy framework like FiT has been covered in the work [22].

Another upcoming developing country like India which is steadily growing in renewable energy sector is Brazil. Presently worldwide renewable energy contributes 12.9% of primary energy, while Brazil this figure is 45.9% [23]. Brazil represents more than 90% of investment made in Latin America in 2008 [24] and investment in renewable energy in Brazil in 2008 amounted to US $ 10.8 billion, compared with US$ 155 billion invested worldwide. This has mainly contributed by ethanol and hydro-electric sectors and not by solar energy sector. The program like 'Proálcool' has successfully implemented large scale substitution of petroleum derivatives. The motivation behind this program to avoid increased dependence on foreign currency loans in the wake of the 1970s oil crisis. In area of solar energy Brazil has huge potential [25] but there is no aggressive program for the capacity building in this area. Pereira et al. have studied the present market for renewable energy in Brazil and examine specific public policies aimed at overcoming barriers to this market [26]. The study has not mentioned about policies or barrier which has contributed for not making solar energy as a main stream renewable energy contributor despite of ample availability of the solar resources.

From aforesaid literatures it appears that there are lots of opportunities are available for solar energy in India, still there are some implementations issues as well. With reference to above mentioned literature it is evident that there is no generous study is available which may describe about the 'Viability of the solar energy project in conjunction with present policy framework for India'

4. Present policy framework tools in indian solar power sector

In India, solar power project can be installed in two ways. The first is as per the guidelines issued by central government e.g. NSM and another is as per state level government e.g. solar park/long term PPA. Both the frameworks have their own individual pros and cons which project developers need to understand deeply before investing the money.

4.1. Central policy incentives/schemes for solar power

4.1.1. Tax benefits

Central Government provides tax benefits for solar power projects. It is divided into two parts. First is indirect tax benefit such as sales tax exemptions or reductions, Excise Duty exemptions and Custom Duty exceptions. Another is direct tax benefit in which project developers are exempted from income tax on earnings by selling the power produced by solar energy project in first 10 years of operation [27].

4.1.2. Feed in Tariff (FiT)

FiT is a preferential benchmark tariff set by CERC for encouraging the developers to participate in developing Renewable Energy (RE) based power plants. Under the preferential tariff, state or national utilities are obligated to buy renewable energy based electricity at the price determined by regulators using cost-plus approach. This approach enables investors to get a sensible return on their investments. It mainly includes guarantee for grid access and long-term purchase contract for the electricity produced by the plant. In 1st Phase of the NSM, a reverse bidding process has been employed which has set lowest FiTs for selected projects.

4.1.3. Power Purchase Agreements – PPAs (for long term basis)

Under the NSM, solar power project developers has provision to sign a long term (10 years and 25-years) PPAs with special tariffs. The structure of PPA has design in such a way that a considerable incentive for the solar project developers but at the same time it seemed like an intense load for the power distribution companies, which are bound to purchase a power at the Feed in

Tariff rate but sell it at lesser price i.e. government determined average grid price retail rates.

4.1.4. Renewable Purchase Obligation (RPO)

State Electricity Regulatory Commission (SERC) has been empowered by Energy Conservation (EC) Act of 2001 to allocate Renewable Purchase Obligation (RPO) to the distribution companies (DISCOMs), captive power producers and open access consumers means to specify some percent of share of electricity procured from renewable sources to them. The motive behind this policy was to create the demand of grid connected renewable energy however, most of the DISCOMs have failed to purchase the required amount of generated renewable energy, which would have been a significant incentive for renewable energy based electricity specifically for solar based and could attract investors in the sector.

4.1.5. Renewable Energy Certificates (RECs)

Renewable Energy Certificates (RECs) mechanism is an extended part of RPO and has introduced to enhance the demand of renewable energy based electricity and also to keep rationale among the states for generation of renewable energy. Besides it was also envisaged that REC would help to maintain the prerequisite of the obligated entities to ensure their RPOs. Under this mechanism, there are two options available for green energy producers. First is producers may offer green energy at special tariffs and secondly, they may offer electricity covered with 'environmental attributes' related to green energy separately. These attributes are tradable like REC [28]. The first trading session for REC transaction was held in March 2011, [29].

In year 2011–12, the Central Electricity Authority (CEA) has revealed that non-conventional energy contributes 5.5% of the entire electricity generated in India [30]. This 5.5% share is not equally contributed by the states. Further to this, RPOs set by SERC also differs state to state basis. Tamil Nadu and Karnataka state have achieved RPO level in excess of 10% however several states do not exceed 2% [31].

In this mechanism, the REC section is transferable to other state where renewable potential is relatively less and the electricity component can be consumed by host state. RECs are exchangeable within the range of floor price and forbearance price directed by the CERC (Table 1).

To increase the attractiveness of solar energy based electricity generation, solar REC has traded proportionately higher than non-solar RECs. In contrast, the declining price may disappoint investors to investment in other renewable energy projects.

4.1.6. Clean Energy Cess

The Clean Energy Cess has basically emerged from philosophy to discourage to use of coal based produce energy and also to raise the fund for capital intensive new and renewable energy projects. The fund is named as National Clean Energy Fund (NCEF). In 2010; Indian government has introduced it with cess of INR 50 per ton of national or imported coal. It has been estimated that this tax has generated INR 325 million [33] for FY 2011–2012 and further may reach to INR 386 million [34]. The fund is channelized by IREDA, an Indian Renewable Energy Development Agency and can be contribute up to 40% of the total cost of the project [35].

4.1.7. Generation Based Incentives (GBI)

The cost of generation of the electricity by solar PV plant is higher compare with other sources energy as the upfront cost of the solar plant is higher. Hence, to support the solar power project developers MNRE launched the scheme of Generation based incentive. The amount of GBI for Solar Power Project Developer is determined after deducting the Power Purchase agreement (PPA) tariff signed with distribution utility. GBI is higher component that the PPA tariff and preferential tariff offered by state utility. According to CERC guidelines the maximum base tariff was INR5.5/KWh (for FY 2010–2011) and for solar tariff was 10.39 per kW h for fiscal year 2012 [36]. Hence, GBI value would be INR4.89/kW h (INR 10.39–INR 5.5). The minimum eligible capacity of the solar PV plant for availing GBI incentive is 1 MW plant which should be grid connected. IREDA is the main authority for issuing GBI from MNRE. Before that project developer has to be required to register with state designated agency and thereafter enroll online with IREDA.

The capacity addition targets framed by MNRE are outlined in Table 2.

4.1.8. Viability gap funding

Viability gap funding is a mechanism wherein government supports infrastructure sector projects through capital grants and incentives to make them commercially viable. The concept first ever launched by finance ministry in 2006 to fund in infrastructure projects by providing 20% of the total project costs and make them financial viable. Similar way, MNRE has launched the scheme to fund maximum 20% of the project costs, to make sure the viability of the project. In phase II of the NSM, solar project developers have participated in bidding of VGF funding by quoting in INR per MW with a selection criteria of a lowest cost basis [29]. In VGF scheme disbursement of the payment is slightly different i..e. first 50% at the commercial operation start and 10% at the end of each of the first five years of operation subject to performance evaluations.

The disbursement schedule for the VGF was also slightly different:

VGF reduces the cost of financing as capital costs would be decreased partially and hence will also help to boost other financial return parameters as well. Earlier NVVN was the nodal agency at central level to implement the schemes for subsidies. Now MNRE has come up with new Public Sector Undertaking (PSU) company i.e. Solar Energy Corporation of India (SECI) for executing projects as per central government policies. Recently, SECI has announced the list of Projects selected under Part-A (for Domestic Content Requirement) and Part-B (Open) under the scheme. In Part A category, 22 project are selected for VGF of capacity 375 MW and Part B category total 25 projects has been awarded for another 375 MW solar power capacity. Total awarded projects are equal to 750 MW of another additional capacity under NSM.

Table 1
RECs from 1st April 2012 until 2015 from CERC guidelines 2011 [32].

	No solar based REC (INR/MW h)	Solar based REC (INR/MW h)
Forbearance price (maximum)	3480 (3900)	13,690 (17,000)
Floor price (minimum)	1400 (1500)	9880 (12,000)

Table 2
NSM capacity addition target.
Source: MNRE [29]

Sr. no.	Area segment	Phase I (2010–13)	Phase gII (2013–17) cumulative	Phase –III (2017–22) cumulative
1.	Grid Connected (including rooftop)	1100 MW	10,000 MW	20,000 MW

4.2. State Policy Incentives/schemes for solar power

Like central policy framework, states have also their tariff orders and incentive schemes under which project developers may install solar power projects.

4.2.1. Feed –in-Tariff (FiT)

Before NSM, state like Gujarat has came up with its own tariff order for solar power project. Based on it, developers have to sign the contract for supply of solar power to the grid for next 25 years for declared preferential tariff by state Electricity Regulatory commission (SERC). Based on similar kind of structure, several other SERCs have also announced their tariff order with keeping interest for ensuring project viability for installation of solar power projects in their respective states. Based on these tariff order and its comparison with CERC's tariff order, some of the key points have been noticed which are summarized here below. (refer Fig. 1 with following observations)

i. CERC's tariff is lowest among all except Haryana (not mentioned in graph), where tariff is categorized according to type of PV technology.
ii. From Maharashtra to Rajasthan seems to be closed one with CERC's tariff (INR8.98 per unit to INR8.33 per unit)
iii. From Tamil Nadu to West Bengal comes under higher tariff category i.e. INR18.45 per unit for Tamil Nadu to INR 10 per unit for West Bengal.
iv. The same pattern can be observed for capital cost of the plant as well with respect to bench mark cost described for CERC's order.

4.2.2. Accelerated Depreciation (AD)

Accelerated Depreciation benefit has been introduced in renewable energy first in wind energy sector to encourage project developers for installation of the wind power projects. AD benefit means developers are allowed to depreciate 80% of the assets value in the first year [37]. Under this scheme project developers become eligible to compensate their profits of earlier tax periods.

4.2.3. Renewable Energy Infrastructure Development Fund (REID)

This is infrastructure support fund which is generally required as a last mile of the project. The quantum of this fund is approximately 5–10% of the total project cost [38]. Rajasthan is the first state who has initiated this fund and provides financial support for transmission lines and related infrastructure of green energy projects. REID support may further help to accelerate commissioning of the project as well.

4.2.4. Exemption of miscellaneous charges

The charges covered under these schemes are basically for conveying and banking of electricity within the respective state. In Andhra Pradesh, solar power generators have not to pay for wheeling and transmission charges for selling of electricity within the state [39] Likewise, Tamil Nadu also offers same exemptions for solar power projects [40]. Being already in existence of transmission infrastructure state may run such schemes for exemptions of charges' which reduces O&M cost and increases viability of the project. Other support/subsidies like lower interest rate on debt, exemption of state duties, etc. Chhattisgarh is the first state for this type of scheme which provides subsidies on interest rate on investment (e.g. debt) to solar energy developers. Additionally it also offers exemptions from electricity and stamp duties till March 2017 [40]. Besides some state has also provision of no Availability-Based Tariff (ABT) within state and registration charges paid for land purchase.

4.3. Policy-wise solar power installed capacity

The installed capacity of the solar power projects in India based on above discussed policies is summarized in Table 3. From table it can be observe that the policy, out of total installed capacity of PV plant (3002 MW), 48% share is of state government policy based plants and 28% come from central policy framework (MNRE). Rest of the capacity has been contributed by RPO/REC policy, PSUs and by private player contribution. Further to this from 48% share of state, Gujarat has shared major share i.e. 64% among other states. This has indicated that Gujarat's policy is quite acceptable compare to other states's success in solar power projects.

5. Policy effect on the viability of the solar power project

From the analysis of the various schemes and the projects developed under it has been learnt that how existing policy framework affects the viability of the project. The review of the same has been detailed out here below:

5.1. Preferential tariff scheme

In year 2010, after announcement of the ambitious solar policies like FiT, NSM etc, the confidence and opportunities in India's solar development were at an all-time high. But when central government, CERC has announced reverse bidding process in preferential tariff scheme (or FiT) to create fare competition among the project developers it has raised questions, how this bidding will maintain harmony without compromising with the financial viability of project. Recent coal power projects in India the price of electricity at about INR5.5 a kW h. In comparison, the most recent national solar auction priced photovoltaic power at about INR6.5 per kW h. With this competition in the solar power auctions, project developers have offered discounts of more than 50% of the base tariff on offer.

This indicates that government has got cheaper solar power, saved nation's money and may achieve grid parity as well. Contrary, the aggressive competition of reverse bidding has forced some developers to even give up the project that they had secured in bidding. The reason behind it is due to this un-viable offered tariff which has actually no financial sense to pursue them further [41]. A fear about excessive competition in the solar power sector has already sensed when India's most ambitious National Solar Mission has introduced competitive bidding. Further to this, several states have implemented similar policy of reverse auctions which has contributed for provoking low price bid in state level as well. Gujarat is the state which has a largest installed capacity of solar power in the country and has never introduced bidding to allocate solar power projects. Today, an every single large-scale solar power project operational in Gujarat was allocated to project developers with a Feed-in Tariff for 25 years.

5.2. Accelerated depreciation (AD)

An AD benefit has been introduced in solar power project for increasing it is the financial viability which allows project developers to pay quite low income tax on the profit. However, inadequacy of AD benefit is that in initial days after installation of the plant, project developer experiences very low or a non-taxable profit which confines the tax benefit that can be claimed [43]. Additionally, state like Andhra Pradesh has declared no charges for transmission and banking facility for the power generated by solar energy and hence such project does not qualify for availing AD benefit. Here it is a question whether AD benefit is comparable with state wheeling and transmission charges? Or is it significantly contributes much in early years after installation of the project?

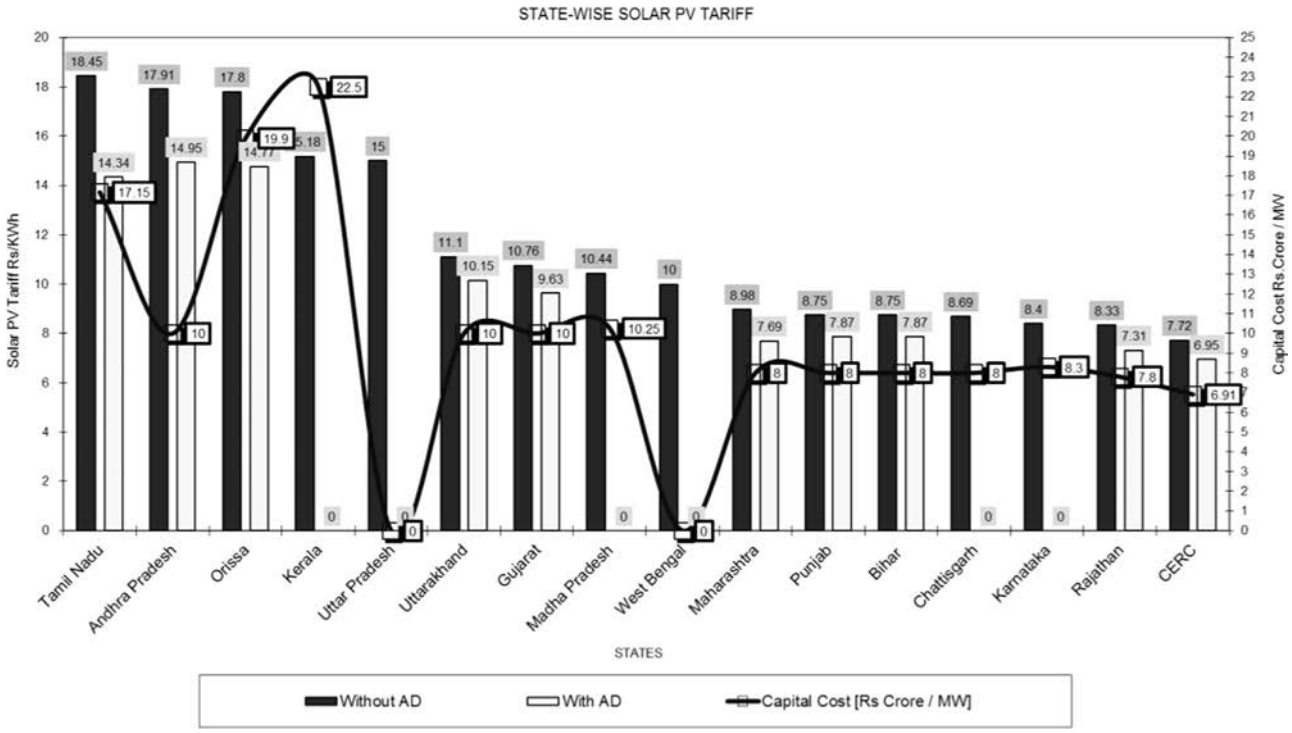

Fig. 1. State-wise tariff for solar PV project. *Source*: Indian Renewable Energy and Energy Efficiency Database (www.ireeed.gov.in) on April 2015.

Table 3
State wise installed capacity of slar PV projects under various scheme as on 15.12.2014 [42].

SN	State/UT	Total MNRE projects	State scheme	Other programs (MW)			PSU	Total (till 15th Dec 2014)
		MW	MW	RPO MW	REC MW	Private MW	MW	MW
1)	Andhra Pradesh	94.75	96.19		32.6	1.62	10	234.86
2)	Arunachal Pradesh	0.025						0.025
3)	Telengana				2	6		8
4)	Kerla	0.025						0.025
5)	Chhattisgarh	4			3.1	0.5		7.6
6)	Gujarat		873.05	50	6			929.05
7)	Haryana	7.8					5	12.8
8)	Jharkhand	16						16
9)	Karnataka	5	40	10		3	9	67
10)	Madhya Pradesh	5.25	222.55		75.78		50	353.58
11)	Maharashtra	47	126		113.75	0.15		286.9
12)	Orissa	12		5	4.5		10	31.5
13)	Punjab	9	39		7.52	0.25		55.77
14)	Rajasthan	593.5	25	40	181			839.5
15)	Tamil Nadu	16	3		83.06	2.14		104.2
16)	Uttar Pradesh	12	2				15.51	29.51
17)	Uttarakhand	5						5
18)	West Bengal	2.05	5			0.16		7.21
19)	Delhi	0.335			2.14	2.99		5.465
20)	Andaman & Nicobar	0.1					5	5.1
21)	L'dwip							
22)	Pudduchery							
23)	Chandigarh							
24)	Others	1.615						1.615
Total (MW) (%)		**833.4 (27.9)**	**1436.7 (47.84)**	**100 (3.3)**	**511.15 (17)**	**16.81 (0.5)**	**104.5 3.4)**	**3002.66 (100)**

5.3. Renewable Purchase Obligation and REC

The motivation behind the solar energy based RPOs or REC were primarily to create demand for grid connected solar power. However, REC are saleable by solar power producers and the same can be buy by entities that need to fulfill their RPO is not so effective due to—are ineffective because of insignificant compliance. The lack of RPO enforcement by state authorities has weakened a key indicator for investors that could stimulate solar power capacity addition.

5.4. Cost of finance/manage debt

Financial institution plays very important role for viability of any solar project. In NSM phase –I, self-financing and non-returnable grant has provided the majority of finance. Domestic

banks remained reluctant to loan the money as there is traceable loss with solar energy. In India the cost of debt is very high which adds about 24–32% to the cost. Additionally, the debt tenure and variable rate debt adds about 13–14% to the cost [17]. Despite experience added in Phase I, many inland banks remain to identify substantial threat in solar area funds due to lack of information and the absence of a successful track record related with realization of loan money given by bank for any particular project. It is now expected that international financing is going to decline and this will raise the burden on domestic banks and hence may also affects financial viability of the solar project as well.

5.5. Technology and location impact

State like Haryana has offered tariff based according to technology used in solar PV. E.g. for Crystalline, Thin film and Rooftop it offers INR5.70, INR 5.36 and INR5.32 respectively. Such policies are initiated to ensure the quality of the solar plant but may contribute towards lessen the interest among developers to invest money for such low tariff. As per the solar map of India, north–west portion seems to be high potential to install the solar project and hence states belongs to those part of the country (e.g. Gujarat and Rajasthan) are initiating accordingly. But at central level policies, tariff variation according to geographical location has not considered yet. This also affects economic viability of the projects as output of the electricity varies place to place [44].

Hence, the site-specificity is an important feature in order to reduce uncertainty and to achieve good regional coordination [45].

6. Recommendations

To enhance the viability of the solar power project and to make them an attractive alternative to invest money in the sector, the central government may upgrade through inventive state initiatives e.g. Andhra Pradesh's exemption from transmission and wheeling charges, Gujarat's AD policy and Rajasthan's REID Fund to take care of waive off transmission costs or last minute infrastructure cost towards commissioning of the solar projects.

As the Current tariffs for solar power project is derived through reverse auctions bidding which has been pushed the project developers to levels where projects may lose its viability. To avoid to develop another policy barrier, government may consider go for fixed Feed-in Tariff system for the solar power sector as it exist in all other renewable energy sectors.

Enforcement on RPO/REC: due to un-availability of well-established REC market, the solar energy investors are missing a crucial opportunity to attract further investors. The central agency may hand hold with state utilities, state regulators or MNRE to impose renewable purchase obligations and cherish the REC market.

Federal banks or authorized money lenders having experience in providing money to the solar markets may share their experience in positive manner to develop a sustainable model or products to support solar energy projects. Organizations could work jointly to form a pool of consortium loans and share information, by conducting workshops where solar energy investor and its ecosystem could exchange their learnings and boundaries associated with solar investments.

7. Conclusion

The study concludes that state policies seems to upper position as project developers have invested more under state policy regime compare with central government. The reason behind this is states have come up with many encouraging policies like AD benefit on capital investment, no transmission and wheeling charges, single window clearance, reduction in electricity tax, tax concessions, no registration charges paid for land purchase and no Availability-Based Tariff (ABT) within state.

At central level policy framework 'reverse bidding' has achieved quite low tariff and may match with conventional power tariff soon. By this government has secured cheaper solar power, and saved nation's money as well. Contrary, such aggressive competition of reverse bidding has forced some developers to give up the projects they had secured in auctions as it made no financial sense to pursue them further.

Additionally, financial institutions/nationalized bank have also learned lessons whether they should lend their money under such policy framework or not irrespective of credibility of the bidder.

From the result of different initiatives taken in last five years it has been noticed that the role of both state government vis-à-vis the national government seems to be independent but complementary with the each other.

Further to this, in last five years CERC has reduced solar PV tariffs by about 15–20% every year. Now there are indications that this reduction would not be as steep over the next few years. Such situation indicates the maturity level of the sector where financial institutions have to play key role to contribute for making solar projects economically viable and sustainable as well.

Grid connected solar roof top system and solar home system (both are in kW size only) is another upcoming area of deployment of solar energy in India. Presently, this area is supported with capital cost subsidy and auction/bidding is not included yet. And hence may consider viable option for the solar project developers/investor. This paper has mainly focused on large scale MW size grid connected Solar PV plant and not included scheme like roof top system and solar home system as it is subject of in-depth analysis separately.

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Analysing Market Feasibility of Residential Green Buildings in Tier-II Cities in India

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Abstract: *Going green is the latest trend among corporate and residential apartments. The Indian Green Building Council (IGBC) estimates the demand for Green building materials and equipment will reach $ 8 billion per annum by 2015. In tune with the global trend to protect the environment, the number of Green building projects in India went up from 164 in 2009 to over 2000 by 2012. Looking into this scenario, the objective of this paper is to assess and improvise level of knowledge among developers, customers, and local authorities regarding residential green buildings in Tier II cities in India.The study is limited only for Tier-II city of Bhopal, which is an upcoming residential hub situated in the heart of India. A three-tier survey involving three parties, viz. Potential Buyers, Developers and Government Bodieshelped in determining the level of awareness regarding green building concepts in the general public and local real estate developers of Bhopal; ascertaining the willingness of the public to pay for energy efficiency; assessment of the customers', developers' and Government's perspective on Green buildings; analysis of the market scope of residential green buildings from the developers' and Government's perspective; identifying the challenges that the developers face in building green; and getting an insight of the current scenario of the residential green building market.The results show that if all the above parties involved in the process of residential green building development work in sync with each other, residential green buildings can be made feasible for Tier-II cities in India.*

Keywords: *IGBC, Residential Green Buildings, Energy Efficiency.*

I. Introduction

Green building is the practice of increasing the efficiency with which buildings use resources – energy, water and materials – while reducing building impacts on human health and the environment, through better site, design, construction, operation, maintenance and removal i.e. the complete building life cycle.Today a variety of Green buildings are coming up in the country – residential complexes exhibition centers, hospitals, educational institutions, laboratories, IT parks, airports, Government buildings and corporate offices.India, which has an estimated 19 years for the domestic oil reserve to last and 86% of its oil consumption being imported, has taken a leading role in promoting Green buildings. Green buildings utilize designs and materials that are environment friendly. They ensure pollution-free environment and reduction in energy bills through application of smart energy management, building management, application of solar photovoltaic system, high performance windows and heat resistant paints among others.Green buildings have provision for solar protection to prevent heat gain in the premises during the day. This helps in putting less of load on air-conditioning system to maintain ambient temperature within the premises. The solar protection mechanism in Green building ensures the usage of natural light to the maximum and that results in the reduction in the consumption of electricity used for lighting. This mechanism also protects the premises from the glare and heat of harsh Sun in the summers and maintains the warmth of Sun during the winter. This helps in the increase in the comfort level of users as it enables natural ventilation, natural light and climate control in a natural way.

Around the World, green building is accelerating as it becomes viewed as a long-term business opportunity. Fifty-one percent of the architects, engineers, contractors, owners & consultants from all over the World anticipate that more than 60% of their work will be green by 2015, up from 28% of firms in 2012 according to a study conducted by McGraw Hill Constructions across 62 countries from all around the World including India. According to McGraw Hill Constructions, the growth of green is not limited to one geographic region or economic state-it is spreading throughout the global construction marketplace. The Indian Green Building Council (IGBC) estimates the demand for Green building materials and equipment will reach $ 8 billion per annum by 2015. Going green is the latest trend among corporate and residential apartments. Green building, as the concept is called, ensures environment protection, water conservation, energy efficiency, use of recycled products and renewable energy. In tune with the global trend to protect the environment, the number of Green building projects in India went up from 164 in 2009 to over 2000 by 2012.

Statement Of The Problem

The main problem lies in the fact of awareness of Residential Green building design in India. This problem is nationwide, lack of awareness among public and developers has resulted into wide range of disbelief. Every expert depicts the same story to take measure regarding the perception of customer behavior. It may be small start to use the technique of pamphlets reciting the concept of green building design along the project brochure, but this impacts to wide range of customers.The issue of addressing such issues under myth category is a big challenge that its needs to be improvised. Indian real estate market is widely unorganized, wide range of developers from big groups to a local developers impacts the quality of project and the trust of customer. Lack of knowledge, traditional methods are some main factors which contribute in making projects like green building a myth. Developers need to improvise in their level of knowledge, just putting green belt in front of multi-storey residential complex does not account that building as green building. This problem is not limited up to developers but even the local development authorities are not aware with the idea of innovation or any new technique.

The question arises on how this can be achieved in a Tier-II city of population around 34 lakh with India moving towards the stage of global platform. The idea of conducting survey with customers is to ascertain the level of awareness and judging their behavior with respect towards new concept or innovation. The idea of conducting survey with different developers is to ascertain the level of technical expertise and knowledge regarding green building construction in the residential real estate sector. The interview with government officials provided an insight to the policies and regulatory environment of green buildings in the residential real estate sector.The question also revolves around the level of awareness among developers and local government bodies. Is it right to presume that our government bodies lack in the idea of development? The questionnaire will provide data that will ascertain the value of business and its related myths and will ultimately serve as a guide to whether the concept of residential green buildings is feasible for the market of Bhopal or not. The local government bodies will determine the level of influence towards new idea and technology.

Objective Of Study

• To identify the necessity of Green Buildings with respect to the present scenario.
(Source: Consultation from Environmental Planning & Conservation Organisation, EPCO).
• To identify challenges associated with Green Buildings, including entry barriers to Green Building construction.
(Source: Consultation from IGBC & Developers)
• To conduct Market Analysis with respect to green buildings in the Bhopal region.
(Source: Survey at three different levels)

Significance Of The Study

It is must to contribute towards society, this study will not only benefit the customer, developers in terms of money but it will also enhance their knowledge about a new concept or innovation. The study revolves around a basic plan to make people aware of the concept and to determine whether the citizens of Bhopal are open towards a new innovation, whether for them is just a new concept or it something which will provide customer with a sense to acquire for knowledge before investment. Today‟s customer has become conscious but does this mentality is just in terms of investment or it would provide upper hand to customer with knowledge of the concept. Many experts have argued for the feasibility of green building design, but the truth is seen to be that such concept will be accepted not today but may be after 10 years. It just a matter of time when government will opt for such measures to achieve the dream of sustainable development. Government need to put efforts to promote such concepts in order to make public aware of such new work. Government is often found to be reluctant on such matters, but being reluctant can‟t make our nation progress. The public should be a part of change until the public still living in the old world it‟s a duty of government to work on such cases to promote green buildings. Such things can be achieved if government uses the same concept to promote its new era buildings which will be built on the same concept. The idea of creating such an environment is to generalize the public towards the sustainable growth.

Market of developers is poorly organized, big developers have the idea of brand image and customer satisfaction. The basic need is to bring such characters in local developers. The idea of marketing can‟t be improvise until there is satisfied platform where a customer and developer transaction can take place. The main motive for such enhancement is to provide level of awareness among local developers so that the market can be organized.Developers require to work on concept which is not universally accepted. Also it is the duty of developer to provide every possible details regarding the project to the customer as per the Indian real estate act 2013. Everyone has the tendency to follow which is successful. The project success is not only determined by the market but it is also determined by the level of effort done by the developer to provide customer with an interest of satisfaction.

Limitations Of The Study

This study will show result only for the region of Bhopal. The study will not entertain any public outside Bhopal. Further study will not include any work regarding the pricing, place or further any market mix. Also arriving from developer‟s point of view suggest following disadvantages which can‟t be covered in this study:

1. Economies of scale:

While many green developments are enormous, a number of them are small and seem to have a little of everything. As an owner, or as a larger tenant, it may be difficult to get the economies of scale you need in a smaller green building development.

2. Difficulty of management:

For many property managers, managing this kind of development can be a gargantuan task. Most property managers focus on office management or retail space management. Unless the development is enormous and justifies several property managers on one project, this can be a beast to manage. As a tenant, you will have to realize that your property manager may excel at dealing with office tenants, but not understand well how to manage retail tenants. Before leasing in a mixed-use location you may wish to investigate this further with your Landlord.

II. Literature Review

The Concept Of Green Building:

There have been various popular definitions of sustainable buildings or green buildings. USGBC (United States Green Building Council), one of the pioneers in propagating green buildings across the globe states that the term „green building‟ is synonymous with „high performance building‟, „sustainable design and construction‟ as well as other terms that refer to a holistic approach to design and construction. Green building design strives to balance environmental responsibility, resource efficiency, occupant comfort and well-being, and community sensitivity”. According to the Indian Green Building Council (IGBC), a building which can function using an optimum amount of energy, consume less water, conserve natural resources, generate less waste and create spaces for healthy and comfortable living, as compared to conventional buildings, is defined as a green building. The Energy and Resources Institute (TERI), a not-for profit organisation working in the field of sustainable development defines it as, “A Green building is designed, constructed and operated to minimize the total environmental impacts while enhancing user comfort and productivity”.

Some of the key attributes of Sustainable buildings are as under:

- Consideration of sustainability aspects in all phases of building design and planning
- Consideration of sustainability aspects during construction and production of building materials
- Use of healthy and environmentally friendly building materials and products
- Use of efficient systems
- Use of constructions and systems which are easy to maintain and service
- Safeguarding of high functionality, flexibility and adaptability
- Safeguarding of health and comfort of users, occupiers and visitors
- High aesthetic and urban design quality; high public acceptance
- Appropriate location with good access to public transportation services and networks

Conventional methods of building use tremendous quantities of material, many of them non-renewable and toxic, and pay little attention to the impact the building has on the environment. Green buildings not only reduce these impacts but are also healthier and consume less energy saving money in the long run. Green building design is a practical and climate conscious approach to building design. Various factors, like geographical location, prevailing climatic conditions, use of locally available and low embodied energy materials and design parameters relevant to the type of usage of the building are normally taken into consideration. Such an approach ensures minimum harm to the environment, while constructing and using the building. A green building uses minimum amount of energy, consumes less water, conserves natural resources, generates less waste and creates space for healthy and comfortable living. When a number of green buildings are located in proximity, they would create a green zone, providing much healthier environment and minimise heat-island effect. The ultimate aim will then be to create many such areas, which would help the towns and cities and therefore the nation in reducing total energy requirement and also the overall global carbon footprint. In a nutshell, sustainable buildings use less energy and water, generate less greenhouse gases, use materials more efficiently, and produce less waste than the conventional buildings over their entire life cycle.

Compulsions Of Going Green:

Studies show that the global urban population is expected to grow from 47% of the total in 2000 to 70% in 2050. The urban populations of China and India are continuing to grow rapidly to 2050, reaching more than one billion in both China and India. In India drastic urbanization is mainly due to both socio–political motivation. In line with expanding development and population, India‟s building sector is expected to grow five-fold till 2050 as two-thirds of the commercial and high-rise residential structures that will exist in 2030 are yet to be built (70%). While India's total energy requirement is projected to grow at 6.5% per year by 2016-17 to support the country‟s projected growth rate. India is en route to becoming the world‟s second largest emitter of greenhouse gases. It is a globally excepted fact that green buildings save the resources in the entire lifecycle of the structure and it starts from Green design. Green design has environmental, economic and social elements that benefit all stakeholders, including owners and the occupants. With rapid improvements in construction techniques and ethos, it is visible that many of the contemporary office buildings being built across metropolitan cities in India are already including some of the Green features as part of the buildings being delivered for occupation.

In such a scenario, the residential developments also need to switch to green development in order to address the future issues of energy efficiency, increased pollution, increasing carbon footprint and emissions. Going green will ultimately lead to the sustainable development of the society, the nation and the world on the whole.

Benefits Of Green Building:

Buildings have an enormous impact on the environment, human health, and the economy. The successful adoption of green building strategies can maximize both the economic and environmental performance of buildings. Research continues to identify and clarify all of these benefits and costs of green building, and of how to achieve the greatest benefits at the lowest costs. According to IGBC, green building has the following benefits:

- Environmental Benefit
- Emissions Reduction
- Water Conservation
- Storm water Management
- Temperature Moderation
- Waste Reduction
- Economic Benefits
- Energy and Water Savings
- Increased Property Values
- Decreased Infrastructure Strain
- Improved Employee Attendance
- Increased Employee Productivity
- Sales Improvements
- Development of Local Talent Pool
- Social Benefits
- Improved Health

Green Building Economy And Market

Recent studies predict that energy efficiency in building and appliances can reduce 1.6 Gt CO2 in 2020 and up to 7Gt CO2 in 2050. About $158 billion per annum between 2010 and 2050 are required to diffuse the energy efficiency technologies globally. According to study by McGraw Hill Construction, about half of new global commercial building projects will be planned as green buildings and 45% of retrofitting projects on existing buildings are targeted to improve energy performance. In terms of region, the fastest growing regional green building market is Asia, where the population of firms largely dedicated to green building is expected to jump from 36% today to 73% in 2013. More than half study firms expect to be largely dedicated to green building (on over 60% of projects), up from 30% today. Over 85% firms expect rapid or steady growth in sales and profit levels associated with green building.

Studies show that the Green building movement in India has gained tremendous momentum during the past 3-4 years, since the CII-Godrej GBC embarked on achieving the prestigious LEED rating for its own center at Hyderabad. The Platinum rating awarded for this building sparked off considerable enthusiasm in the country. Today a variety of green building projects are coming up in the country residential complexes, exhibition centers, hospitals, educational institutions, laboratories, IT parks, airports, government buildings and corporate offices.

Green Building Rating Systems

Motivated by a desire to appear environmentally conscious, many commercial facilities have adopted "Green technologies" in order to earn "Green and Sustainable" certifications. According to USGBC, the Green Buildings Ratings and Certification process has gained tremendous momentum over the last few years. Particularly, growth in the number of projects certified by rating systems such as Energy Star and LEED has nearly doubled in size during this period. In India, the Indian Green Building Council (IGBC) provides LEED ratings to structures and aims to make the country one of the leaders in green buildings by the year 2015. The Green rating for Integrated Habitat Assessment (GRIHA) is the National Rating System of India. It has been conceived by The Energy and Resources Institute (TERI) and developed jointly with the Ministry of New and Renewable Energy, India. It is a design evaluation system for green building and is intended for all kinds of buildings across every climatic zone in India. According to a 2008 news report in the Indian Express, Mumbai had registered 30 green building projects, at the time the highest among Indian cities. Thanks to the gradual spread of awareness about eco-friendly constructions, there has been a considerable rise in the number of registered green buildings in India. According to 2008 IGBC data, there are 315 green buildings in India, of which 250 are commercial properties.

IGBC offers specialised rating systems for green residential developments. Some of the rating systems are briefly described below:

- IGBC Green Homes Rating System: IGBC Green Homes is the first rating programme developed in India, exclusively for the residential sector. It is based on accepted energy and environmental principles and strikes a balance between known established practices and emerging concepts. The system is designed to be comprehensive in scope.
- IGBC Green Townships Rating System: This rating system is designed to address large developments and it is mandatory to include residential development as part of the township. Some typical examples of large scale developments are integrated townships, satellite cities, gated communities, campuses with multiple buildings etc.

The Kyoto Protocol

The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change, which commits its Parties by setting internationally binding emission reduction targets. Carbon credits and carbon markets are a component of national and international attempts to mitigate the growth in concentrations of greenhouse gases (GHGs). One carbon credit is equal to one metric tonne of carbon dioxide, or in some markets, carbon dioxide equivalent gases. Carbon trading is an application of an emissions trading approach. Greenhouse gas emissions are capped and then markets are used to allocate the emissions among the group of regulated sources. Carbon credit may be prove as a good source of income for rural areas and industrial, factories etc. by minimizing GHG emission or increasing the trees plants and other environment friendly techniques, which is not tough for Indians. Promotion and knowledge of such business opens should be promoted through education system.

Green Buildings In India – The Challenges

Building energy-efficient 'green' homes sounds like a great idea in theory. But in practice, especially in developing countries, it can be extremely expensive. In India, there are no direct incentives for building energy-efficient homes or commercial spaces. The Indian housing industry faces several problems while trying to be eco-friendly, according to international real estate services specialist Jones Lang LaSalle.

A major challenge is that the overall demand for space in Indian cities has been gradually falling. India's top seven cities will see about 25 percent vacancies by 2014, says RajatMalhotra, head of Integrated Facilities Management for West Asia at Jones Lang LaSalle. Finding tenants or buyers willing to pay more for green space, therefore, is a serious challenge for developers. For private homeowners, there is no immediate motivation to take the energy efficient path.

In the absence of mandatory standards for green and energy efficient buildings in India, most municipalities do not have a uniform and practicable energy code especially for passive and solar designs. There are no clear implementation guidelines in place for state and municipal bodies to develop and implement building energy efficiency programmes and policies. There is also no effective local implementation infrastructure for code administration and enforcement including code checking and inspections.

Building owners tend to under invest in green technologies and energy efficiency during building design and construction because of the split incentives. The developers do not gain from the initial investments in building energy efficiency and thus pass on the cost of inefficiency to the tenants and the environment. The current high cost of borrowing can be a strong impediment to incremental funding in efficiency that would be offset by future savings of energy costs.

Bhopal-An Emerging Tier-Ii Residential Hub

Bhopal is the capital of the Indian state of Madhya Pradesh and the administrative headquarters of Bhopal district and Bhopal division. The city was the capital of the former Bhopal State. Bhopal is known as the City of Lakes for its various natural as well as artificial lakes and is also one of the greenest cities in India. Bhopal is the 16th largest city in India and 134th largest city in the world. It is basically divided into two parts - old Bhopal and new Bhopal.

A Tier-II city, Bhopal houses various institutions and installations of national importance. Some of these include ISRO's Master Control Facility, AIIMS Bhopal (Established in 2012), National Institute of Fashion Technology (NIFT) AMPRI, MANIT, IISER, SPA, IIFM, BHEL, School of Planning and Architecture (SPA Bhopal) and NLIU, Gandhi Medical College.

The city attracted international attention after the Bhopal disaster, when a Union Carbide India Limited (UCIL) pesticide manufacturing plant leaked a mixture of deadly gases including methyl isocyanate on the intervening night of 2/3 December 1984, leading to one of the worst industrial disasters in the world's history. Since then, Bhopal has been a center of protests and campaigns which have been joined by people from across the globe. Bhopal is widely known for its silver jewelry, fashioned beadwork, embroidered and sequined velvet fashioned purses and cushions. In recent times, Bhopal has emerged as a potential real estate destination after Indore in Madhya Pradesh. It offers various investment opportunities for both property developers and property investors. The economy of Bhopal mainly comprises of electrical major BHEL, services and administration sectors. The development of property in Bhopal seems to be following a wholesome approach as all the sectors, be it residential, commercial or retail, are growing rapidly.

III. Research Methodolgy

The study is based on both Primary and Secondary data. The secondary data consists of information collected from journals, magazines, books and internet. The primary data is collected through questionnaires on three separate levels. Three separate questionnaires were prepared for three different parties: Potential Buyers, Developers & Officials from EPCO (Environmental Planning & Conservation Organization). All the questionnaires were of structured non-disguised type.

The sample size for potential buyers was taken as 200 and the sample size for Developers was taken as 10. The sample size of the officials from EPCO was taken as 2 depending upon the availability of the government officials. The sample size is kept small as the study is done only for the Bhopal region.

The analysis is based on both Primary and Secondary data. The secondary data consists of information collected from journals, magazines, books and internet. The primary data is collected through questionnaires on three separate levels. Three separate questionnaires were prepared for three different classes: Potential Buyers, Developers & Officials from EPCO (Environmental Planning & Conservation Organization). The sample size for Customers will be 200 and for Developers was 10. The sample size of the officials from EPCO is taken to be 2. The sample size is kept small as the study is done only for the Bhopal region.

Interpretation

Based on the analysis of the three-tier survey, following are the final consolidated key findings:

Buyer's perspective:

- 20% of the potential buyers are completely aware of the green building concept and almost 50% of the potential buyers are somewhat aware of the green building concept.
- Majority of the potential buyers belong to the age group of 18-35 years and 35-49 years. Out of these, the most aware potential buyers belong to the 18-35 years age group.
- Majority of the potential buyers belong to the middle and upper middle class of the society. 47% of the potential buyers belong to the income group of Rs. 2-5.9 LPA and 42% of the potential buyers belong to the income group of Rs. 6-12 LPA.
- The major source of awareness regarding green building concept for the potential buyers has been the print media, accounting for a 42% share. Social media accounts for 10% as a source of awareness.
- Almost all the new developing areas in Bhopal like Hoshangabad Road, Ayodhya Bypass and Arera Colony Extension fetch a good amount of customer interest, i.e. 30%, 22% and 28% respectively.
- Around 40% of the potential buyers have a wrong perception about the green building concept.
- Almost 25% of the potential buyers think that all the features of a green home are equally important to them.
- 60% of the potential buyers are willing to pay more for a green home in the current scenario.

The Developers' Perspective

- 80% of the developers have read information regarding the green building concept, but never used it.

- Majority of the developers (90%) are currently using measures like rainwater harvesting, alternate energy sources, natural lighting and water recycling techniques etc. in one or the other project.
- 30% of the developers are found to be reluctant in using green building technology because of regulatory concerns.
- 40% of the developers do not opt for green building technology because of market concerns.
- 50% of the developers are reluctant in using green building technology because of the complexity of information and the complex set of guidelines they have to follow in order to achieve a green rating certification.
- 40% of the developers do not engage in green development because of the high level of initial investment which is associated with green building construction.
- The major source of awareness regarding green building concept for the potential buyers has been the print media, accounting for a 42% share. Social media accounts for 10% as a source of awareness.
- A whopping 90% of the developers think the Government and City Administration should take steps to facilitate green development in the residential real estate sector.
- 50% of the developers suggest that the Government should engage in promotion of the green building concept among the general public.

The Government's Perspective

- The Government of Madhya Pradesh in collaboration with EPCO, BDA and BMC is currently working on the development of a Clean Development Management (CDM) Agency in Bhopal, which will address the issues associated with sustainable development and will facilitate the development of green homes in the city.
- Officials think that in order to facilitate green building development in the residential real estate sector, the current guidelines and rating systems should be revised and should be made a little bit favorable to the developers.
- There is a definite scope for residential green development in the upcoming future according to the Officials" viewpoint.
- The Government of Madhya Pradesh is on the verge of kick starting promotion of sustainable development and green building technology in order to generate awareness in the general public.

IV. Conclusion

Increasing development across all sectors of realty has resulted in a considerable hike in property rates in Bhopal. Prices in major developmental areas or prime locations have shot up significantly in wake of the growth of real estate in Bhopal. Residential sector has been witnessing developing of both luxury villas as well as low-cost or budget housing, diversifying the housing scenario.Bhopal property market scenario is getting hot like never before as even leading national builders are taking interest in developing property in the city. It is considered a „virgin land" known for its „nawabi" culture like Hyderabad and Lucknow and has been going through a dynamic phase of realty development.

In the present scenario, when the level of awareness in the general public is mediocre, a majority of the potential buyers willing to pay more for a green home, the developers ready to invest in green housing projects on the condition that they are provided authentic information on green building technology and full support from the Government and the Government itself engaged currently in developing a promotional strategy and a Clean Development Agency (CDM) in Bhopal, green building development is definitely the need of the hour.

If all the above parties involved in the process of residential green building development work in sync with each other, residential green buildings can be made feasible for a city like Bhopal. If the facts fetched by the analysis in this project report are taken into consideration, the dream of building green homes in a city like Bhopal can definitely be turned into reality.

V. Recommendations

Based on the Analysis and Interpretation, following is a set of recommendations in order to make residential green building development feasible in the Bhopal region:

- In order to generate awareness among the general public regarding green building development, an effective promotion strategy and campaign should be designed which targets the majority of potential buyers, i.e. people belonging to the middle class and upper middle class in the age group of 18-49 years of age
- The promotion strategy should cover all the aspects of green building construction and development so that the customers are fully aware and the developers cannot take illegal advantage of the customers.
- Print media accounts for majority of the source of awareness, followed closely by internet and social media. Keeping in mind the fact that a majority of the potential buyers belong to the age group of 18-49 years of

age, who are the major users of internet and social media as well, the promotional strategy should focus on using internet and social media as an effective tool for promotion of the green building concept.

- The Government of Madhya Pradesh should engage in organising training programs for developers and engineers in which they are trained on the technicalities associated with green building construction.
- The Government should also encourage partial funding of green building projects so that the developers can easily develop green residential projects and the potential buyers develop a sense of trust in the green home projects because of the Government intervention.
- The Green Building Principles (GBPs) and Rating Systems for Green should be revived and should be made favorable to the developers so that they can invest in green residential development projects.
- The various Government bodies like the Bhopal Municipal Corporation (BMC), Environmental Planning & Conservation Organisation (EPCO) and Bhopal Development Authority (BDA) along with the local developers and Non-Governmental Organisations (NGOs) should work in perfect harmony with each other in order to make residential green building development feasible and successful in the upcoming future.

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RESEARCH ARTICLE

Assessment and Improvement of Safety Culture in a Sugar Industry in India

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ABSTRACT:
The assessment of safety culture is a suitable aspect for measuring key elements of safety culture and identifying an organization's current level of development (or maturity) in order to learn and improve the safety performance. The work is focused toward the improvement of industry's safety performance by the interpretation of result from the survey methodology and to measure the performance of improvement efforts of ongoing safety. Safety culture and their assessment has also been touched upon.

KEYWORDS: Safety Performance, and interpretation, Safety culture, etc.

1. INTRODUCTION:
The Safety Culture assessment in a company can determine the level of safety culture. It also helps us to identify the positive and negative aspects of health and safety in the work place and to raise the health and safety profile in the organization. This establishes a base-line against which an organization can monitor the impact of interventions designed to improve Health and Safety. It also enables us to identify areas for improving Health and Safety management systems. Generally Hazards in the workplace are effectively controlled by effective management processes in place. 'Human Factors' plays a prominent role in the maintenance of high standards of Health and Safety of organizations. Workers view, an important aspect which gives importance to increase the quality of Health and safety of the organization. Management commitment, Involvement and Safety competence forms the key aspect in improving the safety culture. The commitment indicates the priority, resources and visibility given to health and safety by the management. Involvement is indicated by active participation, co-operation and communication. Finally safety competence should be accepted by organization to improve the safety culture.

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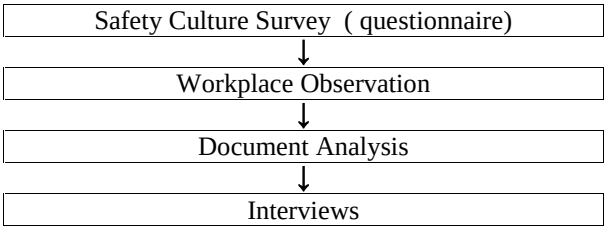
2. MATERIALS AND METHODS:
The key elements of safety culture are assessed using four methods. As survey alone doesn't provide adequate accurate picture of safety culture within an organization, these variety of methods helps us to assess the safety culture and allows us to interpreted the results obtained from each section.

ASSESSMENT METHODOLOGY:



I) Safety culture survey (questionaire)
The survey is designed with questionnaire to assess each of the key elements which forms the important aspect of safety culture. For first section, Workers rate these statements from (Never to Agree).

The survey was completed by most of the employees. Response for the survey was received from 21 employees. The input received was satisfactory and provides with a reasonable representation of overall

Cold Chain: A Weak Link in the Fruits and Vegetables Supply Chain in India

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Cold Chain: A Weak Link in the Fruits and Vegetables Supply Chain in India

Saurav Negi* and Neeraj Anand**

As Indian economy is based on agriculture, development of cold chain infrastructure will play a crucial role in reducing the losses and wastages, increasing the farmer income, generating employment opportunities for the local people, and improving the livelihood of the farmers which leads to developing the economy and helping India to emerge as a global leader in the food sector. The present study undertakes a thorough review of basic and contemporary literature available to explain the present status of and challenges to cold chain pertaining to the Fruits and Vegetables (F&V) sector in India. The study is an attempt to draw the attention of the stakeholders towards an urgent need to develop intelligent cold chain infrastructure which is the major impediment and a weak link in the supply chain of F&V sector in India. Cold chain infrastructure facilities include grading, sorting, packing, storage, processing and transportation facilities in the supply chain network.

Introduction

Fruits and Vegetables (F&V) is a very growing sector and constitutes around 90% of horticultural produce in India. Production of horticultural crops in India has increased as compared to the situation a couple of decades ago. Several factors like globalization, increasing urbanization, nuclear families, working women, disposable income, changing lifestyles and rise of organized retails are gearing up the Indian fruits and vegetables supply chains for a better future. Supply chain plays a very vital role in this sector. This area becomes even more important because of perishability and very short shelf life. Supply Chain Management (SCM) not only helps to cut costs, but also adds to maintain and improve the quality of produce delivered, which are perishable in nature. India, the world's second largest fruits and vegetables producer, is also one of the biggest wasters in the world, wasting ₹2 lakh cr worth of fruits and vegetables every year (ASSOCHAM, 2013). Owing to the very short shelf life and perishability, these items require proper transportation, handling and storage facilities in order to reach the customer in fresh state. Here, cold supply chain plays a very vital role in fulfilling the demand of the customer. Though India is an agrarian economy, it also faces various challenges in terms of infrastructure for fresh business. The infrastructure (road network, transportation, facilities, storage areas, etc.) has been a major barrier in the growth of agriculture sector. The cold chain infrastructure

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has been a weak link in the supply chain of fruits and vegetables as India has incurred huge losses due to poor post-harvest management and infrastructure facilities.

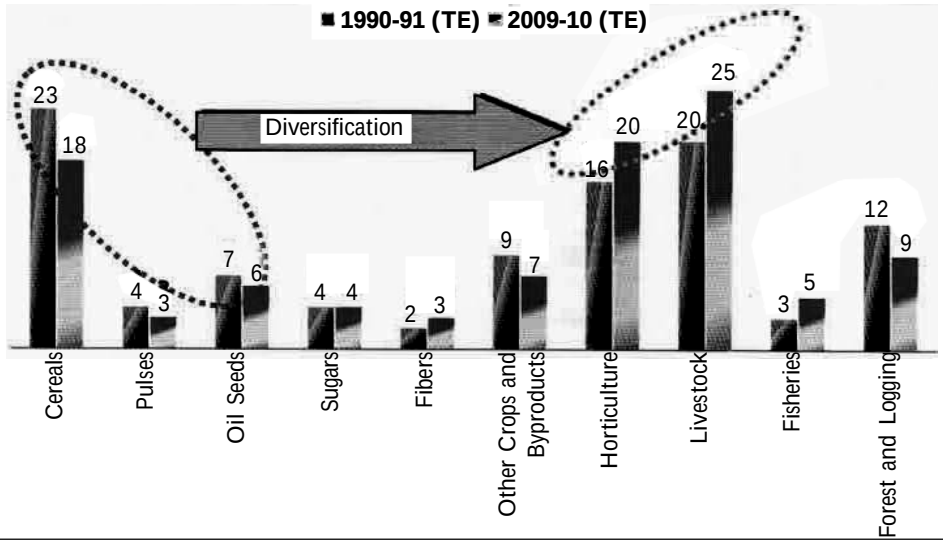
The present study undertakes a thorough review of basic and contemporary literature available to explain the present status of fruits and vegetables supply chain in India and identifies the bottlenecks in the cold supply chain. The study is an attempt to draw the attention of the stakeholders towards an urgent need to develop intelligent cold chain infrastructure which is the major impediment and a weak link in the supply chain of fruits and vegetables in India.

Significance of Fruits and Vegetable Sector

The agriculture sector in India has undergone significant structural changes in the form of decrease in the share of GDP from 30% in 1990-91 to 13.7% in 2013, indicating a shift from the traditional agrarian economy towards a service-dominated one, but more than half of the total workforce (about 52%) is still employed by the agriculture, and despite a steady decline of its share in the GDP, is still the largest economic sector and a significant piece of the overall socioeconomic development of India (ASSOCHAM, 2013)**.**

Structural change in the composition of agriculture and allied sector is leading to a diversification of Indian agriculture sector into horticulture, livestock and fisheries sectors. The share of horticulture in the total output from agriculture and allied sectors increased from 16% to 20% during the period of 1990-91 to 2009-10, as shown in Figure 1. The share of traditional crops like cereals, pulses and oil seeds declined in the same period.

Figure 1: Contribution of Different Agriculture Segments to Agriculture and Allied Sectors



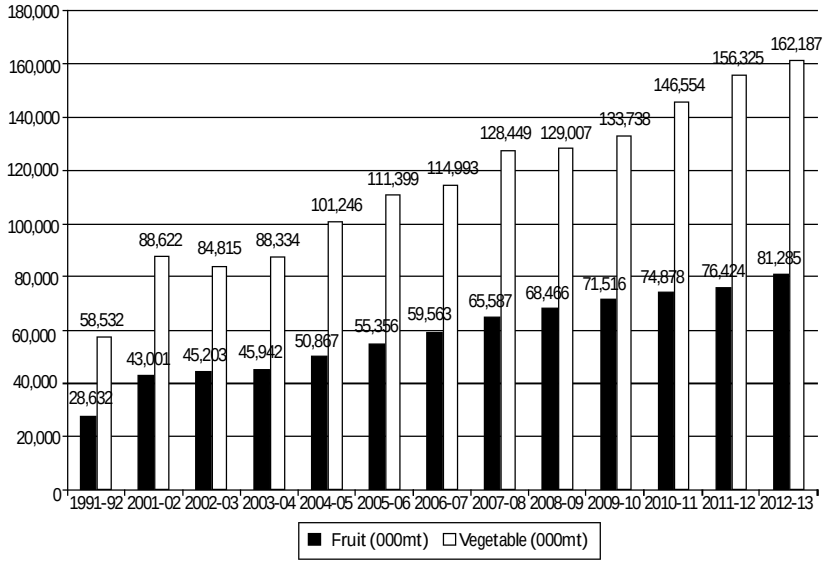
Source: ASSOCHAM Report, May 2013

Government data shows that the consumption of wheat and rice has been declining around 1-2% in both urban and rural India, while the demand for fruits and vegetables has been rising by 2-3% annually (IFMR, 2012). The horticulture sector has been a driving force in stimulating a healthy growth trend in Indian agriculture. The increased share of horticulture in agriculture and allied sectors implies that they have been growing at a much faster rate than the traditional crop sector. Given the rising share of high value commodities in the total value of agricultural output and their growth potential, this segment is likely to drive agricultural growth in the years to come. It plays a unique role in India's economy by improving the income of the rural people. Cultivation of these crops is labor-intensive and as such they generate a lot of employment opportunities for the rural population. Thus, cultivation of horticultural crops plays a vital role in the prosperity of a nation and is directly linked to the health and happiness of the people.

Fruits and Vegetable Sector Production in India

India is the second largest fruits and vegetables producer in the world after China with the total production of 81.285 MMT of fruits and 162.187 MMT of vegetables till the year end 2013 (NHB, 2013). The production of F&V is shown in Figure 2 from the year 1991-2013. The share increased from 28.63 MMT to 81.285 MMT in fruits and 58.53 MMT to 162.187 MMT in vegetables from the year 1991-2013. A large variety of fruits and vegetables are grown in India like banana, mango, apple, papaya, sapota, citrus, pine apple, grapes and guava in fruits and potato, tomato, onion, brinjal, etc., in vegetables.

Figure 2: Fruits and Vegetables Production in India



Source: Indian Horticulture Database, NHB (2013)

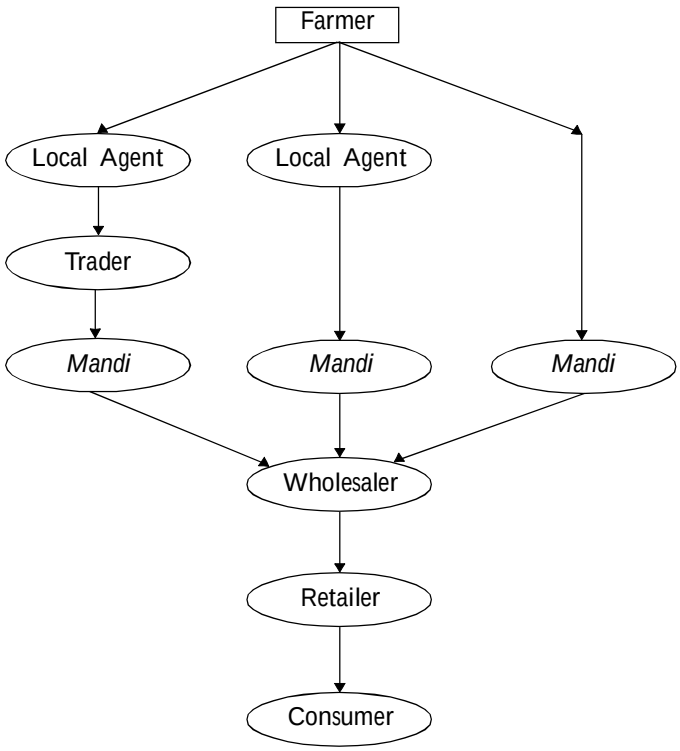
Fruits and Vegetables Supply Chain in India

SCM is defined as a set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses and stores, so that merchandise is produced and distributed at the right quantities to the right locations and at the right time, in order to minimize system-wide costs while satisfying service level requirements (Simchi-Levi *et al*., 2008).

The SCM of F&V constitutes the processes from production to delivery of the fresh produce, i.e., from the farmer to the customer and is complex as compared to other supply chains due to the perishable nature of the produce, high fluctuations in demand and prices, increasing consumer concerns for food safety and quality (Vorst and Beulens, 2002), and dependence on climate conditions (Salin, 1998). Because of their perishable nature, these commodities require proper cold chain management throughout the chain to keep the quality and freshness of the fresh produce. The SCM for F&V in India is still in a very pathetic state and fraught with various issues like inadequate cold chain storage and transportation facilities, fragmented and long supply chain, high cost of packaging, poor distribution, etc. (Dharni and Sharma, 2008). A large share of a farmer's realizable value is lost in commission, supply chain mishandling and other losses. On its way to market, lack of proper cold chain results in greater wastage of produce. This results in immense loss in the quantity and quality of the produce, giving rise to 40% value loss in the Indian supply chain for fruits and vegetables (Narula, 2011). The extent of loss of fruit and vegetable is about ₹10,000 cr to ₹12,000 cr per annum, and the loss of quantity ranges from 10 and 80% in some of the most perishable fruits and vegetables (Mittal, 2007). Inadequate usage/improper management of cold chains are leading to loss in the quality of the vegetables and fruits which in turn is leading to loss of profits and business opportunity (Halder and Pati, 2011). Without an efficient supply chain, there is a high amount of wastage for the companies (Rathore *et al*., 2010). The existing supply chain for the F&V involves many intermediaries **(**Figure 3) who eat up the share of about 75% of the total net margin accruing to the entire supply chain (Modi *et al*., 2009). The commission agents and local traders perform the function of aggregators who procure fresh produce from the small growers on behalf of big traders. Some farmers having large land size holding used to sell their produce directly to the local *Mandis* (market place), but usually farmers prefer to sell their produce to local agents or trader rather than selling directly to *Mandis*. Sidhu *et al*. (2010) found that more than 90% of the produce is disposed through commission agents/wholesalers, and a small proportion is sold through retailers and directly to consumers.

The presence of these large intermediaries and highly inefficient supply chain results in instability in prices and in farmer's not getting remunerative prices as the differential between the farmer's realization and the final consumer price in India is the highest in the world even in fresh produce (National Food Processing Policy), resulting in farmers' frustrations and suicides (Rathore *et al*., 2010) and increased additional costs in the supply chain which ultimately forces the final consumers to pay high charges from his pocket.

Figure 3: Supply Chain for Fruits and Vegetables in India

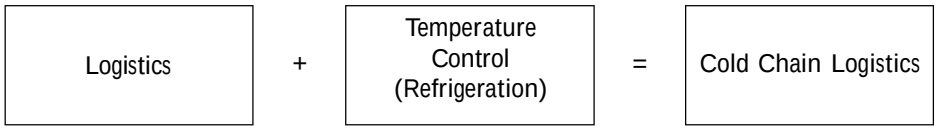


Source: Modi et al. (2009)

Cold Supply Chain

Cold chain is the logistics system that provides ideal condition to the perishable goods from the point of source to the point of consumption through thermal and refrigerated packaging methods and logistical planning to protect the quality and increase the shelf life of these shipments. A cold chain is a temperature-controlled supply chain which begins at pre-cooling stage prior to shipping. It involves temperature and moisture controlled transportation and storage of refrigerated goods and frozen goods. With the growing demand of ready meal, frozen products and fast food, logistics organizations are seeking to provide better cold chain solutions. Organizations are using several food temperature levels to suit the different food items. Frozen, cold chilled, medium chilled, exotic chilled are some of the frequently used nomenclature with specified product range, depending on the products, whether it is meat, or banana, or potatoes, or ice-cream (Figure 4).

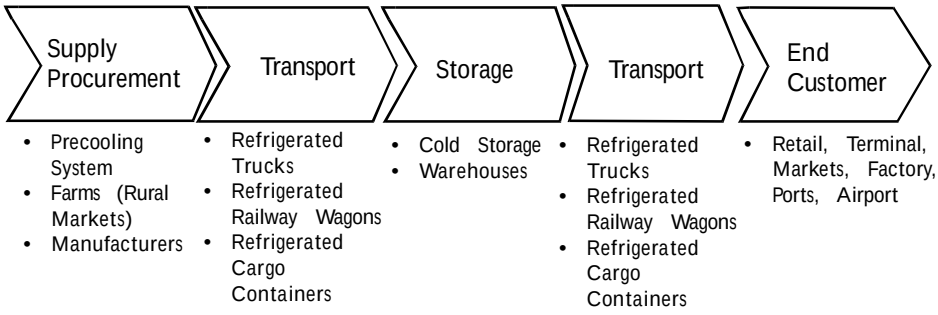
Figure 4: A Cold Chain



Source: Sapra and Joshi (2011)

A cold chain protects a wide variety of food produce in the whole supply chain by providing temperature-controlled facility. It is a logistic system that provides a series of controlled temperature storage and transport conditions from the point of origin to the point of consumption, i.e., from farm to fork. It saves fresh produce from degradation, humidity, and improper exposure to temperature, and keeps them frozen, fresh and chilled (Bishara, 2006). Any disorder in temperature or time-distance in the cold chain could hamper the net present value and their added value (Bogataj *et al*., 2005). The cold chain starts at farm level and covers up to the consumer level, using the temperature-controlled practices and behavior. Cold chain infrastructure generally consists of grading, sorting, packing, storage, processing and transportation facilities. A typical cold chain is shown in Figure 5.

Figure 5: The Cold Supply Chain Infrastructure



Source: Sapra and Joshi (2011)

Bottlenecks in the Cold Supply Chain

Cold chain is now recognized as a sunrise sector in India. It is very true that the country, which ranks second in F&V production in the world, needs a fully developed cold chain sector. However, the current scenario reveals that there is tremendous scope for the development of cold chain facilities.

An overview of the cold chain industry in India indicates that a cold chain was established right at the beginning of the 20th century, but further development was fairly

slow. These units were mostly engaged in storage of potato and were located in areas like UP, Punjab, West Bengal, Bihar, etc.

Realizing the importance of the cold chain industry, the Government of India has taken various initiatives through bodies like NHB to establish standards for all the arms of the cold chain. In short, the cold chain industry is on the cusp of a revolutionary change.

With a warm tropical climate for most of the year, high ambient temperature and high humidity conditions, preservation techniques involving pre-cooling at the farm level, low temperature storage and refrigerated transportation system are mandatory in India for slower aging, extending shelf life and inhibiting the growth of spoilage organisms. Unfortunately, as pointed out in an FICCI report, India does not have a comprehensive cold-chain network. More than 50% of produce is transported using bullock carts or trucks with no packaging or packaged in gunny bags. Also, most of the transportation is done in un-refrigerated open trucks. The farmers resort to this means at the cost of a high percentage loss probably because the price they get from the wholesalers hardly covers the cost they incur in refrigerated transport.

The trend for fresh fruits and vegetables is gaining acceptance in India and is growing at a steady rate. This increasing trend has raised various issues associated with quality, safety and availability of these fresh produce. To make the fresh produce available and to achieve quality and safety, it requires proper cold chain management. The cold chain industry in India is estimated to be presently worth over ₹13,000 cr ($2.6 bn) per annum (Narula, 2011) with various opportunities in the F&V segment in terms of trade and value addition. Despite the huge opportunities, the cold chain industry is at a nascent stage with various bottlenecks discussed below. A lot is yet to happen in the industry with respect to development of technology, government plans, and strategy before it can transform the lives of farmers and the growth of Indian economy.

In 2010, the cold storage gap was of about 370 lakh metric tons, as shown in Table 1 on the basis of peak season production and highest arrival/harvesting of storable fruits and vegetables in a month (NCCD, 2012). The existing cold storage facilities are available only in the wholesale market or nearer to that market. The local market or regional market, where the major fresh produce is sold by the farmer does not have cold storage facility.

Jain (2007), Viswanadham (2007), Bhardwaj and Palaparthy (2008), FICCI (2010), Rathore *et al*. (2010), Halder and Pati (2011), Narula (2011), and Veena and Venkatesha (2011) found poor cold chain as a major problem in the supply chain of F&V, which is resulting in various inefficiencies, leading to losses. Supply chain of perishable food requires proper controlled temperature to maintain and sustain the quality as well as increase the shelf life of the produce and make them easily available to the customer in a quality manner; but the weak and ill-equipped cold chain infrastructure (Rathore *et al*., 2010), and improper marketing systems and facilities (Gauraha and Thakur, 2008; and Singh *et al*., 2008) of the country have become the major impediments to the growth of the sector.

Table 1: Gap in the Cold Storage Capacity of Various States in India

(lakh MT)

State	Cold Storage Requirement	Present Capacity	Gap
Andhra Pradesh	23.24	9.01	14.23
Assam	9.19	0.88	8.31
Bihar	42.41	11.47	30.94
Chhattisgarh	5.43	3.42	2.01
Gujarat	27.48	12.67	14.81
Haryana	8.04	3.93	4.11
Himachal Pradesh	4.87	0.20	4.67
Jammu & Kashmir	7.37	0.43	6.94
Jharkhand	7.96	1.70	6.26
Karnataka	24.04	4.07	19.97
Kerala	27.71	0.58	27.13
Maharashtra	62.73	5.47	57.26
Manipur	0.80	0.00	0.80
Meghalaya	2.39	0.03	2.36
Mizoram	0.74	0.00	0.74
Madhya Pradesh	12.13	8.08	4.05
Nagaland	0.70	0.06	0.64
Orissa	18.35	2.91	15.44
Punjab	13.18	13.45	0.00
Rajasthan	3.91	3.24	0.67
Tamil Nadu	79.06	2.39	76.67
Tripura	1.63	0.30	1.33
UP and Uttaranchal	122.28	101.87	20.41
West Bengal	105.66	56.82	48.84
Total	**611.30**	**242.98**	**368.32**

Source: NCCD (2012)

The major bottlenecks which are found from the literature in the cold supply chain are lack of cold storage and warehousing facilities (Bhardwaj and Palaparthy, 2008; Dharni and Sharma, 2008; and Veena and Venkatesha, 2011), inadequate capacities to serve the needs (Narula, 2011), inadequate usage/improper management of cold storage (Bhardwaj and Palaparthy, 2008; and Halder and Pati, 2011), irregular supply of power or shortage of power to run cold chain (Kapoor, 2009; and Shukla, 2010), poor post-harvest cold chain technology (Kapoor, 2009), etc. Maheshwar and Chanakwa (2006) also found various gaps in cold chain like poor infrastructure, unavailability of cold storage in close proximity to farms, insufficient cold storage capacity, poor transportation infrastructure, etc. Because of these bottlenecks in cold supply chain, this sector is suffering from maximum inefficiency and decline in the returns of F&V which affect the income of the farmers and their livelihood. Cold chain plays a very vital role and is the backbone of the supply chain of F&V industry, but due to the bottlenecks, it has become a very weak link and one of the main reasons for supply chain losses in food.

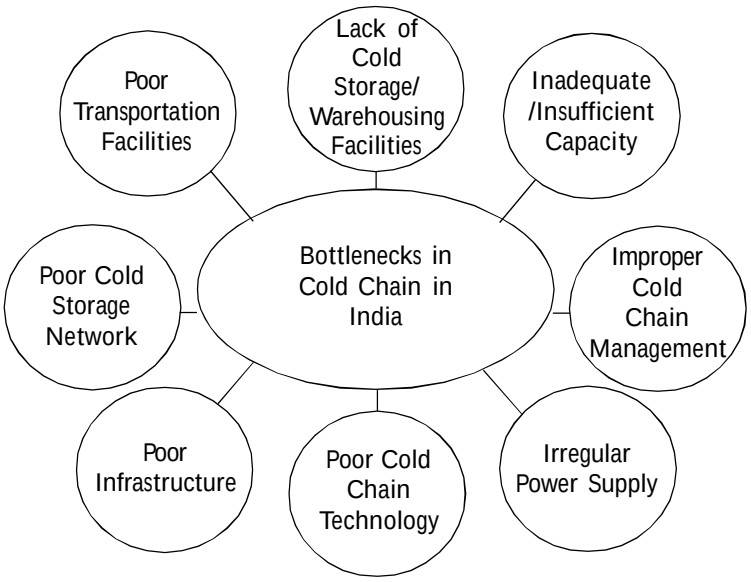
Around 95% of the cold storages are in private hands and because of high charges, an average Indian farmer is not able to avail the facilities of cold storage (Dharni and Sharma, 2008). There is a lack of ownership within the chain and all the players are concerned with their own revenue maximization with limited attention towards the overall profit of the chain. This lack of holistic view of supply chain is leading to post-harvest waste (Shukla and Jharkharia, 2013). The magnitude of losses is also due to absence of infrastructure such as road connectivity and network (Kader and Rolle, 2004). In India, most of the northern and eastern regions are hilly terrain areas and are the major sources of F&V. The road connectivity for cold chain and network infrastructure in such areas is very poor, and hence it takes a long time to take the fresh fruits and vegetables to the market, resulting in the deterioration of the quality and condition of the produce and wastage. Modi *et al*. (2009) highlighted that the villages, farms and the markets in the Uttarakhand state (hilly region) are not well connected and there is a lack of cold chain facilities and the farmers have to somehow take their harvests to the nearby road for transportation, which leads to the wastage of their produce. On its way to market, lack of proper cold chain facilities results in greater wastage of the fresh produce. Prompt measures are required by the government and other stakeholders in India to improve the state of cold chains and to reduce the huge losses of fruits and vegetables and large amount of money. The major identified bottlenecks are depicted in Figure 6.

Post-Harvest Losses and Need for Cold Chain Infrastructure

Many varieties of F&V are produced for economic purpose such as mango, apple, litchi, citrus, pineapple, banana, tomato, onion, okra, capsicum, etc. Inspite of this, the consumers are not getting better quality food products.

Post-harvest losses have been highlighted as one of the determinants of the food problem in most developing countries (Ojo, 1991; and Babalola *et al*., 2008). However, food wastage is not good for two main reasons: firstly, there may be a material loss in terms of

Figure 6: Bottlenecks in Cold Suppy Chain



energy protein and other nutrients; and secondly, there may be an economic loss in terms of the value of food. The major concern for F&V SCM is the post-harvest wastage. It has been reported that a huge amount of F&V is wasted in various operational stages of the FSCM (Murthy *et al.*, 2009).

There have been staggering losses in the F&V sector due to ill-equipped and weak cold chain infrastructure of the country. Various studies have highlighted the quality and quantity losses in F&V supply chain and cited this as a major problem for the Indian economy. The study by CIPHET has estimated that the pre-harvest and post-harvest losses of major agricultural produces at national level was to the order of ₹44,143 cr per annum at 2009 wholesale prices and found that most of the wastage is happening in fruits and vegetables (of about 5.8-18%) to the value of ₹7,437 cr in fruits and ₹5,872 cr in vegetables (GOI, 2012). It is estimated that food production in India is going to double in the next 10 years; but post-harvest losses of about 35-40% of the total produce (Narula, 2011; and MOSPI, 2012), which amounts to ₹58,000 cr annually is a cause for concern. From various studies on post-harvest losses in India, it is evident that the amount of food wasted in a year in India is equivalent to annual food consumption in the UK (Rathore *et al.*, 2010) and the total production of the Great Britain (Khan, 2005). Singh *et al*. (2009) found losses during transportation and storage as one of the existing problems in Indian fresh produce supply chain. Even at current level of production, farm produce valued at ₹70,000 mn ($1,400 mn) is being wasted every year only because there are no adequate storage, transportation, cold chain facilities and other infrastructure supports (Viswanadham, 2007). In developing countries, the poor cold chain infrastructure and lack

of marketing facilities resulted in losses of fresh vegetables ranging from 20% to 50% (Verma and Singh, 2004). Adequate cold storage facilities are available for just about 10% of India's horticulture production. Because of the lack of cold chain infrastructure, poor post-harvesting technology, and inadequate storage and transportation about 20-30% of all food produced in India (₹500 bn) gets wasted annually (Jain, 2007; Viswanadham, 2007; and Mishra and Anjani, 2010). Cumulative waste is worth an estimated $6.7 bn, the equivalent of 40% of the total production of F&V (Jain, 2007). Kader (2005) estimated that worldwide about one-third of all F&V produced is never consumed by humans. Murthy *et al*. (2009) highlighted that about 1.2% of agriculture GDP—33.85 lakh tons of mango, 35.26 lakh tons of banana and 2.12 lakh tons of grape—are discarded every year in India as post-harvest losses worth value of ₹7,618.77 cr.

The major concern for F&V SCM is the post-harvest wastage. It has been reported that a huge amount of fresh produce is wasted in various operational stages of the F&V supply chain (Murthy *et al.*, 2009). According to the calculation of India (ASSOCHAM, 2013), the producers have to forgo every year ₹2.13 lakh cr due to losses in the supply chain of fruits and vegetables. The losses among major producing states in India are shown in Table 2.

Table 2: Fruits and Vegetables Losses Among the Major Producing State

Rank	State	Total Loss (₹ cr)
1	Maharashtra	10,100
2	Andhra Pradesh	5,633
3	Tamil Nadu	8,170
4	Gujarat	11,398
5	Karnataka	7,415
6	Uttar Pradesh	10,312
7	Bihar	10,744
8	Madhya Pradesh	5,332
9	West Bengal	13,657
	All India	**212,552**

Source: ASSOCHAM Report, May 2013

Given the characteristics of fruits and vegetables, such as perishability, seasonality, bulkiness and delicate nature of the products, coupled with inadequate storage and transport facilities, the extent of wastage can be reduced only by ensuring a proper and efficient supply chain. Because of the high level of losses and wastage in the supply chain of perishable fresh produce, there is an urgent need to develop intelligent cold supply chains to curb losses and increase the shelf life of perishable food and ensure safety and desired quality.

Conclusion

This paper presents the status of F&V cold supply chain and highlights the need for cold chain infrastructure to remove the bottlenecks. The research conducted on the supply chain of F&V in India suggests that there is a dearth of cold chain infrastructure and it has become a weak link in the supply chain of fruits and vegetables. Cold chain, which is the backbone of the F&V supply chain, is suffering from various bottlenecks, which results in the losses of produce and money. These losses can be avoided by providing proper cold chain facilities, such as cold storage, processing facilities and refrigerated transportation system, to the farmers in the local or regional markets and by attracting a large number of private agri-business players to set up infrastructural facilities. So, the government and private organizations have to put in the necessary efforts to improve the cold chain infrastructure in India to reduce the levels of wastage and poverty of farmers.

As the Indian economy is based on agriculture and as it has a huge potential to serve domestic and global markets through various value addition, the development of cold chain infrastructure will play a crucial role in reducing the losses and wastages, increasing farmer income, increasing the revenue from export, generating employment opportunities for the local people, and improving the livelihood of the farmers, leading to the development of the economy, helping India to emerge as a global leader in food sector.

Future Scope: To the best of our knowledge, the concept of efficient cold supply chain in F&V sector in India is still at a nascent stage and several possible future research directions can be defined. Addressing the problem of supply chain losses and wastage, and temperature-controlled transportation and storage can be the area of focus. The bottlenecks and challenges highlighted in this paper can be further empirically tested. Researches can also be done on cold chain infrastructure like Return on Investment (ROI) models for establishing cold chain infrastructure. It can be carried out separately for hilly and plain areas. Also, developing a cold chain framework to improve the supply chain efficiency of F&V sector can be a very interesting area of study.⌘

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Comparative Design and Analysis of Mesh, Torus and Ring NoC

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Abstract

The research article presents the simulation and FPGA synthesis of mesh, torus and ring Network on Chip (NoC). The network is based on the Multiprocessor System on Chip (MPSoC) structure for a network cluster of 256 nodes. The paper focuses on the comparative analysis based on hardware design parameters, memory utilization and timing parameters such as minimum and maximum period, frequency support. The interprocess communication among nodes in verified using Virtex-5 FPGA with an arbitration logic. The designs are developed in Xilinx ISE 14.2 and simulated in Modelsim 10.1b with the help of VHDL programming language. Network topological structures help for on chip intercommunication, routing, switching, flow control, queuing, scheduling and to communicate among different networks.

Keywords: Network on Chip (NoC), Multiprocessor System on Chip (MPSoC), Field Programmable Gate Array (FPGA)

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1. Introduction

Today, the designers are facing the problem of on chip interconnects apart from increasing the no. of nodes. The systems using traditional bus system are facing the problem of scalability are not capable to fulfill the requirement

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for future SoC in terms of power, timing parameters, hardware utilization, performance and predictability. To overcome the design productivity gap, cost, and signal integrity for future SoC, a scalable NoC structure is helpful to realize the on chip communication problems. Chip processors (CMP)[2] and MPSoC[1,5] uses bus structure for on chip communication and integrates nodes on a single die to meet the requirement of transistor density, more throughput, less delay, less time to market, and operating frequency.

The internode communication in multiprocessor system is based on the concept of memory sharing or message passing. The message passing among nodes is dependent on APIs such as *transmit ( ), receive ( ).* The APIs need some protocol to connect each other. In many multiprocessor NoC system shared memory architecture concept is used and data transfer is possible trough memory access points. MPSoC architecture is based on processor memory hierarchy and topological structure helpful for interprocess communication in network. The shared memory based architecture provide high throughput because of shared or cache memory between processors and pipelined processing for data transactions. Lucent developed a single chip multiprocessor called Daytona[1].It was having 64 bits processing elements targeted for DSP applications with scalable structures and performs transactions with different sizes. On chip was there to perform the on chip communication that split transactions and different targets. MIPS based processor was developed by Stanford Hydra[5] chip. It used shared level-2 cache memory to perform interprocess communication. DEC developed the project Piranha[6] to perform on chip communication based on packet routing. In the work eight alpha processors were integrated on a single chip multiprocessor.

A shared memory multiprocessor[7] consists of several nodes/processors or processing elements form an on chip interconnected network. All PEs[4] have their own CPU or hierarchy of their memory, may be one or two level of cache memory. The multiprocessor system [3,4] has a big memory unit physically but it has shared memory accessed by different processors globally. The data packet arrives at a particular node is based on the request by the node. The memory will return a reply packet to requested node containing the data of the requested node. Read the data of the requested node and write data to destination node is accessed through cache reference. In MPSoC system, the major problem is cache coherence[7,8] because the data is saved by the different caches should be updated otherwise one data can have multiple copies. The problem of cache can be resolved with the help of cache updating that updates all node memories whenever there is new data in memory.

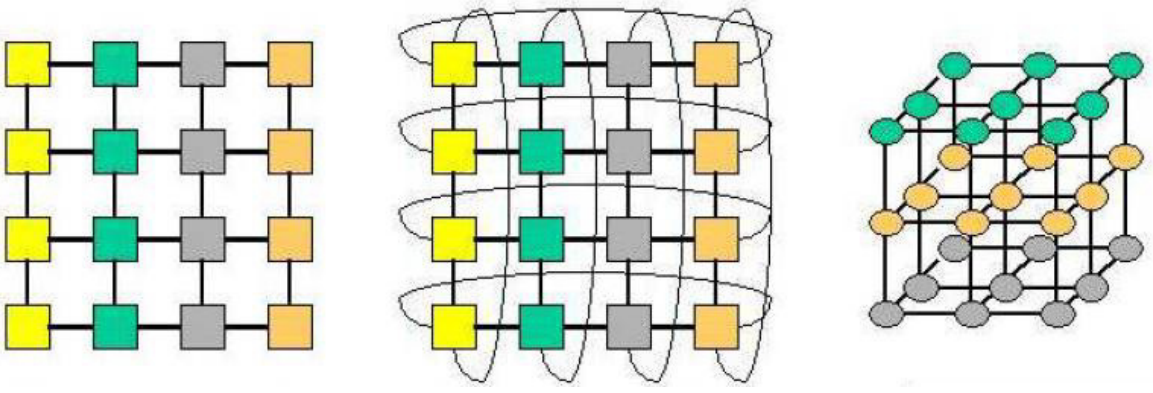

Fig. 1(a) 4 ary 2 dim mesh [7] (b) 4 ary 2 dim torus (c) 4 ary 3 dim mesh

Multiprocessor system consist of different network topologies may be targeted to specific application to enhance the NoC performance and throughput. The MPSoC network structure can form direct network and indirect network structure. In direct form all the nodes are connected directly with each other with the help of network only. The arbitration and data flow is possible with the help of each node. In indirect network structure data flow is possible by an intermediate switch. The switching and routing is performed with the help of switch between the processors. Multistage network configurations are formed using indirect networks. Orthogonal topological [7,10] structures are the examples of direct topologies. The nodes in the orthogonal topologies can form mesh structure (with k ary and n dimensional or k ary n cube) or torus (with k ary and n dimensional). The pipelined operations and

parallel processing can be performed with the help of mesh or torus [9,10] structures because the structures provide easy connection and simple routing and interconnection length between nodes can be same.

2. NoC Design Consideration

The design considerations for the mesh and torus structure for (256 x 256) is shown in fig. 2(a) and (b) in which 256 nodes can process intercommunication. Each node is identified with its address assigned N_0 (00000000), N_1(00000001), N_2(00000010), N_3(00000011), N_4(00000100),N_5(00000101).....N_{255}(11111111). There is also row and column address assigned for node identification based on row and column processing having 8 bits addresses because (2^8= 256). The functionality of mesh and torus NoC structure is understood with the help of table. For an example node, the identification of node 18 is based on row address (00000001) and column address (00000010) but it has the probability to communicate with any node in NoC.

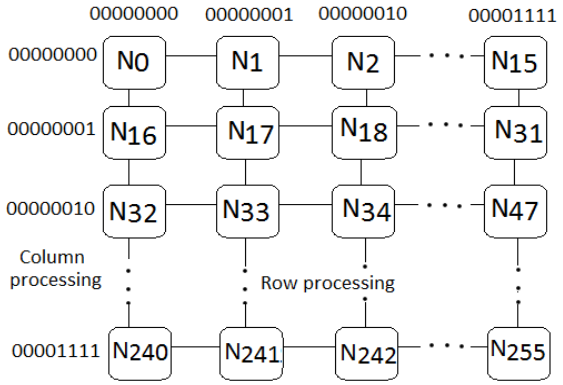

Fig. 2(a) Mesh NoC (256 x 256)

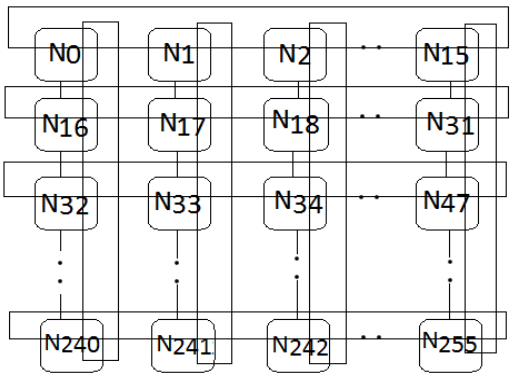

Fig.2 (b) Torus NoC (256 x 256)

Table 1 Node selection in mesh and torus ring topological NoC

Row_address(8 bit)	Column_address (8bit)	Node Selection
00000000	00000000 : 00001111	Node 0 : Node 15
00000001	00000000 : 00001111	Node 16 : Node 31
00000010	00000000 : 00001111	Node 32 : Node 47
00000011	0000000 : 00001111	Node 48 : Node 63
: :	: :	: :

00001111	00000000 : 11111111	Node 240 : Node 255

The topological structure of ring NoC for 256 nodes is shown in fig.2(c). The structure has 256 nodes, arranged in a ring configuration. The functionality of the ring NoC can be understood with the help of table 2. All 256 nodes are counted from N_0 to N_{255} sequentially counted with their node address of 8 bits starting from "00000000" to "11111111" Let node N_0 is assigned a source_address "00000000", Node N_1 has address "00000001". In the same way, all the nodes can be assigned their 8 bits of address and node N_{256} is assigned source_address "11111111". Moreover, nodes have the priority mechanism to communicate in multiprocessor system. The data packet arrival to source and delivery to destination node is considered with the help of arbiter which assigns the priority for interconnection of destination node in mesh, torus and ring NoC.

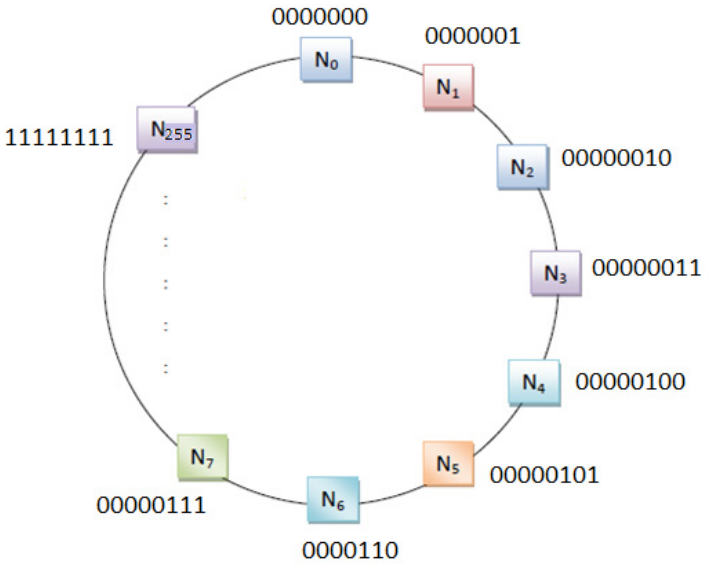

Fig. 3 Ring NoC (256)

Table 2 Node selection in ring topological NoC

Source_node_address (8 bit)	Destination_node_address (08bit)	Node Selection
00000000	00000000 : 11111111	Node 0 : Node 255
00000001	00000000 : 11111111	Node 0 : Node 255
00000010	00000000 : 11111111	Node 0 : Node 255
00000011	0000000 : 11111111	Node 0 : Node 255
:	:	:

:	:	:
11111111	00000000	Node 0
	:	:
	11111111	Node 255

3. Results & Discussions

The RTL view is the description of input and outputs of the developed chip. The RTL view of the NoC is shown in fig. 4. The functionality of the individual pin is described in table 3. The functional modelsim simulation shown in fig. 5, shows the data transfer scheme from node N_3 to node N_4. The functional simulation depends on the following steps input.

Step input 1: Reset = '1' and run, all node data will contains zero output.

Step input 2: Reset = '0', Apply rising edge clock pulse, source_address and destination_address value and data of destination node with input_data_packet, then run.

Step input 3: Apply the source address and destination address of another nodes and data on input_source.and run

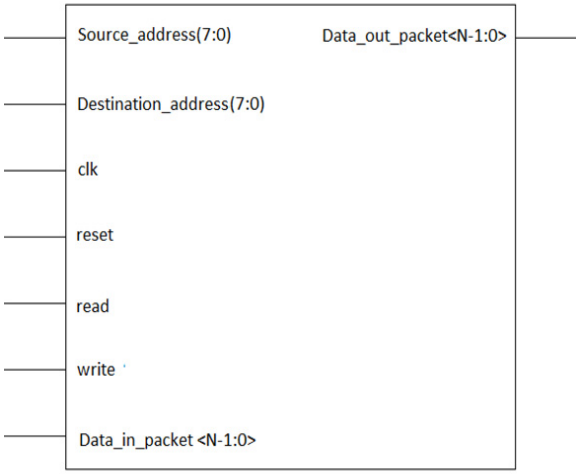

Fig. 4 RTL view of NoC (Common to mesh, torus and ring NoC)

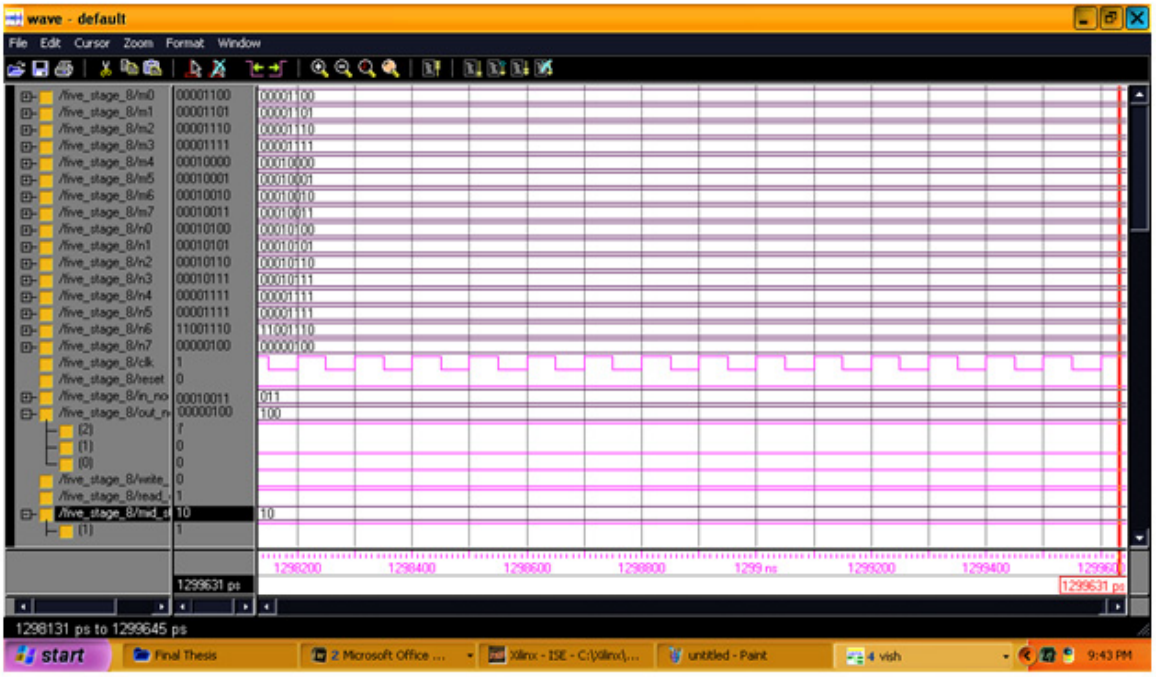

Fig.5 Modelsim simulation for NoC from N_3 to N_4 (Common to mesh, torus and ring)

Table 3 Pin details of NoC

Pins	Description
reset	Default input signal used to reset the memory contents zero for synchronization of the components by using clk of std_logic (1 bit)
clk	Synchronized input for sequential logic to work on rising edge of clock pulse of std_logic.(1 bit)
source_address [7:0]	Address of input source nodes of std_logic_vector (8 bit)
destination_address [7:0]	Address of output destination nodes of std_logic_vector (8 bit)
input_data_packet [N-1:0]	Input data of 'N' bits of the source node of std_logic_vector (N-1:0)
output_data_packet [N-1:0]	Output data of 'N' bits of the source node of std_logic_vector (N-1:0)
write	Memory control signal to perform write operation with respect to individual node of std_logic(1 bit)
read	Memory control signal to perform read operation with respect to individual node of std_logic(1 bit)

4. FPGA Synthesis Results

Device utilization report gives the percentage utilization of device hardware for the chip implementation. Device hardware includes no. of slices, no. of flip flops, no. of input LUTs, no. of bounded IoBs, and no of gated clocks (GCLKs) used in the implementation of design. Timing details provides the information of delay, minimum period, maximum frequency, minimum input arrival time before clock and maximum output required time after clock. Table 4 and table 5 show the synthesis results as device utilization and timing parameters for mesh, torus and ring NoC. Total memory utilization required to complete the design is also listed for individual stage. The target device is: xc5vlx20t-2-ff323 synthesized with Virtex-5 FPGA.

Table 4 Device utilization in NoC structures

Device Part	Utilization		
	Mesh (256 x 256)	Torus (256 x 256)	Ring (256)

Number of Slices	344 out of 12480,	3%	324 out of 12480,	3%	131 out of 12480,	1%
Number of Slice Flip Flops	362 out of 12480,	3%	358 out of 12480,	3%	142 out of 12480,	1%
Number of 4 input LUTs	120 out of 362,	33%	115 out of 358,	32%	87 out of 362,	24%
Number of bonded IOBs	86 out of 172,	50%	81 out of 172,	47%	53 out of 172,	34%
Number of GCLKs	1 out of 32,	3%	1 out of 32,	3%	1 out of 32,	3%

Table 5 Timing parameters for NoC structures

Timing Parameter	Utilization		
	Mesh (256 x 256)	Torus (256 x 256)	Ring (256)
Minimum period	1.457ns	1.497 ns	0.987ns
Maximum frequency	600.00 MHz	589.00 MHz	780.00 MHz
Minimum input arrival time before clock	3.190 ns	3.460 ns	1.189 ns
Maximum output required time after clock	2.230 ns	2.490 ns	2.150 ns
Total memory usage	221985 kB	207895 kB	126740 kB

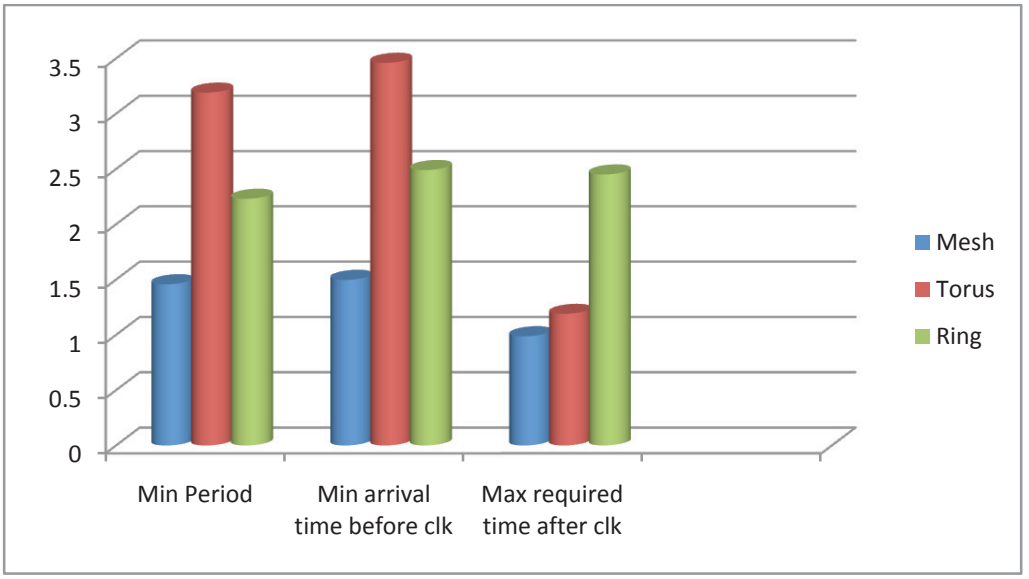

Fig. 6 Comparative graph for mesh, torus and ring NoC structure

Fig. 6 describes the timing variations in the design of mesh, torus and ring NoC. From the device utilization and timing parameters, it clarified that ring NoC has optimized parameters. In torus structure min period 2.74 %, minimum input arrival time before clock 8.45 % and maximum output required time after clock 11.65 %, is greater than in comparison to mesh structure. In ring NoC structure min period 32.25 %, minimum input arrival time before clock 62.72 % and maximum output required time after clock 3.58 %, is less than in comparison to mesh structure. The hardware and memory utilization in torus and ring NoC is less than mesh NoC. The frequency support for the same targeted device is 600.00 MHz, 589.00 MHz and 780 MHz dor mesh, torus and ring NoC respectively, which

signifies that ring NoC is faster in comparison to mesh and torus and has significant less hardware optimization to support a particular network configuration.

5. Conclusions

The NoC design for mesh (256 x 256) torus (256 x 256) and ring (256) is implemented on Virtex 5 FPGA successfully. The architecture is based on shared memory architecture and optimal routing scheme is suggested. The design is tested for the different test cases. In each NoC configuration, the data transfer with arbitration scheme is verified on modelsim 10.1 b and FPGA successfully. The synthesis report is generated and contains the information for hardware utilization in terms of No of slices, No of flip flops, No of input LUTs, No. of bounded IOBs and No of gated clocks (GCLKs) used in the implementation of design. Timing analysis is also carried out for the staged network which provides the information of delay, minimum period, maximum frequency, minimum input arrival time before clock and maximum output required time after clock. A comparative study is carried out for the mesh, torus and ring NoC structure hardware and timing parameters and estimated that ring NoC has optimized results.

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Does the knowledge and skill acquired during simulator training gets applied on the job by the seafarers- An empirical study

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Abstract: *Training is an integral part of organisational development process. A training imparted is expected to have the desired results. The results depend upon various factors. After a successful training, it is also important to evaluate if the acquired knowledge and skills were applied on the job by the trainees. The study is aimed at identifying the favourable and unfavourable perceptions of the trainees for all the factors of the knowledge acquired during the training imparted, being used on the job. The results show that the knowledge and skill acquired during the simulator training is being used on the job by the seafarers.*

Keywords: *Training transfer, transfer of knowledge, training evaluation maritime training, simulator training,*

I. Introduction

A simulator, in the simplest way, may be defined as a machine with a similar set of controls designed to provide a realistic imitation of the operation of a ship, vehicle, aircraft, or other equipment. Simulation is the imitation of the operation of a real-world process or system over time. The act of simulating something first requires that a model be developed; this model represents the key characteristics or behaviours of the selected physical or abstract system or process. The model represents the system itself, whereas the simulation represents the operation of the system over time.

There are three attributes that every simulation has. If all three attributes exist, then you can legitimately call something a simulation. However, if even one attribute is missing, then it's not a simulation.

Here are the three attributes required for every simulation;

A simulation:

a) Imitates something real, but

b) It is not real, and

c) It may be altered by its users (hence instructor plays an important role)

Training Evaluation:

Training evaluation is considered a critical component of analysing, designing, developing, and implementing an effective training programme. To understand whether the training programme had the desired results or not, the training programme needs to be evaluated.

Even if the participants leave the training room looking happy and they also give high scores on an evaluation or feedback sheets, it may not necessarily mean that the course participants learned or if they can apply what they learned to their job. Of course, it may be taken that course participants enjoyed themselves for the time spent in the training session with some of old friends or shipmates. Only a systematic, targeted approach to training evaluation will help you answer the question, did participants learn?

There are many models and different ways to evaluate training. The Four-Level Model approach is most often used to evaluate training and development programs (Kirkpatrick, 1994). It focuses on four levels of training outcomes: reactions, learning, behaviour, and results. The major question guiding this kind of evaluation is, "What impact did the training have on participants in terms of their reactions, learning, behaviour, and organizational results?"

II. Sample size

Sample Size:

There were 2850 students/officers trained at the four training centres chosen for research. Out of these 2850 students 1922 were trained using simulators.

Hence N= 1922. A 95% confidence level is deemed acceptable and thus statistically z = 2. The proportion of responses that would be relevant to the survey is p. If p is 0,5 , a new formula is derived as illustrated in the equation below;
Mathematically derived Yamane formula;

$$n = \frac{N}{1 + Ne^2}$$

Where:

n = required responses
e^2 = error limit
N = sample size

Source: Yamane (1967:258)

If another value were to be used for p, the denominator in the formula in equation above would increase and a smaller response size would then be required. p = 0,5 therefore offers the biggest possible response rate and confidence and risk levels can be maintained.
Placing information in mathematical formulae above at a 95% confidence level and an error limit of 5% results in:

$$n = \frac{1922}{1 + 1922\ (0{,}05)2}$$

= 331 responses

III. The Research Methodology

Kirkpatrick's model level three i.e. Behavior (The Transfer of Training)has been used for this study to evaluate if the knowldge and skills acquired during the training are being utilised on the job.

Kirkpatick gave the following guidelines for evaluating Behavior (The Transfer of Training):
1. A systematic appraisal should be made of on-the-job performance.
2. The trainees who attended the simulator based trainingg were sent a questionnaire to get the feedback on whether they were able to apply the knowlege and skill acquired on the job.
3. A statistical analysis was carried out using SPSS version 20 and a one sample t-test was carried out.

Survey method has been used for measuring the The transfer of training imparted by using maritime simulators. The course participants were observed before, during and after training. The questionnaire for the purpose was prepared based upon and adapted from Kirkpatrick's model. The questionnaire was served to the specialists in the field for their views. The questionnaire was tested for internal consistency using Cronbach's Alpha Test. The final questionnaires were used to collect the data for the study. The data collection was done from three training centres.
One sample t-test: A one sample t-test is a type of Univariate analysis. It is used whenever the variable is on Interval scale or Ratio scale. For this study, all the factors of knowledge acquired after training being used on the job, are on interval scale. A hypothesis test uses sample data to test a hypothesis about the population from which the sample was taken. One sample t-test using SPSS is one of many procedures available for hypothesis testing. Testing a hypothesis means making inferences about one or more populations when sample data are available. The following tools are utilised for this research:

- Charts and tables for diagrammatic representation
- Microsoft: Excel, power point and word
- Cronbach's Alpha test
- One sample t-test

Hypothesis:
H $_a$: There is a significant difference in the perceptions of the trainees for all the factors of the knowledge acquired being used on the job. (Ha: $\mu \neq 3$).
H $_0$: There is no significant difference in the perceptions of the trainees for all the factors of the knowledge acquired being used on the job. (H_0: $\mu = 3$).

Analysis;
The paired t-test was used to analyse the scores of the repsondents before and fater training. For teesting the hypotheses, one sample t-test was utilised. The results of paired t-test are given as below;

A one-sample t-test was run to determine whether the scores as calculated using Kirkpatrick's model and SPSS, were different from the hypothesized score of 3. The scores were assumed to be normally distributed.

Out of the total twelve questions from the questionnaire, it was decided to choose the most relevant to indicate the knowledge and skills acquired during training is being used by the seafarers on the job. A total of eight questions were picked up and analysed by formulating sub-hypothesis.

H1 $_0$: I did not have the opportunity to use the knowledge and/or skills presented in this course.
H1 $_a$: I have had the opportunity to use the knowledge and/or skills presented in this course
H2 $_0$: I did not use the knowledge and/or skills presented in this course, to good extent.
H2 $_a$: I used the knowledge and/or skills presented in this course, to good extent.
H3 $_0$: There is no increase in my confidence using knowledge and skills as a result of this course.
H3 $_a$: There is an increase in my confidence using knowledge and skills as a result of this course.
H4 $_0$: I did not have a good access to the necessary resources to apply the knowledge and/or skills on your job.
H4 $_a$: I had good access to the necessary resources to apply the knowledge and/or skills on your job.
H5 $_0$: As a result of this course, my performance on the course objectives has not changed for good.
H5 $_a$: As a result of this course, my performance on the course objectives has changed for good.
H6 $_0$: I did not receive help, through coaching and/or feedback, with applying the knowledge and/or skills on the job.
H6 $_a$: I received help, through coaching and/or feedback, with applying the knowledge and/or skills on the job.
H7 $_0$: As a result of this course, my overall job performance has not improved.
H7 $_a$: As a result of this course, my overall job performance has improved.
H8 $_0$: The simulator training did not help me do my job better.
H8 $_a$: The simulator training helped me do my job better.

The results are analysed using the table below;

Factors	**Sub Hypothesis**	***p*-Value**	**Inference(α=0.025)**
Change in behaviour	$H1_{0 : oppor\ to\ use\ k\ s}=3$ $H1_{a: oppor\ to\ use\ k\ s} \neq 3$	.001	$H1_0$ – Rejected $H1_a$ – Accepted ($p < \alpha$)
	$H2_{0 :\ act\ use\ k\ s}=3$ $H2_{a: act\ use\ k\ s} \neq 3$	.001	$H2_0$ – Rejected $H2_a$ – Accepted ($p < \alpha$)
	$H3_{0 :\ confi\ in\ k\ s}=3$ $H3_{a: confi\ in\ k\ s} \neq 3$	.001	$H3_0$ – Rejected $H3_a$ – Accepted ($p < \alpha$)
	$H4_{0 :\ resource\ in\ k\ s}=3$ $H4_{a: resource\ in\ k\ s} \neq 3$	.001	$H4_0$ – Rejected $H4_a$ – Accepted ($p < \alpha$)
	$H5_{0 :\ perfo\ change}=3$ $H5_{a:perfo\ change} \neq 3$	.001	$H5_0$ – Rejected $H5_a$ – Accepted ($p < \alpha$)
	$H6_{0 :\ coach\ f\ b}=3$ $H6_{a: coach\ f\ b} \neq 3$	.001	$H6_0$ – Rejected $H6_a$ – Accepted ($p < \alpha$)
	$H7_{0 :\ overall\ perfo}=3$ $H7_{a: overall\ perfo} \neq 3$	.001	$H7_0$ – Rejected $H7_a$ – Accepted ($p < \alpha$)
	$H8_{0 : sim\text{-}\ job\ better}=3$ $H8_{a: sim\text{-}\ job\ better} \neq 3$	.001	$H8_0$ – Rejected $H8_a$ – Accepted ($p < \alpha$)

There was a statistically significant difference between means ($p < .05$) and, therefore, we can reject the null hypothesis and accept the alternative hypothesis. These results suggest that the knowledge acquired during training is being used by the seafarers on the job.

Perception Table

Factors	Mean	Inference/Decision
Change in behaviour		
To what extent did you use the knowledge and/or skills prior to attending this course?	3.34	Favourable perception by the respondents.
To what extent have you had the opportunity to use the knowledge and/or skills presented in this course?	4.04	Favourable perception by the respondents.
To what extent have you actually used the knowledge and/or skills presented in this course, after completing the course?	4.17	Favourable perception by the respondents.
To what extent has your confidence in using the knowledge and/or skills increased as a result of this course?	4.33	Favourable perception by the respondents.
To what extent have you had access to the necessary resources to apply the knowledge and/or skills on your job?	3.99	Favourable perception by the respondents.
As a result of this course, my performance on the course objectives has changed by.	4.01	Favourable perception by the respondents.
To what extent have you received help, through coaching and/or feedback, with applying the knowledge and/or skills on the job?	3.99	Favourable perception by the respondents.
As a result of this course, my overall job performance has changed by %	4.16	Favourable perception by the respondents.
I feel that the simulator training helped me do my job better.	4.54	Favourable perception by the respondents.

There was a statistically significant difference between means ($p < .05$) and, therefore, we can reject the null hypothesis and accept the alternative hypothesis.

IV. Conclusions

Most respondents agreed that the simulator training improved their overall performance, had access to the necessary resources to apply the knowledge and/or skills on job; there is an increase in confidence using knowledge and skills. They also agreed that the simulator training helped them to do their job better. The null hypotheses (Main hypotheses and sub hypotheses) were rejected and alternate hypotheses were accepted. These results suggest that the knowledge acquired during training is being used by the seafarers on the job.

V. Future Works

In near future the training effectiveness of other maritime training courses being offered by other training centres may be carried out similarly, using the research methodology as discussed above.

VI. Acknowledgements

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Human Resource & AdministrationFactors impacting Contingency: A Study onConstruction of Substations in UAE

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Abstract

Purpose
To identify the significant risk factors related to the Human Resource & Administration,which are impacting the project performance due to contingency estimation for the construction of substations in United Arab Emirates.

Design / Methodology / Approach
A structured questionnaire for Human Resource & Administration sectionwith 14questionswas prepared for response in 5 point scale of Importance. The questionnaire was distributed by means of electronic mail and paper prints. The responses were received by e-mail, by hand& by telephonic conversations. These responses were further analyzed using Factor Analysis in SPSS.

Findings
A condensed list of 5 significant risk factors was identified out of the original 14 risk factors in the Human Resource & Administration section, based on their importance, as received from various respondents,after carrying out factor analysis of the responses.

Research Limitation / Implication
The present study provides a list of significant risk factors faced in the construction of substations in United Arab Emirates, which is being taken up for further research to check the impact of the contingency perception of these risk factors on the project performance in terms of Time and Cost. The findings and result are related to the **Human Resource & Administration**section of the Questionnaire.

Originality / value
This research provides an output that is very useful for organizations involved in construction of substations projects in United Arab Emirates for taking up these risk factors for a detailed analysis and adopting a suitable mitigation plan for improving the project performance.

Keywords: *Project Management, Risk factors, Contingency, Substations, UAE*

Introduction

In recent years, the world has suffered a multitude of crises. Financial and economic turmoil have disrupted the world economy through loss of jobs,incomeand social stability. Natural disasters many being severe, have devastated entire communities from Haiti to Japan, leaving a trail of fatalities and economic losses in their wake (The World Development Report, 2014).

In many ways, this year turned out to be better than had been feared,with none of the worst case scenarios facing the global economy materializing namely a Eurozone breakup, hardeconomic landing in China, the U.S. toppling over the fiscalcliff, or a large-scale escalation of Middle East tensions, however many of the economic and political issues remains unresolved. In these times of contraction in the spending for Infrastructure projects in most parts of the world, the Infrastructure / Construction sector in the Middle East envisaged a minimal impact.

Time delay & Cost overrun is a very frequent phenomenon and is almost associated with nearly all construction projects. There is always an increase in the number of construction projects experiencing delays resulting in exceeding the initial time and budgeted cost. This trend is more severe in developing countries where time and cost overruns sometimes exceed more than 100% of the estimated cost of the project (Ghaleb J. Sweis, 2013).

Worldwide, Time and Cost are generally the major considerations throughout project life cycle and are regarded as the most important project parameters which act as the major driving factors for the undertaken project's success.

The pwcSurvey (December 2012) on the Middle East's Mega Projects reports that 64% of the survey respondents had experienced budget overruns while 80% of the survey respondents had experienced delays. It is also noted from this survey report, that the Energy & Utility projects are facing cost and schedule over run along with increase project spending. The study also emphasizes on the importance of proper handling of the projects for better performance.

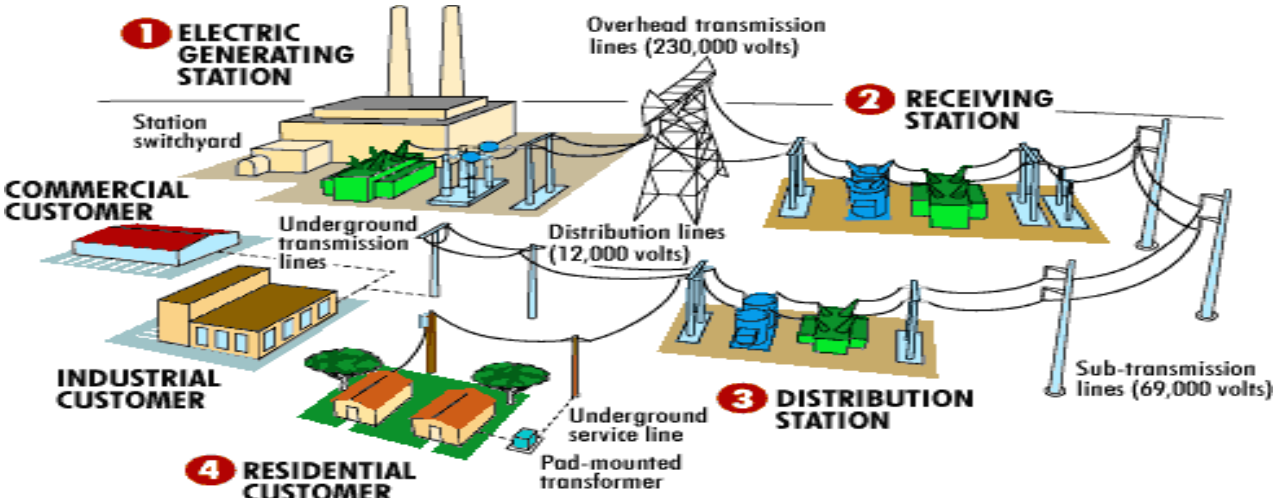
An AECOM Survey (2012) points out that in the Middle East region "clients are faced with the challenge of project teams not delivering projects within budget and schedule. Quality of work has also been cited by clients as a major concern, which has partly been explained by poor project management in some parts of the industry".

An EC Harris's report (November 2013) on Middle East Major Construction Programmesspecifty that "History has shown that major programmes are often subject to scope change, delay and, in the worst cases, contract dispute. Estimated costs and values at launch are likely to rise over time as risks materialize, delays occur, material and labour costs rise and plant may no longer be available. Many of the major programmes have been formally announced, but have not yet started on site and therefore spend patterns could well shift over time. The ability to 'shoulder' workload over the critical 2014 to 2019 period will enable some clients to reduce their exposure to extreme market conditions – albeit at the cost of delayed delivery".

Deloitte report(2013) about 'GCC Powers of Construction'indicates that one of the major Energy project **"Power Project in Abu Dhabi – UAE" has been plagued by project delays and cost inflation.** The cost estimate has risen by a staggering USD 10 Billion since its initial announcement, taking the total to USD 30bn. The report further emphasizes that the *Power Generation, Transmission & Distribution* which are handled by the Utilities is one of the major areas for consideration in UAE. It also indicatethat "*the* ***contingency*** *amount allocated in the budget for unforeseen conditions / events is often a fixed percentage of the total project cost and usually turns out to be insufficient for covering the risks associated with the project*".

A primary understanding of the Power Projects indicating the *Power Generation, Transmission & Distribution* system may be gained from the pictorial representation as shown in Figure # 1 below:

Figure # 1 – Typical Power Generation, Transmission & Distribution



(Operating Voltage levels are typical and vary from utility to utility)

As it can be seen from the above figure that a typical power distribution system consist of a Power Plant where the electricity is generated at Medium voltage levels (6.6kV, 11kV, 22kV or 33kV) and are stepped to a higher voltage levels (66kV, 132kV, 220kV, 400kV or more) by a Step up transformer. This is connected to a Substation for interconnecting with the Transmission Grid. The Transmission Grid will have many intermediate Substations to cater the load points. The load points will be receiving the electricity through a Distribution Substation at lower voltage levels (110V, 220V, 440V). Substation is required at all levels in power distribution, and hence occupies key position in the power network. Hence, a detailed research on the Construction of Substation project in UAE is essential.

The Objective of this research is to identify the activity wise significant risk factors impacting contingency applicable to construction of substations in United Arab Emirates. The present study in this paper identifies the significant risk factors related to Human Resources & Administrationactivities only.

Literature Review

Literature Review on Theoretical Significance

The initial review was done to understand the theoretical significance of Construction Projects, Project Risk, and Contingencies.

A **Project** has a defined beginning and end in time, and therefore defined scope and resources (PMBOK® Guide, 2013); (Businessdictionary.com). A project is unique in that it is not a routine operation, but a specific set of operations designed to accomplish a singular goal. Hence a project team often includes people who do not usually work together. Sometimes they are from different organizations and across multiple geographies. Hughes (2001), shows that every project passes through a number of phases and each phase has a unique purpose, duration and scope. Hence it is important to break down the entire project into various phases.Project must start from some kind of definition of need followed by design, contracting, construction and project completion. For a project to be successful, it needs to overcome some of the major constrains and challenges lying in the project management. Risk and uncertainty are inherent in all the phases through which the construction project passes.

Construction is a process that consists of the building or assembling of infrastructure. Far from being a single activity, large scale construction is a feat of human multitasking. Construction is an industry that involves complex and dynamic processes. It consists of successful coordination of multiple

discrete business entities such as professionals, tradesmen, manufacturers, trade unions, investors, local authorities, specialists, trade contractors and others (Keane, P. J. &Caletka, A. F, 2008).

Construction Projects are classified into four categories namely Residential Building construction, Industrial construction, Commercial Building construction and Heavy Civil construction. Each type of construction project requires a unique team to plan, design, construct and maintain the project which leads to numerous risk exposures. Latham (1994)states that,no construction project, is free of risk. Risk can be managed, minimized, shared, transferred or accepted but it cannot be ignored. Risks do not appear only in major projects. Although size may be a cause of risk; complexity, construction speed, site and many other factors may affect time, cost and quality to a greater or lesser degree.

Project Risk is an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives such as scope, schedule, cost and quality. Known risks (controllable known risks) are those that have been identified and analyzed, making it possible to plan responses for those risks. Known risks that cannot be managed proactively (uncontrollable known risks), are assigned to a contingency reserve. Unknown risks that cannot be managed proactively are assigned to a management reserve. (PMBOK® Guide, 2013).

Contingency is generally an added amount to the project estimates,considered for items, conditions, or events for which the state, occurrence, or effect is uncertain and that experience shows, will likely result, in aggregate, in additional costs,typically estimated using statistical analysis or judgment based on past asset or project experience(Wikipedia). The below Figure # 2shows the contingency allocation in the Project Budget (PMBOK® Guide, 2013)

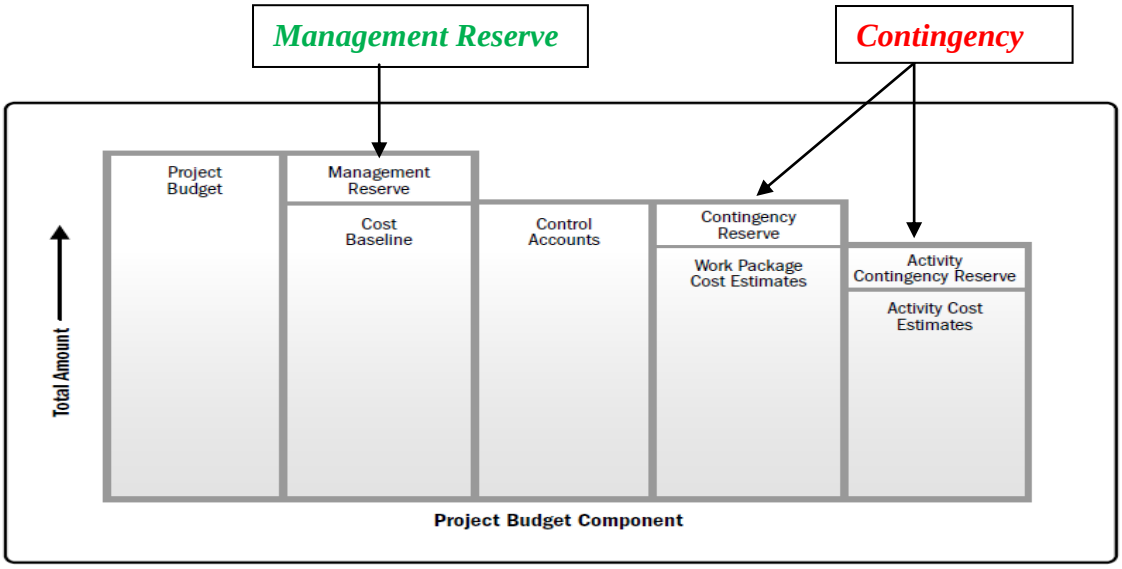


Figure # 2 – Contingency Estimation as per PMI's PMBOK – Fifth Edition (2013)

Literature Review on Construction Projects

Construction Projects are characterized as very complex, always unique projects, where risks raise from a number of different sources. Construction Project management involves numerous stakeholders: end users; promoters; construction companies; consultants; government bodies, subcontractors, suppliers, and other entities (Perez et al., 2010, RasoolMehdizadeh, 2012). These projects require continuous decision making due to numerous sources of risk, many of which are not under the direct control of project participants. Intensive research and development has been done in the area of project risk management, which is widely recognized as a critical area in the field of project management. (Anna Klemetti, 2006).

Literature Review on Project Risk Management Process

Various Project Risk Management process classification is available in literatures perceived based on the understanding, requirement and expertise of the authors. Risk identification is the common in all the processes. The potential risks associated with a project are identified during this step. Various checklists and risk breakdown structures were suggested to identify potential risks which have probability of having adverse effect on project objectives are suggested in many Literatures. Project Management Institute's PMBOK® Guide, (2013) details the general process including the Tools and Techniques for risk identification.

Risk Factors identified during the above process are listed out and are classified on broader basis for grouping and further analysis. These factors cause impact on the Cost or Time or Both. The Risk factors are grouped into 16 categories based on the Literatures reviewed and are listed below:

Political - Ruqaya Al-Sabah, Carol C. Menassa, Awad Hanna, (2012), Chidambaram Ramanathan, SP Narayanan and Arazi B Idrus (2012), Mohammad A. Mustafa, and Jamal F. Al-Bahar, (1991), Francis, Adam J. and Skitmore, Martin (2005); **Legal** - Ruqaya Al-Sabah, Carol C. Menassa, Awad Hanna, (2012), NidaAzhar, Rizwan U. Farooqui and Syed M. Ahmed, (2008), Francis, Adam J. and Skitmore, Martin (2005); **Social** - Ruqaya Al-Sabah, Carol C. Menassa, Awad Hanna, (2012) B.P. Sunjka and U. Jacob, (2013), Adnan Enshassi, Sherif Mohamed, Saleh Abushaban, (2009), Francis, Adam J. and Skitmore, Martin (2005); **Natural** - Ruqaya Al-Sabah, Carol C. Menassa, Awad Hanna, (2012), Chidambaram Ramanathan, SP Narayanan and Arazi B Idrus (2012), **Design** – Ruqaya Al-Sabah, Carol C. Menassa, Awad Hanna, (2012), Chidambaram Ramanathan, SP Narayanan and Arazi B Idrus (2012), Mohammad A. Mustafa, and Jamal F. Al-Bahar, (1991) , Sadi A. Assaf, Sadiq Al-Hejji (2006), Francis, Adam J. and Skitmore, Martin (2005); **Project / Construction** - Ruqaya Al-Sabah, Carol C. Menassa, Awad Hanna, (2012), Long Le-Hoai, Young Dai Lee, and Jun Yong Lee, (2008), Adnan Enshassi, Sherif Mohamed, Saleh Abushaban, (2009), Chidambaram Ramanathan, SP Narayanan and Arazi B Idrus (2012), Mohammad A. Mustafa, and Jamal F. Al-Bahar, (1991), Sadi A. Assaf, Sadiq Al-Hejji (2006), Francis, Adam J. and Skitmore, Martin (2005); **Finance / Economics** - Ruqaya Al-Sabah, Carol C. Menassa, Awad Hanna, (2012), Adnan Enshassi, Sherif Mohamed, Saleh Abushaban, (2009), Chidambaram Ramanathan, SP Narayanan and Arazi B Idrus (2012), Mohammad A. Mustafa, and Jamal F. Al-Bahar, (1991) , Motaleb, O and Kishk, M (2010), NidaAzhar, Rizwan U. Farooqui and Syed M. Ahmed, (2008), Francis, Adam J. and Skitmore, Martin (2005); **Management** - Ruqaya Al-Sabah, Carol C. Menassa, Awad Hanna, (2012), NidaAzhar, Rizwan U. Farooqui and Syed M. Ahmed, (2008), B.P. Sunjka and U. Jacob, (2013), Adnan Enshassi, Sherif Mohamed, Saleh Abushaban, (2009), **Quality** - Ruqaya Al-Sabah, Carol C. Menassa, Awad Hanna, (2012), Adnan Enshassi, Sherif Mohamed, Saleh Abushaban, (2009), Francis, Adam J. and Skitmore, Martin (2005); **Safety** - Adnan Enshassi, Sherif Mohamed, Saleh Abushaban, (2009), Mohammad A. Mustafa, and Jamal F. Al-Bahar, (1991), Francis, Adam J. and Skitmore, Martin (2005); **Consultant** - Mamoon M. Atout (2013), B.P. Sunjka and U. Jacob, (2013), Long Le-Hoai, Young Dai Lee, and Jun Yong Lee, (2008), Chidambaram Ramanathan, SP Narayanan and Arazi B Idrus (2012), Abdullah Albogamy, Darren Scott, NashwanDawood, GhanimBekr, (2013), Sadi A. Assaf, Sadiq Al-Hejji (2006), Motaleb, O and Kishk, M (2010), Ren, Z, Atout, M and Jones, J (2008), **Contractor** - B.P. Sunjka and U. Jacob, (2013), Long Le-Hoai, Young Dai Lee, and Jun Yong Lee, (2008), Chidambaram Ramanathan, SP Narayanan and Arazi B Idrus (2012), Abdullah Albogamy, Darren Scott, NashwanDawood, GhanimBekr, (2013), Sadi A. Assaf, Sadiq Al-Hejji (2006), Motaleb, O and Kishk, M (2010), Ren, Z, Atout, M and Jones, J (2008), **Clien**t - B.P. Sunjka and U. Jacob, (2013), Long Le-Hoai, Young Dai Lee, and Jun Yong Lee, (2008), Adnan Enshassi, Sherif Mohamed, Saleh Abushaban, (2009), Chidambaram Ramanathan, SP Narayanan and Arazi B Idrus (2012), Abdullah Albogamy, Darren Scott, NashwanDawood, GhanimBekr, (2013), Sadi A. Assaf, Sadiq Al-Hejji (2006), Motaleb, O and Kishk, M (2010), Ren, Z, Atout, M and Jones, J (2008), **Labour / Equipment** - B.P. Sunjka and U. Jacob, (2013), Long Le-Hoai, Young Dai Lee, and Jun Yong Lee, (2008), Adnan Enshassi, Sherif Mohamed, Saleh Abushaban, (2009), Chidambaram Ramanathan, SP Narayanan and Arazi B Idrus

(2012), Sadi A. Assaf, Sadiq Al-Hejji (2006), **Materials** - B.P. Sunjka and U. Jacob, (2013), Long Le-Hoai, Young Dai Lee, and Jun Yong Lee, (2008), Chidambaram Ramanathan, SP Narayanan and Arazi B Idrus (2012), Sadi A. Assaf, Sadiq Al-Hejji (2006) and **External / Others** - B.P. Sunjka and U. Jacob, (2013) , Long Le-Hoai, Young Dai Lee, and Jun Yong Lee, (2008), Adnan Enshassi, Sherif Mohamed, Saleh Abushaban, (2009), Chidambaram Ramanathan, SP Narayanan and Arazi B Idrus (2012), Abdullah Albogamy, Darren Scott, NashwanDawood, GhanimBekr, (2013), Mohammad A. Mustafa, and Jamal F. Al-Bahar, (1991), Sadi A. Assaf, Sadiq Al-Hejji (2006), Motaleb, O and Kishk, M (2010), Francis, Adam J. and Skitmore, Martin (2005).

Avoiding risk will not eliminate them; it is better to face it, analyze it, and have proper action ready in case it takes place (Mohamed K. Khedr – 2006). As noted Risk has impact on all project outcomes. The major impacts as noted are the Project Cost and Schedule. Schedule delay can to the extent be mitigated by means of acceleration, fast tracking and crashing. However, cost overrun containment needs a continuous control from the commencement of the project until its closure. Project cost is one of the most important criteria with regards to project success but is by far the hardest to control. Cost uncertainty in rates, availability and usage can all contribute to cost overruns. (Dr. Dan Patterson, 2006). Cost area of risk management of the construction projects are identified for further research in many of the literatures (Qaqish Tamer Ayoub, 2011; Ekaterina Osipova, 2008; Dan BENȚA, 2011, Anna Klemetti, 2006; David James Bryde and Jurgen Marc Volm, 2009; Hans Thamhain, 2013).

Specific Literatures on UAE Construction Projects

Few research works were carried out on the Construction projects in United Arab Emirates, which identified many risks impacting the project performance and recommended on further research. Motaleb, O and Kishk, M (2010), had identified 42 caused of delays and grouped them into 5 sets : Contractors, Consultants, Project Managers, Clients, Financial and other unforeseen factors. Ren, M. Atout and J. Jones (2008), had identified 5 major root causes (risk factors) of project delays for each of 3 groups; Client, Consultant and Contractor. Mamoon M. Atout (2013), had identified 9 major causes of delay due to consultants.ArshiShakeelFaridi&SamehMonir El-Sayegh, (2006)had identified 44 caused of delays.

Specific Literatures on Power Projects

Shaun Frazerhurst, Neil Watson, (2013), detailed the commercial cost risks encountered in a power project and the action taken to mitigation the same to achieve project goals; while Francis, Adam J. and Skitmore, Martin (2005) identified key risk areas in a Substation project and found low level of awareness of the project participants in formal risk management and V M Rao Tummala, John F Burchett, (1999) stated that adopting a risk management strategy, such as risk prevention or risk transfer in a power project, enabled the contingency to be reduced, all remaining risks still need to be properly managed to avoid any likely cost overruns, however, as per the Otahuhu Substation Diversity Project report of Transpower New Zealand Limited, (2012), various cost risk were identified and mitigation plans were implemented but with limited success ultimately leading to cost overrun, due to simple cost estimation and underestimation of contingencies.

Specific Literature Review on Contingency

Successfully controlling project cost is a science unto itself and a highly sought after project management skill. Add to this the complexity of risk and uncertainty and the situation only becomes even more involved. Miscalculate cost estimates at the bidding phase will result into the risk of entering into a loss-making venture. Mismanage cost overruns due to uncertainty during the execution of the project will cause "the best laid plans fall to the wayside…". The risk related to cost is taken care by proper contingency allocation for the project. However, objectively determining how much to set aside in the form of contingency within a project is not easy, but can be done by proper Risk Analysis (Dr. Dan Patterson, 2006).

Taylor (2005) found some gaps between theory and practice in risk monitoring and contingency handling in the implementation stage and posited that this may be caused by a lack of understanding of the theory on the part of the managers; while David James Bryde&Jurgen Marc Volm (2009) stated that further research could focus on other project participants to identify their perceptions of project risk and the extent to which practice aligns with theory. Hans Thamhain (2013) recommend for testing of impact of contingencies on project performance and organizational conditions that are most conducive for risk management.

Very few literatures are found to detail the Contingency Calculation / Modelling / Methods. Probabilistic concepts for Cost Contingency Analysis for Construction Projects using Spreadsheets Dr. Khaled Nassar (2002), Probabilistic Estimation and Allocation of Project Time Contingency Gabriel A. Barraza (2011) and Multiple linear regression to predict the contingency amount for significant variables that may influence or serve as indicators of potential cost overruns Alfred E. Thal Jr.; Jason J. Cook; and Edward D. White III (2010).

Determining the actual contingency amount can be accomplished by either expert opinion or statistical methods. Statistical methods are very useful especially when previous cost history has been collected and good record keeping is being followed. Statistical techniques used to analyze contingency can range from Monte Carlo simulations to regression and variance analysis. Expert opinion is usually a prudent choice even when considering statistical methods, to augment the quantitative approach and check for logicality and consistency. Dr. Khaled Nassar (2002).

Implementing a formal cost risk management approach (where contingency plays a major role), and incorporating this very closely into the estimating and planning process further ensures that the project will be a success and not fall foul to irreversible cost overruns. (Dr. Dan Patterson, 2006).

However, due to various limitations applied in the above models, specific variables considered for the contingency calculation therein, result in mismatch for a general usage in all construction projects.

Identified Research Gaps from Literature Review

Since the projects require continuous decision making, they are exposed to numerous sources of **risk**, which needs a critical and intensive research. (Perez et al., 2010);(RasoolMehdizadeh, 2012); (Anna Klemetti, 2006). Hence a detailed **Risk Analysis** is required.(Patrick X. W. Zou; Ying Chen; and Tsz-Ying Chan, 2010);(William Imbeah and Seth Guikema, 2009);(SumitDatta, S.K. Mukherjee, 2001);(Dr. Dan Patterson, 2006). From the risk analyzed, **Strategies** to be formulated for **Managing Risk (**Nie-JiaYau and Jyh-Bin Yang, 2012);(Baydoun, M. 2011) and necessary **Risk Mitigation measures** to be developed (Baydoun, M. 2011). In order to implement the above, there is a need to study **Contingency handling / planning / perception.**(Transpower New Zealand Limited, 2012);(Hans Thamhain, 2013);(David James Bryde, JURGEN Marc Volm, 2009).**Perception of Contingency Project Risk** and the extent to which practice aligns with theory by project participants need to be studied (David James Bryde, JURGEN Marc Volm, 2009) and their **Impact of Contingencies on Project Performance** and organizational conditions that are most conductive for risk management (Francis, Adam J. Skitmore, Martin 2005). While going specifically into the power projects worldwide, it is noted that, there is often a lack of contingency allowance to cover project risk and lack of use of any risk management methods in electrical distribution projects (Francis, Adam J. Skitmore, Martin 2005). There is a need to properly manage the Contingencies to avoid any likely cost overruns (V M Rao Tummala, John F Burchett, 1999), while "Underestimation of Contingencies" during construction due to over simplified "rule of thumb" many a times leads to cost overrun(Transpower New Zealand Limited, 2012).

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From the above identified gaps, the problem arises whether ~~t~~the contingency perception of the stakeholders impact the project performance in terms of minimizing the cost overruns in the construction of substation in United Arab Emirates", which has been taken up for a detailed research.

While the detailed research consists of various sections of the project activities, for the purpose of this paper, only the Human Resource & Administration factors are considered.

Research Methodology

The present research is an exploratory and analytical. A total of 14 risk factors related to the Human Resource & Administration were identified based on above literature review and input from the project professionals. The questionnaire was developed to identify the importance of the risk factors while estimating the contingency for the construction of substations in United Arab Emirates.

Primary data was collected through survey from Clients, Consultants, Design Consultants, Main Contractors, Subcontractors and Vendors involved in substations construction projects in UAE.

Thereafter the data received were checked for its completeness and then taken up for Factor Analysis using SPSS tool to identify the significant risk factors related to the Human Resource &Administration activity. The output of this factor analysis is analyzed for detailed interpretation and provided with further research &recommendations.

Objectives

Questionnaire Design

Data were gathered through a detailed Questionnaire. The questionnaire was divided into two parts with 1st part being collection of personal information which has been kept as an optionwhile the 2nd part is the list of identified risk factors considered during estimating the contingency for the construction of substation in UAE, which are divided into various section based on the Project Activities.

For each risk factor, respondents are requested to answer a 1 to 5 scale with ~~1~~ = Not Important", ~~2~~ = Least Important", ~~3~~ = Important", ~~4~~ = More Important" and ~~5~~ = Most Important".

Sampling Technique

The sampling technique used for this research is judgemental sampling.

Sample Size

Sample size provides the basis for the estimation of sample error and their impacts on the ability of the model to be correctly estimated. In general, with any statistical method, the critical question is how large a sample is thereby required for analysis? Bentler and Chou (1987) had suggested that in SEM the sample size requirements vary for measurement and structural models. To test a measurement model, a ratio of ten responses per free parameters is required to obtain trustworthy estimates(Bentler and Chou, 1987). Others suggest a thumb rule of ten subjects per item in scale development is prudent (Flynn and Pearcy, 2001). However, the number of data collected shall be increased to fifteen subjects per item, if the received data is found to be volatile (Bentler and Chou 1987; Hair, Black et al. 2010).

Data Collection

The complete set of Questionnaire, which was having different sections including the presently dealt Human Resource & Administration section, was sent to SubstationConstruction / Project professionals with experience in various activities in the construction of substation in UAE. They were requested to fill out the relevant sections based on their expertise and experience.

Data Analysis approach

The collection data are analyzed a popular Multi-variant analytical technique called Factor Analysis.Factor analysis is an exploratory tool and is used to guide for making various decisions. Factor analysis is a class of procedures primarily used for data reduction and summarization, while in factor analysis relationship among sets of many interrelated variables are examined and represented in terms of new underlying factors. In this research, SPSS was used as a tool for carrying out this Factor Analysis. Sample reliability is tested using **–Cronbach's α (alpha)**"

Limitations

While the data analysis is carried on 9 sections of the questionnaire, however, due to huge quantum of output from the factor analysis for all these 9 sections, only a specific section (i.e. Human Resources and Administration) has been taken up for proceeding with Checking the Reliability, Sampling Adequacy, Data Analysis, Findings and Conclusion in this paper.

Research Findings

a. General Finding on Response pattern

The Table # 1 below shows the output of Risk Factor and the No. of respondents with their response and their % of response towards the specific scale.

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Table # 1 :: Number of Responses and % of Responses against each Factor

Sl. No.	Risk Factor	Responses (in Numbers)						Responses (in Percentage)					
		Not Important	Least Important	Important	More Important	Most Important	Total	Not Important	Least Important	Important	More Important	Most Important	Total
1	**Laws and Regulations and the changes during the tenure of the contract**	0	6	20	21	9	56	0%	11%	36%	38%	16%	100%
2	**Requirement for No Objection (NOC) / Approvals from Statutory Bodies**	1	4	10	17	24	56	2%	7%	18%	30%	43%	100%
3	**Cultural Impact / Personality Impact / Language Impact**	3	15	27	9	2	56	5%	27%	48%	16%	4%	100%
4	**Employee Turnover & Availability of Skilled Personnel** ***Help Text :*** *Resignation / Termination*	0	0	23	24	9	56	0%	0%	41%	43%	16%	100%
5	**Dependence on external sources** ***Help Text :*** *Hiring of Resources from manpower supply agencies, etc.*	1	13	25	13	4	56	2%	23%	45%	23%	7%	100%
6	**Resources Deployment** ***Help Text :*** *Timely deployment with proper skill set enables timely completion of project.*	0	2	16	20	18	56	0%	4%	29%	36%	32%	100%
7	**Productivity of Human Resources** ***Help Text :*** *Motivation will lead to enhanced Morale; leading to better productivity.*	0	0	16	22	18	56	0%	0%	29%	39%	32%	100%
8	**Utilization of Resources** ***Help Text :*** *Role Clarity & Appropriate Assignment enhances resources utilization.*	0	2	9	27	18	56	0%	4%	16%	48%	32%	100%
9	**LEADERSHIP qualities of Key personal** ***Help Text :*** *Such as Decision Making / Responsibility / Unethical Acts / Behaviour.*	0	1	11	22	22	56	0%	2%	20%	39%	39%	100%
10	**Resistance to change by Team Members** ***Help Text :*** *Non acceptance of assigned role due to possession of different skill set / experience.*	2	9	28	14	3	56	4%	16%	50%	25%	5%	100%
11	**Appropriate Training & Development of Skill Set**	1	4	26	17	8	56	2%	7%	46%	30%	14%	100%
12	**Conflict among Stakeholders** ***Help Text :*** *Stakeholders are Team Members, Clients, Consultants, Subcontractors, Vendors, etc.*	0	3	25	15	13	56	0%	5%	45%	27%	23%	100%
13	**Extreme Weather condition (Heat) / Working Hours during Summer**	0	8	22	18	8	56	0%	14%	39%	32%	14%	100%
14	**Natural Calamity** ***Help Text :*** *Such as Flood / Rain / Fog / Sand Storm / Fire / Earthquake*	5	15	22	11	3	56	9%	27%	39%	20%	5%	100%

Overall, 56 respondents have provided their response for the Human Resource & Administration section and their distribution of the response against the 5 point scale has been analyzed as at Table # 1 above and had noted that the general tendency is to rank them mostly in **Important factor or above**, which are highlighted in Yellowcolor, reflecting the importance of these factors while estimating the contingency for the construction of substations in UAE.

b. Reliability Test

The reliability test on the data was carried out for finding **"Cronbach's α (alpha)**" using SPSS. The result of the test is given in Table # 2 below:

Table # 2 :: Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.805	.809	14

Theoretical value of alpha varies from zero (0) to One (1), since it is the ratio of two variances. However, depending on the estimation procedure used, estimates of alpha can take on any value less than or equal to 1, including negative values, although only positive values make sense.Higher values of alpha are more desirable for reliability. Some professionals,require a reliability of 0.70 or higher (obtained on a substantial sample),as a rule of thumb, before they will use an instrument (Wikipedia) for analysis. The range of Cronbach's alpha and their interpretation of the value are shown in below Table # 3:

Table # 3 :: Cronbach's alpha and its interpretation

Cronbach's alpha	**Internal consistency**
$\alpha \geq 0.9$	Excellent (High-Stakes testing)
$0.7 \leq \alpha < 0.9$	Good (Low-Stakes testing)
$0.6 \leq \alpha < 0.7$	Acceptable
$0.5 \leq \alpha < 0.6$	Poor
$\alpha < 0.5$	Unacceptable

Since the present data set had resulted in a value of **Cronbach's α (alpha)** of 0.805 resulting in GOOD internal consistency, the reliability of the sample is adequate to proceed further with data analysis.

c. Factor Analysis

i) Principal component analysis:

The Table # 4 gives the output of the Factor Analysis using SPSS.

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Table # 4 - Correlation Matrix[a] (Page 1 of 2)

		Laws and Regulations and the changes during the tenure of the contract	Requirement for No Objection (NOC) / Approvals from Statutory Bodies	Cultural Impact / Personality Impact / Language Impact	Employee Turnover & Availability of Skilled Personnel	Dependence on external sources	Resources Deployment	Productivity of Human Resources	Utilization of Resources	LEADERSHIP qualities of Key personal	Resistance to change by Team Members	Appropriate Training & Development of Skill Set	Conflict among Stakeholders	Extreme Weather condition (Heat) / Working Hours during Summer	Natural Calamity
Correlation	Laws and Regulations and the changes during the tenure of the contract	1.000	0.143	0.155	(0.021)	0.235	0.028	0.099	0.079	0.119	0.254	0.253	(0.100)	0.082	0.235
	Requirement for No Objection (NOC) / Approvals from Statutory Bodies	0.143	1.000	(0.011)	0.116	0.303	0.203	0.087	0.016	0.230	0.133	0.463	(0.099)	(0.027)	0.094
	Cultural Impact / Personality Impact / Language Impact	0.155	(0.011)	1.000	0.372	0.405	0.229	0.270	0.123	0.110	0.424	0.503	0.171	0.354	0.443
	Employee Turnover & Availability of Skilled Personnel	(0.021)	0.116	0.372	1.000	0.403	0.564	0.338	0.454	0.228	0.281	0.332	0.014	0.318	0.174
	Dependence on external sources	0.235	0.303	0.405	0.403	1.000	0.372	0.198	0.214	0.399	0.303	0.428	(0.158)	0.333	0.194
	Resources Deployment	0.028	0.203	0.229	0.564	0.372	1.000	0.426	0.556	0.371	0.173	0.325	0.148	0.409	0.240
	Productivity of Human Resources	0.099	0.087	0.270	0.338	0.198	0.426	1.000	0.404	0.451	0.099	0.286	0.042	0.128	0.234
	Utilization of Resources	0.079	0.016	0.123	0.454	0.214	0.556	0.404	1.000	0.262	0.036	0.220	0.041	0.394	0.174
	LEADERSHIP qualities of Key personal	0.119	0.230	0.110	0.228	0.399	0.371	0.451	0.262	1.000	0.203	0.345	0.023	0.144	0.162
	Resistance to change by Team Members	0.254	0.133	0.424	0.281	0.303	0.173	0.099	0.036	0.203	1.000	0.595	0.168	0.153	0.368
	Appropriate Training & Development of Skill Set	0.253	0.463	0.503	0.332	0.428	0.325	0.286	0.220	0.345	0.595	1.000	0.174	0.344	0.397
	Conflict among Stakeholders	(0.100)	(0.099)	0.171	0.014	(0.158)	0.148	0.042	0.041	0.023	0.168	0.174	1.000	0.141	0.108
	Extreme Weather condition (Heat) / Working Hours during Summer	0.082	(0.027)	0.354	0.318	0.333	0.409	0.128	0.394	0.144	0.153	0.344	0.141	1.000	0.542
	Natural Calamity	0.235	0.094	0.443	0.174	0.194	0.240	0.234	0.174	0.162	0.368	0.397	0.108	0.542	1.000

Table # 4 - Correlation Matrix[a] (Page 2 of 2)

		Laws and Regulations and the changes during the tenure of the contract	Requirement for No Objection (NOC) / Approvals from Statutory Bodies	Cultural Impact / Personality Impact / Language Impact	Employee Turnover & Availability of Skilled Personnel	Dependence on external sources	Resources Deployment	Productivity of Human Resources	Utilization of Resources	LEADERSHIP qualities of Key personal	Resistance to change by Team Members	Appropriate Training & Development of Skill Set	Conflict among Stakeholders	Extreme Weather condition (Heat) / Working Hours during Summer	Natural Calamity
Sig. (1-tailed)	Laws and Regulations and the changes during the tenure of the contract		0.147	0.126	0.438	0.040	0.420	0.233	0.282	0.190	0.030	0.030	0.231	0.273	0.040
	Requirement for No Objection (NOC) / Approvals from Statutory Bodies	0.147		0.467	0.197	0.011	0.066	0.262	0.453	0.044	0.164	-	0.235	0.422	0.246
	Cultural Impact / Personality Impact / Language Impact	0.126	0.467		0.002	0.001	0.045	0.022	0.184	0.210	0.001	-	0.104	0.004	-
	Employee Turnover & Availability of Skilled Personnel	0.438	0.197	0.002		0.001	-	0.005	-	0.046	0.018	0.006	0.459	0.008	0.100
	Dependence on external sources	0.040	0.011	0.001	0.001		0.002	0.071	0.057	0.001	0.012	0.001	0.123	0.006	0.076
	Resources Deployment	0.420	0.066	0.045	-	0.002		0.001	-	0.002	0.102	0.007	0.139	0.001	0.037
	Productivity of Human Resources	0.233	0.262	0.022	0.005	0.071	0.001		0.001	-	0.234	0.016	0.378	0.173	0.041
	Utilization of Resources	0.282	0.453	0.184	-	0.057	-	0.001		0.025	0.396	0.051	0.382	0.001	0.100
	LEADERSHIP qualities of Key personal	0.190	0.044	0.210	0.046	0.001	0.002	-	0.025		0.066	0.005	0.435	0.145	0.116
	Resistance to change by Team Members	0.030	0.164	0.001	0.018	0.012	0.102	0.234	0.396	0.066		-	0.108	0.129	0.003
	Appropriate Training & Development of Skill Set	0.030	-	-	0.006	0.001	0.007	0.016	0.051	0.005	-		0.100	0.005	0.001
	Conflict among Stakeholders	0.231	0.235	0.104	0.459	0.123	0.139	0.378	0.382	0.435	0.108	0.100		0.150	0.214
	Extreme Weather condition (Heat) / Working Hours during Summer	0.273	0.422	0.004	0.008	0.006	0.001	0.173	0.001	0.145	0.129	0.005	0.150		-
	Natural Calamity	0.040	0.246	-	0.100	0.076	0.037	0.041	0.100	0.116	0.003	0.001	0.214	-	

a. Determinant = .007

In principal component analysis, the total variance in the data is considered. The diagonal of the correlation matrix consists of unities, and full variance is brought into the factor matrix. Principal analysis is recommended when the primary concern is to determine the minimum number of factors that will account for minimum variance in the data for use in multivariate analysissubsequent. These factors are called principal components.

The above table # 4shows the correlation matrix result. These data represents the correlation among the 14 variables. As from the above table # 4, it shows variable –Resistance to change by Team Members" is showing the correlation of .595 with the variable –Appropriate Training & Development of Skill Set" which is high. Likewise, it shows the correlation among the 14 variables which can be either high or low. It can be either positive or negative correlation among the 14 variables. In statistics, the value of correlation coefficient of +0.5 to +0.7 (-0.5 to -0.7) is considered to have moderate relationship, while +0.7 (-0.7) and above towards +1 (-1) is considered to be having strong linear relationship, while +1 (-1) shows a perfect linear relationship. For the evaluation purpose value only above +0.5 & -0.5 are considered.The following correlations exist between the different variables as shown highlighted in the table # 4:-

1. –Cultural Impact / Personality Impact / Language Impact" is more correlated only with –Appropriate Training & Development of Skill Set" with value of 0.503.

2. –Employee Turnover & Availability of Skilled Personnel" is more correlated with, –Resources Deployment" with value of 0.564.

3. –Resources Deployment" is more correlated with –Employee Turnover & Availability of Skilled Personnel" and –Utilization of Resources" with values 0.564 and 0.556 respectively.

4. –Utilization of Resources" is more correlated only with –Resources Deployment" with value of 0.556.

5. –Resistance to change by Team Members" is more correlated only with –Appropriate Training & Development of Skill Set" with value of 0.595.

6. –Appropriate Training & Development of Skill Set" is more correlated with –Cultural Impact / Personality Impact / Language Impact" and –Resistance to change by Team Members" with values 0.503 and 0.595 respectively.

7. –Extreme Weather condition (Heat) / Working Hours during Summer" is more correlated only with –Natural Calamity" with value of 0.542.

8. –Natural Calamity" is more correlated only with –Extreme Weather condition (Heat) / Working Hours during Summer" with value of 0.542.

9. Variables such as –Laws and Regulations and the changes during the tenure of the contract", –Requirement for No Objection (NOC) / Approvals from Statutory Bodies", –Dependence on external sources", –Productivity of Human Resources", –LEADERSHIP qualities of Key personal" and –Conflict among Stakeholders" are less correlated with all variables.

ii) KMO and Bartlett's Test:

The result of the KMO and Bartlett's test is as given in Table # 5 below:

Table # 5 :: KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.704
Bartlett's Test of Sphericity	Approx. Chi-Square	243.251
	df	91
	Sig.	.000

KMO and Bartlett's Test is an important part of the output produced using factor analysis by the SPSS tool. KMO i.e. Kaiser-Meyer-Olkin measures the sampling adequacy of the data. The KMO statistic varies between 0 and 1. A value of _0' indicates that the sum of partial correlations is large relative to the sum of correlations duly indicating diffusion in the pattern of correlations. A value close to _1' indicates that pattern of correlations are relatively compact and so factor analysis should yield distinct and reliable factors from the data. Kaiser (1974) recommends accepting values greater than 0.5 as acceptable level. Furthermore, values between 0.5 and 0.7 are mediocre, values between 0.7 and 0.8 are good, values between 0.8 and 0.9 are great and values above 0.9 are superb. For the collected data, KMO value is 0.704, which falls into the GOOD category and are in acceptable range. Hence the factor analysis is appropriate for these data.

Bartlett's measure tests the null hypothesis that the original correlation matrix is an identity matrix. For factor analysis to work we need some form of relationships between variables and if the R-matrix were an identity matrix then all correlation coefficients would be zero. Therefore, we want this test to be significant (i.e. have a significance value less than 0.05). A significant test tells us that the R-matrix is not an identity matrix; therefore, there are some relationships between the variables. For the collected data, Bartlett's test has resulted in highly significant (sig. < 0.001) level and therefore factor analysis is appropriate.

iii) Communalities:

Table # 6 :: Communalities

	Initial	**Extraction**
Laws and Regulations and the changes during the tenure of the contract	1.000	.451
Requirement for No Objection (NOC) / Approvals from Statutory Bodies	1.000	.599
Cultural Impact / Personality Impact / Language Impact	1.000	.593
Employee Turnover & Availability of Skilled Personnel	1.000	.531
Dependence on external sources	1.000	.597
Resources Deployment	1.000	.700
Productivity of Human Resources	1.000	.468
Utilization of Resources	1.000	.654
LEADERSHIP qualities of Key personal	1.000	.525
Resistance to change by Team Members	1.000	.635
Appropriate Training & Development of Skill Set	1.000	.775
Conflict among Stakeholders	1.000	.774
Extreme Weather condition (Heat) / Working Hours during Summer	1.000	.677
Natural Calamity	1.000	.600
Extraction Method: Principal Component Analysis.		

The above output in Table # 6 shows the communalities before and after extraction. Principal component analysis works on the initial assumption that all variance is common; therefore, before extraction the communalities are all _1'. The communalities in the column labeled *Extraction* reflect the common variance in the data structure analyzed. From the table # 6 of communalities, we can have the first variable showing the variance of 45.1%. Another way of looking at these communalities is in

terms of the proportion of variance explained by the underlying factors. After extraction some of the factors are discarded and so some information is thereby lost. The amount of variance in each variable that can be explained by the retained factors is represented by the communalities after extraction, as shown in the above table # 6.

iv) Component Matrix:

Table # 7 :: Component Matrix[a]

	Component			
	1	2	3	4
Laws and Regulations and the changes during the tenure of the contract		0.414		
Requirement for No Objection (NOC) / Approvals from Statutory Bodies			(0.632)	
Cultural Impact / Personality Impact / Language Impact	0.623			
Employee Turnover & Availability of Skilled Personnel	0.648			
Dependence on external sources	0.645			
Resources Deployment	0.689	(0.467)		
Productivity of Human Resources	0.544			
Utilization of Resources	0.542	(0.577)		
LEADERSHIP qualities of Key personal	0.534			
Resistance to change by Team Members	0.550	0.531		
Appropriate Training & Development of Skill Set	0.750			
Conflict among Stakeholders			0.568	0.653
Extreme Weather condition (Heat) / Working Hours during Summer	0.593		0.429	
Natural Calamity	0.577			

Extraction Method: Principal Component Analysis.
a. 4 components extracted.

The above Table # 7 shows the component matrix output before rotation. This matrix contains the loadings of each variable onto each factor. The output displays all loadings. This matrix is not particularly important for interpretation.At this stage SPSS has extracted four factors from the given data.

v) Total Variance Explained:

Table # 8 :: Total Variance Explained

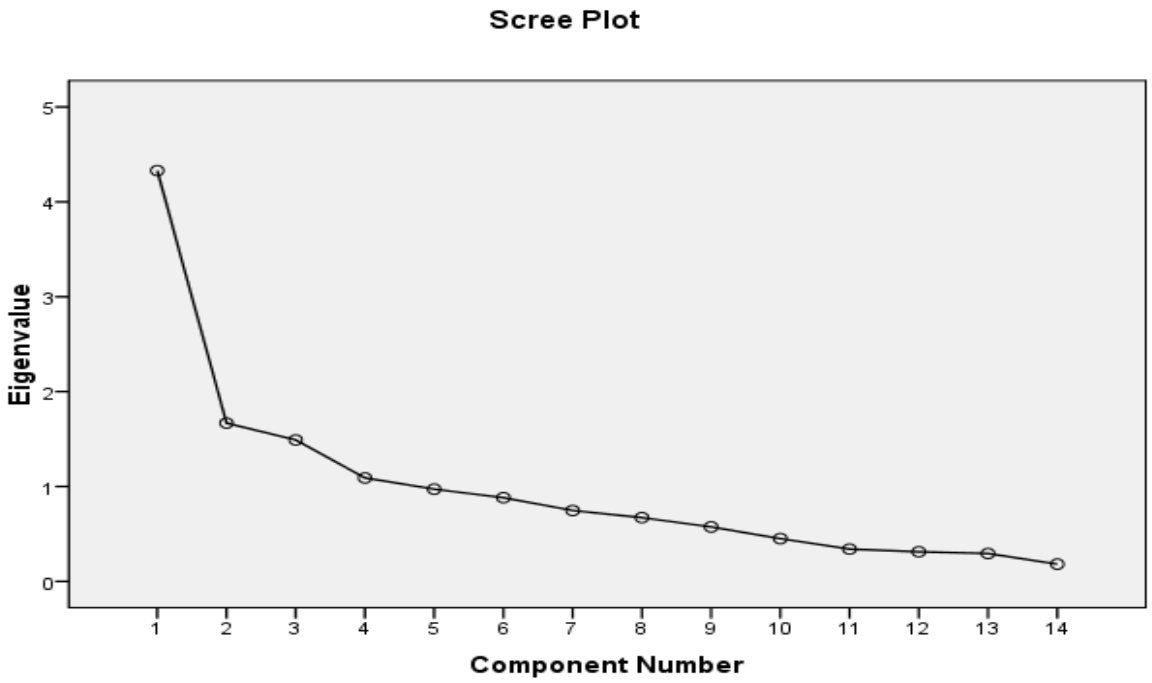
		Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings	
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.329	30.924	30.924	4.329	30.924	30.924	2.852	20.374	20.374
2	1.668	11.914	42.838	1.668	11.914	42.838	2.713	19.378	39.752
3	1.490	10.645	53.483	1.490	10.645	53.483	1.793	12.806	52.558
4	1.090	7.786	61.270	1.090	7.786	61.270	1.220	8.711	61.270
5	0.972	6.940	68.210						
6	0.882	6.297	74.507						
7	0.747	5.335	79.843						
8	0.672	4.798	84.641						
9	0.574	4.097	88.737						
10	0.451	3.218	91.955						
11	0.340	2.428	94.383						
12	0.312	2.226	96.609						
13	0.293	2.096	98.705						
14	0.181	1.295	100.000						

Extraction Method: Principal Component Analysis.

The above SPSS Output Table # 8 lists the eigenvalues associated with each linear component (factor) before extraction, after extraction and after rotation. Before the extraction, SPSS has identified 14 linear components within the data set (as we know that there should be as many eigenvectors as there are variables and so there will be as many factors as variables). The eigenvalues associated with each factor represent the variance explained by that particular linear component and SPSS also displays the eigenvalue in terms of the percentage of variance explained (so, factor ‗1' i.e. explains 30.924% of total variance). It should be clear that first few factors explain relatively large amounts of variance (especially factor ‗1') whereinsubsequent factors explains only small amounts of variance. SPSS then extracts all factors with eigenvalues greater than 1, which leaves us with four factors). In the final part of the table # 8 (labeled *Rotation Sums of Squared Loadings*), the eigenvalues of the factors after rotation are displayed. Rotation has the effect of optimizing the factor structure and one consequence for these data is that the relative importance of the four factors is equalized. Before the rotation, factor ‗1' accounted for considerably more variance than the remaining three (30.924% compared to 11.914%, 10.645% and 7.786%), however after rotation it accounts for only 20.374% of variance compared to 19.378%, 12.806%and 8.711% respectively.

vi) Scree Plot:

The below Figure # 2 shows the Scree Plot as produced from SPSS output.



The scree plot shown in above Figure # 2is produced by SPSS. In the scree plot, the curve falls steeply and then becomes nearly straight towards downward direction. The point after which the curve becomes nearly straight is the point of inflexion on the curve. This curve is difficult to interpret because the curve begins to tail off after four factors, but there is another drop after six factors before a stable plateau is reached as above. From the above, we could probably justify retaining between four tosix factors.

vii) Rotated Component Matrix:

Table # 9 :: Rotated Component Matrix[a]				
	Component			
	1	2	3	4
Laws and Regulations and the changes during the tenure of the contract				0.485
Requirement for No Objection (NOC) / Approvals from Statutory Bodies			0.751	
Cultural Impact / Personality Impact / Language Impact		0.741		
Employee Turnover & Availability of Skilled Personnel	0.679			
Dependence on external sources				0.423
Resources Deployment	0.805			
Productivity of Human Resources	0.632			
Utilization of Resources	0.794			
LEADERSHIP qualities of Key personal	0.492		0.532	
Resistance to change by Team Members		0.65	0.434	
Appropriate Training & Development of Skill Set		0.606	0.597	
Conflict among Stakeholders				-0.843
Extreme Weather condition (Heat) / Working Hours during Summer	0.453	0.612		
Natural Calamity		0.751		
Extraction Method: Principal Component Analysis.				
Rotation Method: Varimax with Kaiser Normalization.				
a. Rotation converged in 8 iterations.				

The above SPSS Output Table # 9 shows the rotated component matrix (also called as rotated factor matrix in factor analysis) which is a matrix of the factor loadings for every variable onto each factor. This matrix contains the same information as the component matrix except that it is calculated *after* rotation. Compare this matrix with the un-rotated solution. Before rotation, most variables loaded highly onto the first factor and the remaining factors didnot really get a look in. However, the rotation of the factor structure has clarified things considerably: there are six factors and variables load very highly onto only one factor. The suppression of loadings less than 0.40 has also made the interpretation considerably easier. As per Hair et al. (1998) Table of Loadings for Practical Significance (p112) 5 factors having a factor loading of more than 0.7 has been considered as having practical significant in the above SPSS output and the identified factors are listed in Table # 10,are being taken up for further research.

Table # 10:: Identified Significant Risk Factors from the Factor analysis

Sl. No.	Risk Factor	Factor Loading
1.	Requirement for No Objection (NOC) / Approvals from Statutory Bodies	0.751
2.	Cultural Impact / Personality Impact / Language Impact	0.741
3.	Resources Deployment	0.805
4.	Utilization of Resources	0.794
5.	Natural Calamity	0.751

SUMMARY AND CONCLUSION

The research objective was to identify the activity wise significant risk factors impacting contingency applicable to the construction of substations in United Arab Emirates. Risk Factors were identified through literature review, interview and group discussions with subject matter experts. Thereafter the Survey Questionnaire was designed and was distributed to a group of professionals working in client, consulting, project management, contracting, subcontractors and vendors having experience in the construction of substations in the UAE.

Due to the limitation of the research in this paper only the Human Resource & Administration section has been taken into detailed factor analysis which consists of 14variables with a total of 56 responses from the experts involved in the construction of substations in United Arab Emirates.

Factor Analysis was carried out with SPSS. The reliability of the collected data was tested by finding out the Cronbach's α (alpha)whichfor the present data set had resulted in a value of of 0.805 as in Table # 2, resulting in GOOD internal consistency thereby the reliability of the sample is adequate to proceed further with data analysis. The sampling adequacy was thereafter checked using KMO test and found to be 0.704 as per Table # 5, being adequate for the data collected and utilized for the analysis.The co-relation between different variables has been identified by using Principal Component Analysis as given in Table # 4. The significance of the factor analysis has been concurred by means of Bartlett‘s test which has resulted with significance value of < 0.0001. Subsequently Five (5) significant factors were factored out as in Table # 10 from the total Fourteen (14) factors from the output of Rotated Component Matrix given at Table # 9.

These Five (5) significant factors are further considered for taking up for detailed research by data collection and analysis for identifying the Probability and impact of these risk factors on the project performance.Further development work of the significant factors after further analysis shall be done by preparing a risk matrix showing the significant risk factors, their risk score from the probability and impact, detailed mitigation plan for the significant risk factors and the monitoring status with the implemented solution.

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Importance and Need of Accurate Modelling of Soil of High Voltage Substation for Optimal Designing of Grounding System

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Abstract

The main objective of grounding electrical systems is to provide a suitably low resistance path for the discharge of fault current which ultimately provide safety to working personnel and costly installed equipments in the substation. The flow of heavy fault current results in rise of potential in the substation area and with respect to remote ground. There is need to ensure that the ground potential rise, and touch and step voltages are within permissible limit, an accurate soil model is required to design grounding system of the substation that ensures that the resistance of the grounding grid through the earth is sufficiently low. Soil resistivity data is of fundamental importance in performing grounding system analyses. Reliable data is required to achieve good correlation between design and measured grounding system performance. This soil model is derived from the accurate soil resistivity measurement structure at the proposed grid location. This paper provides a overview of 4 pin method for measurement of resistivity & provide the method of single and two layer soil modelling of substation area with help of MATLAB GUI software and provides an example to understand the modelling procedure.

Key Words: Grounding, Soil Resistivity, Substation, Resistance, Single and Two Layer soil Model

1. INTRODUCTION

Grounding/ Earthing means making a connection to the general mass of earth. The use of grounding is so widespread in an electric system that at practically every point in the system, from the generators to the consumers' equipment, earth connections are made.[3,4]

Earlier, the design criterion was to achieve lowest earth resistance, However, the modern design criterion for grounding system is to achieve low earth resistance and also to achieve safe' step-potential', 'touch potential' and voltage gradient during an earth fault between conductor and any of the earthed bodies in the substation.

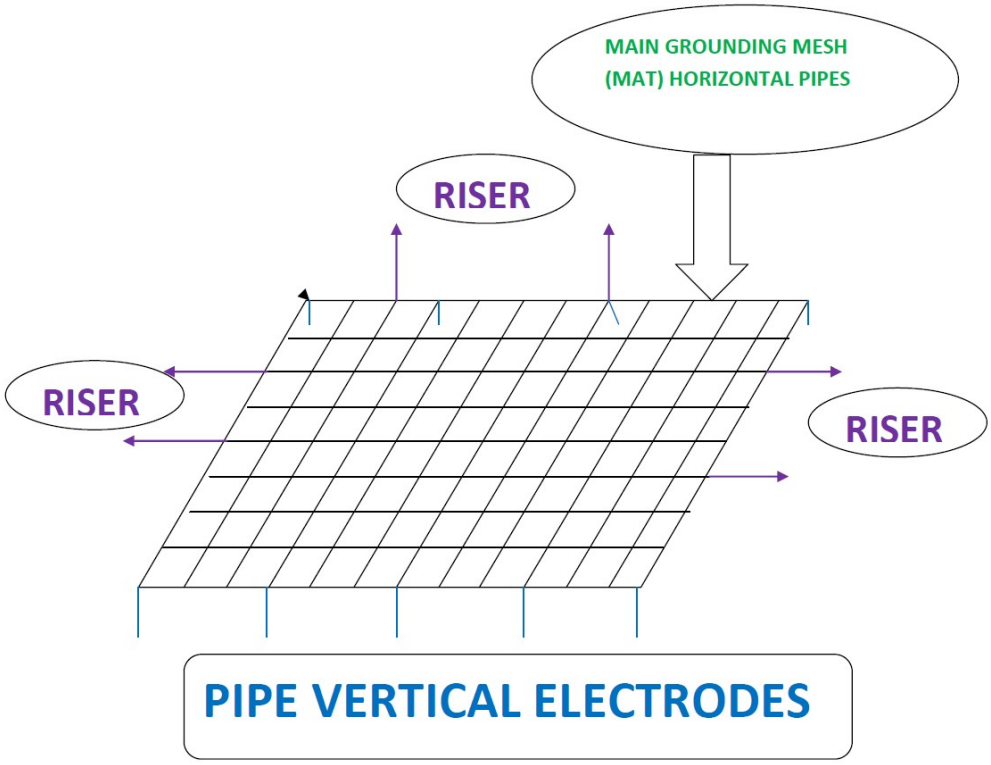


Fig 1 Grounding Mat of the Substation

2. Step Potential And Touch Potential

During an earth-fault in the substation the earth fault current flows from the fault-point to earth via the metallic path having certain total resistance R. This flow of fault current (I_f) flowing through resistance R causes a voltage drop $V = I_f R_0$. This voltage drop results in a voltage-gradient along the substation floor during the earth faults. This voltage gradient should be held in safe limits by proper design of station grounding system.[3]

A operation maintenance person is subjected to 'step potential' and 'Touch Potential' during an earth-fault in the substation. The ***'Step-Potential'*** is defined as the potential difference between two steps of a person standing on the substation floor during the flow of earth fault current. The ***'Touch Potential'*** is defined as the potential difference between a step and the tip of the raised hand touching a substation structure during the flow of the earth fault current through the latter [1].

The Step Potential and touch Potential depend upon the following aspects :

1. Earth fault current I_f
2. Duration of earth fault

(a) Whether short time (less than 3 sec.)
(b) Whether sustained (more than 3 sec.)

3. Fault current flowing through body I_b
4. Values of body resistances in the path of R_b

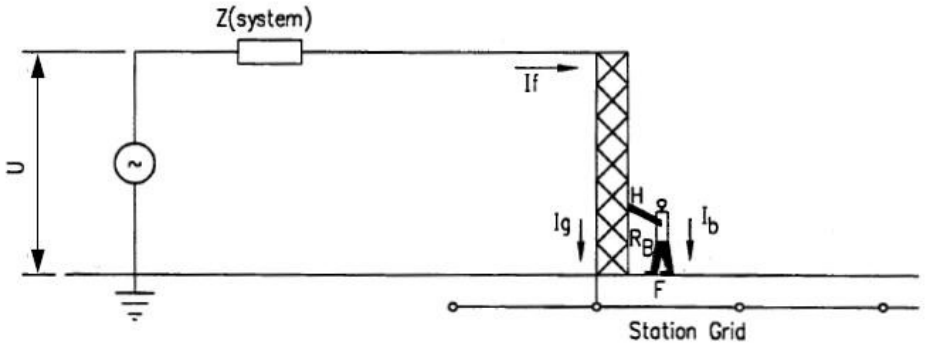


Fig 2 Touch Potential [1]

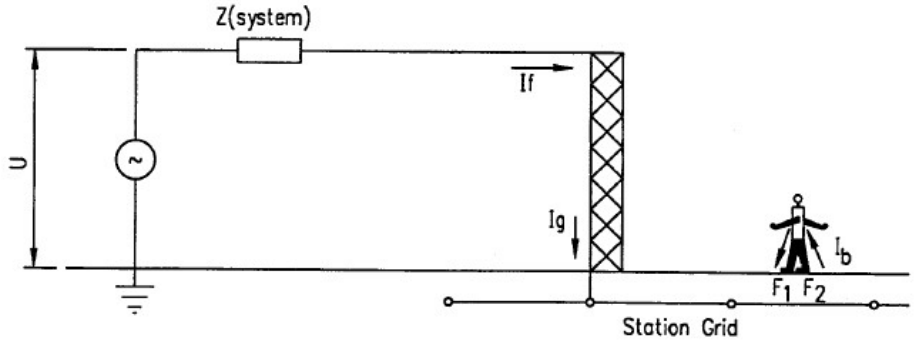


Fig 3 Step Potential[1]

3. Concept of Soil Resistivity

Soil resistivity can be defined as the resistance between the opposite sides of a cube of soil with a side dimension of one meter. Soil resistivity values in vary widely, depending on the type of terrain; e.g., silt on a riverbank may have a resistivity value around 1.5 Ω-m, whereas dry sand or granite in mountainous country may have values higher than 10,000 Ω-m. The factors that affect resistivity may be summarized as follows [5,13]:

1. Type of earth (e.g., clay, loam, sandstone, granite).

2. Stratification of layers of different types of soil (e.g., loam backfill on a clay base).

3. Moisture content: resistivity may fall rapidly as the moisture content is increased, but after a value of about 20%, the rate is much less. Soil with moisture content greater than 40% is rarely encountered.

4. Temperature: above the freezing point, the effect of temperature on earth resistivity is negligible.

5. Chemical composition and concentration of dissolved salts. Presence of metal and concrete pipes, tanks, large slabs, cable ducts, rail tracks, or metal pipes. Figure1 shows how resistivity varies with salt content, moisture, and temperature. It is found that earth resistivity varies from 0.01 to 1 Ω-m for sea water, and upto109 Ω-m for sandstone. The resistivity of the earth increases slowly with decreasing temperatures from 25^0C, while for temperatures below 0^oC, the resistivity increases rapidly. In frozen soil, as in the surface layer in winter, the resistivity may be exceptionally high.

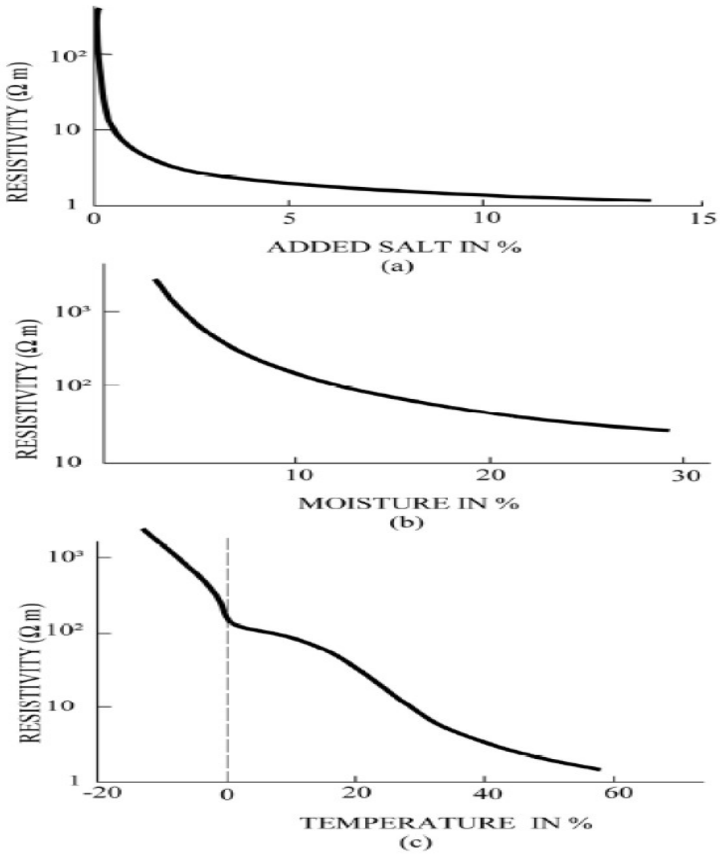


Fig 4 Impact of Salt, Moisture and Temperature on Soil Resistivity

Table 1 shows the resistivity values for various soils and rocks that might occur in different grounding system designs. The electrical properties of the soil are determined by the thicknesses of layers and their changes in resistivity, resistivity is dependent upon water and chemical content, as well as soil texture. Usually there are several soil layers, each having a different resistivity, in which case the soil is said to be non-uniform. Lateral changes may also occur, but, in general, these changes are gradual and negligible, at least in the vicinity of a site where a grid is to be installed. In most cases, measurements will show that the resistivity, ρ, is mainly a function of depth. The interpretation of the measurements consists of establishing a simple equivalent function to yield the best approximation of soil resistivity's to determine the layer model.

TABLE 1 Typical Resistivity of Soil

Type of Soil or Water	Typical Resistivity (ohm- meter)	Usual Limit (ohm- meter)
Sea water	2	0.1 to 10
Clay	40	8 to 70
Ground well and spring water	50	10 to 150
Clay and sand mixtures	100	4 to 300
Shale, slates, sandstone, etc.	120	10 to 100
Peat, loam, and mud	150	5 to 250
Lake and brook water	250	100 to 400
Sand	2000	200 to 3000
Moraine gravel	3000	40 to 10000
Ridge gravel	15000	3000 to 30000
Granite	25000	10000 to 50000
Ice	100000	10000 to 100000

4 Method and Procedure of Resistivity Measurement

There are many methods being used worldwide for measurement of resistivity. Four point method of resistivity measurement is quite common.

Four-point method [2]

A good method for measuring the apparent resistivity of large volumes of undisturbed earth is the four point method. Four auxiliary probes are installed in the earth, all at depth *b* and spaced
(in a straight line) at intervals *a*. A test current *I* is passed between the two outer probes, and the potential *V between* the two inner probes is measured with a potentiometer or high-impedance voltmeter. Then, the *V/I* ratio gives the resistance *R* in ohms. Two different variations of the four-point method are often used, as follows:

a) ***Equally Spaced or Wenner Arrangement.*** With this arrangement, the probes are equally spaced, as shown in Figure 5(a). Let *a* be the distance between two adjacent probes. Then, the apparent resistivity in the terms of the length units in which *a* and *b* are measured is

$$\rho = \frac{4\pi aR}{1+\frac{2a}{\sqrt{a^2+4b^2}}-\frac{a}{\sqrt{a^2+b^2}}}$$

Theoretically, the electrodes should be point contacts or hemispherical electrodes of radius *b*. However, in practice, four rods are usually placed in a straight line at intervals *a*, driven to a depth not exceeding 0.1 *a*. Then, the user can assume $b = 0$ and

the equation becomes $\boldsymbol{\rho = 2\pi aR}$ and gives the approximate apparent soil resistivity to the depth *a*.

A set of readings taken with various probe spacing gives a set of resistivity that, when plotted against spacing, indicates whether there are distinct layers of different soil or rock and gives an idea of their respective model.

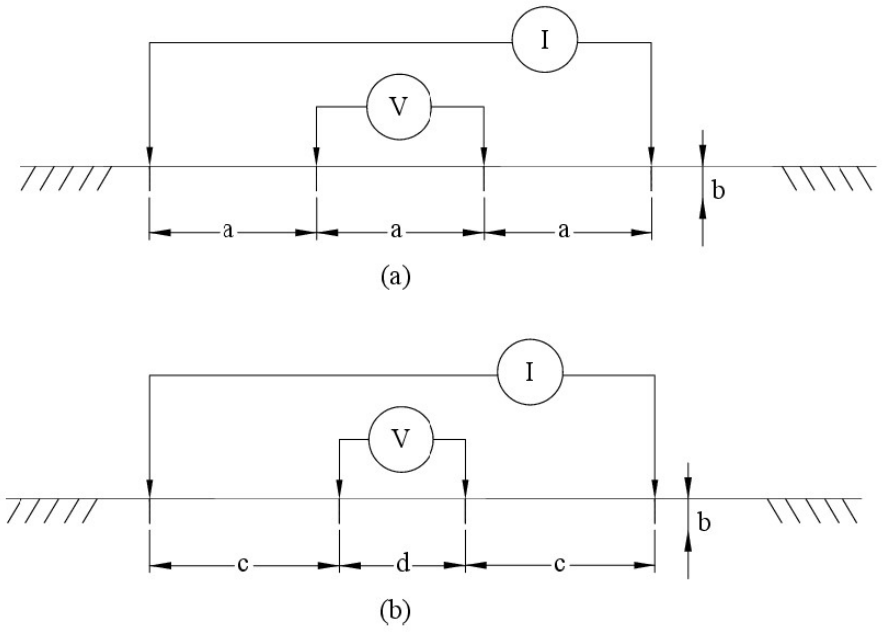


Figure 5 Wenner Method and Schlumberger-Palmer Method

b) ***Unequally Spaced or Schlumberger–Palmer Arrangement***.
One shortcoming of the Wenner method is the rapid decrease in magnitude of potential between the two inner electrodes when their spacing is increased to relatively large values. Historically, instruments were inadequate for measuring such low potential values, although improved sensitivity in modern testers mitigates this disadvantage to some extent. Another disadvantage with the Wenner method is the requirement to reposition all four probes for each depth to be measured. The arrangement shown in Figure 5(b) can be used to measure soil resistivity successfully when current probes are separated by a large distance or to expedite testing for multiple current probe locations. With the Schlumberger method, the inner probes are placed closer together and the outer probes are placed farther apart. Unlike the Wenner method, which requires all probes to be moved to calculate soil resistivity at different depths, the Schlumberger method only required the outer probes to be

repositioned for subsequent measurements. Reducing the number of probes to be repositioned for each test makes the Schlumberger method a faster choice for testing at different depths. The equation to be used in this case can be easily determined. If the depth of burial of the electrodes *b* is small compared to their separation *d* and *c*, and $c > 2d$, then the measured apparent resistivity can be calculated as follows:

$$\mathbf{P=\pi(c+d)R/d}$$

5.0 Different Soil Models

Uniform soil model is seldom found in the field. Grounding design engineers usually come across the following types of soil models.[19]

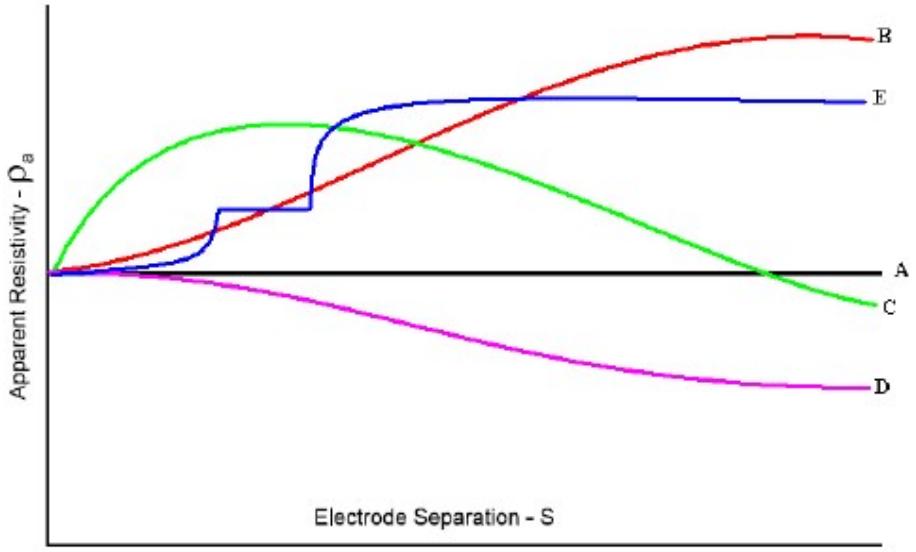


Fig 7 Soil Resistivity Vs Electrode Separation Curve for Non- Uniform Soil

- Curve (A) represents homogenous resistivity
- Curve (B) represents a low resistance layer overlaying a higher resistivity layer
- Curve (C) represent a high resistivity layer between two low resistivity layer
- Curve (D) represents a high resistivity layer overlaying a lower resistivity layer
- Curve (E) represents a low resistivity layer over a high resistivity layer with vertical discontinuity.

6. Estimation of Two Layer Soil Parameters

When the measured apparent resistivity at a site is not uniform, the data can be interpreted to obtain the best fit two layer equivalent. The process basically involves an iterative search for such values of two layer parameters ρ_1, ρ_2, and h as make the appropriate theoretical apparent resistivity expression for the two layer soil fit the measured data by the least squares criterion. Either the infinite series expression of apparent resistivity as given by (A) or one of the finite term expressions evolved in the previous section can be used. However, use of the latter makes the search for unknown parameters much faster with insignificant loss in accuracy. The present development is based on the finite formulae as given in equations (B) and (C). The objective function to be minimized in the search process is formulated as [5,9,10]

$$f(\rho_1, \rho_2, h) = \sum_{j=1}^{n} \frac{[\rho_{m(j)} - \rho_{c(j)}(\rho_1, \rho_2, h)]^2}{\rho_{m(j)}}$$

Where,

n = number of electrode spacing for which apparent resistivity measurements are made.

$\rho_{m(j)}$ = measured apparent resistivity for jth electrode spacing.

$\rho_{c(j)}$ = apparent resistivity at the jth electrode spacing computed by using finite expression (13) or (17) depending on whether lower layer has higher or lower resistivity than the upper layer

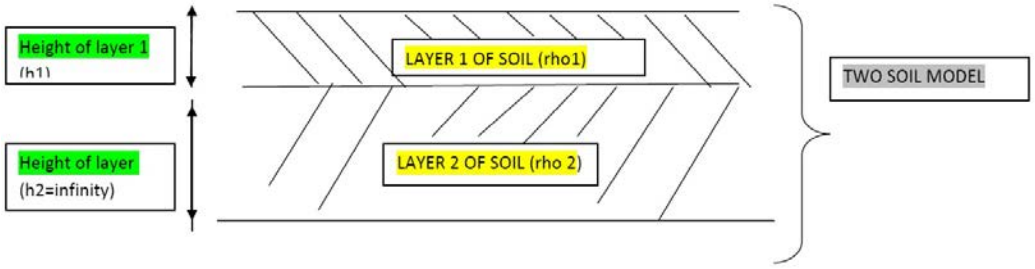


Fig 6 Two Soil Model

1. Expressions for apparent resistivity for two layer soil with infinite series expression [5]

$$\rho_a = \rho_1 \left[1+4 \sum_{n=1}^{\infty} k^n \left(\frac{1}{\sqrt{1+\frac{(2n\,h)^2}{a^2}}} - \frac{1}{\sqrt{1+\frac{(2n\,h)^2}{a^2}}} \right) \right] \quad \text{------(A)}$$

Where,
ρ_a = Apparent Resistivity Ohm- meter
ρ_1 = Resistivity of the upper layer soil in Ohm- meter
ρ_2 = Resistivity of the lower layer soil in Ohm- meter
h = depth of the upper layer in meter
k = reflection factor $(\rho_2 - \rho_1) / (\rho_2 + \rho_1)$
a = Separation of electrode in meters

2. Expressions for apparent resistivity for two layer soil with finite series expression $\rho_2 > \rho_1$ [5]

$$\rho_a = \rho_1 + 4\,\rho_1\,k\;a\left(\frac{1}{\sqrt{a^2+4h^2}} - \frac{1}{\sqrt{4a^2+4h^2}}\right) + 4\pi V_b\,a\left(\sqrt{\frac{c}{c+(a/h)^{\beta}}} - \sqrt{\frac{c}{c+(2a/h)^{\beta}}}\right)$$

Where,
$V_b = \rho_1 [-k - \ell n (1-k)] /(2\pi h)$
$c = x_1 \ell n (\rho_2 / \rho_1)^{X_3}$ & $\beta = 2.0 - x_2 \ell n (\rho_2 / \rho_1)$
$x_1 = 16.4133$; $x_2 = 0.136074$; $x_3 = 0.393468$

3. Expressions for apparent resistivity for two layer soil with finite series expression $\rho_2 < \rho_1$ [5]

$$\rho_a = \rho_2 + (\rho_1 - \rho_2) [2\, e^{-b(a)} - e^{-b(2a)}] \quad \text{-------(C)}$$

where
$b = [b_m - (b_m - x_1) e^{-x_2 a/h}] /h$ and $b_m = x_3 - x_4 (\rho_2 - \rho_1)^{x_5}$
$x_1 = 0.673191$: $x_2 = 0.479513$: $x_3 = 1.33335$: $x_4 = 0.882645$; $x_5 = 0.697106$

The above written equations can be used to get two soil model of any substation area.

7. Example of Soil Resistivity Measurement and Soil Modelling

In order to get clarity or understand the impact of soil modelling, an arbitrary data of soil resistivity measurement for three different locations within the premises of the HV substation is considered as follows:

LOCATION1

SEPARATION OF SPIKES (S) Meter	N	NE	E	SE	S	SW	W	NW	AVG RESISTIVITY
0.5	33.45	14.38	17.67	30.77	11.52	8.44	9.63	40.66	**20.82**
1	36.73	17.96	21.47	19.84	9.54	6.84	10.99	34.79	**19.77**
2	6.65	14.06	17.2	12.43	6.02	2.26	6.28	12.05	**9.62**
3	7.34	9.04	9.79	8.85	5.08	1.884	3.39	8.47	**6.73**
5	0.94	7.85	7.53	6.9	6.59	3.14	2.19	6.59	**5.22**
10	1.25	10.04	6.28	6.28	9.42	7.53	3.24	5.65	**6.21**
15	1.88	5.65	3.76	6.59	5.65	4.56	2.13	4.57	**4.35**
AVG RESISTIVITY	**12.61**	**11.28**	**11.96**	**13.09**	**7.69**	**4.95**	**5.41**	**16.11**	

LOCATION2

SEPARATION OF SPIKES (S) Meter	N	NE	E	SE	S	SW	W	NW	AVG RESISTIVITY
0.5	227.96	39.59	46.22	36.48	39.72	34.1	15.26	241.46	**85.10**
1	71.59	40.94	37.42	24.61	38.55	27.5	17.39	20.09	**34.76**
2	30.14	26.37	20.72	20.09	22.85	2.51	19.34	2.51	**18.07**
3	16.95	12.81	16.2	16.39	8.85	0.75	9.23	15.07	**12.03**
5	25.12	7.22	12.56	15.38	6.59	4.39	7.53	9.4	**11.02**
10	12.56	6.28	10.67	13.18	8.16	2.51	6.28	12.56	**9.03**
15	9.42	4.71	8.93	11.3	3.76	18.84	3.76	9.42	**8.77**
	56.25	**19.70**	**21.82**	**19.63**	**18.35**	**12.94**	**11.26**	**44.36**	

LOCATION3

SEPARATION OF SPIKES (S) Meter	N	NE	E	SE	S	SW	W	NW	AVG RESISTIVITY
0.5	39.25	49.8	49.07	21	194.68	45.93	18.87	149.15	**70.97**
1	61.6	30.58	11.86	53	63.42	19.40	23.55	153.23	**52.08**
2	20.84	19.71	4.39	4.14	16.32	6.40	5.52	3.39	**10.09**
3	8.85	8.28	3.23	3.95	13.18	7.72	5.46	5.65	**7.04**
5	0.62	5.43	3.12	2.45	12.56	5.96	4.39	6.28	**5.10**
10	11.3	4.32	2.21	2.34	12.56	1.88	3.14	6.28	**5.50**
15	10.8	3.51	2.09	2.01	6.28	5.65	4.71	9.42	**5.56**
AVG RESISTIVITY	**21.89**	**17.38**	**10.85**	**12.7**	**45.57**	**13.28**	**9.377**	**47.63**	
	N	**NE**	**E**	**SE**	**S**	**SW**	**W**	**NW**	**AVG RESISTIVITY**
location 1	12.60	11.28	11.95	13.09	7.68	4.95	5.40	16.11	**10.39**
location 2	56.24	19.70	21.81	19.63	18.35	12.94	11.25	44.35	**25.54**
location 3	21.89	17.37	10.85	12.69	45.57	13.27	9.37	47.62	**22.33**
AVG RESISTIVITY	**30.25**	**16.12**	**14.88**	**15.14**	**23.87**	**10.39**	**8.68**	**36.03**	**19.42**

From the above data, it is clear that if single soil model is considered the grounding system is designed based on the average resistivity of the soil as shown above and this value in this comes out to be 19.42 ohm-meter.

Two Soil Modelling Data Obtained from Above Single Soil Data

Using the above data of soil resistivity measurement for two soil modelling with the help of computer program developed in the MAT LAB GUI, the following results are obtained.

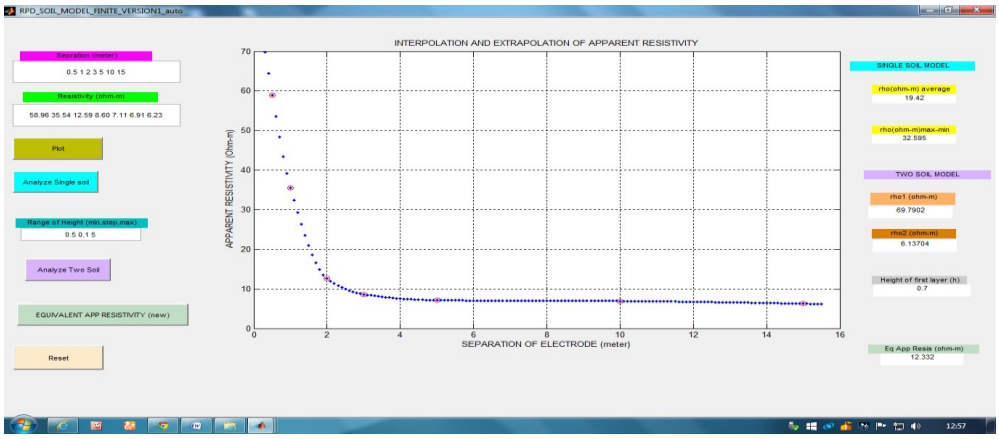
AVERAGE RES FOR LOCATION AT GIVEN SEPARATION	**0.5**	**1**	**2**	**3**	**5**	**10**	**15**		
location 1	20.81	19.77	9.61	6.73	5.21	6.21	4.34		
location 2	85.09	34.76	18.06	12.03	11.02	9.02	8.76		
location 3	70.96	52.08	10.08	7.04	5.10	5.50	5.55		
AVG RESISTIVITY	**58.96**	**35.54**	**12.59**	**8.60**	**7.11**	**6.91**	**6.23**	**19.42**	**AVERAGE VALUE**

RESULTS:

Final results of the two soil model for above resistivity measurement data is as follows:

Resistivity of Top layer (ohm-meter)	69.79
Resistivity of Top layer (ohm-meter)	6.13
Height of Top layer (meter)	0.7

The screen shot of the MATLAB GUI program showing the results for the above data is given below.



From the above it can be observed that with single soil model the resistance of the substation grounding system which depends on resistivity of soil in the above case (case of Negative K, reflection factor) is less as compare with two soil model. It further reduces the calculated GPR, Step Potential and Step Potential for the substation.

7. Conclusion

This paper highlights the importance of accurate measurement of the soil resistivity and proper interpretation of the data for modelling of soil structure. A both infinite & finite expression for Wenner apparent resistivity calculation for two layers have been used to develop the two layer soil model of the H.V. substation in MATLAB GUI and has been tested for a number of combinations of soil resistivity measurement data.
The computed apparent resistivity depends on resistivity of top layer, depth of the upper layer, reflection factor (K) and distance between electrodes of earth tester/ resistivity measuring device.

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Legislative Note: Regulation 5(9) of the Combination Regulations under the Competition Act, 2002

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Abstract

After the provisions relating to combinations under the Competition Act, 2002 were brought into force accompanied with the coming into force of the Competition Commission of India (Procedure in regard to the transaction of business relating to combinations) Regulations, a number of uncertainties cropped up with respect to its applicability. Even after amending the regulations, in February 2012, the affected sectors still grappled with certain ambiguities in the finer details. One such issue deals with partial acquisition of an enterprise under Regulation 5(9) which has been discussed in this paper. It has been argued that no parameters have been laid down as regards the determination of the 'purpose' of the transfer of assets in cases where the transaction does not specify an express purpose. There have also been issues with regard to interpretation of these regulations in as much as even a liberal interpretation of these regulations would render the objectives of these regulations unfulfilled. Also, the dissonance between the global and Indian interpretation of these Regulations has inconvenienced the stakeholders. Taking these issues into account, it has been concluded that appropriate guidelines should be laid down to ensure that 'purpose' of the transaction can be determined with certainty and unrelated transactions are not treated as forming part of the same transaction. It has also been concluded that

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following the internationally accepted position in this area of law may actually be a beneficial position to take. The paper subscribes to doctrinal research through the use of primary and secondary sources of information, which have been critically analysed.

Keywords: Combinations Regulation, Competition Commission of India, Mergers and Acquisitions, Purposive Interpretation, Regulation 5 (9).

Introduction

As a part of the process that could be described as proliferation of laws regulating market competition around the world,[1] India enacted its competition law in the form of the Competition Act, 2002 (the Act).[2] Subsequent to the enactment, however, it was faced with several hurdles relating to enforcement of the substantive provisions.[3]

The most protracted was the enforcement process of the substantive provisions relating to Combinations.[4] Eventually, on 1 June 2011, Sections 5 and 6 of the Act were brought into force[5] accompanied by the coming into force of the Competition Commission of India (Procedure in regard to the transaction of business relating to combinations) Regulations (the Regulations). Not only did this result in the competition law framework being

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[1] MARK R. JOELSON, AN INTERNATIONAL ANTITRUST PRIMER 7 (Kluwer Law International, 3rded. 2006); T. RAMAPPA, COMPETITION LAW IN INDIA5 (Oxford University Press, 2nd ed. 2011).

[2] COMPETITION COMMISSION OF INDIA, *available at:* http://www.cci.gov.in/index.php?option=com_content&task=view&id=18(last visited on Sep. 22, 2015).

[3] BrahmDutt v. Union of India, A.I.R. 2005 S.C. 730.

[4] The Competition Act, § 5.

[5] COMPETITION COMMISSION OF INDIA, Notification S.O. 479 (E) of the Competition Commission of India, *available at*:http://www.cci.gov.in/images/media/notifications/SO479(E),480(E),481(E),482(E)240611.pdf (last visited on Sep. 22, 2015).

fully operational, but also established the merger control regime in India.

However, the regulations brought with them a number of uncertainties.[6] Even after an attempt at resolving some of these through an amendment to the Regulations in February 2012, the affected sectors are still grappling with certain ambiguities in the finer details. The following paragraph discusses one such issue, the partial acquisition of an enterprise.

Before writing a legislative note on the chosen topic, it is worth justifying how a comment on regulations, instead of a statute is justified under this heading.

Delegated legislation has assumed a vital role in the functioning of modern democratic countries. To quote from a leading book on Administrative Law[7]:

> Only a relatively small part of the total legislative output emanates directly from the legislature. The bulk of the legislation is promulgated by the executive and is known as delegated legislation… It is so extensively used today that… that the statute book will not only be incomplete but even misleading unless it be read along with the delegated legislation which amplifies and supplements it.

In this light, it is submitted that subject to various doctrinal controls over the substance and procedure of delegation, legislative powers delegated to the executive can be rightfully exercised. Further, all rules and regulations in such exercise of powers, must be considered a part of legislation and worthy of academic analysis.

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[6] Tony Reeves & Dan Harrison, *India's New Merger Control Regime: When Do You Need to File, Antitrust,* CLIFFORD CHANCE L.L.P.http://www.cliffordchance.com/content/dam/cliffordchance/PDF_2/Article_on_India_New_Merger_Control_Regime.pdf(last visited on Sep. 22, 2015).

[7] M. P. JAIN & S. N. JAIN, PRINCIPLES OF ADMINISTRATIVE LAW 269 (Lexis Nexis, 6thed. 2013).

Regulation 5(9) of the Combinations Regulations

After the enforcement of the regulations in May 2011, many experts were of the view that in cases where a unit in an enterprise was being acquired, whether the applicability of the regulations for the purpose of calculation of turnover under Section 5 extended to the specific unit of the whole enterprise.[8] This ambiguity also extended to the applicability of the *de minimis* exemption granted by the Competition Commission of India (the CCI) in March 2011. It provided that enterprises being acquired within the meaning of Section 5(a), which have assets valued at ₹ 250 crores or less or turnover of ₹ 750 crores or less, shall be exempted from the application of Section 5 (the Target Enterprise Exemption).[9] Whereas it was considered prudent to take the value of the entire enterprise, it was expressed that this would undermine significantly the usefulness[10] of the exemption and will also be inconsistent with internationally accepted standards.[11] Subsequently, amendments to the regulations were brought into force in February 2012.[12] *Inter alia*, the amendments inserted Regulation 5(9). It provided:

> Where, in a series of steps or individual transactions that are related to each other, assets are being transferred to an enterprise for the purpose of such enterprise entering into an agreement relating to an

[8] Pallavi S. Shroff, *India: Merger Control, Asia-Pacific Antitrust Review 2012*, GLOBAL COMPETITION REVIEW http://www.globalcompetitionreview.com/reviews/42/sections/146/chapters/1646/india-merger-control/(last visited on Sep. 22, 2015).

[9] Competition Commission of India, Notification S.O. 482(E) of the Competition Commission of India, *available at*http://www.cci.gov.in/images/media/notifications/SO479(E),480(E),481(E),482(E)240611.pdf. (last visitedon Sep. 22, 2015).

[10] Reeves & Harrison, *supra* note7at 97.

[11] *Id.*

[12] COMPETITION COMMISSION OF INDIA, *available at*

http://www.cci.gov.in/images/media/Regulations/CCI_Combination_Regulations_as_amended_upto_23_02_2012.pdf(last visited on Sep. 22, 2015).

> acquisition or merger or amalgamation with another person or enterprise, for the purpose of section 5 of the Act, the value of assets and turnover of the enterprise whose assets are being transferred shall also be attributed to the value of assets and turnover of the enterprise to which the assets are being transferred.

As soon as the amendments were issued, a number of observations were made regarding the changes it brought. As regards the insertion of Regulation 5(9), it was argued that it clarifies the situation to the extent that where assets are being hived off to another enterprise, the assets and turnover for the enterprise transferring those assets will now be attributed to the transferee enterprise.[13] However, it was also argued that it could lead to undesirable circumstances involving smaller transaction by large companies.[14]

Analysis of Regulation 5(9)

As mentioned in the preceding paragraphs, it has been argued that as a result of the application of this provision, it is now clear that where assets are hived off to a new enterprise, a valuation of the assets and turnover of such an enterprise for the purposes of Section 5 of the Act will include the assets and turnover of the company which transferred the said unit. Although as a matter of practical prudence, attributing such an interpretation to this regulation may indeed be wise. However, there are two potential problems with the way the provision has been worded which suggest difficulties such interpretation:

i. No parameters have been laid down as regards the determination of what the 'purpose' of the transfer of assets is. There may be situations where such purpose is

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[13] Pratibha Jain, Shashank Gautam & Simone Reis, *CCI Relaxes Notification Requirements!,*MONEYCONTROL.COM http://www.moneycontrol.com/news_html_files/news_attachment/2012/M&A%20Edge%20Special_BMR%20Advi sors.pdf(last visited on Sep. 22, 2015).

[14] *Id.*

expressed. For example, in *CCI* v. *Navyug Special Steel Private Limited*[15] the transfer of the steel and rings division of MUSCO to Navyug was a condition precedent to the very acquisition of Navyug by the acquirers.[16] In such a situation, it might not be difficult to establish the purpose of the transaction. However, such intention of the parties might not always be documented or otherwise unequivocally expressed.

In such a situation, it might be argued that the proximity in time of the 'series of steps or individual transaction' between themselves and along with the acquisition might be indicative of the purpose. However, the potential problem with this argument is that since there is no time based consideration in the provision, as a corollary, no actual time limit has been set which will guide the CCI in inferring purpose.[17] This will lead to ambiguity in the assessment of those enterprises which had transferred one of their units to a new enterprise long ago and with no specific purpose of acquisition and such enterprise would now, as per a fresh business decision wish to dispose of such subsidiary to a third party.

Thus, it is submitted that the regulation fails in drawing a distinction between two sets of transactions which are entirely different in terms of their purpose and leads to the danger of according purpose where there is none and vice versa.

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[15] COMPETITION COMMISSION OF INDIA, Commission Registration No. C-2011/12/14, http://www.cci.gov.in/May2011/OrderOfCommission/CombinationOrders/mitsuijan2012.pdf (last visited on Sep. 22, 2015).

[16] *Id.*

[17] *C.f.,* Commission Consolidated Jurisdictional Notice under Council Regulation (EC) No 139/2004 on the Control of Concentrations between Undertakings (2008/C 95/01) *available at* http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52008XC0416%2808%29 (last visited on Sep. 22, 2015).

ii. The Target Enterprise Exemption provides that it exempts enterprises satisfying the conditions therein 'from the provisions of Section 5 of the said Act.' On the other hand, Regulation 5(9) provides that the attribution of the value of assets and turnover of the transferee company to that of the transferor company will happen 'for the purpose of Section 5 of the Act.'

It is submitted that where the exemption excludes the applicability of Section 5, to interpret that a valuation under Section 5 will extend to matters exempt from Section 5 might not be consistent with the literal interpretation of the provisions. Thus, literal interpretations of the two provisions taken together, suggest that the Target Enterprise Exemption will apply notwithstanding Regulation 5(9).

However, it may be argued that literal interpretation of the two provisions might not be the correct approach and under the circumstances, a purposive reading of the provisions of law may be needed. This leads us tentatively to an important question the answer which seems to have been lost sight of in the Regulation 5(9) - what is the purpose of these provisions?

Purpose of the Regulatory Provisions

For a merger control analysis under the European Union, where an acquisition 'concerns the acquisition of parts of one or more undertakings, only those parts which are the subject of the transaction shall be taken into account with regard to the seller.'[18] Also, it is recognized that only those economic resources that are being subject to combination will have any impact on the market concerned and other parts of the business of the seller are irrelevant

[18] Commission Consolidated Jurisdictional Notice under Council Regulation (EC) No 139/2004 on the control of concentrations between undertakings (2008/C 95/01) *available at:* http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52008XC0416%2808%29.

for an analysis under the competition law.[19] This recognition is consistent with the international best practices.[20]

However, the Indian position in this regard seems to be different.[21] Although it is imperative that guidance derived from foreign legislations will be moulded according to factors relevant in Indian context, it is submitted that this particular departure from the internationally accepted standards does not appear to be satisfying any requirement unique to India. On the contrary, apprehension prevails that this requirement will continue to hamper transactions which in reality are extremely small and insignificant from a competition perspective and thus puts avoidable administrative burden on CCI as well as enterprises.[22]

Conclusion

The following suggestions may help to resolve the aforementioned issues:

i. As regards the valuation of the assets and turnover of the entire enterprise for the acquisition of a part of it, it is suggested that such an approach should be replaced with only such part or unit being considered.

ii. It is also noted that since the entire competition law framework in India is in a nascent stage, it is not surprising that the early stages of its implementation are rife with issues. However, it is suggested that where no patent harms are foreseen in applying an internationally accepted standard and such standard is rooted in a strong economic analysis, any alteration of such standards to suit the Indian context must be done only after careful and detailed analysis.

[19] *Id.*

[20] Reeves & Harrison, *supra* note7.

[21] *Id.*

[22] Jain, Gautam & Reis, *supra* note 13.

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Protection of Witness and Whistle Blower in India

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Abstract:
This research paper looks into the major problem which lies in Indian legal system in relation to witnesses. Since adversarial judicial system does not afford effective protection mechanism to witness as to their identity and physical and mental protection of witness, the justice seems to be a dream because in most of the criminal cases the destiny of case depends upon the statement made by witness. The legislation has many grey areas which are to be corrected otherwise Indian criminal justice system will get worsen and the rate of successful justice will fall down Though there is a Whistle-blowers Protection Act 2014, the effectiveness of the same is doubtful. The researcher has attempted to demonstrate the intense need for effective implementation of witness protection program and Whistle Blower protection by elaborating the problems faced by them.
In a number of criminal cases, including high profile cases such as Andhra film actor's shoot out case, Best Bakery case, a blast in a former Andhra minister's case, Jessica Lal case etc., the justice delivery system has failed to deliver justice and all these cases ended up with acquittal of accused due to the reason that witness turned hostile or witnesses were murdered. Other recent cases like VYAPAM case, ASARAM case, several witnesses were murdered or attacked. In Asaram's case, cook Akhil Gupta was attacked and other witness was killed since the arrest of Asaram in September, 2013. Other witnesses were subjected to acid attacks in the year 2014.
Similarly, the death of so many RTI activists and Satyendra yadav proves that there is a need to have a strong whistle-blower protection regime so that more people come forward and expose the wrongdoers. These cases have given rise to number of debates on the working of criminal justice system. In such state of affairs, we require to understand whether the carrying out of Witness Protection Program is a solution to prevent failure of justice due to witness turning hostile.
This research paper aims at discussing the inadequacy of law relating to protection of witness and whistle-blowers due to which there is a failure in criminal justice delivery system. Defending the defenders i.e. witness and whistle-blowers have become the need of an hour because they play an eminent role in the administration of justice.[i]

Keywords: *Witness Protection, whistle-blower, RTI activists, corruption, hostile witness, criminal justice system, The Whistle-blowers Protection Act, 2014, The Whistle-blowers Protection (Amendment) Bill, 2015.*

1. Introduction

Witness protection mechanism is the need of an hour for the effective delivery of justice since their statement can change the destiny of a case and thereby destiny of accused and victim The Supreme Court has that "legislative measures to emphasise prohibition against tampering with witness, victim or informant, have become the imminent and inevitable need of the day."[i] In many cases whole issue revolves around the statement made by witnesses and many a times it happens that they retract from their earlier statement. Judicial system not only has a responsibility to guard witnesses from being injured by the unknown or known parties interested in case but also to ensure that they do not turn hostile. Further the working of investigating agencies in India also casts a serious doubt on their integrity since in many cases they fail to protect the witnesses and witnesses disappear or are killed. Article 21 of the constitution of India provides for right to life, the role of law in case or criminal justice system is to punish the wrongdoer and give justice to aggrieved, however in the present situation these is a hike in rate of crime, and state is not able to prevent such crimes from being committed, further criminals take advantage of the loopholes of law and escape, they threaten the witness and he retracts from his statement, thereby frustrating the justice delivery system in India.[ii]

The witnesses and whistle-blowers do not feel safe to come to court and give statement against the accused that may belong to a wicked family or any powerful family and even if they give statement afterwards they deviate from their statement and turn hostile thereby leaving avenues for the accused to get acquitted and hampers the justice. Similar is the issue with the protection of

[i] Zahira Habibullah Sheikh v/s State of Gujarat, 2004 AIR SCW 2325; 2004 (4) SCC 158, Sir William Shakespeare has said, "You cannot witness for me, being slain"

[ii] Law Commission of India, '185th Report on Review of the Indian Evidence Act, 1872' Part-III A (March, 2003) available at lawcommissionofindia.nic.in/reports/185thReport-PartIIIA.pdf accessed on 28th August,2015

whistleblowers, who exposes the wrongdoings, as was done by Satyendra Dubey in Bihar who was killed because he exposed the wrongdoings of the highway authority. India does not have a law on protection of whistleblowers.

In 2010, of the total 1.68 lakh criminal cases pending before various magisterial and civil and session courts, the prosecution could secure conviction orders in just 1,948 cases, state CID figures reveal. The same year, defendants got acquitted in almost 7,000 cases, while another 1.58 lakh cases stayed pending.[iii] Further in Nagpur on 10th of july 2012 100 of people attacked 3 witness in Nagpur Session court, defeating the police security.[iv]

Although witness is the very important part in criminal justice system, he is a vital component for the administration of justice, he performs the public duty of assisting the court to reach to a decision, he invests his time and money, yet he is not treated with respect in the court of law, he is subjected to humiliation by the lawyers, they are put to lengthy irrelevant questions so that he feels frustrated and does not answer correctly in order to escape from the dishonour to which he is subjected, he is also subjected to threats, inducement, etc., at the hands of interested parties, all these things arouse a feeling that why is the judicial process in India not modified to cure such problems.? Often we come across with the issue that in criminal cases, the accused was acquitted because the witness on whose statement the edifice of evidence was based retracted from his earlier statement.

The witness protection has two aspects, firstly the investigating authority has to make sure that the statements made by witness before them is not changed during the proceedings in the court when he is put to oath. This is one aspect of problem of observable fact of witness turning hostile. So to prevent such occurrences, special provisions are to be introduced in the criminal law, but legislatures have to be careful while making law, since they have to make a balance between two aspects one is the need for anonymity of witnesses and other is the right of accused to cross examine the witness and to have an open trial. Secondly is the concern for physical as well as mental protection of the witness at every stage of criminal justice system, since he is under the clouds of death from the moment of witnessing the crime till the final conclusion of the case, for this we require a witness protection program.

Increase in rate of Hostile witness is a serious threat to criminal justice system. False statement given by hostile witness gives an opportunity to the accused to get acquitted, despite of the fact that he brutally committee any crime. There is a causal relationship between the increase in witness turning hostile and decrease in conviction rate in India. It can also be said that as the corruption grows in state machinery, the justice delivery system will collapse since it is the state on which we rely for delivery of justice. However, it is due to the weak judicial system and security issues that compels a witness to state false testimony and evidence. In most of the High profile cases, witness is threatened by the politicians, defence etc., due to which a weak witness does not dare to give statement against them. Due to which there is a very low conviction rate and in most of the cases the accused go unpunished thereby frustrating the very object of setting up the judiciary system. Every other day one can find in newspaper about the decrease in conviction rate in India, most of the accused escape by threatening the witness. In a number of case, witness has been attacked in the court itself, infront of the police, magistrate. This shows serious lack of responsibility on the part of police administration and security.

In trial of mass killing in Gujrat in 2002, witnesses changed their statements as they were threatened by the authorities and influential nationalist groups. If this continues to be so, then where the vulnerable section of society can get justice. Due to such prominent corruption in government, judiciary and other authorities, many cases are not filled in the courts and several lie in abeyance. If no witness protection program or and whistleblower program is drafted, then in future no person would come forward to give statements against the accused and conviction rate will go down till it reaches negligible.

The word witness has not been defined in Indian criminal law there fore the researcher refers to the Black's Law Dictionary which defines the word Witness as "one who sees, knows or vouches for something or one who gives testimony, under oath or affirmation in person or by oral or written deposition, or by affidavit"[v] Successful conclusion of a case depends upon the central role played by witness from the very beginning till the end

The word hostile is taken from the common law country; Indian Evidence Act does not mention this word. A hostile witness is one who according to The Black's Law Dictionary as "A witness who is biased against the examining party or who is unwilling to testify" the word hostile is nowhere defined under Indian law. Hostile witness is one who deviates from his previous statement, and does not speak in favour of his calling party.[vi]. Section 38 of the evidence Act provides that party calling the witness can cross examine the witness when the party is not satisfied with the answers, it is at this point of time that witness turn hostile and cause failure of justice.[vii]

2. Law Commission Report

Law commission 14th report initiated for the witness protection program, it focused on the decrease in conviction rate of accused due to witness turning hostile. This report provided for the allowances, adequate arrangement but no recommendations were made for physical security.

Further 154th law commission report also discussed other things; it provided for responsibilities of courts to work in such a manner that there are no unnecessary adjournments. Under The Chairmanship of Justice M. Jagannadha Rao Chairman Law Commission of

[iii] Rebecca Samervel, TNN Dipping conviction rate a sign of 'poor sleuthing' available at http://articles.timesofindia.indiatimes.com/2012-02-01/mumbai/31012048_1_conviction-rate-prosecution-cases-case-beyond-reasonable-doubt last accessed on 7th September 2015.

[iv] Low conviction rate, a result of poor security? TNN Jul 10, 2012, available at http://articles.timesofindia.indiatimes.com/2012-07-10/nagpur/32617550_1_district-court-security-measures-conviction-rate last accessed on 7th September 2015

[v] Garner Bryan A. (Ed), Black's Law Dictionary, West Group, St. Paul, Minnesota,17th Ed., 1999, p. 1596

[vi] Hostile witnesses not only destruct the interest of litigating party but also the duty of the court to reach the end of justice.

[vii] The term hostile is derived from the English law. Supreme Court in Gura Singh v State of Rajasthan (AIR 2001 SC 330) defined hostile witness under the common law as one who is not wishing to tell the truth at the request of party calling him and an unfavourable witness is one who fails to prove a particular fact or proves the opposite test.

India 198th Report[viii] witness identity protection and witness protection programmer was passed. This report provided a bill for the witness identity protection but does not provide a bill for witness protection program and only makes recommendations.
In its 178th Report (2001), the Law Commission recommended the insertion of Sec. 164A to provide for recording of the statement of material witnesses in the presence of magistrates on oath where the offences were punishable with imprisonment of 10 years and more. On the basis of this recommendation, the Criminal Law (Amendment) Bill, 2003 was introduced in the Rajya Sabha and is still pending. However, the second aspect has hardly received any attention in India.[ix] However this proposed amendment is impractical since there are number of offences, whose punishment is 10 years or more, then it would be very difficult for the magistrate to discharge his other functions, he will be busy in taking statements of witnesses on oath only. Mallimath committee[x] also suggested for a witness protection program to prevent failure of justice and to repose confidence in judiciary. However, the report did not exhaustively do much to solve the problem.

3. Challenges Faced by Witness

Some of the reasons are as follows:

- One of the most overwhelming reasons behind witness turning hostile is threat or terrorization to which they are subjected.
- Further witness undergoes a sense of insecurity due to lack of witness protection program. Since he is given no security why would he give statement against wicked people, who may injure him or his family?
- Thirdly even if he comes to give statement, the protracted judicial procedure frustrates him. It is common in India to adjourn the cases. The lawyers together with their clients through political pressure or absence of other party due to medical emergency gets their case adjourned.
- Fourthly witnesses are not treated with respect. They are made to wait under the tree, with no designated place of their own, with no proper arrangement of food, water etc.
  The Mallimath Committee has expressed its opinion about such witnesses by saying, "The witness should be treated with great respects and should be considered as a guest of honour."[xi]
- Sixthly there is no payment of allowances system followed by court officers. Sometimes witnesses come from a far away distance, and he may belong to a poor family, then also he is not compensated[xii].
- Witnesses get annoyed during investigation and trial because of prolonged examination and sometimes irrelevant questions, as a result of which they give a statement which pleases the court easily and this leads to acquittal of accused.

4. Importance of Witness

Witnesses carry out an important responsibility in criminal justice system. As rightly stated by Wadhwa J., "A criminal case is built on the edifice of evidence, evidence that is admissible in law. For that, witnesses are required whether it is direct evidence or circumstantial evidence[xiii].
The statement given by the witnesses helps the court to a great extent to frame the facts and circumstances of the case It is said that witness is weighed, they are not numbered. If a fact is fully proved by two witnesses, it is as good as if proved by a hundred[xiv]
There exists a responsible duty on a witness to state the truth and nothing else that is why before being examined he is put to oath. If he does not give correct answers he will be put to trial under section 190[xv] of the Indian penal code and may be penalized under section 193-195

[viii] Law Commission of India 198th report on witness identity protection and witness protection programs. Available at http://lawcommissionofindia.nic.in/reports/rep198.pdf last accessed on 22 August, 2015

[ix] SWAPNESHWARG, Witness Protection Law Vis-a-Vis Hostile Witness, available at http://jurisonline.in/2010/05/witness-protection-law-vis-a-vis-hostile-witness-2/ as visited on 16 August 2015

[x] Dr. Justice V.S. Malimath, 'Committee on Reforms of Criminal Justice System Government of India, Ministry of Home Affairs' Report VOLUME 1(March 2003), available at www.mha.nic.in/pdfs/criminal_justice_system.pdf, accessed in August 2015.

[xi] Committee on Reforms in Criminal Justice System, Headed by Justice Mallimath, Volume I, Page 151

[xii] "A witness in a criminal trial may come from a far-off place to find the case adjourned. He has to come to the Court many times and at what cost to his own-self and his family is not difficult to fathom. It has become more or less a fashion to have a criminal case adjourned again and again till the witness tires and he gives up. It is the game of unscrupulous lawyers to get adjournments for one excuse or the other till a witness is won over or is tired. Not only that a witness is threatened; he is abducted; he is maimed; he is done away with; or even bribed. There is no protection for him. In adjourning the matter without any valid cause a Court unwittingly becomes party to miscarriage of justice. A witness is then not treated with respect in the Court. And when he does appear in Court, he is subjected to unchecked and prolonged examination and cross-examination and finds himself in a hapless situation. For all these reasons and others, a person abhors becoming a witness. It is the administration of justice that suffers. Then appropriate diet money for a witness is a far cry. Here again the process of harassment starts and he decides not to get the diet money at all." G.S. Bakshi v. State AIR 1979 SC 569, Dr. Paramjit Kaur, 'TESTIMONY OF HOSTILE WITNESS : RECENT DEVELOPMENTS'(11/07/2009) available at lawherald.in/articlefull.php?id=8, accessed 4th September 2015

[xiii] Wadhwa J. in Swaran Singh v. State of Punjab, (2000)5 SCC 68 at 678

[xiv] Mr. Justice Buller in Calliand v. Vaughan, 1798; also see H.L. Menkin's Dictionary of Quotations on Historical
Principles from Ancient and Modern Sources, Collins, London and Glasgow, 1982 Edition, Page 1311, As rightly said "those in power, their henchmen and hirelings, political clouts and patronage and innumerable other corrupt practices ingeniously adopted to smother and stifle truth and realities coming out to surface rendering truth and justice to become ultimate casualties. Time has come when serious and undiluted thoughts are to be bestowed for protecting witnesses so that ultimate truth is presented before the court and justice triumphs and that the trial is not reduced to a mockery." (R vs. Scaife (1851) 20 L.J.M.C 229)

It is true that the statement given by hostile witness looses its credibility but as a whole it is not rejected as has been held in number of cases by Supreme court, to name few of them Balu Sonba Shinde v. State of Rajasthan[xvi], Koli Laxman Chana Bhai v. State of Gujrat[xvii],Gura Singh v. State of Rajasthan[xviii].

5. Legal Position

Regrettably India has no law relating for the protection of witness and the term is not defined in Criminal Procedure Code. Any person may be summoned at any stage of inquiry, trial by the court or court may examine any person if his evidence appears to have some relevance the case.[xix]

There are several provisions which protects witness from being asked indecent, scandalous, offensive questions, and questions which intend to annoy or insult them. Further once when accused is released on bail, one of the conditions is that he would not tamper the evidences or approach the witness. However, effectiveness of these provisions is highly suspicious. There are few special legislations like the Juvenile (Care and Protection of Children) Act, 2000 etc. But there are no concrete solutions of the issue of witness turning hostile or witness being murdered.

However initially provisions for protection of witness were laid down under Terrorists and Disruptive Activities (Prevention) Act, 1987 (TADA) and Prevention of Terrorism Act, 2002 (POTA)[xx]. Under abovementioned acts the judges were authorized to keep the identity of witness secure and whosoever was found disclosing the identity was penalized. However, such provision under the act was not found to be effective.

The certain changes have been made in Penal Code, Code of Criminal Procedure and Evidence Act. By the Criminal Law (Amendment) Act, 2005 (No.2 of 2006)[xxi] has been enforced with effect from. 16.4.2006. Section 195A[xxii] was introduced in Indian penal code. Further under Cr.P.C. Section 195 had also undergone changes.

SECTION 154[xxiii]: This section allows party to cross-examine his own witness like an adverse party with the permission of the court. However, the term used in the section 'put any question" does not mean cross-examining his own witness, it is asking him leading questions. This is not the same thing as cross examining.[xxiv] After going through the section 154 of Indian evidence act, the researcher winds up that section 154 only gives the authority to court to exercise its discretion that is when the court feels that the attitude revealed by the witness does not stand in accordance with the sense of duty to speak the truth. The provision does not mention the need to declare such witness as hostile witness before being invoked. Further the provision only mentions that such questions may be asked as are asked in cross-examinations. Therefore, it can be said that while common law classifies witness as hostile and adverse for the reason of cross-examining. Indian law does not distinguish; it only provides for the revelation of truth.

Section 151[xxv] forbids lawyers to ask indecent and scandalous questions, but there is an exception to this, if they relate to any fact in issue or is essential to bring out the truth, however in reality such provision has been misused, crooked lawyers ask such questions to witnesses which they would not like to answer, and insult them as well. Such behavior annoys the witness and he refrains from stating the truth.

Under section 161, police officer is authorized to take statements from the witness; however, such statements are not admissible in the court of law. The reason behind this is that sometimes police coerce the witness to state the things they want them to say. Hence he is required to state again in front of the magistrate and if there he retracts from his previous statement, then prosecution gets the chance to ask questions that may be asked in cross-examination. Unfortunately, such situation casts a serious doubt on the case of prosecution and looses the case.

However, section 164 lays down another option i.e. to produce the witness infront of he magistrate, so that his statement can be recorded infront of the magistrate, but such is not a substantive piece of evidence. It can only be used to corroborate the witness who made it and if it is found that he is lying or has reason to believe that what he knows is false, he can be punished for perjury.

[xv] Section 190. Threat of injury to induce person to refrain from applying for protection to public servant: Whoever holds out any threat of injury to any person for the purpose of inducing that person to refrain or desist from making a legal application for protection against any injury to any public servant legally empowered as such to give such protection, or to cause such protection to be given, shall be punished with imprisonment of either description for a term which may extend to one year, or with fine, or with both.--

[xvi] AIR 2002 SC 3137

[xvii] AIR 200 SC 210

[xviii] AIR 2001 SC 330

[xix] The Code of Criminal Procedure, 1973, s. 311.

[xx] POTA has been repealed by the Prevention of Terrorism (Repeal) Act 2004; w.e.f. 21-12-2004

[xxi] The Gazette of India-Extraordinary Part II-Section 3, Sub Section (ii); No.348, New Delhi, Wednesday, April 12, 2006, Ministry of Home Affairs Notification-S.O.523 (E)

[xxii] 195A.Threatening any person to give false evidence--Whoever threatens another with any injury to his person, reputation or property or to the person or reputation of any one in whom that person is interested, with intent to cause that person to give false evidence shall be punished with imprisonment of either description for a term which may extend to seven years, or with fine, or with both;

[xxiii] Article 154--Question by party to his own witness.- The Court may, in its discretion, permit the person who calls a witness to put any questions to him which might be put in cross- examination by the adverse party.

[xxiv] Bikiam Ali v. Emperor, AIR 1931 Cal. 139, Further in Ganga Singh v. State of Rajasthan AIR 2001 SC 330 it was stated that Section 154 authorizes the court to permit the party calling the witness to ask such questions that may be asked in cross-examination.the court has to exercise such discretion in cautious manner.

[xxv] Article 151--Indecent and scandalous questions.- The Court may forbid any questions or inquiries which it regards as indecent or scandalous, although such questions or inquiries may have some bearing on the questions before the Court unless they relate to facts in issue, or to matters necessary to be known in order to determine whether or not the facts in issue existed.

Further there are certain provisions under Criminal Procedure Code, which provides under Section 327 for trial in open court, so that there is transparency however clause 2 of section 327 provides for in-camera trial for certain offences such as rape under section 376 of IPC and 376A to 376D of IPC. The accused has a right to cross examine the witness however under section 299 an accused may be denied the right to cross examine in open court. Further under section 173(6) if the police officer finds that any statement under section 161 need not be disclosed to the accused in public interest then he may do so.

Article 14 of the International Covenant on Civil and Political Rights, which has been ratified by India, and is now a part of the Protection of Human Rights Act (1973), recognizes the right to fair trial as a human right, however in India fair trial has become a dream.

In the USA, agencies such as The United States Marshals Service, the Office of Enforcement Operations (OEO) and the Federal Bureau of Prisons (BOP) and The U.S. Attorney General's office, are associated with the programme.[xxvi] Under this a memorandum of association is signed by witness and his family member, the protection program is well coordinated with secrecy and the witness is given a job opportunity when he is shifted to other place. Further they are provided with identity documents on which fake names are entered for security reasons. They are given 24 hours' security when required. In India we do not have such responsible agencies to look for the protection of witnesses due to which conviction rate in India is very low as compared to US where it is 89% as per Marshal Services. Effective witness protection laws exist in US. Under Organized Crime Control Act of 1970, the Witness Protection Programme also known as WITSEC) was established which provides for the protection of witness. It also gives new identities to the witnesses who put their life into danger.

English law provides that attempt to persuade a witness to refrain from giving statement by threatening is contempt of court. Criminal Justice and Public Order Act, 1994 lays down provisions for punishment of such criminal intimidation of witnesses. Section 51 of Criminal Justice and Public Order Act, 1994 provides protection not only to the person who provides evidence before court but also to the person who is of potential help to the investigation. There is a Serious and Organised crime Act 2005, which provides that witnesses who are under a threat to life are to be provided with protection, further in addition to this police machinery may also provide protection to such witness. Further The Youth Justice and Criminal Evidence Act 1999 provides for protection of originality of the evidences. The act also authorizes the court to prohibit publication of matter which discloses identity of witness during his life time.

However, Delhi High court directed the government to draft a policy for witness protection and Delhi government took a step in the direction of witness protection under the rule of Aam Admi Party Leader and Delhi Chief Minister Mr. Kejriwal.[xxvii] But the fact that it still lay in abeyance proves that government is not keen to come up with witness protection programme.

The Whistle-blower Bill was first introduced by Law commission in 2011, due to the awful murder of Satyendra Dubey in 2003 and Manjunath Shanmugham in 2007. Further it was amended and in the year 2014 Protected Disclosures Act 2014 became operational. It is a counterpart of the RTI Act and endows people to address corruption and malpractice. Further The Whistle-blowers Protection (Amendment) Bill, 2015 was also introduced in Lok Sabha on May 11, 2015.[xxviii] This Bill has been introduced to give effect to the earlier amendments which could not be given effect.

The 2014 Act enables the person to disclose acts of corruption, misuse of power or criminal offence committed by public servant, but does not include maladministration as recommended by the Law Commission which is present UK, US Legislation. Further the Public servant does not include ministers so ministers are out of the purview of the Act. The Competent Authority before who the complaint can be made is the Prime Minister or Chief Minister in the case of Ministers, the Speaker or Chairman for Members of Parliament or state legislatures, the Chief Justice of the High Court for district court judges, and the Central or State Vigilance Commission for government servants.[xxix]

The Bill provides a procedure for receiving and making an inquiry into the public disclosures against acts of corruption, abuse of power, criminal offences by public servants. However, the Bill as compared to the Act provides 10 categories in which cases no reporting can be made of the disclosure. These categories relate to sovereignty, scientific, economic interests and security of India, proceedings of the Council of Ministers, breach of privilege of legislatures, intellectual property, an investigation process, etc. Further the Act permits disclosures that are prohibited under the Official Secrets Act (OSA), 1923.[xxx] The Bill amends the Act to prohibit the disclosure of 10 categories of information to a Competent Authority.

[xxvi] The Marshals Service, in the USA, assist witnesses with finding employment -- however, if a witness fails to aggressively seek employment, subsistence payments will be terminated. At that point, the relocated witness can enroll in public assistance if he or she chooses. At present, in India, we do not have such public assistance programmes. Dr G V Rao Witness Protection Program : Are we ready, available at http://www.lawyersclubindia.com/articles/Witness-Protection-Program-Are-we-ready-5036.asp#.UEiW5uGQNII last accessed on 6th September 2012.

[xxvii] The Delhi Witness Protection Scheme "envisages categorisation of witnesses, creation of witness protection fund, types of protection and procedure for processing such request by the competent authority," read a statement issued by the Home Department. Available at The Times of India, 15 July, 2015, http://timesofindia.indiatimes.com/india/Deaths-continue-but-witness-protection-law-still-a-far-cry/articleshow/48077837.cms last accessed on 19th December, 2015.

[xxviii] The Whistle-blowers (Amendment) Bill, 2015, http://www.prsindia.org/billtrack/the-whistle-blowers-protection-amendment-bill-2015-3784/. Last accessed on 19th December, 2015).

[xxix] See the Whistle Blower Protection Act 2014.

[xxx] The Whistleblowers Protection (Amendment) Bill, 2015 Available at http://www.prsindia.org/uploads/media/Public%20Disclosure/Brief%20Whistleblowers%20Protection%20(Amendment)%20Bill%202015.pdf Last accessed on 19th December, 2015).

RTI Act which permits the public authority to disclose all those categories which fall under 10 other categories of prohibited information in the Act and that falls under the Official Secrets Act 1923, if disclosing it in public interest is more important than harm done to protected interests. RTI Act also excludes few security and intelligence organizations from its ambit. It also provides a two stage process to appeal against a decision; such provisions are not there in the Whistle-blower (Amendment) Bill 2015.

In the procedural aspect the bill provides that if competent authority receives a public interest disclosure that falls under any of the 10 categories, he will forward that to government authorised authority. However, the bill is silent about the qualification or the members of such authority. If the authority is not independent or is not transparent then the whole idea of coming up with the bill is shattered.

Other jurisdictions like South Africa has no exemptions which makes it a strong whistle blower protection law, USA provides exemption in case of National Defence or Foreign Affairs or is prohibited by law, UK prohibits it case of national security, if it results in breach of legal professional ethics, if the person making the disclosure commits an offence by making it. The Bill, 2015 in India provides a list of exemptions which surely puts an umbrella restriction on the disclosure which can be made by any person against any public servant.

6. Judicial Decisions

Judiciary has time and again expressed the need for witness protection law, Madras High Court in August 2014, opined the need for statutory witness protection, because of the rise in multiple instances of witness turning hostile and witness deaths.

Jessica Lal murder case was one of the most disastrous case where after a long proceeding of 7 years, Session court acquitted the accused Manu Sharma, Manu Sharma was the son of Congress Political Leader, due to lack of evidence. The prosecution could not make a strong case, the investigating authority could not gather enough evidences, the witnesses turned hostile, and overall there was an awful failure of justice delivery system. Despite of the fact that everyone knew that accused is guilty, he was acquitted, what could be more disgusting than these Procedural technicalities together with the hostile witness caused gross injustice to the victim and her family.

Another famous case is Best Bakery case *(Zahira Habibulla H. Sheikh and Another vs. State of Gujarat and Others*[xxxi] *)*.wherein; Human rights commission intervened and raised the issue of failure of judiciary in delivering justice. In this case as well witness turned hostile; however, we need to ask who the culprit is, is it the parties or the witness himself or the state? In reality it is the state machinery, because responsibility lies on state to efficiently deliver justice and protect witness; however, state fails to do so. Public offices are full of corrupt people. Court has also become a mockery and nothing else. In this case witness Zahira found herself in an undesirable condition; she suffered not only at the hands of accused but also prosecution. She retracted from her earlier statement to save herself, but she could not escape from the punishment for perjury for changing her statement. Thus a witness suffers because of the failure of the state to protect him, which is highly lamentable. However, in this case Supreme Court made remarks about the state administration, court said that people have lost confidence over the state administration because of the negligent manner in which they work. The court further held that there is a need to have a witness protection program to generate successful justice system

In a recent decision of the Supreme Court in State of Maharashtra vs. Dr Praful B. Desai[xxxii]statement recorded through video-conference has been held to be permissible since the victim experience more comfort and feels free to answer without terror.

In the year 2003 Delhi high court issued certain guidelines[xxxiii] to police in providing protection to witness from the accused. A bench comprising Justice Usha Mehra and Justice Pradeep Nandrajog gave decision on the petition filled by Neelam Katara , as her son was kidnapped and killed by the accused, who was son of Rajya Sabha MP DP Yadav.

However even after such effort the fact that it has not been successful shows more stringent laws and effective implementation is required as Naroda Patia carnage[xxxiv] present a suitable case in point in this case the witness was provided with one police guard for

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[xxxi] (2004) 4 SCC 158

[xxxii] 2003 (4 SCC 601) The court while lamenting upon the conditions of witness in Swaran Singh v. State of Punjab AIR 2000 S.C. 2017 said that a given case is built on the statements made by witnesses, meaning thereby that they are crucial for the proper delivery of justice, but in reality they are not given due importance. As one can easily make out that in courts that they are not treated with respect. They are expected to wait for long hours without proper arrangement for water etc. He has no place to sit further he goes through prolonged examination, all these things together make him frustrated, as a result of which people refrain from becoming witness. The major reason behind witness turning hostile is danger to which they are exposed; they are threatened by the opposite parties.

[xxxiii] The guidelines were as follows:

- Member Secretary, Delhi Legal Services Authority would be competent authority who on, receipt of a request on a witness, decide "whether a witness requires protection, to what extent and for what duration", the court said.
- However the protection would be available only to witnesses who were to depose in cases punishable with death sentence or life imprisonment.
- In deciding whether to grant protection to a particular witness, the Competent Authority "shall" take into account the nature of the risk to the security of witness emanating from the accused or his associates and the nature of probe or the criminal case.
- The authority shall also consider the importance of the witness and the value of evidence given or agreed to be given by him/her besides the cost of giving protection to him or her.
- While recording the statement of witness under Section 161 of the CrPC, it would be the duty of the investigating officer to make the witness aware of these guidelines and also the fact that in case of any threat he/she can approach the Competent authority.
- Once the competent authority decides to extend the protection to a particular witness, it "shall" be the duty of the police Commissioner to provide protection to him or her.

Nishant Gaurav Gupta, 'REPORT ON PROTECTION OFWITNESSES' available at,www.ccsindia.org/ccsindia/ec/ec_feb2005_gupta.pdf, accessed on 5th September 2014

protection but after he finished his duty for the day, the witness was attacked by 30 persons. It is highly lamentable that the prime witness was given only one police guard and that to only for the day.

7. Conclusion

The researcher concludes by stating that Indian criminal system consists of several lacunas which are required to be spotted and amended by the legislature. Referring to best bakery case, Jessica lal and other cases, it is pertinent to mention that such cases makes the need for witness protection programme more necessitated. Present working of state administration, judicial system casts a serious doubt on criminal justice system. Therefore, at this time legislature must be up and doing to make laws for witness protection. Further as the society transforms, criminal attitudes, tactics implemented by lawyers and the same changes, therefore such change is also required to be made in laws so as to cope up with the criminal attitudes. Time has come when the existing criminal system is to be taken out from the hands of corrupt, unprincipled lawyers and lethargic state machinery and to be placed on proper plinth. There is a graver need to have stringent laws for the protection of witnesses and whistleblowers those justice triumphs over the inherent complexities of the adversarial judicial system.

The researcher is immensely moved by deaths of whistleblowers, who sacrifice their life knowingly that exposing the illegal activities will put him under the clouds of death. Their deaths can never be compensated with anything but effective and efficient legislation can be passed to make them feel secured. We can not afford to loose such righteous nation- oriented persons at the cost of wicked people who like parasites are eating away the nation's reputation.

While there are few provisions dealing with witness protection where it is the duty of police to protect witness however the amount of corruption that exists in administration machinery shakes the faith of a common man on police, and people do no rely on police for their protection. Police is considered to be the last person; a common man would like to approach. The police, judicial officers, they all work together to make money by hook or by crook, and ignore the fact that they have a duty to discharge their functions properly in public interest and not in their personal interest. Therefore, if witnesses continue to turn hostile and the whistle blowers are restricted to make disclosure or are killed then it will smash to smithereens the criminal justice system in India and people will loose confidence in the reliability in judiciary, legislature, police and other authorities.

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vi. Hostile witnesses not only destruct the interest of litigating party but also the duty of the court to reach the end of justice.
vii. The term hostile is derived from the English law. Supreme Court in Gura Singh v State of Rajasthan (AIR 2001 SC 330) defined hostile witness under the common law as one who is not wishing to tell the truth at the request of party calling him and an unfavourable witness is one who fails to prove a particular fact or proves the opposite test.
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xii. "A witness in a criminal trial may come from a far-off place to find the case adjourned. He has to come to the Court many times and at what cost to his own-self and his family is not difficult to fathom. It has become more or less a fashion to have a criminal case adjourned again and again till the witness tires and he gives up. It is the game of unscrupulous lawyers to get adjournments for one excuse or the other till a witness is won over or is tired. Not only that a witness is threatened; he is abducted; he is maimed; he is done away with; or even bribed. There is no protection for him. In adjourning the matter without any valid cause a Court unwittingly becomes party to miscarriage of justice. A witness is then not treated with respect in the Court. And when he does appear in Court, he is subjected to unchecked and prolonged examination and cross-examination and finds himself in a hapless situation. For all these reasons and others, a person abhors becoming a witness. It is the administration of justice that suffers. Then appropriate diet money for a witness is a far cry. Here again the process of

[xxxiv] Witness Hostility sabotaging fair trials and Frustrating the Courts in India available at http://legalsutra.org/3243/witness-hostility-sabotaging-fair-trials-and-frustrating-the-courts-in-india/ last accessed on 4th September 2012

harassment starts and he decides not to get the diet money at all." G.S. Bakshi v. State AIR 1979 SC 569, Dr. Paramjit Kaur, 'TESTIMONY OF HOSTILE WITNESS : RECENT DEVELOPMENTS'(11/07/2009) available at lawherald.in/articlefull.php?id=8, accessed 4th September 2015

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xix. The Code of Criminal Procedure, 1973, s. 311.

xx. POTA has been repealed by the Prevention of Terrorism (Repeal) Act 2004; w.e.f. 21-12-2004

xxi. The Gazette of India-Extraordinary Part II-Section 3, Sub Section (ii); No.348, New Delhi, Wednesday, April 12, 2006, Ministry of Home Affairs Notification-S.O.523 (E)

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xxx. The Whistleblowers Protection (Amendment) Bill, 2015 Available at http://www.prsindia.org/uploads/media/Public%20Disclosure/Brief%20Whistleblowers%20Protection%20(Amendment)%20Bill%202015.pdf Last accessed on 19th December, 2015).

xxxi. (2004) 4 SCC 158

xxxii. 2003 (4 SCC 601) The court while lamenting upon the conditions of witness in Swaran Singh v. State of Punjab AIR 2000 S.C. 2017 said that a given case is built on the statements made by witnesses, meaning thereby that they are crucial for the proper delivery of justice, but in reality they are not given due importance. As one can easily make out that in courts that they are not treated with respect. They are expected to wait for long hours without proper arrangement for water etc. He has no place to sit further he goes through prolonged examination, all these things together make him frustrated, as a result of which people refrain from becoming witness. The major reason behind witness turning hostile is danger to which they are exposed; they are threatened by the opposite parties.

xxxiii. The guidelines were as follows:

- Member Secretary, Delhi Legal Services Authority would be competent authority who on, receipt of a request on a witness, decide "whether a witness requires protection, to what extent and for what duration", the court said.
- However the protection would be available only to witnesses who were to depose in cases punishable with death sentence or life imprisonment.
- In deciding whether to grant protection to a particular witness, the Competent Authority "shall" take into account the nature of the risk to the security of witness emanating from the accused or his associates and the nature of probe or the criminal case.
- The authority shall also consider the importance of the witness and the value of evidence given or agreed to be given by him/her besides the cost of giving protection to him or her.
- While recording the statement of witness under Section 161 of the CrPC, it would be the duty of the investigating officer to make the witness aware of these guidelines and also the fact that in case of any threat he/she can approach the Competent authority.
- Once the competent authority decides to extend the protection to a particular witness, it "shall" be the duty of the police Commissioner to provide protection to him or her.
- Nishant Gaurav Gupta, 'REPORT ON PROTECTION OFWITNESSES' available at, www.ccsindia.org/ccsindia/ec/ec_feb2005_gupta.pdf, accessed on 5th September 2014

xxxiv. Witness Hostility sabotaging fair trials and Frustrating the Courts in India available at http://legalsutra.org/3243/witness-hostility-sabotaging-fair-trials-and-frustrating-the-courts-in-india/ last accessed on 4th September 2012

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Public financing of solar lanterns versus subsidizing kerosene for domestic lighting in India: A feasibility assessment

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ABSTRACT

In India, kerosene is primarily used for domestic lighting in un-electrified rural households. The government incurs significant expenditure on subsidies and under-recoveries associated with supply of kerosene distributed through public distribution system. In addition to poor illumination and indoor pollution, kerosene lamp usage necessitates expenditure on purchase of kerosene for lighting. The study evaluates the feasibility of diverting subsidies and under-recoveries provided by government and the fuel cost incurred by the user to finance replacement of kerosene lamps with solar lanterns. It is found that such an initiative will save money for both the government as well as the users besides providing better quality illumination without any indoor pollution.

1. Introduction

Access to affordable energy is essential for socio-economic development of a society [1]. Energy availability for domestic lighting has been an important factor in assessment of access to energy [2]. In electrified households, illumination is normally provided by lighting devices (incandescent bulb, fluorescent tube, compact fluorescent lamp or light emitting diode) powered by electricity. On the other hand, un-electrified households often use kerosene based lighting devices such as wick lamp, hurricane lantern, etc. for lighting [3]. The illumination provided by commonly used kerosene based lighting devices is rather poor (10–100 lumens) [4]. Also, a significant fuel cost is incurred in operation of a kerosene lamp [4–6]. In addition, use of kerosene for domestic lighting contributes to indoor air pollution besides its contribution to GHG emissions [4]. For an oil importing country such as India, kerosene consumption is directly related to the import of crude oil that impacts the import bill of the country [7]. Also, kerosene is supplied at subsidized price in India leading to increased government expenditure [3,8–11].

It is therefore desirable to develop and promote better domestic lighting alternatives to the households that have little possibility of accessing conventional electricity grid. Such alternatives could also be attractive for households suffering from an erratic supply of electricity. Use of solar lighting device such as solar lantern can be considered as a domestic lighting option for such households. However, as a substantial fraction of the potential users may not have the purchasing power to invest in a solar lantern, different possibilities of incentivizing such an adoption need to be carefully assessed. In fact, the state of Chhattisgarh in India has announced a scheme that involves free delivery of solar lanterns in lieu of the withdrawal of kerosene subsidy made available to the eligible users [12]. In addition to capital subsidy, soft loan has also been used to promote solar lanterns in India [13–15]. However, there could be several other potential modalities of promoting the adoption of solar lanterns among such users with corresponding withdrawal of subsidy from kerosene delivered to them. Thus, in this paper, an attempt has been made to assess the feasibility of promoting solar lanterns through various modalities (including capital subsidy and/or soft loan) as against the supply of subsidized kerosene for domestic lighting. The paper highlights the issues associated with kerosene distribution and its usage in India. It presents the expenditure on subsidies incurred by the government in distribution of kerosene and the fuel expenses by households practicing kerosene based lighting. A comparison of kerosene lamp with solar lantern is also presented in the paper. Based on expenditure assessments of government and household for kerosene distribution and usage respectively, various options for promotion of solar lanterns have been explored.

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2. Use of kerosene as a domestic fuel in India

Kerosene is used in the domestic sector of India for lighting and cooking. A summary of some aspects of kerosene use in the country is presented in this section.

2.1. End-use of kerosene

India is predominantly a rural society with about 69% of its total population of 1.21 billion living in villages [16]. Only 55.3% of the rural households are reportedly electrified [16]. In the absence of grid electricity, 43.2% of the rural households are reportedly using kerosene for lighting (Table 1). Even electrified households in areas facing erratic power supply are reportedly using kerosene as a backup fuel for lighting [3]. In India, kerosene is also used for cooking in 0.7% and 7.5% rural and urban households respectively (Table 1) [16]. Thus, with significantly higher usage of kerosene, domestic lighting is the primary end-use of kerosene in India. Usage of kerosene as a secondary fuel for lighting and cooking has also been reported across India [10].

2.2. Kerosene distribution in India

In India, kerosene is primarily supplied through government established Public Distribution System (PDS) [8]. Kerosene is distributed at subsidized price through PDS to the households designated as targeted consumers of PDS kerosene. The eligibility and entitlement criteria of PDS kerosene varies across the states in India as these are fixed by state governments [9,17]. In general, eligibility of a household depends on a number of factors – access to LPG, electrification, area (rural/urban), income of household (above/below poverty line), etc. [17]. However, access to LPG is the most common eligibility criteria used across the states in India [8,17]. For example, in the state of Maharashtra, households with 2 LPG cylinders are not entitled to kerosene made available through PDS whereas households with 1 LPG cylinder are entitled to 4 L of kerosene per month per household. Similarly, quota allocation for a household without any LPG cylinder increases with family size up to a maximum of 15 L per month in Maharashtra [8].

In addition to PDS, Government of India introduced parallel marketing of kerosene in 1993 [3]. Under this scheme, private parties may import and market kerosene at market-determined prices. To differentiate PDS kerosene from the kerosene sold by parallel marketers, a blue dye is added to it [3].

Apart from the government authorized suppliers, unauthorized open market sale of kerosene through diversion of subsidized PDS kerosene has also been reported in India [3,8,9,11,18]. Diversion of PDS kerosene is done to arbitrage the price difference between PDS kerosene and open market kerosene [10]. PDS kerosene is also diverted to adulterate diesel [9,11,19]. Reportedly, about 25% of PDS kerosene is diverted to open markets across India for unauthorized sale at higher prices [3]. According to a survey conducted by National Council for Applied Economic Research in 2005, states such as Bihar, Delhi, Jharkhand, Orissa and Punjab have reported more than 50% diversion whereas Assam, Chhattisgarh, Tamil Nadu and Uttarakhand have reported 40–50% diversion [17]. Some households purchase a fraction of their kerosene requirement from open markets [3]. A survey conducted in the state of Maharashtra in India has reported that households purchase over 40% of their consumption from open markets [8]. Diversion of PDS kerosene to open markets leads to wastage of government subsidy on PDS kerosene as the households purchasing kerosene from such markets are paying much higher price than the subsidized price of kerosene. To check unauthorized sale of PDS kerosene in open market, government of India has proposed Direct Transfer of Cash Subsidy on PDS Kerosene (DTCK) [9,11,20]. DTCK scheme intends to curb diversion of PDS kerosene to unauthorized open market by supplying kerosene at market price and directly transferring the subsidy to the bank account of the beneficiary [20]. After the satisfactory pilot in Alwar district of Rajasthan, DTCK scheme is about to be implemented in 7 districts in India [21]. However, it has been reported that though cash transfers may be beneficial to the households as it provides them wide ranges of spending options, it may not be the best option to promote efficient and cleaner forms of energy such as solar lantern [9,22].

2.3. Financial implications of kerosene distribution

Distribution of kerosene through PDS at subsidized price in India has resulted in significant government expenditure. Reportedly, India has the highest subsidy levels for kerosene in the world [23]. During the last decade, international prices of crude oil and kerosene have experienced an upward trend (Fig. 1) whereas price of PDS kerosene in India has not been allowed to increase proportionately (Table 2). To keep the price of PDS kerosene artificially low, a mechanism involving subsidies to consumers and under-recoveries to oil companies has been implemented by Government of India [9]. Under-recoveries to the oil companies are indirect subsidies that are compensated by two mechanisms: a) cash assistance is provided to the oil companies by the government; b) government devises a burden-sharing formula varying from year to year by which oil exploration companies and oil marketing companies share the under-recoveries [9]. The increase in subsidies (including under-recoveries) per liter of kerosene under PDS and price of PDS kerosene are presented in Table 2. The table also presents the subsidies and under-recoveries related expenditure associated with PDS kerosene in India. In the absence of a fixed formula, there has been uncertainty with respect to burden sharing

Table 1
Fuel mix (in percentage) for domestic lighting and cooking in rural and urban households of India [16].

Fuel	Cooking		Fuel	Lighting	
	Rural households (%)	Urban households (%)		Rural households (%)	Urban households (%)
Fire-wood	62.5	20.1	Electricity	55.3	92.7
Crop residue	12.3	1.4	Kerosene	43.2	6.5
Cow dung	10.9	1.7	Other sources	1.0	0.5
Coal, lignite, charcoal	0.8	2.9	No lighting	0.5	0.3
Kerosene	0.7	7.5			
LPG/PNG	11.4	65.0			
Electricity	0.1	0.1			
Biogas	0.4	0.4			
Any other	0.6	0.2			
No cooking	0.2	0.5			

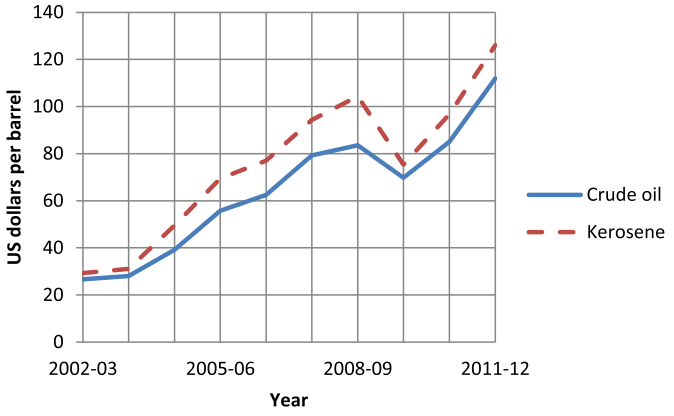

Fig. 1. Time trend of international prices (at current price) of crude oil and kerosene [7].

of under-recoveries among government of India, oil exploration companies and oil marketing companies [24]. About 60% of the under-recovery was borne by the government during 2008–2013 [24]. Sharing of under-recoveries by oil exploration and oil marketing companies coupled with delay in its compensation by the Government of India has been adversely affecting the cash flow of the companies. Thus, due to subsidies and under-recoveries associated with kerosene, both government and oil companies are being affected financially.

3. Comparison of solar lantern with kerosene based lighting devices

A solar lantern consists of a PV module, a sealed maintenance free (SMF) battery, a charge controller, cable, switches, housing and a CFL or LED. The solar lantern specified by Ministry of New and Renewable Energy (MNRE), Government of India has a designed duty cycle of 4 h per day along with 3 days of autonomy [25]. A comparison of kerosene (hurricane) lantern and solar lantern has been presented in Table 3. Like hurricane lantern, solar lantern is also portable and thus suits outdoor lighting [26]. Kerosene lamps emit harmful GHG during its operation whereas solar lanterns have emission free operation [4]. Ease of operation is another favorable attribute of solar lantern [26]. Operational (fuel) cost is zero for a solar lantern whereas a kerosene (hurricane) lantern with a fuel consumption rate of 0.04 L/hour would consume about 5 L of kerosene per month for 4 h of lighting per day. Useful life and cost of components of solar lantern are presented in Table 4. Apart from scheduled replacement of components, operation and maintenance of solar lantern is almost free. Thus, solar lantern offers the advantages of almost free operation and maintenance with better lighting and reduced environmental emissions as compared to kerosene lamps.

Table 3
Comparison of kerosene (huuricane) lantern and solar lantern [4,32].

Parameter	Unit	Kerosene (hurricane) lantern	Solar lantern (CFL)	Solar lantern (LED)
Luminous flux	Lumen	70	370	150
Specific fuel consumption	Liter/hour	0.04	NA	NA
Daily operational hours	Hours	4	4	4
Useful life of lamp/lantern	Years	5	20	20
CO_2 Emissions per year	kg	149.62	Nil	Nil
Portability	–	Portable	Portable	Portable

4. Feasibility assessment of public financing of solar lantern with kerosene related subsidies and expenditure

Solar lantern has been promoted in un-electrified rural households of India as a domestic lighting option [25]. The households located in sunny areas and practicing kerosene based lighting are potential adopters of solar lantern. Areas having annual average daily value of global solar radiation on a horizontal surface (global horizontal irradiance, GHI) of 5.00 kWh/m^2/day or more are considered as potential areas for PV systems such as solar lanterns [27]. From solar radiation perspective, the state of Uttarakhand in India is a very favorable location. All 13 districts of the state reportedly receive GHI greater than 5.00 kWh/m^2/day (Table 5). Considering the variations in eligibility criteria and entitlement with respect to PDS kerosene across various states and the suitability of Uttarakhand for solar PV devices, this study attempts to assess the feasibility of promotion of solar lanterns in the state. From the study of the state of Uttarakhand, inferences have been drawn to assess the feasibility of promotion of solar lanterns in un-electrified households located in other sunny states of India.

Table 2
Subsidy and under-recovery on PDS kerosene in India.

Year	Subsidy on PDS kerosene (Rs[c]/liter) [28]			Price of PDS kerosene[b] (Rs/liter) [24]	Annual expenditure ($\times 10^7$ R)		
	Government subsidy	Under-recovery	Total[a]		Subsidy [29]	Under-recovery [30]	Total
2002–03	2.45	1.69	4.14	8.98	2098	2067	4165
2003–04	1.65	3.12	4.77	8.98	2657	3751	6408
2004–05	0.82	7.96	8.78	8.98	1147	9480	10,627
2005–06	0.82	12.10	12.92	9.09	1057	14,384	15,441
2006–07	0.82	15.17	15.99	9.09	970	17,883	18,853
2007–08	0.82	16.23	17.05	9.09	978	19,102	20,080
2008–09	0.82	24.06	24.88	9.09	974	28,225	29,199
2009–10	0.82	14.85	15.67	9.09	956	17,364	18,320
2010–11	0.82	17.39	18.21	12.32	931	19,484	20,415
2011–12	0.82	26.46	27.28	14.79	863	27,352	28,215
2012–13	0.82	31.16	31.98	14.79	741	29,410	30,151
2013–14	0.82	33.98	34.80	14.96	676	30,574	31,250
2014–15 [31]	0.82	32.87	33.69	14.96	–	–	–

[a] Total subsidy has experienced large fluctuations during years 2002–03 to 2004–05. Thus, to avoid errors due to large fluctuations that occurred long back, Compound annual growth rate (CAGR)[d] of the total subsidy has been estimated from the year 2005–06. The estimated CAGR of total subsidy is 11.24%.

[b] CAGR of price of PDS kerosene is estimated as 4.34%.

[c] 1 US dollar = Rs 58.50 as on 19th May, 2014.

[d] $CAGR = \left(\frac{Final\ value}{Initial\ value}\right)^{\frac{1}{Number\ of\ years}} - 1$.

Table 4
Useful life and cost breakup of the components of MNRE specified solar lantern.

Component	Solar Lantern (CFL)				Solar Lantern (LED)				
	Useful life (years)	Source	Cost (Rs)	Source	Component	Useful life (years)	Source	Cost (Rs)	Source
CFL (7 W)	5 (8000 h of life and 4 h of operation per day)	[4]	75	[33]	White LED	34 (50,000 h of life and 4 h of operation per day)	[4]	269	[34]
PV module (10 W_p)	20	[4]	899	[35]	PV module (5 W_p)	20	[4]	650	[36]
SMF battery (12 V, 7 Ah)	5	[4]	900	[37]	SMF battery (12 V, 4.5 Ah)	5	[4]	455	[38]
Charge controller	10	[39]	400	[40]	Charge controller	10	[39]	400	[40]
Balance of system	20	[39]	256	[41]	Balance of system	20	[39]	256	[41]
Total cost of system			2530		Total cost of system			2030	

Table 5
Solar radiation (GHI) in Uttarakhand [43].

District	GHI (kWh/m^2/day)
Uttarkashi	5.21
Chamoli	5.27
Rudraprayag	5.32
Tehri Garhwal	5.34
Dehradun	5.15
Garhwal	5.27
Pithoragarh	5.41
Bageshwar	5.35
Almora	5.36
Champawat	5.23
Nainital	5.06
Udham Singh Nagar	5.24
Hardwar	5.27

4.1. Potential usage of solar lantern in Uttarakhand

Uttarakhand is a hilly state in India with about 69% of its population residing in rural areas and only 31% population living in urban areas [16]. In the state, 221,206 and 35,676 households are using kerosene as a primary fuel for lighting and cooking respectively [16]. Many households may also be using kerosene as a back-up fuel for lighting and cooking. In addition to this, the state has reported 40–50% diversion of PDS kerosene [17]. To fulfill kerosene needs of the consumers in the state, kerosene is distributed through PDS. As per the latest data, 3,002,000 L of kerosene was distributed monthly under PDS in Uttarakhand [42]. With good solar radiation availability throughout the year in Uttarakhand, 221,206 households using kerosene for lighting may be considered as the potential users of solar lantern.

4.2. Life cycle savings from replacement of kerosene lamp with solar lantern

Replacement of kerosene lamp with solar lantern in Uttarakhand would result in savings for government and households by avoiding expenditure on subsidies and purchase of kerosene respectively. The savings can be used to finance solar lanterns for adoption among its potential users (Fig. 2). To assess the viability of financing solar lanterns in Uttarakhand, it is necessary to estimate

Table 6
Input parameters associated with government and household expenditure.

Parameter	Unit	Value
Price of PDS kerosene	Rs/liter	14.15
CAGR of price of PDS kerosene	%	4.34
Price of kerosene in open market	Rs/liter	50.00
CAGR of price of kerosene in open market	%	4.34
Stipulated quota of PDS kerosene per household	liter/month	5.00
Total government subsidy on PDS kerosene	Rs/liter	33.69
CAGR of total government subsidy on PDS kerosene	%	11.24
Lighting duration per day	hours	4.00
Specific fuel consumption of kerosene (hurricane) lamp	liter/hour	0.04
Monthly kerosene consumption by a kerosene lamp	liter	5.00
Discount rate (i)	%	10.00

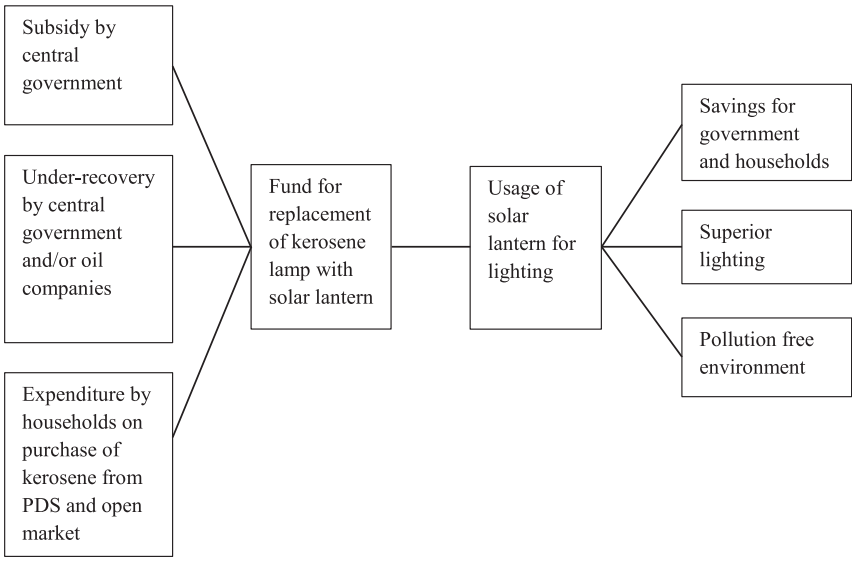

Fig. 2. Public financing of solar lantern with kerosene related subsidies and expenditure.

Table 7
Cash flow and annual savings from replacement of kerosene lamp with solar lantern.

Year	Annual expenditure (Rs) on purchase of CFL/LED based solar lantern		Annual expenditure on replacement of parts of CFL based solar lantern		Annual expenditure on replacement of parts of LED based solar lantern		Annual savings (Rs) by government under Case I at base value of Rs 33.69 per liter with 11.24% CAGR	Annual savings (Rs) by government by under Case II at base value of Rs 33.69 per liter with 11.24% CAGR	Annual savings (Rs) by a household under Case I at base value of Rs 14.15 per liter with 4.34% CAGR	Annual savings (Rs) by a household under Case II (5 L of subsidized PDS kerosene at base price of Rs 14.15 per liter and 5 L of kerosene purchased from open market at Rs 50.00 per liter) with 4.34% CAGR
	CFL	LED	Item replaced	Amount (Rs)	Item replaced	Amount (Rs)				
0	2530	2030								
1							2021	4043	849	3849
2							2249	4497	886	4016
3							2501	5003	924	4190
4							2783	5565	964	4372
5			CFL Battery	75,900	Battery	455	3095	6191	1006	4562
6							3443	6886	1050	4760
7							3830	7660	1096	4967
8							4261	8521	1143	5182
9							4740	9479	1193	5407
10			CFL Battery PCB	75,900,400	Battery PCB	455,400	5272	10,545	1244	5642
11							5865	11,730	1298	5886
12							6524	13,048	1355	6142
13							7257	14,515	1414	6409
14							8073	16,146	1475	6687
15			CFL Battery	75,900	Battery	455	8981	17,961	1539	6977
16							9990	19,980	1606	7280
17							11,113	22,226	1675	7596
18							12,362	24,724	1748	7925
19							13,751	27,503	1824	8269
20							15,297	30,594	1903	8628
Present value	2530	2030		1369		721	40,968	81,936	9785	44,361

Table 8
Summary of parameters obtained from cash flow analysis of replacement of kerosene lamp with solar lantern.

Parameter	Value (Rs)
Present value of expenditure on purchase of CFL based solar lantern ($P_{P,CFL}$)	2530
Present value of expenditure on purchase of LED based solar lantern ($P_{P,LED}$)	2030
Present value of expenditure on operation and maintenance (replacement of parts) of CFL based solar lantern ($P_{OM,CFL}$)	1369
Present value of expenditure on operation and maintenance (replacement of parts) of LED based solar lantern ($P_{OM,LED}$)	721
Present value of government savings under Case I by avoiding subsidy on 5 L of PDS kerosene per month ($P_{GS,CASE\ I}$)	40,968
Present value of government savings under Case II by avoiding subsidy on 10 L of PDS kerosene per month ($P_{GS,CASE\ II}$)	81,936
Present value of household savings under Case I ($P_{HS,CASE\ I}$)	9785
Present value of household savings under Case II ($P_{HS,CASE\ II}$)	44,361

the expenditure involved in supply and use of PDS kerosene for funding the purchase and maintenance of solar lanterns in the state. There are certain variances with respect to PDS kerosene supply in Uttarakhand in comparison to the PDS scheme in other states of India. Uttarakhand is a hilly state and is thus eligible for additional subsidy (freight subsidy) under far-flung area scheme [44]. Due to the additional subsidy, PDS kerosene is being distributed in the state at the rate of Rs 14.15 per liter [45]. Non-LPG connected households in plain areas of the state are eligible for 5 L of kerosene per month whereas those in hilly areas are entitled to 7 L of kerosene per month [42]. Like other states in India, PDS kerosene is also diverted to unauthorized open market sale in Uttarakhand. Inquiries from kerosene vendors in the state have revealed that the current price of kerosene in open market is Rs 50.00 per liter. For assessment of viability, various input parameters pertaining to solar lantern that have been presented in Table 4 were used in the analysis. For estimation of expenditure on distribution and usage of kerosene, input values of relevant parameters are presented in Table 6. CAGR of 4.34% (estimated for price of PDS kerosene in Table 2) is assumed to be applicable to the price of kerosene in open market as well.

Replacement of a kerosene lamp with solar lantern would result in savings for both the government and the household as a result of avoidance of expenditure on subsidies and purchase of PDS kerosene respectively. Generally, one or two kerosene lamps are used in rural households of India for lighting and thus two cases are considered in the study:

a) Case I – In a household, a kerosene lamp is replaced by a solar lantern resulting in avoidance of expenditure on purchase of stipulated quota of 5 L of PDS kerosene.
b) Case II – In a household, two kerosene lamps are replaced by two solar lanterns leading to avoidance of expenditure on purchases of: i) stipulated quota of 5 L of PDS kerosene, and; ii) 5 L of kerosene procured from open market.

In this study, it is assumed that the subsidies and price per liter of PDS kerosene would increase every year as per its corresponding CAGR whereas the cost of solar lantern components would remain constant as technology advancement, learnings and economy of scale would counter inflation. As solar lantern is almost operation and maintenance free apart from the replacement cost of its components during the useful life of the lantern, it is assumed in the study that operation and maintenance cost only involves the cost of component replacement. Considering time value of money, present value[1] of annual savings and expenditure on component replacements during 20 years useful life of solar lantern is estimated for an assumed discount rate of 10% (Table 7). For Case I, the present value of savings for government and household are Rs 40,968 and Rs 9785 respectively. Similarly, for Case II, the present value of savings for government and household are Rs 81,936 and Rs 44,361 respectively. Summary of estimated present values of savings and expenditures for both stakeholders (government and household) is presented in Table 8. The savings may be used for promotion of solar lantern through various schemes that may involve kerosene related subsidies and expenditure.

4.3. Modalities of public financing of solar lantern

The study proposes the following four modalities under each case (Case I and Case II as defined earlier) for promotion of solar lantern among kerosene lamp users in Uttarakhand:

1. Cash grant 1: 100% capital subsidy on solar lantern by government and the household takes care of operation and maintenance of solar lantern
2. Cash grant 2: 30% capital subsidy on solar lantern by government (as prescribed by MNRE) and the household pays remaining 70% amount [15] and also takes care of operation and maintenance of solar lantern
3. Soft loan – Soft loan scheme of MNRE with 40% capital subsidy by government, 20% margin money by the household and 5-year loan on 40% of capital cost at 13% annual rate of interest [13–15,46] and the household takes care of operation and maintenance of solar lantern
4. Own purchase – Household purchases solar lantern and takes care of its operation and maintenance without any government support

Present value of net savings for both government and household under the above mentioned modalities for both the cases (Case I and Case II) has been estimated using the expressions presented in Table 9.

Similarly, estimations have been made for present values of LED based solar lanterns. The results of the estimations for the four modalities under Case I and Case II are presented in Table 10. The present value of net savings for both stakeholders is positive and significant enough to justify replacement of kerosene lamps with solar lantern in Uttarakhand. Even without any government support, the estimated present value of net savings for a household replacing two kerosene lamps with two LED based solar lanterns is Rs 38,859. In spite of being such a feasible option, solar lantern has some uncertainties associated with it. Apart from uncertainties associated with solar radiation availability, variable useful life of lamps (CFL and LED) is another issue of concern. The useful life values quoted by the manufacturers of CFL and LED are presented in Table 11. Useful life of the battery used in the solar lantern may also vary between 4 and 5 years. For conservative estimates, useful life values of 4, 10 and 4 years have been taken for CFL, LED and battery respectively and the results of financial analysis are presented in Table 12. Positive present values of net savings with conservative useful life values of lamps and battery reflect financial attractiveness of solar lantern as a lighting option. With increased awareness

[1] Present value (P) of a cash flow (F) in the n^{th} year from now is expressed as $P = F\left[\frac{1}{(1+i)^n}\right]$ where i is the discount rate.

Table 9
Snapshot of expressions used in financial analysis of replacement of kerosene lamp(s) with solar lantern (CFL).

Present values of net government/household savings	Case[a]	Modality	Expression
Present value of net government savings	I	Cash grant 1	$P_{NGS,CFL,CASE\ I,1} = P_{GS,CASE\ I} - P_{P,CFL}$
Present value of net household savings	I	Cash grant 1	$P_{NHS,CFL,CASEI,1} = P_{HS,CASEI} - P_{OM,CFL}$
Present value of net government savings	I	Cash grant 2	$P_{NGS,CFL,CASEI,2} = P_{GS,CASEI} - 0.3 \times P_{P,CFL}$
Present value of net household savings	I	Cash grant 2	$P_{NHS,CFL,CASEI,2} = P_{HS,CASEI} - 0.7 \times P_{P,CFL} - P_{OM,CFL}$
Present value of net government savings	I	Soft loan	$P_{NGS,CFL,CASEI,3} = P_{GS,CASEI} - 0.4 \times P_{P,CFL}$
Present value of net household savings	I	Soft loan	$P_{NHS,CFL,CASE\ I,3} = P_{HS,CASE\ I} - 0.2 \times P_{P,CFL} - \sum_{n=1}^{5} \frac{0.13 \times 0.4 \times P_{P,CFL}}{(1+i)^n} - \sum_{n=1}^{5} \frac{0.4 \times P_{P,CFL}}{5 \times (1+i)^n} - P_{OM,CFL}$
Present value of net government savings	I	Own purchase	$P_{NGS,CFL,CASEI,4} = P_{GS,CASEI}$
Present value of net household savings	I	Own purchase	$P_{NHS,CFL,CASEI,4} = P_{HS,CASEI} - P_{P,CFL} - P_{OM,CFL}$
Present value of net government savings	II	Cash grant 1	$P_{NGS,CFL,CASEII,1} = P_{GS,CASEII} - 2P_{P,CFL}$
Present value of net household savings	II	Cash grant 1	$P_{NHS,CFL,CASEII,1} = P_{HS,CASEII} - 2P_{OM,CFL}$
Present value of net government savings	II	Cash grant 2	$P_{NGS,CFL,CASEII,2} = P_{GS,CASEII} - 2 \times 0.3 \times P_{P,CFL}$
Present value of net household savings	II	Cash grant 2	$P_{NHS,CFL,CASEII,2} = P_{HS,CASEII} - 2 \times 0.7 \times P_{P,CFL} - 2 \times P_{OM,CFL}$
Present value of net government savings	II	Soft loan	$P_{NGS,CFL,CASEII,3} = P_{GS,CASEI} - 2 \times 0.4 \times P_{P,CFL}$
Present value of net household savings	II	Soft loan	$P_{NHS,CFL,CASE\ II,3} = P_{HS,CASE\ I} - 2 \times 0.2 \times P_{P,CFL} - 2 \times \sum_{n=1}^{5} \frac{0.13 \times 0.4 \times P_{P,CFL}}{(1+i)^n} - 2 \times \sum_{n=1}^{5} \frac{0.4 \times P_{P,CFL}}{5 \times (1+i)^n} - 2 \times P_{OM,CFL}$
Present value of net government savings	II	Own purchase	$P_{NGS,CFL,CASEII,4} = P_{GS,CASEII}$
Present value of net household savings	II	Own purchase	$P_{NHS,CFL,CASEII,4} = P_{HS,CASEII} - 2P_{P,CFL} - 2P_{OM,CFL}$

[a] As discussed in section 4.2, in Case I a kerosene lamp is replaced by a solar lantern whereas in Case II two kerosene lamps are replaced by two solar lanterns.

Table 10
Present value of net savings for government and household under proposed modalities in Case I and Case II.

Modality of financing solar lantern	Present value of net savings over useful life of solar lantern under case I (Rs)				Present value of net savings over useful life of solar lantern under case II (Rs)			
	Government savings		Household savings		Government savings		Household savings	
	Solar lantern (CFL)	Solar lantern (LED)	Solar lantern (CFL)	Solar lantern (LED)	Solar lantern (CFL)	Solar lantern (LED)	Solar lantern (CFL)	Solar lantern (LED)
Cash Grant 1	38,438	38,938	8416	9064	76,876	77,876	41,623	42,919
Cash Grant 2	40,209	40,359	6645	7643	80,418	80,718	38,081	40,077
Soft Loan	39,956	40,156	6644	7642	79,912	80,312	38,079	40,075
Own Purchase	40,968	40,968	5886	7034	81,936	81,936	36,563	38,859

regarding the potential savings and other benefits of solar lantern (good illumination, zero pollution, portability, etc) among the households, it may experience accelerated adoption. Table 10: Present value of net savings for government and household under proposed modalities in Case I and Case II of solar lantern as a lighting option. With increased awareness regarding the potential savings and other benefits of solar lantern (good illumination, zero pollution, portability, etc) among the households, it may experience accelerated adoption.

Government has been distributing 3002 kL of kerosene per month in Uttarakhand [42]. With a total subsidy of Rs 33.69 per liter, government is incurring an expenditure of Rs 1.21×10^9 per year on distribution of kerosene in the state. By avoiding this expenditure, government can annually promote 4.79 lakh CFL or 5.98 lakh LED based solar lanterns with 100% subsidy. These solar lanterns may be promoted firstly among the 221,206 households in Uttarakhand that are dependent on kerosene for lighting and later among the electrified households of the state using kerosene as a back-up fuel for lighting. Thus, replacement of kerosene lamp with solar lantern in sunny locations like Uttarakhand wouldn't require any additional investment from the government or household and would also lead to monetary savings for both the government and household along with the advantages of better lighting and healthier environment.

Historical data on crude oil prices and price of kerosene point (Fig. 1) point that the prices are expected to increase further with time. With price of kerosene being a politically sensitive issue, government may further increase subsidies and/or under-recoveries putting more pressure on its financial resources. Contrary to kerosene price rise, solar lantern prices may reduce further due to technology advancement and economy of scale. Thus, replacement of kerosene lamp with solar lantern would get more attractive in future.

4.4. Inferences for India from the assessment of Uttarakhand as an example

Taking cue from the results of feasibility assessment of promotion of solar lantern in Uttarakhand with usage of kerosene subsidies for funding the lantern, inferences can be drawn for promotion of the lantern in other states of India. Like Uttarakhand,

Table 11
Useful life values quoted by manufacturers of CFL and LED.

Manufacturer	Useful life in hours		Useful life in years (@ 4 h of usage per day)	
	CFL	LED	CFL	LED
Havells	6000	15,000	4	10
GE	8000	25,000	5	17
Philips	8000	50,000	5	34

Table 12
Present value of net savings for government and household under proposed modalities in Case I and Case II (with conservative useful life values of CFL and LED).

Modality of financing solar lantern	Present value of net savings over useful life of solar lantern under case I (Rs)				Present value of net savings over useful life of solar lantern under case II (Rs)			
	Government savings		Household savings		Government savings		Household savings	
	Solar lantern (CFL)	Solar lantern (LED)	Solar lantern (CFL)	Solar lantern (LED)	Solar lantern (CFL)	Solar lantern (LED)	Solar lantern (CFL)	Solar lantern (LED)
Cash Grant 1	38,438	38,938	7987	8760	76,876	77,876	40,765	42,311
Cash Grant 2	40,209	40,359	6216	7339	80,418	80,718	37,223	39,469
Soft Loan	39,956	40,156	6215	7338	79,912	80,312	37,221	39,467
Own Purchase	40,968	40,968	5457	6730	81,936	81,936	35,705	38,251

Table 13
Solar hotspot states (other than Uttarakhand) having favorable conditions for replacement of kerosene lamps with solar lantern.

Solar hotspot state [27]	No. of rural households (in million) [16]	Percentage of rural households using kerosene lamps (%) [16]	Allocation of PDS kerosene during 2011–12 (kiloliters) [17]
Andhra Pradesh	14.2	9.2	530,808
Bihar	16.9	88.4	820,320
Chhattisgarh	4.3	28.2	186,600
Gujarat	6.7	12.8	673,584
Haryana	2.9	11.3	157,260
Jammu and Kashmir	1.4	12.6	95,082
Karnataka	7.8	12.3	539,544
Madhya Pradesh	11.1	40.9	626,412
Maharashtra	13.0	23.9	1,258,812
Rajasthan	9.4	39.3	511,404
Tamil Nadu	9.5	8.3	551,352
Uttar Pradesh	25.4	75.0	1,592,700
West Bengal	13.7	57.8	964,728

there are many solar hotspot states in India having significant fraction of un-electrified rural households that are dependent on kerosene for lighting (Table 13). From Table 13, it is evident that states like Uttar Pradesh, Maharashtra, West Bengal, Madhya Pradesh, Rajasthan, Bihar and Chattisgrah have maximum potential for replacement of kerosene lamps with solar lantern as these states have good solar radiation availability coupled with higher fraction of kerosene lamp users. For these states, the PDS kerosene allocation is also high that may encourage the states to promote the usage of solar lanterns. Replacement of kerosene lamps with solar lanterns would lead to decreased PDS kerosene usage in the states and the states would gain monetarily by avoiding expenditure on kerosene subsidies. As discussed earlier, through various modalities the monetary savings may be used by the states for financing the adoption of solar lantern.

After sales services has been a critical barrier impeding the diffusion of solar lanterns in India [47]. To ensure satisfactory after-sales services, government may engage manufacturers as Energy Service Companies (ESCOs). With the help of government, the ESCOs would open centers across the concerned state or region. The network of centers would not only sell solar lanterns but also provide after sales services. The wide reach of telecommunications in India may be used to deliver effective after sales services by connecting the centers to the solar lantern users through a helpline number.

5. Concluding remarks

A huge amount of government funds are presently being used in ensuring supply of kerosene at subsidized prices to eligible households in India. Kerosene is primarily used for lighting in un-electrified households in the rural areas of the country. The drawbacks associated with usage of kerosene for lighting are poor illumination, pollution and high operation and maintenance cost. This study has assessed the feasibility of utilization of expenditure involved in supply and use of PDS kerosene for funding the purchase and maintenance of solar lanterns. The results of this study indicate that the replacement of kerosene lamp with solar lantern through various financing modalities (involving subsidies and soft loans) would lead to significant monetary savings for both the government and households along with the advantages of better lighting and healthier environment. Even without any government support, a household replacing one or two kerosene lamps with equivalent number of LED based solar lanterns would approximately save Rs 7000 or Rs 39,000 respectively from avoidance of cost associated with kerosene based lighting over the useful life of the solar lantern(s). All the proposed modalities would lead to monetary savings for the government and households along with the advantages of better lighting, ease of usage and pollution free environment.

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Retelling Gods through different tales- A comparative analysis of the writings of Contemporary Indian writers

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ABSTRACT

Many perceive India as a country of intolerant and conservative religious groups who tend to sabotage any voice that doesn't resonate with theirs. However, there is a larger segment within the country which questions religious beliefs on ground of logic while appreciating what is good and beautiful in a culture (any culture). From this segment of people arise writers like Amish Tripathi and Devdutt Patanaik who have taken an attempt to retell Hindu mythology. Both of them, with their own unique approach, have attempted to do what would have been considered a taboo just sometime before- rewriting a Hindu God. This paper will analyze and compare the writing styles of both the writers taking a look at a few of their popular books. The attempt will be to bring out the similarities and uniqueness of the writers. Also, the paper will be set in the premise of the contemporary mythological books gaining ground with the Indian readers.

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INTRODUCTION

Indian mythology with its rich line of stories and archetypical characters has been an area of interest among authors across the globe; be it classical authors who write about Indian Gods with their larger than life image or recent attempts by Indian authors to humanize them. The idea of rewriting a God has almost always been accepted by the readers as well as the publishers. The condition however is that the interpretation is not very deviant from the common belief as was the case with Wendy Doniger's "*The Hindus-An alternative History*" which had to be withdrawn from the market owing to the series of protests against it. [i]

The concept of interpretation in Indian mythology is not entirely new. The two pillars of mythological literature are '*Sruti*' and '*Smriti*'. *Sruti* refers to the divine literature which is believed to have had no human intervention in its making[ii]. *Smriti* on the other hand is what is remembered by the sages and put to words, needless to say with their own subjective interpretations[iii]. Although *Sruti* enjoys a greater status than *Smriti* when it comes to authority, nonetheless, the concept of remembered texts passed on to generation by sages has been there in Indian mythology.

The attempt to retell mythology can have several approaches to it. The televised versions of Ramananad Sagar's *Ramayana* and *Mahabharat* portrayed Gods in the similar larger than life image which made them extremely popular with the Indian masses at that time. The thrust in the more recent times, however, has been to respectfully humanize the Gods, thus bringing them closer to people. The same can be seen in Amish Tripathi's Shiva Trilogy.

The trend was started by Ashok Banker through his series of 8 books where he rewrote the story of Ramayana. A more intellectual and insightful edge was added to it by Devdutt Pattanaik who also works as a leadership consultant, whose work focuses on deriving management insights from mythology to reveal a very Indian approach to modern business.

The idea that Amish Tripathi's *Immortal of Meluha* was rejected 20 times by publishers before indicates that there probably wasn't an established market for that kind of writing.[iv] Or possibly there were doubts about the acceptance of text that humanizes Shiva the God's God. But the series turned out to be a great success. So much so that it became the first book series to have music

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album dedicated to it. This is indicative of a trend where readers are willing to accept and appreciate sensible interpretations.

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BACKGROUND OF THE WRITERS

Devdutt Pattanaik

Devdutt Pattanaik is a famous author and mythologist. Devdutt's parents migrated from Odisha to Mumbai over 50 years ago. He was born and brought up in Mumbai, and he currently lives in Mumbai. He has two sisters, and two nephews. He was a trained medical practitioner before he left it for writing. The celebrated writer has worked for over 15 years in the healthcare industry, with companies such as Apollo Health Street and Sanofi Aventis, before joining Ernst & Young as Business Advisor.

Devdutt has also worked as leadership consultant, deriving management insights from mythology to reveal a very Indian approach to modern business. He has written over 30 books, with best-sellers like *Myth = Mithya, Business Sutra, The Pregnant King*, and *Jaya: An illustrated retelling of the Mahabharata.*

His books have been translated in multiple Indian languages like Hindi, Tamil, Telugu, Gujarati and Marathi. He continues to study and write on mythological stories and symbols, alongside drawing insights about business, leadership, and modern life. He also writes on management and culture regularly in The Economic Times (Corporate Dossier supplement), Mid-Day, Speaking Tree and the DailyO (India Today website).

Devdutt has also worked as the Chief Belief Officer of Future Group and is now a much sought-after public speaker and culture consultant for corporations and business leaders. Additionally, Reliance consults him on matters related to culture and Star TV on various mythological serials. [v]

Amish Tripathi

Amish Tripathi is an IIM (Kolkata)-educated boring banker turned happy author. The success of his first book, *The Immortals of Meluha* of the Shiva Trilogy, encouraged him to give up a fourteen-year-old career in financial services to focus on writing. He is passionate about history, mythology, philosophy and is an ardent admirer of the Lord Shiva.

Amish has most recently written the Shiva Trilogy which includes *The Immortals of Meluha, The Secret of the Nagas & The Oath of the Vayuputras*, which has sold over 2 million copies in India since 2010, grossing over Rs 500 million and making the Shiva Trilogy the fastest selling books series in Indian history. The books that he plans to write in the future are also in the areas of mythology & history.

He has over 14 years of experience in the financial services industry. His last job was as National Head - Marketing & Product Management and Member of the Senior Management Committee at IDBI Federal Life Insurance.[vi]

The Tribal Warrior versus The Earth's Daughter

The *Immortals of Meluha* is Amish's first book in the series of Shiva Trilogy and Devdutt's *Sita* is a version of Ramayan through Sita's eyes. Taking a close look at both the books gives a rich insight into the writing styles of the authors. It also helps in understanding how Amish's writing is different from Devdutt's.

Sita is a version of Ramayan, a retelling, a very small part of the huge texts and interpretations written around the legendary king Ram and his wife, the Queen Sita. Devdutt, right in the prologue of the book states this fact. The author makes no assertions as to being able to cover all that is said and known about the Goddess in the book, but humbly states the story as he could gather from the various interpretations that he has read. "Within all these stories is the truth. Who knows it all? Varuna has but a thousand eyes; Indra, a hundred; You and I only two." (Pattanaik 2013).

The high note of the book *Sita* is that it has information tables across all chapters. These tables enlist views that are known and written about the various characters and incidents of Ramayan across India and beyond. For instance, the name of Sita's mother is different across different interpretation of Ramayan (Pattanaik 2013). Although the author chooses to take up one name, and consequently one version of it, he mentions the rest in the information tables duly. This reflects on the authors understanding of *Smriti* which forms the pillar of Hindu mythology and literary texts. It also shows the author's reluctance to project a personal favorite version among the options available. The treatment of the protagonist Sita is very objectively done by the author.

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On the other hand, Amish's *Immortals of Meluha* reflects the author's personal admiration for the Lord by the way he characterizes Shiva, the tribal warrior. The story entails how a human of flesh and blood becomes Godlike through his deeds. Despite of the author's personal sentiments, he tries to keep the protagonist as human as possible to the point where Shiva introspects about the mistakes that he made in his past life and his total reluctance to be called the chosen Neelkanth, the Destroyer of Evil. "I don't deserve any destiny. If these people knew of my guilt, they would stop this bullshit instantly", thought Shiva. (Tripathi 2010)

Interestingly, Amish chose to have his own explanations for the various incidents known about the Lord Shiva. The Neelkanth or the blue neck of Shiva has been explained as the consequence of drinking poison by the Lord as quoted by Dr. K K Aggarwal.[vii] The book however calls it the consequence of drinking a life giving potion called Somras which eventually turns out to be the evil that the protagonist would fight against. There isn't a major diversion in what is already known commonly, but Amish has attempted to add his own subjective interpretations to it making the book all the more interesting.

Sita and *The immortals of Meluha* agreeably fall under the genre of mythology, but the treatment is pretty different. The former is only one character's account of the story, while the latter is more than just mythology. It is fantasy, somehow touching the genre of books written by Paulo Coelho and Dan Brown. As such, an objective comparison between the protagonists of both the plots that is Sita and Shiva would not be possible. However there still are similarities, the most important one being their characterization as a human and not a larger than life God or Goddess. There are no magic spells, curses, boons or any other such mystic qualities about the characters that would make them any less human than Dan Brown's Robert Langdon (protagonist of the fiction *Angels and Demons, DaVinci Code* and *Inferno*).

The belief officer and the literary popstar:

Pattanaik is an intellectual, peer acclaimed author whose writing is simple yet insightful. His writing is mostly focused on bringing mythology into lifestyles as far as practical. What is unique about his way of writing is that he chose to retell a story through major characters of mythological texts. His Ramayan is Sita's Ramayan & Hanuman's Ramayan, his Mahabharat is through Jaya's

tale of the war (Draupadi's other name). The stories, however, remain more or less the same. Ramayan is still the story of the legendary hero Ram, there are no antagonistic thoughts in Sita's mind against her husband who disowned her because of a petty washer man. There isn't much of fictitious layering in the story which differentiates it from Amish's Shiva Trilogy.

As opposed to the former, Amish has absolutely romanticized Shiva. In the *Immortals of Meluha*, Shiva is a brave tribal warrior who has no clue about his role as the 'Destroyer of the evil', who falls in love with a woman like any other man and tries to woo her. He becomes the hero that people worship, isn't born with enlightenment. Amish carefully made additions to the already known fact about various Gods for example why Ganesha has an elephant head. There are folklores that say different stories about it but Amish chose his own way of explaining it which makes him stand out.

Devdutt is a simple story teller who will keep readers turning the pages. He restricts himself to the plot without experimenting much with the characters. His niche is his sheer understanding of the concept which reflects in his writing style which has depth and clarity of thought. Amish on the other hand has a flamboyant flair for writing. His writing has a modulation of high and low notes. No wonder the *Oath of the Vayuputra* was pre-ordered by readers out of anticipation. Although it wasn't as big a success as the previous two books of the trilogy, nonetheless it was widely accepted and appreciated.

According to the Business World, Amish is on his way to becoming the Paulo Coelho of the east. The Hindustan Times already called his Trilogy as India's *Lord of the Rings*. Additionally, adding much pomp to the fanfare that Amish enjoys, the publication house Westland offered him a sum of 5 crore Indian Rupees for his next book series. [viii]

Another point to consider here is that Devdutt wrote over 30 books and is a regular columnist in leading newspapers while Amish's shot to fame is his Shiva Trilogy which made him a literary pop star already. The trilogy has a music album dedicated to it and big film makers are planning to adapt the story to take it on to the silver screen. It will not be wrong to say that while the former is the conscience keeper, the latter is the populist leader. The paths chosen by them are different yet leading to the same destination.

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Rotator on Chip (RoC) design based on ring topological NoC

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Abstract

The paper presents the ring based Network on Chip (NoC) structure design and modeling in Hardware Description Language (HDL). The network configuration is chosen for 65536 nodes, which is synchronized with same clock pulse. The functionality of each node is checked in Modelsim 10.1b software. The interprocess communication among nodes in verified using Virtex-5 FPGA. The priority of the nodes is assigned using FIFO logic, which is integrated with the NoC chip. The NoC architecture is based on token ring based network concept, called Rotator-on Chip (RoC). The design and modeling is done in Xilinx 14.2 ISE using VHDL programming language and synthesized on Digilent manufactured FPGA, with the target device, xc5vlx20t-2-ff323, Virtex-5. Hardware and timing parameters are extracted from the synthesized results and maximum frequency is found 535.733MHz and memory utilization is 263208 kB.

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*Keywords:*Rotator on Chip, Network on Chip, Hardware Description Language, Very large Scale of Integration , Field Programmable Gate Array

1. Introduction

Network on Chip (NoC) is the latest approach to overcome the limitations of bus based communication network[1]. NoC is a set of routers employed in a network, in which different nodes are interconnected with their cores and can

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communicate with each other. In a network data comes in packets and sent to the destination with IP via routers and links [4]. When a packet reaches its destination address, it means packet is switched[5] to the IP attached to the router. On-chip communications among different networks is possible using interconnection network topology[5], switching, routing, queuing, flow control[11] and scheduling. Research is going on for three dimensional topological structures network on chip design. The idea of NoC is derived from distributed computing and large scale computer networks. There are different routing techniques used in NoC design considerations to meet high throughput. The routing methods for NoC should be very simple,due to constraints on hardware and memory resources utilization can have 2D and 3D network configurations.

NoCs support efficient on-chip communication [6, 7]potentially leads to NoC based multiprocessor systems characterized by high structural complexity and functional diversity. Multiprocessor System On-Chip (MPSoCs)[8] consists of complex integrated components, which communicates with each other at very high speed rates. A single shared bus or hierarchy of buses is not feasible so much for intercommunication. Intercommunication requirements of MPSoCs made of hundreds of cores having poor scalability with their shared bandwidth between all the attached cores, system size and the energy efficient requirements of final products. Networks-on-Chip (NoCs) is a promising solution to the scalability problem of forthcoming MPSoCs [5, 10]. NoC is an approach for designing the telecommunication subsystem between IP cores in a System-on-a-Chip (SoC) [7, 10]. The software and application layer is a very critical aspect on the NoC communication stack [11]. Secured transmission among nodes is possible if it follows the NoC layer protocol [11, 12], mostly physical and network layers. All networked layers follow the pipeline and parallel processing that validate the optimized hardware parameters on chip development.

Rotator on chip(RoC) architecture [3] is based on token ring concept, which guarantees of packet arrival in sequence. It is based on scalable network and control mechanism that is helpful in the implementation of low latency on chip communication NoC. The performance of the ring NoC depends on the time slots and addressing schemes for the intercommunication among nodes in ring topological network. The NoC is applicable in telecommunication systems and is a great solution for rotator switches used in telecommunications systems. The topologies used for NoCs are tree, ring, crossbars, bus and meshes [3, 12]. Crossbar networks are larger in size and have low latency, poor scalability and greater cost. Tree topology structures [8] have good performance in terms of good latency but the networks based on tree topology have high wiring costs and router designing is also costly. There are also the chances of blocking several links in tree topology and messages delivery may fail. Mesh topological structures offers good latency and higher bandwidth but the latency can vary with the traffic intensity.

Ring topological structures achieved very good energy efficiency at low to medium core counts [3]. For a single ring system router, the routing logic needs to handle only two processes, injecting traffic into a ring structure, when there is space, and ejecting traffic when it is addressed to the current router [3]. In the simple structure of routers, most of the energy consumed in the interconnects, is due to link traversal in ring NoC.

2. Ring NoC Structure

The designing block diagram of ring topological NoC is shown in fig. 1. It has 65536 nodes, arranged in a ring. Each node has its Processing Elements (PEs) and addressed by their node addresses. Each Processing Element (PE)[5] operates in a synchronous manner, and is assumed to operate at same frequency.The operation of the ring NoC can be understood with the help of table 1. All 65536 nodes are counted from N_0 to N_{65536} having a node address of 16 bit starting from “0000000000000000” to “1111111111111111” Let node N_0 is assigned a source_address “0000000000000000”, Node N_1 has address “0000000000000001”. Similarly all the nodes can be assigned their 16 bit of address and node N_{65536} is assigned source_address “1111111111111111”. In the full duplex mode, any pair can communicate to each other and vice versa. Let N_0 want to communicate in ring network. It has the probability to be routed via any link targeting any node N_1 to N_{65536} as shown in fig. 2. Each PE can process intercommunication to any other PE. Table 1 list the possibility to access other nodes. The node_address can be configured as source_address and destination_address for the source and destination nodes respectively. Similarly all the nodes can process intercommunication to each other. There is also the first input first output (FIFO) logic in case of multiple nodestry to communicate to the single node. It decides the priority of communicating nodes, based on the token structures. The data is transferred in the form of packets to each node. A data packet is consisting the information of source_address, destination_address and data.

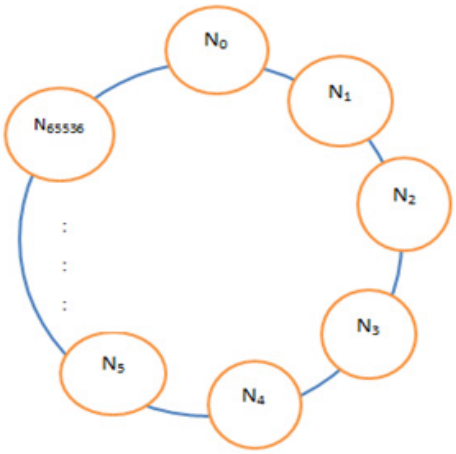

Fig.1 Ring topological structure

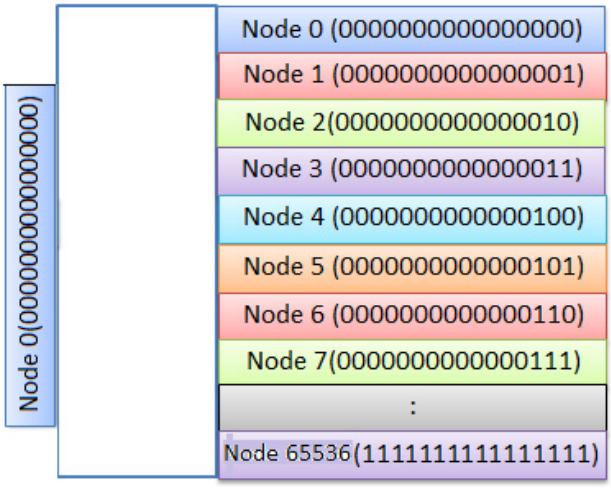

Fig. 2 FIFO logic to address nodes

Table 1. Node selection scheme in ring NoC

Source Address (16 bit)	Destination Address (16 bit)	Node Selection
0000000000000000	0000000000000000 : 1111111111111111	Node 0 : Node 65536
0000000000000001	0000000000000000 : 1111111111111111	Node 0 : Node 65536
0000000000000010	0000000000000000 : 1111111111111111	Node 0 : Node 65536
0000000000000011	0000000000000000 : 1111111111111111	Node 0 : Node 65536
0000000000000100	0000000000000000 : 1111111111111111	Node 0 : Node 65536
0000000000000101	0000000000000000 : 1111111111111111	Node 0 : Node 65536
0000000000000110	0000000000000000 : 1111111111111111	Node 0 : Node 65536
: :	: :	: :
1111111111111111	0000000000000000 : 1111111111111111	Node 0 : Node 65536

In the ring based NoC system, all the nodes are physically connected as a bus trough a coaxial cable as shown in fig.3, but logically form a ring. The node (station), which is outside the ring, is considered as outer node.According to IEEE 802.4 token bus network frame has the following fields. The frame structure of IEEE 802.4 is shown in fig. 4.

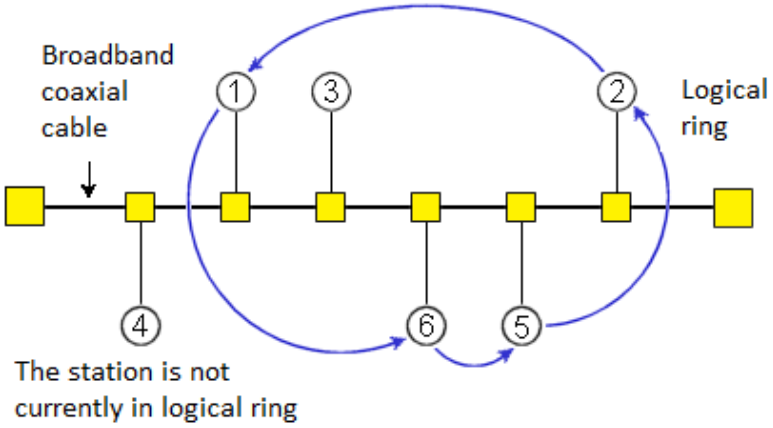

Fig.3. IEEE 802.4 Token ring bus structure

Preamble: It is used to synchronize the receiver's clock.
Starting Delimiter (SD) and End Delimiter (ED):The Starting Delimiter and Ending Delimiter fields contain analog encoding of symbols other than 1 or 0 and are used to mark frame boundaries. The representation of symbols is because both cannot occur accidentally in the user data. Therefore, no length field is needed.
Frame Control (FC): The field is used to distinguish data frames from control frames. The field carries the frame's priority for data frames and a bit which the destination can set as an acknowledgement. Similarly, the Frame Control field is used to specify the frame type, for control frames. The data frame and control frame include token passing and various ring maintenance frames.

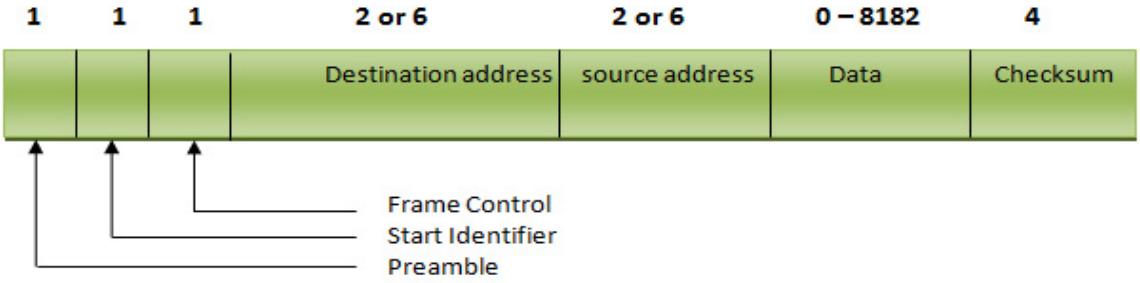

Fig.4. IEEE 802.4 frame structure

Destination and source address*:* The field is used to provide the Destination node and source node address fields. The field may be l and global address. It is of bytes for a local address and 6 bytes for a global address.
Data: The Data field is always variable carries the actual data. It may be 8182 bytes when 2 byte addresses are used and 8174 bytes for 6 byte addresses.
Checksum*:* Checksum field is used in error detection. A 4-byte checksum can be used in the calculations of data.

3. Data Path Architecture

The data path architecture of the ring NoC is shown in fig. 5. It consists of (16 x 65536) decoder and (65536 x 1) demultiplexer. The source address and destination address are configured with the help of 16 address lines (A_0–A_{15}).

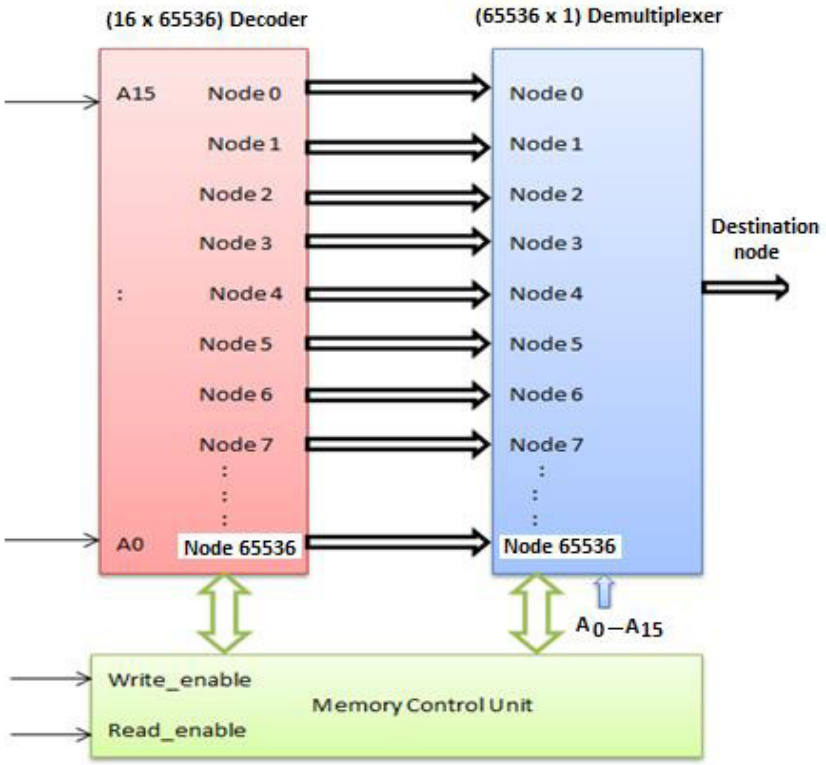

Fig.5. Data path architecture

The 16 bit input decoder can have 65536 output lines, which are be assigned as number of nodes. Each node has control signals read_enable and write_enable to perform read and write operations. The nodes are carrying data of 8182 bytes. The data transfer is possible to one node only at a time, based on the priority logic and FIFO selection. The logic to select the same functionality is demultiplexer. Demultiplexer (65536 x 1) has 65536 inputs with 16 bit address bus ($A_0 - A_{15}$) and one output. The memory control unit performs write and read operations.

4. Results & Discussions

The modeling and design of the RoC is done in Xilinx 14.2 ISE and function simulation is carried out in Modelsim 10.1. The data transfer is carried out for the different test cases and it has shown 100 % successful data transmission form source to destination node. The RTL view of developed chip is shown in the fig. 6 and the functional details of RTL pins is discussed in table 2.The functional simulation of NoC is shown in fig.7, shows the data transfer scheme from node N_4 to node N_{32}. The source_address = "000100" and destination_address = "100000". The input data is transferred from node N_4 input_data_packet = 1'h 12345678ABCDABCD……AD (hex data) and same data is received at node N_{32} = 1'h 12345678ABCDABCD….AD (hex data). The data is received at the positive edge of the clock pulse. The clock signal is synchronized with the reset. FIFO_EMPTY and FIFO_FULL show the status of, FIFO logic or the priority of the source node.The destinaon node is free for intercommunication, then FIFO_EMPTY= '1' and FIFO_FULL = '0'.The functional simulation depends on the following steps input.

Step input 1: Reset = '1' and run, output_data_packet will contains zero output.

Step input 2: Reset = '0', Apply rising edge clock pulse, source_address and destination_address value and 64 bit data of destination node with input_data_packet, then run.

*Step input 3:*Apply the source address and destination address of another nodes and data on input_data_packet.to run

Step input 4: check the output_data_packet of destination node and status of FIFO logic using FIFO_FULL and FIFO_EMPTY inputs.

Fig.6. RTL view of RoC

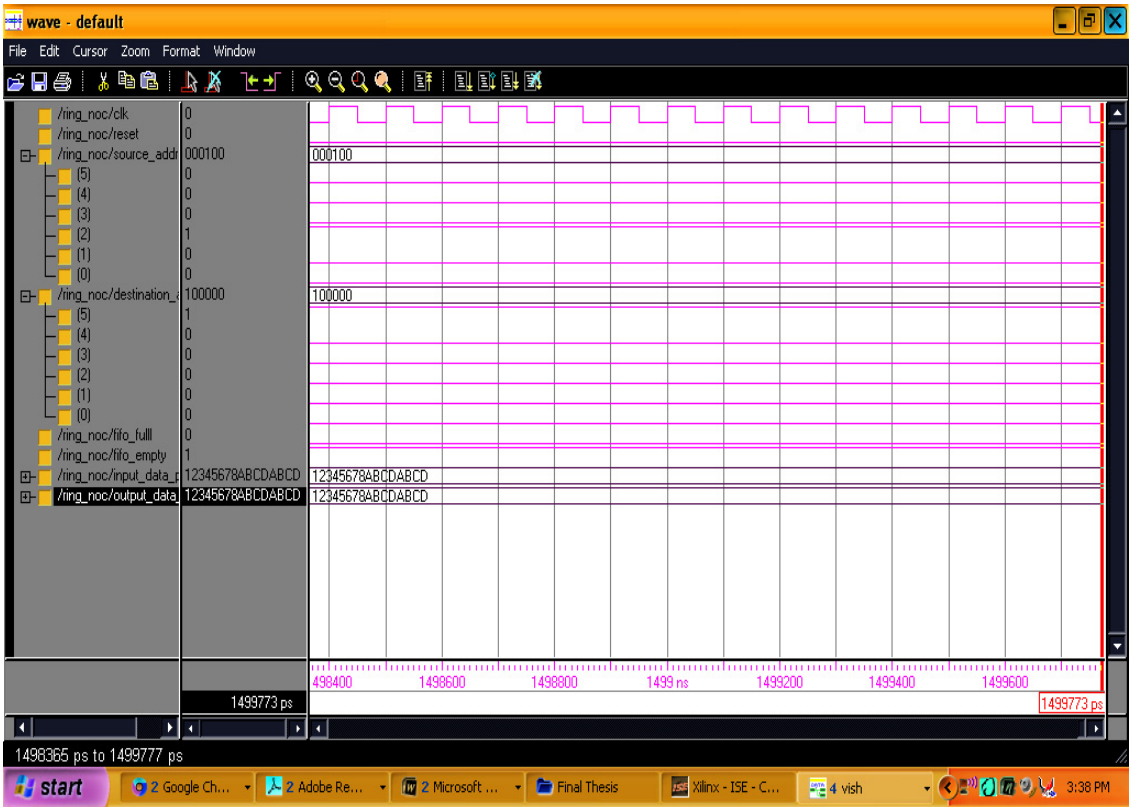

Fig.7. Modelsim simulation for intercommunication in ring NoC

Table 2. Pin details of ring NoC for (N=65536)

Pins	Description
Reset	Used to reset the memory contents zero for synchronization of the components by using clk of std_logic (1 bit)
Clk	Default input for sequential logic to work on rising edge of clock pulse of std_logic.(1 bit)
source_address [15:0]	Address of source node of std_logic_vector (16 bit)
destination_address [15:0]	Address of destination node of std_logic_vector (16 bit)
input_data_packet [8182x 8:0]	Input data of the source node of std_logic_vector (8182bytes)
output_data_packet [8182x 8:0]	Output data of the source node of std_logic_vector (8182bytes)
FIFO_EMPTY	Status of FIFO priority logic, signifies that node is free to communicate of std_logic (1 bit)
FIFO_Full	Status of FIFO priority logic, signifies that commutating node is not free, source subscriber is in assigned priority based on FIFO logic of std_logic (1 bit)
write_en	Control signal to perform memory write operation with respect to individual node of std_logic(1 bit)
read_en	Control signal to perform memory write operation with respect to individual node of std_logic(1 bit)

5. Synthesis & Experimental Analysis

The node data transfer is also verified with the experimental set up carried with the help of Digilent manufactured Virtex FPGA. The parameters supports to FPGA synthesis are discussed as device utilization and timing parameters. The block diagram of an experimental set up is shown in fig. 8. The experiment is carried out to validate the data transfer among inlets/outlets using Virtex -5 FPGA. Two 9-pin RS-232 ports assist in the transmission of serial data to and fro from the FPGA board. 50 MHz clock oscillator is the system clock provides the clock signal to the various events taking place within the FPGA and the various programs that require clock for their working. The input switches are given the source_address [5:0] and destination_address [5:0], reset and clock input to the FPGA board, the logged data can be shown on the motherboard of the PC. The onboard Xilinx Virtex-5 user FPGA is directly coupled to multiple independent banks of DDR2 SDRAM and QDR-II SRAM memory providing up to 13GBytes/sec of sustained memory bandwidth to the FPGA. Optimized memory controller IP cores and reference designs are included as part of the product deliverables along with VHDL source code and API for Windows operating systems. The DATA-V5 is tightly integrated to the Host computer via an 8-lane PCI Express connection supporting sustained bandwidths of up to 2.38GBytes/sec.

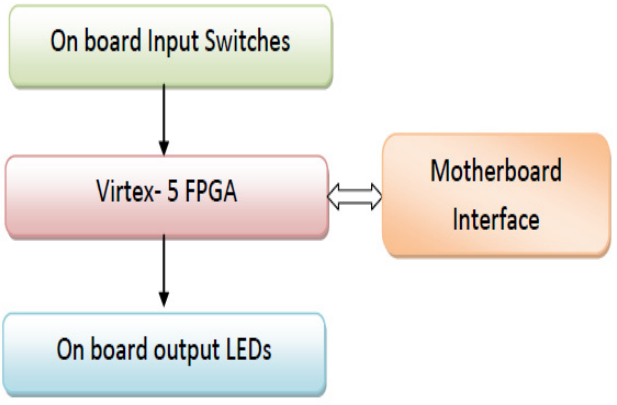

Fig.8. FPGA synthesis block diagram

5.1 Device Utilization And Timing Summary

Device utilization report gives the percentage utilization of device hardware for the chip implementation. Device hardware includes no. of slices, no. of flip flops, no. of input LUTs, no. of bounded IoBs, and no of gated clocks (GCLKs) used in the implementation of design. Timing details provides the information of delay, minimum period, maximum frequency, minimum input arrival time before clock and maximum output required time after clock. Table 3 and table 4 show the synthesis results as device utilization and timing parameters for ring NoC. Total memory utilization required to complete the design is also listed for individual stage. The target device is: xc5vlx20t-2-ff323 synthesized with Virtex-5 FPGA.

Table 3.Device utilization in ring NoC, for N = 65536

Device	Utilization	
Number of Slices	128 out of 12480,	1%
Number of Slice Flip Flops	493 out of 12480,	3%
Number of 4 input LUTs	128 out of 493,	25%
Number of bonded IOBs	156 out of 172,	90%
Number of GCLKs	1 out of 32,	3%

Table 4. Timing parameters for ring NoC, for N = 65536

Timing parameter	Utilization
Minimum period	1.867ns
Maximum frequency	535.733MHz
Minimum input arrival time before clock	4.090ns
Number of bonded IOBs	2.830ns
Total memory usage	263208 kB

The results are compared with ref[3], and ref[7]. In the ref. paper [3] the ring NoC was designed for 16 nodes, support to 2 GHz clock frequency. The ref[7], the ring NoC configuration was designed for 32 nodes on a Xilinx VP100, supports an aggregate bandwidth of about 12 GB/s. The design developed by us supports ring NoC structure for 65536 with the integration of FIFO priority logic, 535.733MHz frequency and synthesized on Virtex-5 FPGA. Moreover, Virtex -5 support the developed design for 50 MHz clock frequency and 13GBytes/sec bandwidth. Hence the developed design is an optimal solution in comparison to the existing solutions, support larger no. of nodes.

6. Conclusions

The RoC or ring NoC chip design and modeling is done in Xilinx 14.2 and functionally simulated in Modelsim 10.1 b software. The NoC chip is designed to communicate 65536 nodes and intercommunication is checked with the data packet arrival on the destination node. There is an integration of token ring concept designed as FIFO logic, to assign the priority of communicating nodes at same instance. The nodes are identified with their node addresses and hardware parameters such as no. of logic gates, no of LUTs, memory utilization and minimum and maximum time values to route the packets are extracted from the Xilinx synthesis results. The results are validated with the data transfer among nodes with the help of Virtex-5 FPGA. The results present an optimal solution over existing ring NoC configured structures. NoC design and FPGA synthesis is a significant effort to design the programmable and reconfigurable structure for ring topological network. In future same structure can be configured for more number of nodes. It is also possible to integrate the concept of cryptographic techniques of encryption and decryption for transferring data among nodes.

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Acronyms

ASIC	Application Specific Integrated circuits
DDR	Double Data Rate
ED	End of Delimiter
FPGA	Field Programmable Gate Array
FSM	Finite State Machine
FIFO	First input First output
FC	Frame Control
IEEE	Institute of Electrical and Electronics Engineering
IP	Intellectual Property
LUT	Look Up Table
MPSoC	Multiprocessor system on chip
NoC	Network on Chip
PE	Processing Elements
RTL	Register Transfer Level
RoC	Rotator on Chip
SD	Staring Delimiter
SoC	System on Chip
SDRAM	Synchronous Dynamic Random Access Memory
VHDL	Very High Speed Integrated Circuit Hardware Description Language
VLSI	Very Large Scale of Integration

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Secured Network on Chip (NoC) Architecture and Routing with Modified TACIT Cryptographic Technique

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Abstract

Network on Chip (NoC) architecture needed secured data processing and routing in multicore system on Chip (SoC). Sometime it becomes very difficult to provide secured network routing for physically access network. The performance of NoC architecture depends on switching techniques, routing scheme and topological structure. The paper proposed the chip implementation of the new technique of securing data in NoC routers. Many algorithms have been anticipated already for secured NoC routing but limited to their key size and block size. In the paper, NoC architecture is integrated with modified TACIT security algorithm on Virtex-5 FPGA. The key generation scheme is considered based on Hash function and distributed under 4 Hash function (4H) scheme. The greatest advantage of TACIT security algorithm is that the block size and key size both can be of 'n' bit. The design is developed for 'n' bit with the help of VHDL programming language in Xilinx ISE 14.2 and Modelsim 10.1 b software and synthesized for 512 and 1024 bit of block size on Virtex-5 FPGA. The design is optimized with the help of device utilization summary, timing parameters, maximum frequency and memory support.

Keywords: Very Large Scale of Integration (VLSI), Field Programmable Gate Array (FPGA), Hardware Description Language (HDL), Network on Chip(NoC), System on Chip (SoC)

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1. Introduction

In Cryptography[5, 6], the original message or data is called plain text which is encoded with key, called cipher text and transmitted over a channel. The process is called encryption. The reverse process of encryption is decryption, in which the plain text is decoded from the cipher text. It takes secret key and cipher text and produces the original plain text. Cryptography involves encryption and decryption with the sharing of same key at both end or the different key on both ends, called symmetric and asymmetric encryption respectively. The model of symmetric key is shown fig.1 in which plaintext (A) is encrypted with key value (K) and transmitted cipher text is B = E [K, A], the same text is extracted with decryption algorithm[6] A = E [K, B], and same key (K).

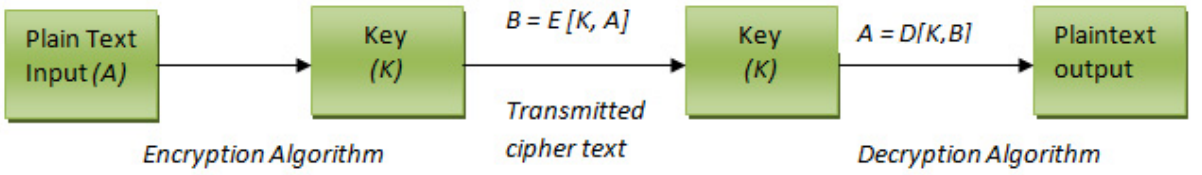

Fig.1 Model of symmetric encryption and decryption

The secret key and key size[6] is very important input to encryption algorithm. The algorithm encrypted output is changed on the key value. The algorithms can produce the different outputs based on specific key value and exact substitutions in the algorithms are dependent on key. The channel security is an issue especially in a Multiprocessor System on Chip (MPSoC) and Network on Chip (NoC).

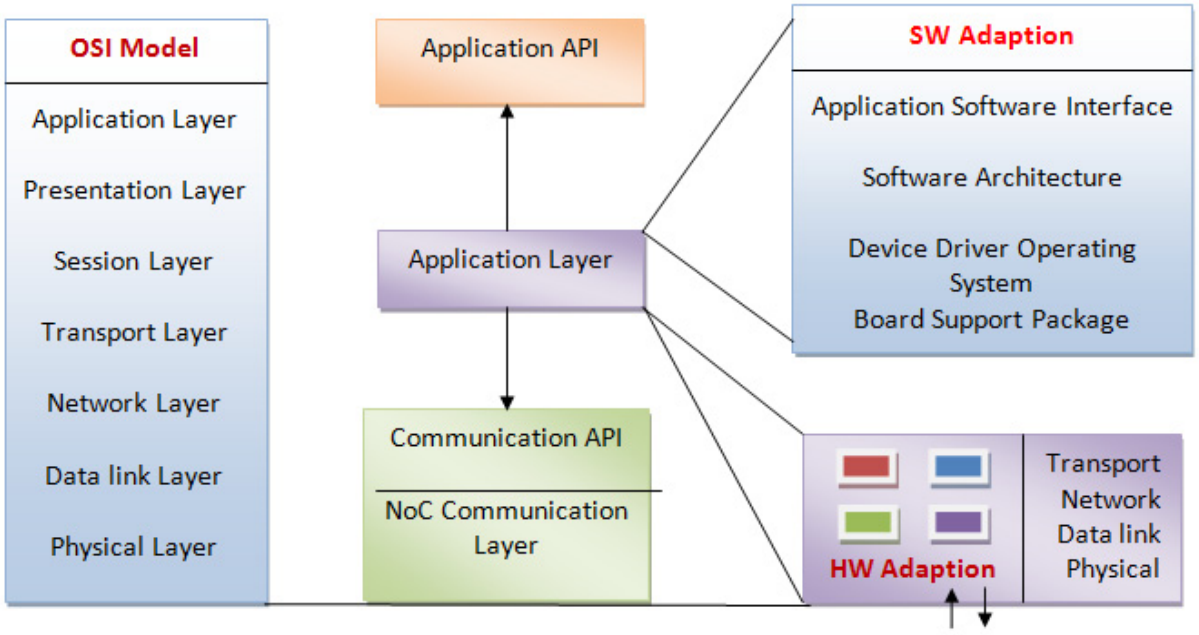

Fig.2 NoC Architecture

Network-on-Chip (NoC) [1, 2] is an approach for designing any network subsystem between IP cores[2] in a System on Chip (SoC)[2]. In NOC communication stack [2], the very critical aspect is software and application layer. A NOC template[4] consists of chip regions which are continuous areas of the chip. Regions can communicate with each other, and are isolated physically. The computing and other resources are embedded in the slots within the switches [2, 3] .A resource can be a microprocessor, memory, FPGA or an I/O resource. In OSI layer model resources are being implemented by the application layer. All resources are connected to networks which consist of network interface and switches [2]. The network interface provides networking services to a resource. Network Interface is being implemented by presentation, session and transport layers. Each network Interface is connected to a switch, which itself is connected to a number of other switches. Switches deliver packets from the source to destination. The switches and the metal wires that interconnect them represent the network, data link and physical layer. Fig. 2 shows the layered NOC structure [1, 4] for data transmission. A resource may have different representations for numbers e. g. floating point or fixed type; there must be some process to convert in the same type. This functionality is provided by the presentation layer. Connections between resources are established by session layer. Transport layer provides a mechanism which checks that no packets are lost in the lower layers Switches are implemented in the network layer. Network layer also deals with the network topology [2, 4]. Addressing scheme is closely related with the topology [1, 2] and is again dealt with network layer. Data link layer [1, 2] ideally passes data from one point to another. Physical layer deals with the electrical properties.

2. TACIT Encryption and decryption Algorithm

TACIT Encryption Algorithm: Fig. 3 shows the flow of the encryption algorithms
Step 1: First, read the text file and apply the concept of initial permutation approach to shuffle the position of each character with the help of key value [5].
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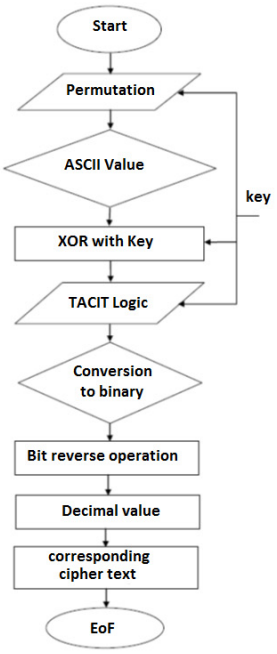

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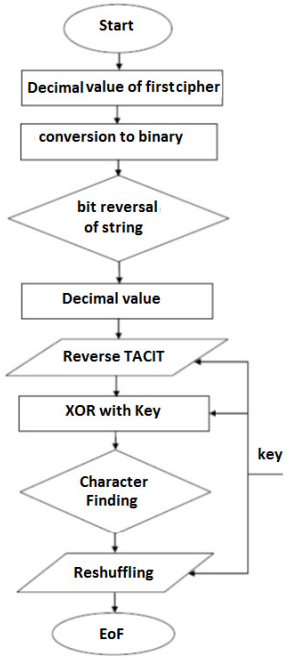

Fig. 4 Decryption Algorithm

TACIT Decryption Algorithm: Fig. 4 shows the flow of the decryption algorithms.
Step 1: Encode text in encryption algorithm is cipher text. Get the corresponding decimal value of cipher text, after reading the first character from the cipher text [5].
Step 2:.Evalute the corresponding binary value[5] and reverse it.
Step 3: Perform the inverse operation of the tacit logic[5].
Step 4: Perform XOR logical operation with next key value or n-bit key value[5].
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Step 7: Repeat the steps (1 to 6) till EoF is achieved [2,5].

3. Key Managgment Policy

In symmetric algorithm, key generation [2,5] is a difficult task for the cryptographer. Sender and receiver both are having the same key value in symmetric encryption algorithm. The key generation can be understood with the help of hash function table 1. The diagram support to key sharing is shown in fig. 5. In the hash function[2,5] table a, b, c, d presents the no. of lower case alphabetic characters, no. of numerical characters, no. of upper case alphabetic characters and no. of special characters.

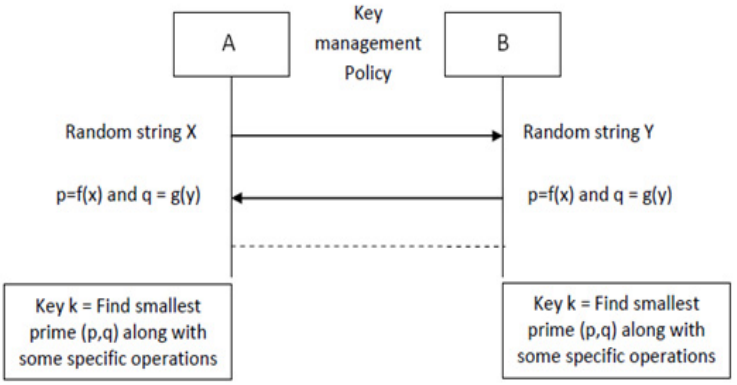

Fig 5 key distribution system[5]

Table 1 Hash Function for 4H key

a	4 H Hash Functions				Hash Function Procedure
	H_1	H_2	H_3	H_4	
	$a_g = a > (b, c, d)$	$b_g = b > (a, c, d)$	$c_g = c > (a, b, d)$	$d_g = d > (a, b, c)$	Generate the stream X and Y and exchange
0	a^b - a.b	b^c - b.c	c^d - c.d	d^a - d.a	*Case 1*: (X = Y = a_g) Get 'a' : p= H_1 and q = H_1
1	$a^c + (a + c)$	$b^d + (b + d)$	$c^a + (c + a)$	$d^b + (d + b)$	Where, $a_g = a > (b, c, d)$
2	$a^d – (c + d)$	$b^a – (d + a)$	$c^b – (a + b)$	$d^c – (b + c)$	
3	$b^c + (d. a)$	$c^d + (a. b)$	$d^a + (b. c)$	$a^b + (c. d)$	*Case 2*: (X = Y = b_g) Get 'a' : p= H_2 and q = H_2
4	$b^d + (b. a)$	$c^a + (c. b)$	$d^b + (d. c)$	$a^c + (a. d)$	Where, $b_g = b > (a, c, d)$
5	b^a - a	c^b - b	d^c - c	a^d - d	
6	c^a - a	d^b - b	a^c - c	b^d - d	*Case 3:* (X = Y = c_g) Get 'a' : p= H_3 and q = H_3
7	$c^b + (b + a - c)$	$d^c + (c + b - d)$	$a^d + (d + c - a)$	$b^a + (a + d - b)$	Where, $c_g = c > (a, b, d)$
8	$c^d + (b+ a+ d- c)$	$d^a + (c + b +a- d)$	$a^b + (d +c+b - a)$	$b^c + (a+d+c - b)$	
9	a.b.d + (a.c)	b.c.a + (b.d)	c.d.b + (c.a)	d.a.c + (d.b)	*Case 4:* (X = Y = dg) Get 'a' : p= H_4 and q = H_4
					Where, $d_g = d > (a, b, c)$

Let random string X is at transmitting end and random string Y is at receiving end. Both exchange the string to familiar with each other and the value of p and q is calculated based on hash table. Now generate a random number at sender's end within a specified range say 0 to 9 and add this number in a code sequence which signifies a specific hash. There exist four cases [2] to break the key. (i) $a_g = a > (b, c, d)$ (ii) $b_g = b > (a, c, d)$ (iii) $c_g = c > (a, b, d)$ (iv) $d_g = d > (a, b, c)$. The algorithm with possible hash functions are listed in table 1. The random sequence has more number of lowercase is alphabetic characters is denoted by a_g. The random sequence is followed at both the ends X string and Y string respectively. After exchange between X and Y, the first value denotes the value of 'a' in the random generated sequence. Based on the value of 'a', the value of p and q is calculated and key value is generated with the least prime number at both the ends with trail solution method. The actual key value is the average of least and lager prime number between 'p' and 'q'. The generated key is used to encrypt and decrypt the data.

Table 2 Example of key generation

Example:	
Let, stream X = ade3010SH#@{}%	stream Y = upes203IND#$^*t5
Here (a = 3, b = 4, c = 2, d = 5)	Here (a = 5, b = 4, c = 3, d = 4)
X supports condition dg = d > (a, b, c) and Hash function H4. Therefore, p = da - d.a = (5)3 – (5.3) = 125 -15 =110	X supports condition ag = a > (b, c, d) and Hash function H1. Therefore, q = ab - a.b = (5)4 – (5.4) = 625 -20 = 605
Key Value: Lowest prime number between 110 and 605 is 111 and largest prime number between 110 and 605 is 601. Then the key value will be the average of Lowest and Largest prime numbers. Key = (Lowest prime + Largest prime) = (111 + 601)/2 = 712/2 = 306	

4. Results & Discussion

The design is developed in VHDL. The method is used for VHDL implantation is finite state machine and behaviour style of modeling in VHDL. The Register Transfer Level (RTL) view of the developed chip is shown in fig. 6 and the description of the chip is explained in table 1.

Step input 1: reset = '1', clk is used for the synchronization and then run. The clock pulse is applied with rising edge, to check the results at 50% duty cycle.

Step input 2: reset = '0', same clk is used for synchronization. Select the input text, Model_selection input to select encryption and decryption mode, enable input to enable the particular logic. The description of the pins in listed in table 1

Mode_selection is forced to function the chip in two modes. If mode_slection = '1', data encryption logic is there and mode_selection = '0' decryption logic is there. It is used to differentiate the encryption and decryption logic from the integrated chip.

There is the need to enable the logic for encryption and decryption also. If enable = '1', it is the encryption logic, for decryption algorithm enable = '0' which disable the encryption logic. Force the mode-selection and enable with input_text <n bit>

Table 3 Pin description of RTL view of encryption and decryption logic

Pins	Functional Description
Reset	Used to reset sender and synchronized with clock of std_logic (1 bit)
Clk	Default input for sequential logic, rising edge of clock pulse of std_logic (1 bit)
input_text [N-1:0]	Input text of the encryption end it can be of 'N' bit. It is of std_logic_vector type
Decryption_text[N-1 : 0]	Decrypted text at receiving end, it is also of 'n'bit and of std_logic_vector type
Mode_Selection	1 bit input(std_logic) to select in a particular mode if mode_selection = '1' it is in encryption mode and mode_selection = '0', it is in decryption mode
Enable	1 bit input (std_logic) enable and disable the encryption logic. If enable = '1' encryption algorithms else decryption logic
Cipher_text [N-1 : 0]	Cipher text is the text which is encrypted with key at the transmitting end. It can be any garbage value and it is of std_logic_vector type

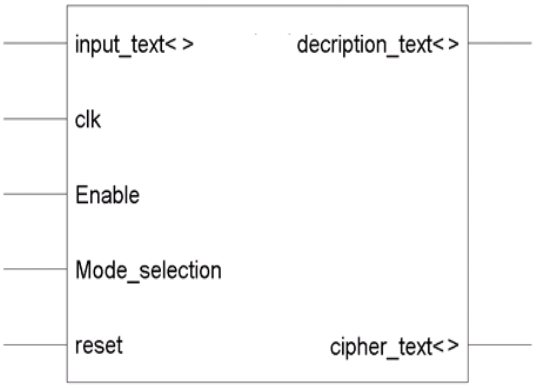

Fig. 6 RTL view of developed chip

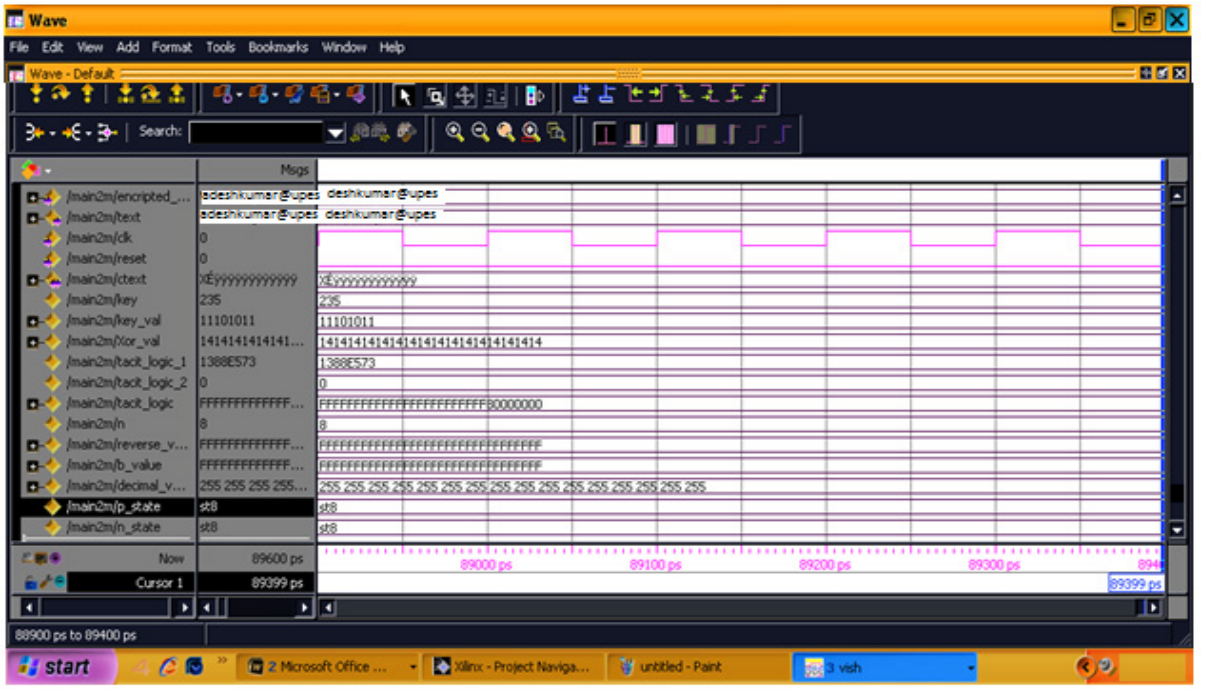

Fig. 7 Modelsim simulation of encryption and decryption

Device utilization and timing analysis

Device utilization report gives the percentage utilization of device hardware for the chip implementation. Device hardware includes No of slices, No of flip flops, No of input LUTs, No. of bounded IOBs and No of gated clocks (GCLKs) used in the implementation of design. Timing details provides the information of delay, minimum period value, maximum frequency value, minimum input arrival time before clock and maximum output required time after clock. Total memory utilization value required to complete the design. The target device is: xc5vlx20t-2-ff323 synthesized with Virtex-5 FPGA. Table 4 and Table 5 list the simulated values of the design.

Table 4 Device utilization summary

Device Part	**Encryption**		**Decryption**	
Block Size	**512 bit**	**1024 bit**	**512 bit**	**1024 bit**
Block size	125 out of 12480 1 %	245 out of 12480 2 %	121 out of 12480 1 %	224 out of 12480 2 %
Number of Slices	100 out of 12480 1%	198 out of 12480 2 %	97 out of 12480 1%	189 out of 12480 2 %
Number of Slice Flip Flops	3 out of 9 33%	3 out of 9 33%	3 out of 9 33%	3 out of 9 33%
Number of 4 input LUTs	16 out of 172 9 %	18 out of 172 10 %	16 out of 172 9 %	18 out of 172 10 %
Number of bonded IOBs	1 out of 32 3%	1 out of 32 3%	1 out of 32 3%	1 out of 32 3%

Table 5 Timing Parameters

Parameters	**Encryption**		**Decryption**	
Block Size	**512 bit**	**1024 bit**	**512 bit**	**1024 bit**
Minimum Period	1.098 ns	1.578 ns	0.918 ns	1.437 ns

Maximum Frequency	750 MHz	789 MHz	715 MHz	756 MHz
Minimum input arrival time before clock	2.732 ns	2.837 ns	2.117 ns	2.481 ns
Maximum output required time after clock	5.826 ns	5.912 ns	4.951 ns	5.124 ns
Total memory usage	102764 kB	115569 kB	92764 kB	101265 kB

In comparison to the existing work we have achieved the optimized results. Ref[5] proposed the future work as chip development of TACIT cryptographic logic. We have developed and synthesized the chip for the logic. In ref[2] the developed design was synthesized for 128 bit of block size, in our work the synthesis is carried out for 512 and 1024 bit of block size with maximum support frequency of 789 MHz in encryption.

5. Conclusions

The TACIT algorithm is simulated for the 'n' bit block size and key value. The results are synthesized on Virtex-5 FPGA for 512 bit and 1024 bit of block size successfully. The proposed TACIT algorithm has proven good results and simulated data is tested for different test cases. The greatest advantage of the proposed algorithm is that it will have key size and block size of 'n' bit. NoC security concern can be resolved using TACIT hardware FPGA chip integration embedded with NoC router. In future, the work can be done with the security with compression of data packets.

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Secured Network on Chip (NoC) Architecture and Routing with Modified TACIT Cryptographic Technique

Adesh Kumar[a]*, Piyush Kuchhal[b] , Sonal Singhal[c]

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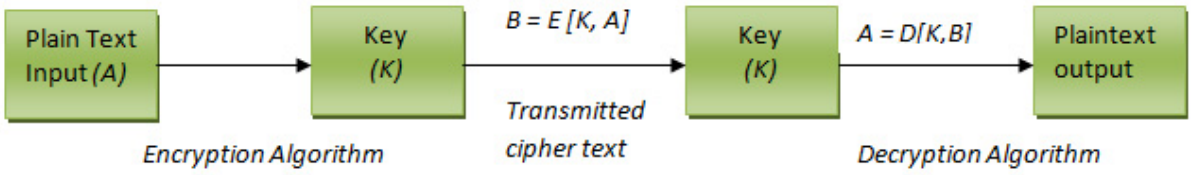

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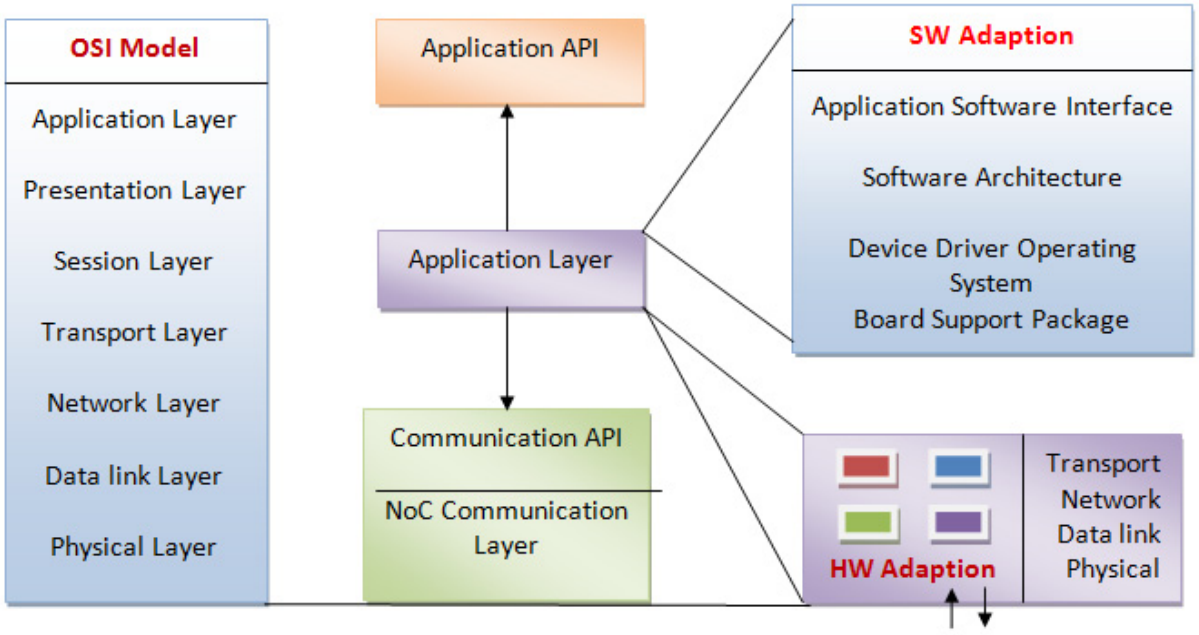

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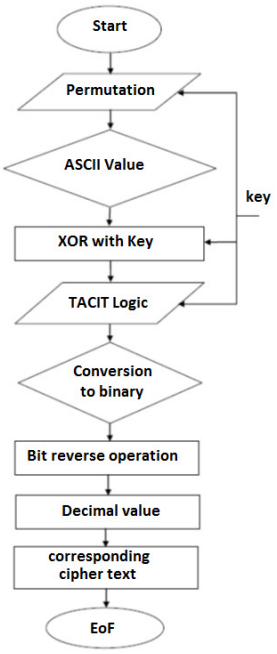

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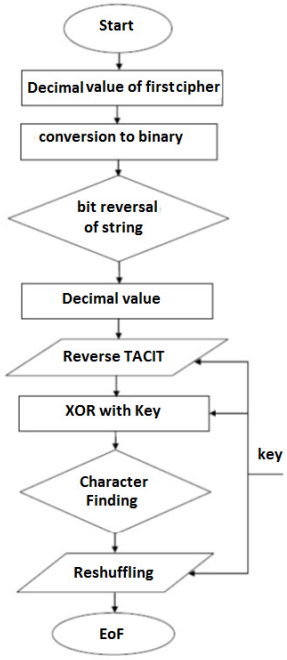

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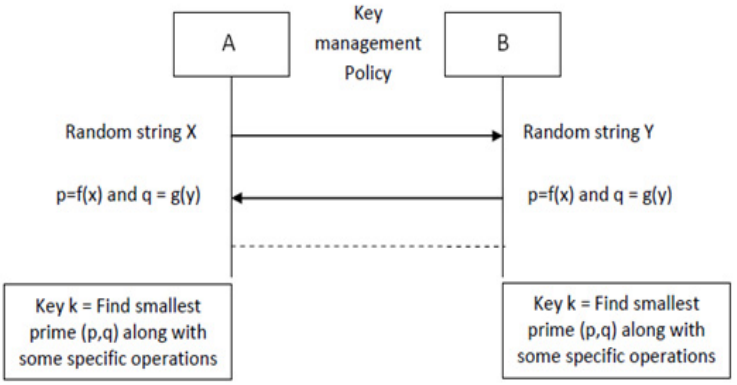

Fig 5 key distribution system[5]

Table 1 Hash Function for 4H key

a	4 H Hash Functions				Hash Function Procedure
	H_1	H_2	H_3	H_4	
	$a_g = a > (b, c, d)$	$b_g = b > (a, c, d)$	$c_g = c > (a, b, d)$	$d_g = d > (a, b, c)$	Generate the stream X and Y and exchange
0	a^b - a.b	b^c - b.c	c^d - c.d	d^a - d.a	*Case 1*: (X = Y = a_g) Get 'a' : p= H_1 and q = H_1
1	$a^c + (a + c)$	$b^d + (b + d)$	$c^a + (c + a)$	$d^b + (d + b)$	Where, $a_g = a > (b, c, d)$
2	$a^d – (c + d)$	$b^a – (d + a)$	$c^b – (a + b)$	$d^c – (b + c)$	
3	$b^c + (d. a)$	$c^d + (a. b)$	$d^a + (b. c)$	$a^b + (c. d)$	*Case 2*: (X = Y = b_g) Get 'a' : p= H_2 and q = H_2
4	$b^d + (b. a)$	$c^a + (c. b)$	$d^b + (d. c)$	$a^c + (a. d)$	Where, $b_g = b > (a, c, d)$
5	b^a - a	c^b - b	d^c - c	a^d - d	
6	c^a - a	d^b - b	a^c - c	b^d - d	*Case 3:* (X = Y = c_g) Get 'a' : p= H_3 and q = H_3
7	$c^b + (b + a - c)$	$d^c + (c + b - d)$	$a^d + (d + c - a)$	$b^a + (a + d - b)$	Where, $c_g = c > (a, b, d)$
8	$c^d + (b+ a+ d- c)$	$d^a + (c + b +a- d)$	$a^b + (d +c+b - a)$	$b^c + (a+d+c - b)$	
9	a.b.d + (a.c)	b.c.a + (b.d)	c.d.b + (c.a)	d.a.c + (d.b)	*Case 4:* (X = Y = dg) Get 'a' : p= H_4 and q = H_4
					Where, $d_g = d > (a, b, c)$

Let random string X is at transmitting end and random string Y is at receiving end. Both exchange the string to familiar with each other and the value of p and q is calculated based on hash table. Now generate a random number at sender's end within a specified range say 0 to 9 and add this number in a code sequence which signifies a specific hash. There exist four cases [2] to break the key. (i) $a_g = a > (b, c, d)$ (ii) $b_g = b > (a, c, d)$ (iii) $c_g = c > (a, b, d)$ (iv) $d_g = d > (a, b, c)$. The algorithm with possible hash functions are listed in table 1. The random sequence has more number of lowercase is alphabetic characters is denoted by a_g. The random sequence is followed at both the ends X string and Y string respectively. After exchange between X and Y, the first value denotes the value of 'a' in the random generated sequence. Based on the value of 'a', the value of p and q is calculated and key value is generated with the least prime number at both the ends with trail solution method. The actual key value is the average of least and lager prime number between 'p' and 'q'. The generated key is used to encrypt and decrypt the data.

Table 2 Example of key generation

Example:	
Let, stream X = ade3010SH#@{}%	stream Y = upes203IND#$^*t5
Here (a = 3, b = 4, c = 2, d = 5)	Here (a = 5, b = 4, c = 3, d = 4)
X supports condition dg = d > (a, b, c) and Hash function H4. Therefore, p = da - d.a = (5)3 – (5.3) = 125 -15 =110	X supports condition ag = a > (b, c, d) and Hash function H1. Therefore, q = ab - a.b = (5)4 – (5.4) = 625 -20 = 605
Key Value: Lowest prime number between 110 and 605 is 111 and largest prime number between 110 and 605 is 601. Then the key value will be the average of Lowest and Largest prime numbers. Key = (Lowest prime + Largest prime) = (111 + 601)/2 = 712/2 = 306	

4. Results & Discussion

The design is developed in VHDL. The method is used for VHDL implantation is finite state machine and behaviour style of modeling in VHDL. The Register Transfer Level (RTL) view of the developed chip is shown in fig. 6 and the description of the chip is explained in table 1.

Step input 1: reset = '1', clk is used for the synchronization and then run. The clock pulse is applied with rising edge, to check the results at 50% duty cycle.

Step input 2: reset = '0', same clk is used for synchronization. Select the input text, Model_selection input to select encryption and decryption mode, enable input to enable the particular logic. The description of the pins in listed in table 1

Mode_selection is forced to function the chip in two modes. If mode_slection = '1', data encryption logic is there and mode_selection = '0' decryption logic is there. It is used to differentiate the encryption and decryption logic from the integrated chip.

There is the need to enable the logic for encryption and decryption also. If enable = '1', it is the encryption logic, for decryption algorithm enable = '0' which disable the encryption logic. Force the mode-selection and enable with input_text <n bit>

Table 3 Pin description of RTL view of encryption and decryption logic

Pins	Functional Description
Reset	Used to reset sender and synchronized with clock of std_logic (1 bit)
Clk	Default input for sequential logic, rising edge of clock pulse of std_logic (1 bit)
input_text [N-1:0]	Input text of the encryption end it can be of 'N' bit. It is of std_logic_vector type
Decryption_text[N-1 : 0]	Decrypted text at receiving end, it is also of 'n'bit and of std_logic_vector type
Mode_Selection	1 bit input(std_logic) to select in a particular mode if mode_selection = '1' it is in encryption mode and mode_selection = '0', it is in decryption mode
Enable	1 bit input (std_logic) enable and disable the encryption logic. If enable = '1' encryption algorithms else decryption logic
Cipher_text [N-1 : 0]	Cipher text is the text which is encrypted with key at the transmitting end. It can be any garbage value and it is of std_logic_vector type

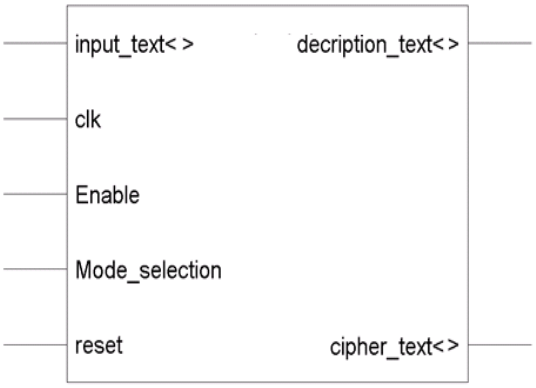

Fig. 6 RTL view of developed chip

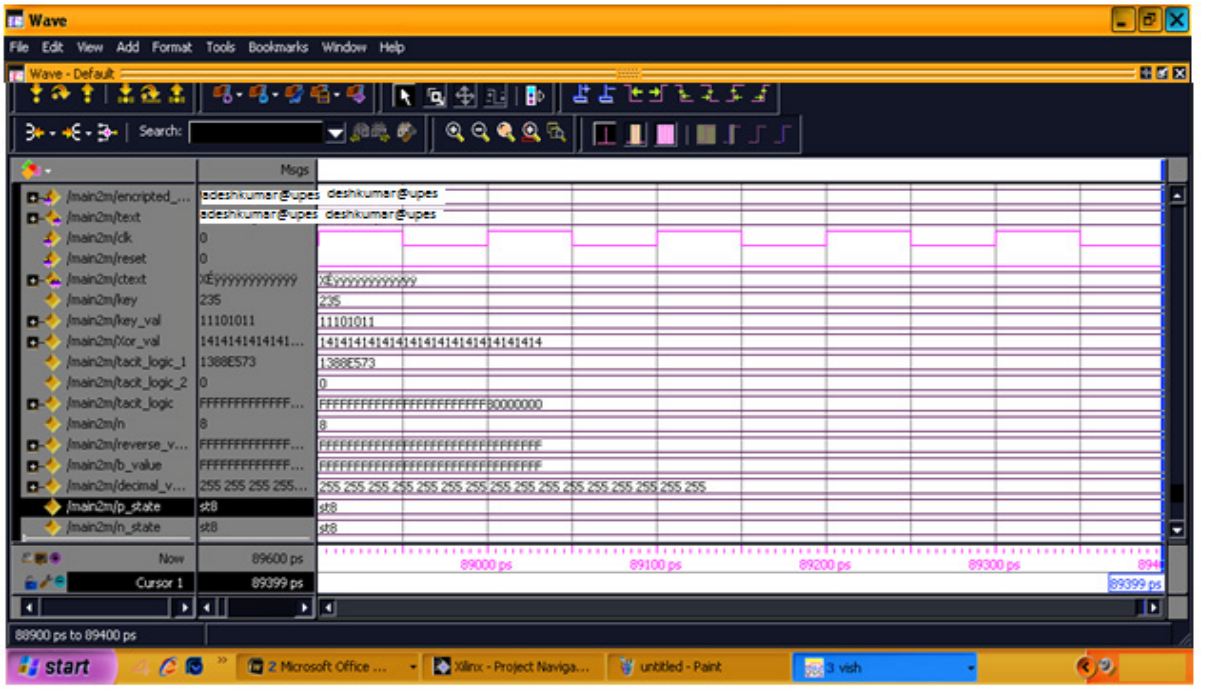

Fig. 7 Modelsim simulation of encryption and decryption

Device utilization and timing analysis

Device utilization report gives the percentage utilization of device hardware for the chip implementation. Device hardware includes No of slices, No of flip flops, No of input LUTs, No. of bounded IOBs and No of gated clocks (GCLKs) used in the implementation of design. Timing details provides the information of delay, minimum period value, maximum frequency value, minimum input arrival time before clock and maximum output required time after clock. Total memory utilization value required to complete the design. The target device is: xc5vlx20t-2-ff323 synthesized with Virtex-5 FPGA. Table 4 and Table 5 list the simulated values of the design.

Table 4 Device utilization summary

Device Part	**Encryption**		**Decryption**	
Block Size	**512 bit**	**1024 bit**	**512 bit**	**1024 bit**
Block size	125 out of 12480 1 %	245 out of 12480 2 %	121 out of 12480 1 %	224 out of 12480 2 %
Number of Slices	100 out of 12480 1%	198 out of 12480 2 %	97 out of 12480 1%	189 out of 12480 2 %
Number of Slice Flip Flops	3 out of 9 33%	3 out of 9 33%	3 out of 9 33%	3 out of 9 33%
Number of 4 input LUTs	16 out of 172 9 %	18 out of 172 10 %	16 out of 172 9 %	18 out of 172 10 %
Number of bonded IOBs	1 out of 32 3%	1 out of 32 3%	1 out of 32 3%	1 out of 32 3%

Table 5 Timing Parameters

Parameters	**Encryption**		**Decryption**	
Block Size	**512 bit**	**1024 bit**	**512 bit**	**1024 bit**
Minimum Period	1.098 ns	1.578 ns	0.918 ns	1.437 ns

Maximum Frequency	750 MHz	789 MHz	715 MHz	756 MHz
Minimum input arrival time before clock	2.732 ns	2.837 ns	2.117 ns	2.481 ns
Maximum output required time after clock	5.826 ns	5.912 ns	4.951 ns	5.124 ns
Total memory usage	102764 kB	115569 kB	92764 kB	101265 kB

In comparison to the existing work we have achieved the optimized results. Ref[5] proposed the future work as chip development of TACIT cryptographic logic. We have developed and synthesized the chip for the logic. In ref[2] the developed design was synthesized for 128 bit of block size, in our work the synthesis is carried out for 512 and 1024 bit of block size with maximum support frequency of 789 MHz in encryption.

5. Conclusions

The TACIT algorithm is simulated for the 'n' bit block size and key value. The results are synthesized on Virtex-5 FPGA for 512 bit and 1024 bit of block size successfully. The proposed TACIT algorithm has proven good results and simulated data is tested for different test cases. The greatest advantage of the proposed algorithm is that it will have key size and block size of 'n' bit. NoC security concern can be resolved using TACIT hardware FPGA chip integration embedded with NoC router. In future, the work can be done with the security with compression of data packets.

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State of Inspirational Leadership in new millennium Human Resource Environment

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Abstract
Leadership is a known phenomenon in the gamut of business since its inception. The word is undergoing drastic changes in the field of business like business leader, leader-manager, transactional leader, authentic leader, ethical leader, transformational leader, spiritual leader and so on. Leadership is a hot cake discipline to most of the researchers in different disciplines. However, in the field of business the term has different connotations due to organizational convenience or structures. Leadership by its nature is a complex theme in the field of business. There were lots of researches on this crucial element. However, a research in the field of inspirational leadership is gaining momentum these days and most of the researches are incomplete in this domain. One of the major reasons for incomplete research in this field is its nature and connections to various other disciplines. The other reason for its gaining importance is dynamic Human Resource environment.

Human Resource Environment in new millennium has placed before the business lot of challenges. Human Resource Departments and HR Managers have to deal with these challenges by building necessary competencies, capabilities and talents. The present research paper aimed at identifying these challenges and made attempts to resolve certain issues and problems with the help of "Inspirational Leadership" mechanism.

Key Words: Inspirational Leader, Structures, HR Environment, Challenges and Competencies

Introduction:

Leadership is known phenomenon but it is very difficult to define. In one way leader is an individual within in a group who wields most influence over others. It is evident from any civilization or mythology that leaders are considered to be special. However most of the early notions speak about personal abilities of a leader such as with supernatural powers, ability to see through men's minds, telling the future and extracting obedience hypnotically.

In the field of business it is generally viewed as influencing others towards the accomplishment of goals. In one way the desires of organization are transformed into a burning passion for accomplishment by the leader. Though organizations may not use specifically the word "Leader", they generally resorts to usage of similar other words such as leader-manager, manager, managing director, chair personnel, chief and chief executive officer etc. as per the individual's position in the organizational hierarchy.

There are certain concepts that a manager is more than a leader. According to the position of a manager, he has to organize and control the activities of people toward the plan, accomplishment of objectives. However, some researchers made attempts to differentiate leadership from manager ship. Finally they sum up one theme that **"all managers are leaders but all leaders are not managers".**

As per this theme, a leader-manager in an organization is the foundation, he/she has to plan and organize all the activities with coordination and team orientation. However, this appears to be simple but very complex due to the dynamic nature of business. A manager-leader must be visionary and intended to foresee each and every aspect with a different mind set by analyzing the pros and cons of

all aspects in the business for which he is intended to act as transactional leader-manager. The leader-manager may occupy his/her position as production, marketing, finance, research & development and human resource manager. Leader-manager has to keep an eye on the dynamic nature of environment and its ramifications on the business. The potential leader-manager must possess certain key competencies to diagnose various environments such as marketing, legal, political, economical, technical, cultural, and demographical and one of the complex environments dealing with all these environments is "Human Resource Environment". All leader-managers should aware of their HR environments failing to do so is in one way an invitation to disastrous environment to the business for which he/she is intended. Leader-managers need not necessarily possess expertise on this crucial HR environment and it is their responsibility to understand this complex environment and most of the researchers have sum up one theme on this aspect that **"all managers are human resource managers".**

Problem Statement:

Human Resource Environment is highly volatile than in any other period since World War II. During the last 10 years of the twentieth century, many political development at home and abroad were took place and they have massive impacts on human resources. The erstwhile communistic countries became global markets for western goods, suppliers of labour and competitors. Technology and internet had its impact on thousands of e-business and e-commerce operations. Implementation of People Soft and SAP has led to restructuring of human resource departments, jobs and processes. A drastic shift from individual to joint accountability has spread in most of the business houses. Float of new organizational structures created new organizations like unbundled corporations, network organizations, cellular organizations and respondent organizations.

The above mentioned dynamic changes cannot take place overnight and without any forethought. There must be a driving force behind any change. One such driving force that captured the interest of the present research is "Inspirational Leader". A problem statement is thus formed on "State of Inspirational Leadership on organizational building in Human Resource Environment".

Methodology:

The present research majorly relied on secondary sources of data like reference books, research articles, journal papers, web sources, and other published sources. These sources are further analyzed to find the gross root causes behind any environmental force to take place in business.

Review of Literature:

The current study is the culmination of the following early researches in the field. There have been thousands of published articles and books dealing with leadership over the past 40 years. The situation with respect to Human Resource Management is not uncommon on this aspect.

Ronald J.Burke and Cary L.Cooper (2006) in an edited book on Inspiring Leaders reviewed early researches in the field of leadership under the domain emerging models, qualities, development and defects in leadership.

Charles R.Greer (2012) in his book on Strategic Human Resource Management: A General Managerial Approach mentioned significantly the Human Resource Environment and the challenges of HR in various areas.

Jerald Greenberg Robert A.Baron (2010) in their book on Behaviour in Organizations, discussed thoroughly Leadership in Organizations with supportive inputs on Leadership Development.

Rao VSP (2009) in his book on Organizational Behaviour under leadership domain, discussed the importance and improvement of leadership potential with distinction on Transactional and Transformational Leadership.

Kavita Singh (2010) in her book on Organizational Behaviour Text and Cases discussed various perspectives on leadership with emphasis on Charismatic and Ethical Leadership.

David Lepak and Mary Gowan (2009) in their book on Human Resource Management Managing Employees for the Competitive Advantage, given an account of various Human Resource Management Challenges.

Gary Dessler and Biju varkkey (2011) in their book on Human Resource Management mentioned the various trends shaping the human resource management.

P.Jyothi and D.N.Venkatesh (2011) in their book on "Human Resource Management" under Human Resource Management in Dynamic Environment discussed the Presence Scenario of Human Resource Management.

Harold Koontz and Heinz Weihrich (2013) in their book on "Essentials of Management identified that there are similarities between charismatic leaders and transformational leaders

Inspirational Leadership a prologue:
Inspirational Leadership a type of leadership built on leader's charisma and the ability to transform and revitalize their organizations. However, there are certain controversies over this aspect. Some researches viewed that inspirational leadership is beyond charisma. Some researches coined the term with "Transformational Leadership". Nevertheless, the researchers have formed certain guidelines to become transformational or inspirational leader. Some of the guidelines are as follows:

1. Provide clear vision to your subordinates
2. Reward experimentation and tolerate mistakes
3. Set high goals for your followers and expect achievement
4. Develop personal relationships with your followers
5. Provide a supportive environment and
6. Empower them

An interesting point to notice with respect to inspirational leadership is that it starts with "you and me". Inspirational leadership does not begin with imitation – it begins with origination – by the person him or herself.

Are Inspirational Leaders Born or Made?
One of the controversial topics in the field of leadership is, are leaders born or made? There are certain fundamental forces that appear to operate in the development of leaders. Some of them are genetics, childhood dynamics, early life experiences and work experiences. Genetics plays a role both at intelligence and physical energy and other aspects such as emotional intelligence, creativity also have a genetic component.

However, to become an inspirational or transformational leader one may have to suffer for existence in life, though many who suffer will fail as leaders. The difference is how the individual develops by addressing or tackling the difficulties, events and challenges. Another crucial point in emergence of inspirational leadership is it may be positive (through a mentor) or negative (losing a job or termination).

Whether Inspirational Leadership can be learned?

The major problem rests with this question is many organizations do not want leaders but they prefer to have managers. Though organizations wish to have potential leader-managers they generally undertake lot of methods to impart abilities and competencies to build leadership talents. However, in reality leader-manager capabilities develops not through classroom, seminars and other programmes and it majorly takes place through "on the Job" itself.

Agenda of Inspirational Leaders:

Inspirational leader-manager focuses on certain key elements in building their leadership capabilities they are:

1. People
2. Task
3. Values
4. Ethics
5. Emotions

Inspirational leaders use a blend of people orientation with a rigor towards task achievement. In achieving tasks they give a reasonable concern to values, ethics and emotions of people. In one way these five forces are very critical for business development and success. The following table (see table 1) summarizes the areas of concern of great business leader-managers.

Table 1: Great Inspirational Leaders and their areas of concern

Leader – Manager	Organization	Areas of concern
Steve Jobs	Apple Computer	Task
Charles Schwab	Charles Schwab	Ethics
Herb Kelleher	Southwest Airlines	People
Mary Kay Ash	Mary Kay Cosmetics	People
Rupert Murdoch	News Corporation	People
Walt Disney	Walt Disney Co.	Creativity
Jack Welch	GE Group	Task
Jack Stack	Sprinfield Manufacturing	People
JRD Tata	TISCO	People and Task
Deerubhai Ambani	Reliance Industries	Task
Kumaramangalam Birla	Aditya Birla Group	People and Task
Adi Godrej	Godrej Group	Task
Narayana Murty	Infosys	People & Ethics
Ajim Premji	Wipro Group	People & Task
Warren Buffett	Berkshire Hathaway	Shareholders Money
Bill Gates	Microsoft	Skill Building

Source: Author

Though the list is not exhaustive most of these great leaders posses certain characteristics in common. Some of the characteristics as per research are prescribed in Table 2.

Table 2: Characteristics of inspirational leaders

Characteristic	Description
Drive	Desire for high achievement, high levels of energy, ambition
Honesty and Integrity	Trustworthy, reliable and open
Leadership motivation	Desire to exercise influence over others
Self-Confidence	Trust in own abilities
Cognitive ability	Intelligence, ability to interpret large data
Nuts and Bolts of Business	Knowledge of industry and business
Creativity	Originality
Flexibility	Adapting to the needs of followers

Source: Jerald Greenberg and Robert A. Baron

Inspirational Leadership and Human Resource Environment:

Organizations chalk out plans through their vision and mission statements and they convey intentions regularly through strategic planning meetings. These statements and meetings may turn out to be redundant without articulation of the means to achieve. Inspirational Leadership is something different, which focuses "Inspiring" part. Inspirational leaders' attempts to inspire their means may be employees, teams or groups to raise difficult and interesting questions about how people can be committed with high energy in reaching targeted goals. They attempts to touch most critical component of human "emotions" in order to perform well. This typical leadership phenomenon involves influence at three levels. They are:

1. People
2. Connect People with Core Values, and
3. Propelling people to high-energy action

Influencing these three levels is not so easy and it requires solid efforts on the part of inspirational leaders. Some of the efforts of inspirational leaders in influencing the followers are as follows:

a. They will do rigorous strategic homework
b. They shows authenticity
c. They brings clarity to language
d. They follow memorable or inspirational communication (Dream Speech)
e. Sense of respect to each and every body

Inspirational Leadership and Dynamic HR Environment:

Inspirational Leaders are flexible enough to adapt to the changing Human Resource Environment. In fact, they predict the possible course of future environment with their intelligence. They are capable of understanding the situations in an appropriate manner. Nonetheless, the environmental forces under which their business operates and their role in handling those turbulences is quite noteworthy. Some of the challenges in Human Resource Environment in the new millennium are depicted in the foregoing discussion. Overcoming of these challenges without a great leadership is undoubted. It is worth to note such challenges.

Inspirational Leadership – Workforce Diversity:

Diverse workforce in organizations is increasing throughout the world. It may be due to increased educational levels, initiatives of government, women empowerment, organizational issues, rate of immigration and age of level employee entering the corporate world etc.

Effective management of diversity can increase productivity and problem-solving ability. For example, bilingualism and biculturalism have been found be related to divergent thinking, which in turn has been hypothesized to be associated with creativity. A best example from corporate field is Avon Corporation, which had success with this strategy. Companies having good records in managing diversity may be able to attract better employees.

It is the potential leader-manager responsibility to promote HR policies, which are more open-minded, have less standardized operating methods, and have developed skills in dealing with resistance to change.

Inspirational Leadership – Team Management:

Increased team orientation is another phenomenon in dynamic HR environment. This is one of potential areas of interest for leader – manager. A number of companies like P&G, Eli Lilly, and Motorola have developed substantial expertise in the effective utilization of teams. In spite of several advantages with work teams, there are also disadvantages associated with work teams like sometimes they may be dysfunctional.

Potential leader – managers have to organize and see that they are in small size, formed for common purpose, commitment, common standards, accountability and assignment of roles within the team. Another concept that is gaining momentum is "Virtual Teams". Under this members work closely together even though they are based at different locations, including different countries, and may even be in different time zones. A good example for this methodology is "Johnson & Johnson".

Inspirational Leadership – HR Outsourcing:
Human Resource Outsourcing is one of the most significant challenges these days HR is facing. It is understood as the permanent contracting out of activities that were previously performed in-house. Surveys have found that as many as 91 to 93 per cent of responding companies engaging in outsourcing. The potential reason for outbreak of this phenomenon is majorly due to strategic and operational influences. In addition to this outsourcing has been used to obtain specialized expertise that is not available in-house. During the past two decades, downsizing has often reduced the number of human resource specialists in human resource departments. This reduction in staff has required organizations to go to outside vendors to obtain specialized services, such as for test validation or in-depth assessments for leadership development.

Inspirational Leadership – Open-Book Management:
Open-book management philosophy relied on the notion that empowered employees can make informed decisions and take informed actions on behalf of the organization. Basing on the inspirational leadership of Jack Stac of Springfield Manufacturing association, the culture of open-book managed is followed by many organizations like R.R.Donnnelly and Sons, Carolina Safety Associates, and Termined (North Carolina), The Bradshaw Group, Inc., in Richardson, Texas, provides an example of a small company that is also practicing the same philosophy.

Inspirational Leadership – Total Quality Management:
Total Quality Management (TQM) is pioneered by Edwards Deming with a systematic approach in achieving high levels of quality. The leader-managers of leading companies like Motoroloa, Cadillac, and Xerox brought successful TQM through employee empowerment. One of the major requirements for successful implementation of TQM rests with employee training. Employees are empowered in reducing the error rate in terms of products and services.

Inspirational Leadership – Integrated Manufacturing:
Integrated Manufacturing is a new approach for streamlined manufacturing. This system is composed of advanced manufacturing technology (AMT), TQM and just-in-time (JIT) inventory control methods. These systems require knowledge workers whose levels of technical and problem-solving skills are advanced beyond those needed for earlier forms of manufacturing and have major implications for human resource management. Companies in which leader-managers lays emphasis on AMT and TQM, there is more selectivity in hiring, more comprehensive training, greater developmental use of performance appraisal, and greater emphasis on external pay equity.

Inspirational Leadership – Reengineering:
Reengineering also termed as process innovation is in practice since late 1980s by companies, which are facing intense completion. The process of reengineering is directed to lower costs by eliminating unneeded activities and consolidating work. It is also aimed at work across traditional departmental boundaries in order to accomplish work more quickly in cross-functional teams. Reengineering requires team leadership with cross functional coordination and the crossing of organizational boundaries.

Inspirational Leadership – Management of Professionals:
A problem before Human Resource Management in future is to develop career paths for professionals. To move up in an organization, professionals have traditionally pursued an administrative track. Since

they are often unprepared for management or administrative careers, they may not find suck work satisfying. Therefore, dual career ladders have to provided, one in management and the other within professional work. Accordingly, a great challenge before the Human Resource Department-Leader Managers is to develop career tracks for professionals that will enhance organizationally loyalty.

Inspirational Leadership – Aging workforce:

Due to the advent of health consciousness the average age of workforce is moving towards age 55 to 64. Some of the implications of aging are, the workforce will be more experienced, stable, and reliable. As a result, it should be more productive. However, aging workforce may lead to less flexibility, generation of greater costs in terms of pension and health care etc. A study of labour force from 1998 to 2008 indicates a sharp rise of work force in the age of group of 55 to 64 from 13,215,000 to 20,588,000 (+55.8%) alarms leader-managers to handle an experienced and talented age group.

Inspirational Leadership – New Organizational Structures:

Organizational structure basically indicates the superior subordinate relationship. The new millennium HR environment alarms the poor structural hierarchies. Regardless of the exact form, many organizations have become much less hierarchical. More work is being performed in task force teams and project-oriented work groups. Likewise, there is evidence that organizations are becoming more flexible, porous, and adaptive. In some, the organizational structure may become less pyramidal and more like a set of concentric circles. Changes entailing more real participation, de-emphasis of managerial status, new forms of superior-subordinate relations, and rotating leadership roles requires different managerial skills.

Leadership of many companies cannot take for granted the emergence of managers with the skills to operate in such environments. As a result, their numbers and skill requirements must be anticipated and developmental experiences planned so that the organization will have an adequate number on hand when the need emerges.

Inspirational Leadership and Key Competencies:

One of the key themes of leadership is that best leaders inspire others around them. But what allows or enables a person to initiate or sustain such talent?

Research published over the last 30 years or so shows that outstanding leaders appear to require three clusters of talent. They are:

1. Expertise and experience
2. Knowledge
3. Basic cognitive competencies such as memory and deductive reasoning

Though the list of competencies is expanding, the most inspiring insights from research show that competencies can be developed through leadership development. It is on the part of the universities, companies and Government agencies etc., to undertake the process of coaching leadership talents to create noble social environments.

Inspirational Leadership and Charismatic Leadership:

The early studies made by Robert J. House on Charismatic Leadership found that charismatic leaders have certain characteristics, such as being self-confident, having strong convictions, articulating a vision, being able to initiate change, communicating high expectations, having a need to influence followers, demonstrating enthusiasm and excitement and being in touch with reality. At the same time transformational leaders identify what subordinates need to do to achieve objectives, clarify organizational roles and tasks, set up an organizational structure, reward performance, and such leaders work hard and try to run the organization effectively and efficiently. Further, transformational leaders articulate a vision and inspire followers. They also have the capacity to motivate, shape the organization culture, and create a climate for changing the organizations. Therefore, in one way both the charismatic leaders and transformational leaders fall under the category of inspirational leadership.

Overall view of Inspirational Leadership:

In one of the research, seven characteristics of inspiring and motivating leaders were identified. They are:

- They show enthusiasm regularly
- Vision with clarity and a burning desire to cherish it
- They tell memorable stories
- They invite followers to participate
- They have an optimistic outlook
- Ability to encourage people with their full potential
- Flexibility in adjusting their behavior as per the situation

Conclusion:

Though inspirational leadership is a necessary requirement yet inspiring followers, teams, employees, groups and others is not an easier affair. The corporate world has seen more leadership failures than successes. The new millennium raised some new challenges as mentioned earlier for leaders especially in Human Resource Environment. Therefore to conclude aptly that anything less than Inspirational leadership is just a plain leadership, or worse, managerial maintenance.

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"Upshot of Economic Tumult on Equity Investors: A Study of Market Index"

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ABSTRACT
The world economy is facing the turmoil triggered by sub prime crisis in the U.S.A. Now it is spread over to the world over. It has spread its wings to the Equity Markets as well as Debt Market. Decreasing Assets Prices, Falling Margins and Trading effect the countries in a badly manner. Equity Market has been hit by this turmoil because of lack of Foreign Direct Investment and Foreign Institutional Investors. Severe Credit Crunch is under pressure. Credit growth has gone down. Market Index is also variated to a large extent. The present research is an attempt to study the Economic Turmoil position in Indian Economy and analyze the impact of economic turmoil on equity investors and market Index. Moreover the volatility of the return on equity has also been studied through the Beta calculation of some companies. It also emphasizes the relationship between economic turmoil and Investor Behavior using test of Independence.

Introduction

The financial turmoil is complex and began with the deceitful mortgages. It is further triggered by panic buying and selling, decreasing security prices and falling markets. Equity Market is adversely affected by the Economic Turmoil due to back out foreign investors. Credit Growth has gone down. Financial Crisis has affected the financial market rigorously. Trading of equity on BSE and NSE has also effected. Due to current economic turmoil, investment in equity market reduces to a greater extent. Liquidity in the market, Foreign Direct Investment has affected this market badly. Beta (Systematic Risk) of most of the equity scrips is greater than 1. It shows that the security returns are highly volatile leading to less investment. Meltdown of the financial sector led to the losses to the various companies. Accordingly the most affected area is Equity Market because of higher risk possibilities. . Meltdown of Lehman Brothers also led to the bad shape of world economy. It has also affected the consumer spending and the confidence. Securities in the market are under priced or over priced. Pressure on the Banking Sector is also emerged due to banking failures and tight credit conditions. Indian Equity Market is also affected by the sudden pull out of FII's. Domestic Investment is adversely affected by the financial turmoil in U.S.

Key Words: Volatility, Risk and Return, Liquidity, Economic Turmoil, Systematic Risk, Beta

OBJECTIVES OF THE STUDY

The present study is an attempt to achieve the following objectives:

1. To study the economic turmoil position in Indian economy
2. To analyze the impact of economic turmoil on equity investors
3. To analyze the impact of economic turmoil on market index
4. To study the volatility of return on equity based on beta
5. To analyze the volatility between economic turmoil and investor behavior using test of independence
6. To suggest measures for equity investors based on the findings of the study.

METHODOLOGY

PRIMARY DATA: Primary data has been collected by conducting the survey of equity Investors in U.P

SECONDARY DATA:

Secondary data has been collected from various reputed Journals and Magazines.

Nature of Research: Descriptive Research

Sampling Technique: Non-Probability Sampling (Convenience Sampling)

Sample Size: 200
Scope Of Research: U.P. State

Analysis of the questionnaire would be done with the help of statistical tools like Bar diagrams, Pie charts, Line graphs etc. and also using other complex statistical tools like SPSS and Factor Analysis.

FACTOR ANALYSIS:

Factor analysis is a class of procedures primarily used for data reduction and summarization. In factor analysis relationship among sets of many interrelated variables are examined and represented in terms of a new underlying factors. Factor analysis is a exploratory tool and so it should be used to guide the researcher to make various decisions. One important decision is the number of factors to extract.

Correlation Matrix[a]

		Risk	Return	Volatility	Fundamentals_of_the_Company	Economic_Condition	Sectorial_Preference	Market_Condition	Company_Condition	Budget	Price	Liquidity_in_Market	International_Market	GDP_of_Country
Correlation	Risk	1.000	-.070	.110	.041	.062	-.108	.042	.052	.103	-.032	-.085	-.133	.026
	Return	-.070	1.000	-.046	-.021	.019	-.049	.006	-.072	.037	-.104	.133	.080	-.192
	Volatility	.110	-.046	1.000	-.021	.014	-.150	.012	-.006	.071	.002	-.067	-.135	.068
	Fundamentals_of_the_Company	.041	-.021	-.021	1.000	-.039	-.012	.108	-.039	-.007	.065	-.036	-.085	.010
	Economic_Condition	.062	.019	.014	-.039	1.000	.062	.122	.117	-.023	.021	.031	-.128	-.056
	Sectorial_Preference	-.108	-.049	-.150	-.012	.062	1.000	-.010	.023	-.039	-.070	.088	.129	-.137
	Market_Condition	.042	.006	.012	.108	.122	-.010	1.000	-.062	-.010	.053	-.089	-.162	-.069
	Company_Condition	.052	-.072	-.006	-.039	.117	.023	-.062	1.000	.105	.158	.026	.086	.039
	Budget	.103	.037	.071	-.007	-.023	-.039	-.010	.105	1.000	-.098	.086	-.064	-.005
	Price	-.032	-.104	.002	.065	.021	-.070	.053	.158	-.098	1.000	-.004	-.024	.090
	Liquidity_in_Market	-.085	.133	-.067	-.036	.031	.088	-.089	.026	.086	-.004	1.000	-.024	.028
	International_Market	-.133	.080	-.135	-.085	-.128	.129	-.162	.086	-.064	-.024	-.024	1.000	-.098
	GDP_of_Country	.026	-.192	.068	.010	-.056	-.137	-.069	.039	-.005	.090	.028	-.098	1.000
Sig. (1-tailed)	Risk		.162	.061	.282	.192	.064	.279	.232	.073	.327	.116	.030	.359
	Return	.162		.259	.384	.392	.246	.469	.156	.302	.071	.030	.131	.003
	Volatility	.061	.259		.386	.425	.017	.434	.468	.160	.491	.172	.028	.169
	Fundamentals_of_the_Company	.282	.384	.386		.292	.435	.064	.290	.459	.182	.308	.115	.443
	Economic_Condition	.192	.392	.425	.292		.192	.043	.049	.372	.386	.329	.035	.214
	Sectorial_Preference	.064	.246	.017	.435	.192		.441	.373	.290	.161	.106	.035	.026
	Market_Condition	.279	.469	.434	.064	.043	.441		.192	.444	.227	.104	.011	.165
	Company_Condition	.232	.156	.468	.290	.049	.373	.192		.070	.013	.358	.113	.293
	Budget	.073	.302	.160	.459	.372	.290	.444	.070		.085	.114	.186	.474
	Price	.327	.071	.491	.182	.386	.161	.227	.013	.085		.480	.367	.102
	Liquidity_in_Market	.116	.030	.172	.308	.329	.106	.104	.358	.114	.480		.365	.349
	International_Market	.030	.131	.028	.115	.035	.035	.011	.113	.186	.367	.365		.083
	GDP_of_Country	.359	.003	.169	.443	.214	.026	.165	.293	.474	.102	.349	.083	

a. Determinant = .624

INTERPRETATION:

This SPSS output shows an abridged version of R Matrix. The top half of this table contains the Pearson correlation coefficient between all pairs of factors whereas the bottom half contains the one tailed significance of these coefficients. This correlation matrix is used to check the pattern of relationships. First check the significance values and looks for any variable for which the majority of values are greater than 0.05. Then check the correlation coefficients themselves and look for any greater than `0.9. For these data its value is .624which is greater than the necessary
Value of 0.00001. Therefore multicollineraity is not a problem for these data. TO sum up all the factors correlate fairly well and none of the correlation coefficients are particularly large, therefore there is no need to consider eliminating any factor at this stage.

KMO and Bartlett's Test:

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	.519

Bartlett's Test of Sphericity	Approx. Chi-Square	91.297
	Df	78
	Sig.	.144

INTERPERTATION: KMO and Bartlett's Test is an important part of the output produced by the SPSS tool using factor analysis. KMO i.e. Kaiser-Meyer-Olkin measures the sampling adequacy. The KMO statistic varies between 0 and 1. A value of '0' indicates that the sum of partial correlations is large relative to the sum of correlations, indicating diffusion in the pattern of correlations. A value close to '1' indicates the pattern of correlations are relatively compact and so factor analysis should yield distinct and reliable factors. Kaiser (1974) recommends accepting values greater than 0.5 as acceptable. Furthermore, values between 0.5 and 0.7 are mediocre, values between 0.7 and 0.8 are good,values between 0.8 and 0.9 are great and above 0.9 are superb. For these data the value is .519, which falls in to the range of being good. So, therefore the factor analysis is appropriate for these data.

COMMUNALITIES

	Initial	Extraction
Risk	1.000	.493
Return	1.000	.749
Volatility	1.000	.429
Fundamentals_of_the_Company	1.000	.731
Economic_Condition	1.000	.696
Sectorial_Preference	1.000	.702
Market_Condition	1.000	.538
Company_Condition	1.000	.741
Budget	1.000	.668
Price	1.000	.697
Liquidity_in_Market	1.000	.757
International_Market	1.000	.646
GDP_of_Country	1.000	.628

Extraction Method: Principal Component Analysis.

INTERPERTATION:

The above output shows the table of communalities before and after extraction. Principal component analysis works on the initial assumption that all variance is common; therefore, before extraction the communalities are all '1'. The communalities in the column labeled. Extraction, reflect the common variance in the structure. So, from the table of communalities, we can have the first variable (i.e. Risk) showing the variance of 49.3%. Another way to look at these communalities is in terms of the proportion of variance explained by the underlying factors. After extraction some of the factors are discarded and so some information is lost. The amount of variance in each variable that can be explained by the retained factors is represented by the communalities after extraction.

COMPONENT MATRIX(a)

	Component						
	1	2	3	4	5	6	7
Risk	.475						
Return		.476					.482
Volatility	.469						
Fundamentals_of_the_Company						.624	
Economic_Condition				.627			
Sectorial_Preference	-.469						-.467
Market_Condition		.457	-.482				
Company_Condition		-.418		.651			

Budget			.564			.448	
Price		-.447					.413
Liquidity_in_Market					.681		
International_Market	-.582						
GDP_of_Country		-.501					

Extraction Method: Principal Component Analysis.
a 7 components extracted.

INTERPRETATION:

The above output shows the component matrix before rotation. This matrix contains the loadings of each variable into each other. The output displays all loadings. This matrix is not particularly important for interpretation.

At this stage SPSS has extracted for 7 factors. Factor analysis is an exploratory tool so it should be used to guide the researcher to make various decisions. One important decision is the number of factors to extract. By Kaiser's criterion we should extract 7 factors and that is what SPSS has done. However, this criterion is accurate when there are less than 30 variables and communalities after extraction are greater than 0.7 or when the sample size exceeds 250.

TOTAL VARIANCE EXPLAINED

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.581	12.162	12.162	1.581	12.162	12.162
2	1.307	10.057	22.218	1.307	10.057	22.218
3	1.248	9.601	31.819	1.248	9.601	31.819
4	1.226	9.434	41.254	1.226	9.434	41.254
5	1.081	8.317	49.571	1.081	8.317	49.571
6	1.017	7.822	57.392	1.017	7.822	57.392
7	1.015	7.805	65.197	1.015	7.805	65.197
8	.868	6.675	71.873			
9	.841	6.471	78.343			
10	.782	6.012	84.355			
11	.732	5.632	89.987			
12	.660	5.077	95.063			
13	.642	4.937	100.000			

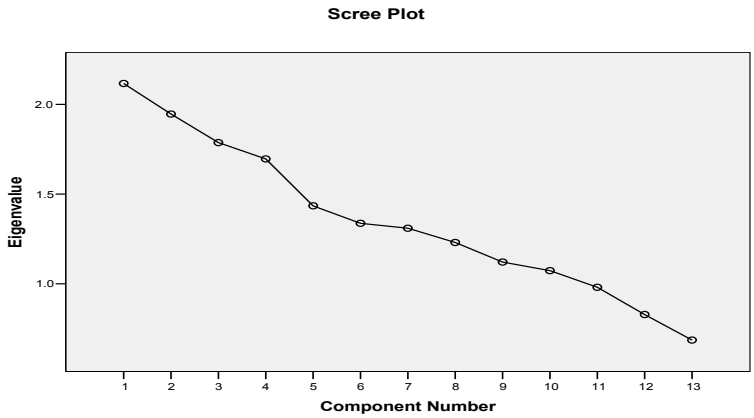
Extraction Method: Principal Component Analysis.

INTERPRETATION:

The above SPSS Output lists the eigenvalues associated with each linear component (factor) before extraction, after extraction and after rotation. Before extraction, SPSS as identified 13 linear components within the data set (we know that there should be as many eigenvectors as there are variables and so there will be as many factors as variables). The eigenvalues associated with each factor represent the variance explained by that particular linear component and SPSS also displays the eigenvalue in terms of the percentage of variance explained (so, factor '1' i.e. Risk' 12.162% of total variance). It should be clear that the first few factors explain relatively large amount of variance (especially factor '1' i.e. Risk) whereas subsequent factors explain only small amounts of variance. SPSS then extracts all factors with eigenvalues greater than 1, which leaves us with 7 factors. The eigenvalues associated with these factors are again displayed (and the percentage of variance explained) in the columns labeled extraction sums of squared loadings. The values in this part of the table are the same as the values before extraction, expect that the values for the discarded factors are ignored (hence, the table is blank after the seventh factor). In the final part of the table (labeled rotation sums of squared loadings), the eigenvalues of the factors after rotation are displayed. Rotation has the effect of optimizing the factor structure and one consequence for these data is that the relative

importance of the seventh factors is equalized. Before rotation factor '1' i.e. Demand for Commodity accounted for considerably more variance then the remaining five (12.162% compared to 10.057%, 9.601%, 9.434%, 8.317%, 7.822 and 7.805%), however after rotation it accounts for only 12.162% of variance (compared to 10.057%, 9.601%, 9.434%, 8.317%, 7.822 and 7.805% respectively

SCREE PLOT:



INTERPRETATION:

The scree plot shown above is produced by SPSS. In the scree plot, the curve falls steeply and then becomes nearly straight towards downward direction. The point after which the curve becomes nearly straight is the point of inflection on the curve. This curve is difficult to interpret because the curve begins to tail off after four factors, but there is another drop after three factors before a stable plateau is reached. Therefore, we could probably justify retaining either 4 or 3 factors.

ROTATED COMPONENT MATRIX(a)

Rotated Component Matrix[a]

	Component						
	1	2	3	4	5	6	7
Risk				.572			
Return			.767				
Volatility		-.530					
Fundamentals_of_the_ Company							.847
Economic_Condition	.735						
Sectorial_Preference		.826					
Market_Condition	.575						
Company_Condition					.798		
Budget				.765			
Price					.656		
Liquidity_in_Market						.860	
International_Market	-.572						
GDP_of_Country			-.703				

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 9 iterations.

INTERPRETATION:

The above SPSS output shows the rotated component matrix (also called the rotated factor matrix in factor analysis) which is a matrix of the factor loadings for each variable onto each factor. This matrix contains the same information as the component matrix except that it is calculated after rotation.

Compare this matrix with the unrotated solution. Before rotation, most variables loaded highly onto the first factor and the remaining factors didn't really get a look in. However, the rotation of the factor structure has clarified things considerably; there are

ANALYSIS OF BETA THROUGH SPSS:

BETA (β):

A measure of the relative volatility of a stock or other security as compared to the volatility of the entire market. A beta above 1 shows greater volatility than the overall market, and a beta below 1 is less volatile.

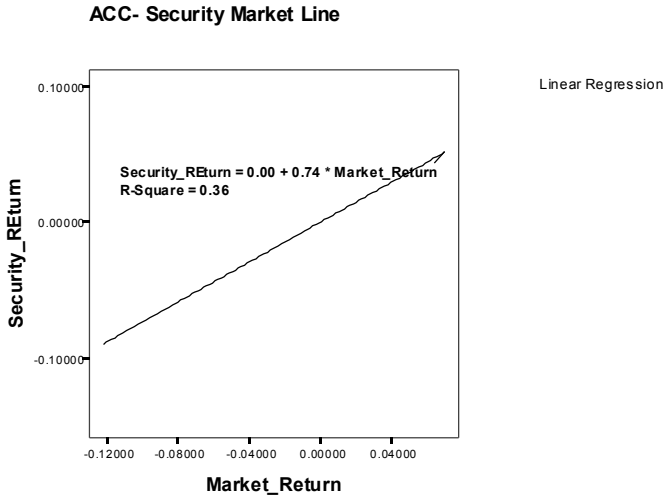
BETA:

- It can be measured through BETA=Covariance(Security, Market)/Market Variance. BETA measures the relative risk. The higher the BETA higher the risk and higher the risk premium

1. ACC

BETA=∑(kj-kj')*(km-km')/(km-km')^2

BETA=.74



INTERPRETATION:

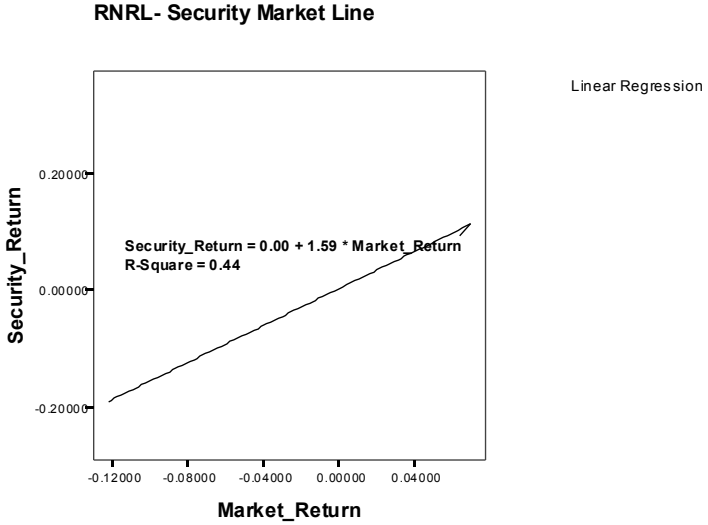
The BETA for ACC is less than 1 so it means that the security is a defensive one, the risk involves in this security is low and the return is also low.

2. RNRL

BETA=∑(kj-kj')*(km-km')/(km-km')^2

Here:

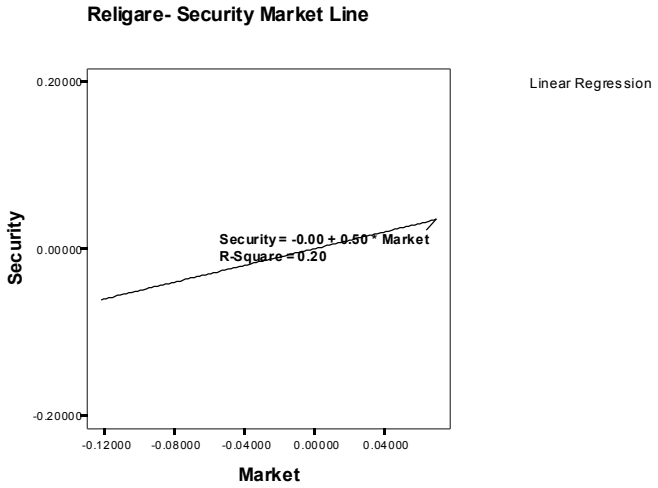
BETA=1.58



INTERPRETATION:
The BETA for RNRL is more than 1 so it means that the security is a aggressive one, the risk involves in this security is high and the return is also high

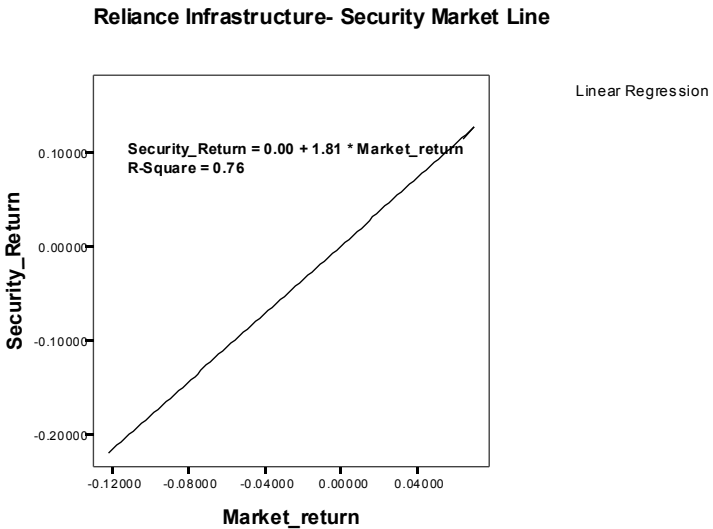
3. RELIGARE

BETA=∑(kj-kj')*(km-km')/(km-km')^2
Here:
Kj= Security Return
Km= Market Return
BETA=.51



INTERPRETATION:
The BETA for Religare is less than 1 so it means that the security is a defensive one, the risk involves in this security is low and the return is also low.

4. Reliance Infrastructure
BETA=∑(kj-kj')*(km-km')/(km-km')^2
Here:
Kj= Security Return
Km= Market Return
BETA=1.81



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INTERPRETATION:

The BETA for Reliance Industries is more than 1 so it means that the security is a aggressive one, the risk involves in this security is high and the risk is also high

5. Reliance Industries

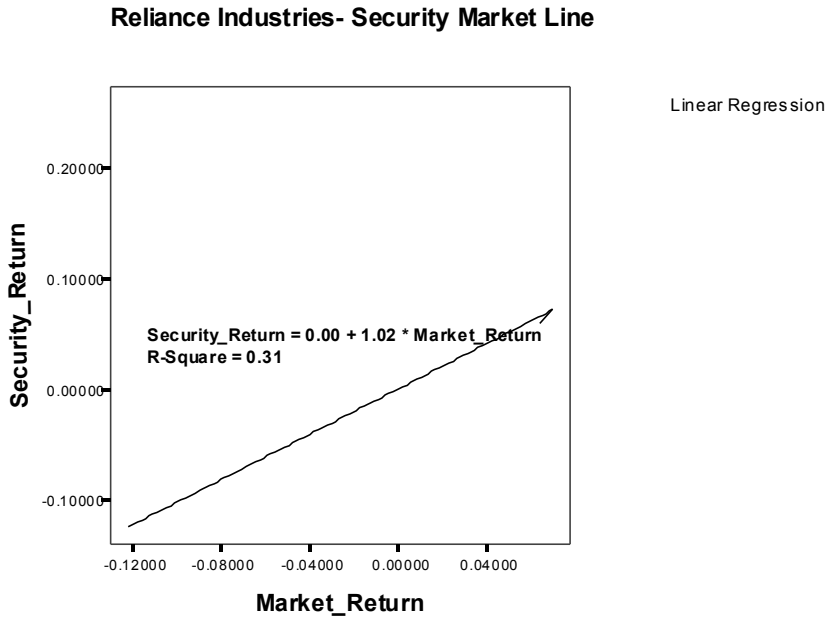
BETA=∑(kj-kj')*(km-km')/(km-km')^2

Here:

Kj= Security Return

Km= Market Return

BETA=1.02



INTERPRETATION:

The BETA for Reliance Industries is more than 1 so it means that the security is a aggressive one the risk involves in this security is high and the return is also high

6. Reliance Communication

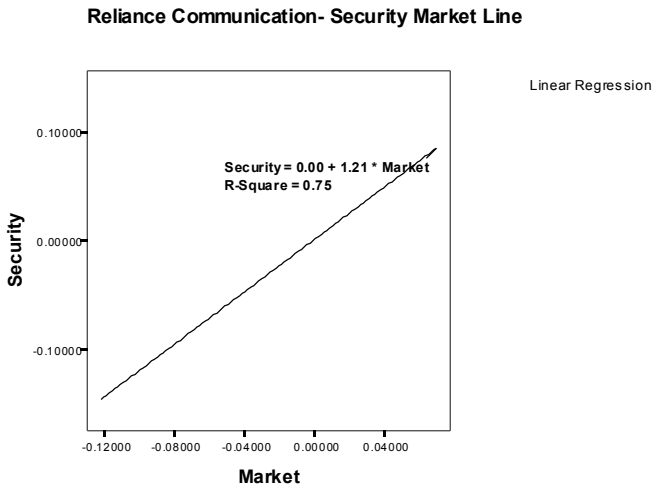
BETA=∑(kj-kj')*(km-km')/(km-km')^2

Here:

Kj= Security Return

Km= Market Return

BETA=1.20



INTERPRETATION:

The BETA for Reliance Communication is more than 1 so it means that the security is a aggressive one, the risk involves in this security is high and the return is also high

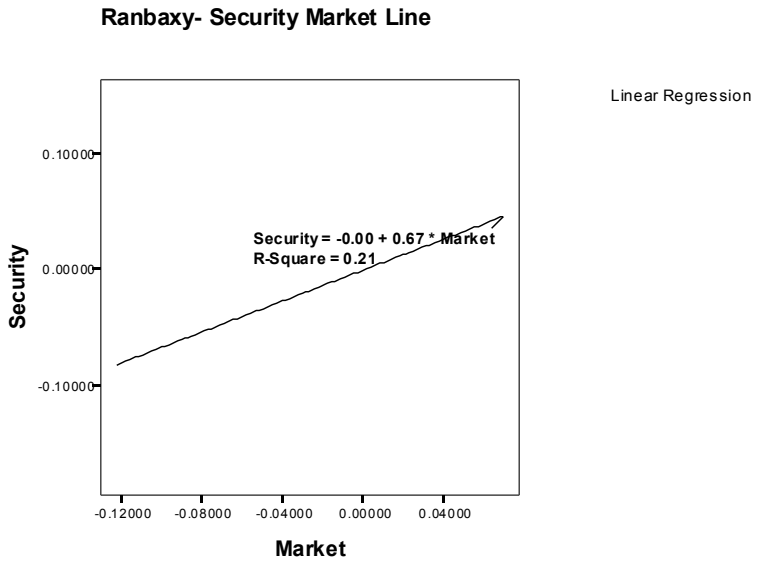
7. Ranbaxy

BETA=∑(kj-kj')*(km-km')/(km-km')^2

Here:

Kj= Security Return

Km= Market Return



BETA=.67II

INTERPRETATION:

The BETA for Ranbaxy is less than 1 so it means that the security is a defensive one, the risk involves in this security is low and the return is also low.

8. Parsvnath

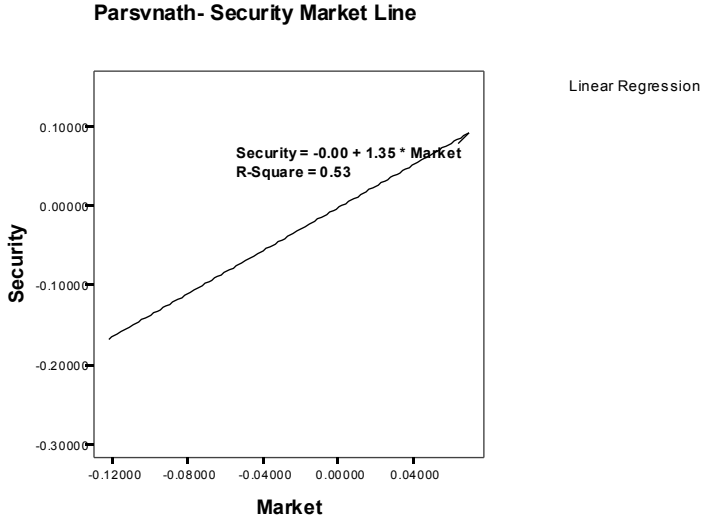
BETA=∑(kj-kj')*(km-km')/(km-km')^2

Here:

Kj= Security Return

Km= Market Return

BETA=1.35



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INTERPRETATION:

The BETA for Parsvnath is 1.35 so it means that the security is a aggressive one, the risk involves in this security is high and the return is also high

9. Oriental Bank of Commerce

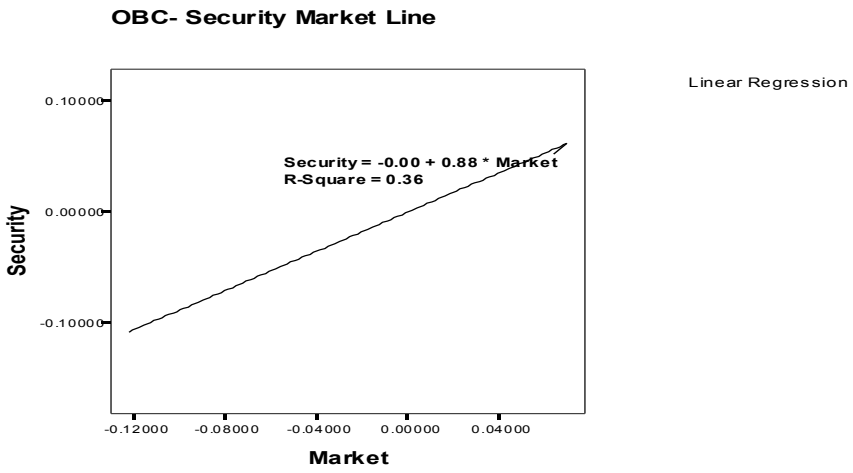
BETA=∑(kj-kj')*(km-km')/(km-km')^2

Here:

Kj= Security Return

Km= Market Return

BETA=.88



INTERPRETATION:

The BETA for Oriental Bank of Commerce is less than 1 so it means that the security is a defensive one, the risk involves in this security is low and the return is also low.

10. ONGC

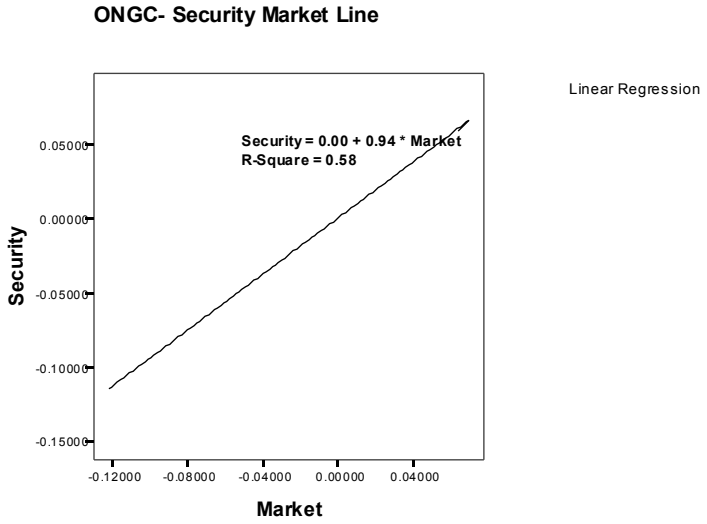
BETA=∑(kj-kj')*(km-km')/(km-km')^2

Here:

Kj= Security Return

Km= Market Return

BETA=.94



INTERPRETATION:

The BETA for ONGC is less than 1 so it means that the security is a defensive one, the risk involves in this security is low and the return is also low.

Conclusion:

Risk and Return are the most important factor an investor consider while investing in any security it will comprise of 80% & other factors only constitute 20%Due to the current economic turmoil investment in equity market reduces a lot70% of the investors belong to the medium term, 20% belong to the long term & 10% belong to the short term investment. Basically the people save 70% out of their earnings and they invest 25-30% in equity market. Secondary market is the main source of investment compare to primary market. The sector which will be affected the most by the current economic turmoil is banking sector. Most of the investors think that the level of sensex will be 12000-14000 at the end of this fiscal year (2009-2010)

Most of the factors are affecting the investing behavior while investing in equity market. . Thus this is a positive and good result for the growth of investing opportunities in equity market. Performance of the equity market has been better than before which would be definitely beneficial for the investors and equity market in the future. Some factors should be considered on priority like International market, Liquidity in market, GDP of Country and Budget. All Rest all the factors have been quite good in creating the growth opportunity for equity market.

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Water-Neutral Concept for a Manufacturing Industry

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RESEARCH ARTICLE

Water-Neutral Concept for a Manufacturing Industry

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ABSTRACT:
Water Neutrality is that one reduces the water footprint of an activity as much as reasonably possible and offsets negative externalities of the remaining water footprint. 'Water Neutral' generally does not mean that water use is brought down to zero, but that the negative economic, social and environmental externalities are reduced to much extent and that the remaining impacts are fully compensated. The idea of the concept is to stimulate individuals and corporations that undertake water consuming or polluting activities to make their activity 'water neutral' by reducing water consumption and pollution and by compensating the negative impacts of remaining water consumption and pollution through investing in projects that promote the sustainable and equitable use of water within the environment and community that is affected. An increasing number of businesses recognize that not only their operations, but also their supplies depend and impact on natural water systems. Hence, this approach offers a great opportunity to translate water footprint impacts into action to mitigate those impacts within both communities and business. In this Paper the concept of water neutrality is discussed in detail and the concept is applied to a bearing manufacturing industry.

KEYWORDS: Water Neutral, Water footprint, negative externalities, manufacturing industry.

INTRODUCTION:
Water is a precious resource that is under increased pressure from climate change and population growth. Water is a vital commodity in many manufacturing industries. It is used in process utilities production processes, and for other miscellaneous purposes. In Production processes water is used either as part of the final product or as a cleaning agent, and in process utilities it is used for cooling towers, air handling units and boilers, etc. General Plant cleaning and Employee sanitation usually constituted in miscellaneous purposes. The efficient use of water should be a major priority in order to ensure that water scarcity will have minimum effects on production process. There are Different water management strategies such as process integration, water audits and use of advanced water treatment technologies which identifies opportunities to improve water consumption efficiency.

A water flow diagram is an easy to understand representation of usually complex process systems. A water flow diagram gives an idea of how much water is being used by each process including the volume and quality of the wastewater being generated. It may suggest abnormalities in water usage which cannot be identified during normal operations.

WATER FOOTPRINT:
The water footprint is an indicator of water use that looks at both direct and indirect water use. The water footprint of a product (good or service) is the total volume of fresh water used to produce the product, summed over the various steps of the production chain. The water footprint of an individual or community is the total volume of fresh water used by the individual or community in direct or indirect way. The indirect water use refers to the water that is used to produce the goods and services consumed by the individual or community. The water footprint of a business consists of its direct water use in its own operations plus its indirect water use, i.e. the water use in the business's supply chain. 'Water use' is measured in terms of water volumes

consumed (evaporated) and/or polluted. A water footprint can be calculated for any product or activity as well as for any well-defined group of consumers (e.g. an individual or family, or the inhabitants of a village, city, province, state or nation) or producers (e.g. a public organization, private enterprise or a whole economic sector). A water footprint is more than a figure for the total volume of water used; it refers specifically to the type of water use and where and when the water was used. The concept of the water footprint shows similarity to the concepts of the ecological footprint and the carbon footprint. The roots and intended purposes of the three concepts differ, however. The roots of ecological footprint analysis lie in the search for an indicator that can show what proportion of the globe's bio capacity has been appropriated. The carbon footprint was formulated later to be able to quantify the contribution of various activities to climate change. The roots of water footprint analysis lie in the exploration of the global dimension of water as a natural resource. The starting point was the discontent with the fact that water resources management is generally seen as a local issue or a river-basin issue at most. The fact that international trade affects the global pattern of water use has been overlooked. The global dimension of water resources management and the relevance of the structure of the global economy have been ignored by most of the water science and policy community. In addition, the production (supply) perspective in water resources management is so dominant that it is hardly recognized that water use relates in the end to human consumption. By looking at the water use along production and supply chains, the water footprint aims to uncover this hidden link between human consumption and water use. Water footprints are defined based on the actual water use per unit of product, not on the basis of global average numbers. This means that water footprints can only be calculated by analyzing the source of products and considering the actual water use in the countries of origin.

WATER NEUTRAL CONCEPT:

The idea of the water-neutral concept is to stimulate individuals and corporations that undertake water consuming or polluting activities to make their activity 'water neutral' by reducing water consumption and pollution and by compensating for the negative impacts of remaining water consumption and pollution through investing in projects that promote the sustainable and equitable use of water within the environment and community that is affected. Water consumption and pollution can be reduced for example by investing in water saving technology, water conservation measures and wastewater treatment. Compensation for negative impacts can be done for example by investing in improved watershed management or by supporting poor communities that do not have access to clean water to set up and maintain their own water supply system.

Water neutrality is an important but relatively new concept for managing water resources in the context of a new development and the associated demand for water. The basic concept of water neutrality is that the demand for water should be the same after a new development is built as it was before. This is achieved by making both new and existing homes and buildings in the area more water efficient. Water neutrality could be achieved in a combination of ways. New developments could be made superefficient, but will still require water to fulfil essential needs. This water can be 'offset' by retrofitting existing buildings within the area with more efficient devices and appliances, expanding metering and introducing innovative tariffs for water use, which reward moderate water users. As well as the household sector, ways to use water more efficiently with nondomestic users should be developed. Water companies should also reduce demand by improving management of leakage where it is cost-effective. These are all techniques applied within the current water resource management planning process.

Water neutrality may give additional focus to these activities and a coherence to demand management activities that balances the coherence of supply-side options. Taking a strict interpretation, no individual or entity that uses water can ever be entirely water neutral, as water use cannot be reduced to zero. It is possible, however, that the term used in a consistent and transparent manner could drive positive action on water issues and will, therefore, have potential, similar to that of carbon neutrality. There are similarities between the water neutral concept and the carbon neutral concept. It is possible to take lessons from 'carbon', but only as far as the similarities go, because water has its own very specific characteristics – like its geographically confined nature and the fact that most water is a renewable and not a fossil resource – to which the carbon lessons will not fully apply. Water neutrality could be achieved in a combination of ways:

- Making new developments more water-efficient.
- 'Offsetting' new demand by retrofitting existing homes with water-efficient devices.
- Encouraging existing commercial premises to use less water.
- Implementing metering and tariffs to encourage the wise use of water.
- Education and awareness-raising amongst individuals.

WATER – NEUTRAL FOR MANUFACTURING INDUSTRY:

Water Requirements:

For a manufacturing industry the water requirements would be mainly for Domestic, Irrigation, Process, Cleaning, Cooling, Fire-fighting, Water treatment.

Domestic:

Most office accommodation is fitted with kitchens, toilets and bathroom all of which can contribute significantly to the water use of a business. Furthermore, many larger businesses, such as mines, provide housing for their employees. The water requirements for day-to-day living purposes, such as health and hygiene, are the same as those in any other urban center.

Irrigation:

Certain businesses develop landscaped gardens and lawns which are maintained to provide a pleasant aesthetic environment and which promote a good corporate image. These tend to be well watered, on top of which, many of the gardens contain exotic plants which are thought to have substantially higher water requirements than indigenous plants.

Process:

One of the major uses of water in the Sector is that related to the actual manufacturing processes and the end product. Water use may be consumptive and non-consumptive.

Cleaning:

Although water use for cleaning can be related to a process, it is also used for non-process related cleaning purposes. The washing down of the floors of a premises or the cleaning of a fleet of vehicles are such examples, and which can result in significant usage.

Cooling:

Cooling is often processes relate, however, there are a number of non-process related cooling requirements, like refrigeration and air conditioning which utilizes water.

Firefighting:

Reticulation systems in businesses are often designed to meet the requirements of firefighting, which often well exceed the requirements for the other water uses within a business, especially in terms of pressure. The levels of service for the others uses may therefore be excessive leading to excessive use.

Water treatment:

Certain business treats their own water to achieve the standards necessary for their process requirements. Furthermore, some businesses also have to treat their effluent to a standard to meet receiving water quality objectives or the requirements to discharge into local sewer systems. Often these treatment facilities are inefficient which may lead to significant quantities of water being wasted.

Methodology to achieve Water Neutrality:

In a manufacturing industry the focus should be on, , to explore potentials for sustainable actions in reducing water foot print of factory and achieve the targets such as To reduce the usage of blue water (from rivers, wells)

- To store more of green water (rain water)
- To increase recycling and reuse of grey water (treated water)
- To increase the awareness for conservative use of water among all the people in indusry at all levels including contractors.

The following steps should be followed to achieve the above targets.

Step 1: Water network mapping

Step 2: Water discharge/consumption point identification

Step.3:Water measurement format development and measurements

Step 4: a) Identification of improvement points.
b).Identification of potential for rainwater harvesting and its use
c) Use of treated water/closing the loop

Step 5: Implementation of points identified.

Water Network Mapping:

Water Network Mapping should be carefully done. All the water lines and meters should be identified and should be placed accordingly. Identification plays a key role. One can refer to the plant layouts drawings and can mark on the layout drawing. There are few GIS software's available for marking the waterlines on the layout drawings.

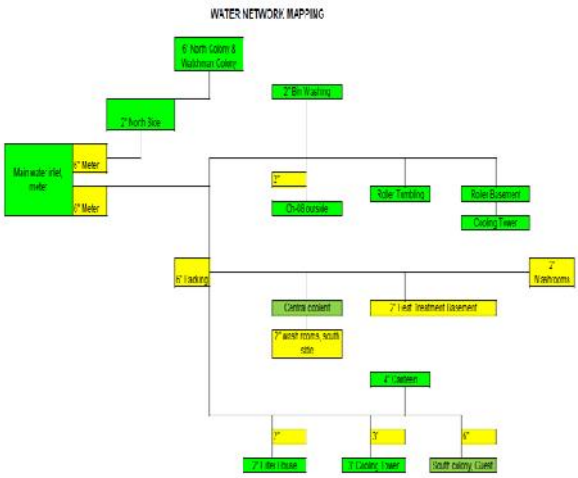

Figure 1: Water Network Mapping of a manufacturing industry

Water discharge/consumption point identification:

The locations of water discharge/consumption points have been identified with meters are shown in table 1.

Table 1: Water discharge/consumption meter locations

WATER FLOW METERS LOCATION :	
LOCATION	**INCH**
Water tower south side	6"
Water tower north side	6"
Packing outside	6"
Filter house	2"
Cooling tower	3"
Canteen outside	4"
Guest house	6"
Grinding basement	2"
Grinding basement/f/od	2"
Roller basement	3"
Office front side	2"
Bath wash	2"
Out side ch-08	2"
Wash rooms south side	2"
Crate washing area	2"
Roller tumbling	2"
Treated stp water	2"
Fire hydrant storage	6"

Water Consumption Measurement:

The water consumption measurement is done by taking readings on daily basis and the total consumption is shown per annum in table 2.

Table 2: Flow Meter Readings

FLOW METER READINGS	
LOCATION	**OVERALL CONSUMPTION PER ANNUM, m3**
Water tower south side	48000
Water tower north side	18000
Packing outside	2100
Filter house	5100
Cooling tower	7200
Grinding basement	3600
Grinding basement/f/od	2700
Roller basement	9000
Office front side	2100
Bath wash	2100
Out side ch-08	1200
Wash rooms south side	2100
Crate washing area	2400
Roller tumbling	1140
Miscellaneous*	5760
Fire hydrant storage	1500
Treated STP water **	4410*

** Treated water can be reusable.
*Miscellaneous includes water supply for Gardening, Guest House, Construction, canteen and leaks.

Identify Improvement Points and suggestions:

The following points have been identified after careful observation of total manufacturing unit.

- The treated water is discharged without any reusability. It can be used for gardening purpose.
- Rain water harvesting can be developed which reduces the consumption of municipal water
- Leaks are identified in some critical areas like heat treatment department; necessary steps should be to arrest leaks.
- Introduce drip irrigation instead of sprinklers in gardens.
- Install sensors for water taps and other common use areas.
- Plant trees in place of lawn to save water.
- Knowledge management program on water conservation in industries.

CONCLUSIONS:

The strength of the water-neutral concept partly lies in its positive connotation, which may trigger communities and businesses to act where otherwise they might not have done so. The strength of the water-neutral concept also lies in its link to the water-footprint concept. The water neutrality concept is explained to the best of the knowledge. The concept is applied to manufacturing

industry. The possible water consumption in the manufacturing industry is identified and necessary improvements or suggestions are mentioned to control the consumption rate in the industry.

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Wireless Controlled Intelligent Heating System using HPSO

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Abstract

A lot of algorithms are available to optimize the heating level to maintain room temperature. In this paper a low cost and energy efficient control system is proposed which comprises of three sections- sensor node, heater node and remote control. For testing, 2kw heater is placed in 20*10*10 cubic feet room area and is controlled through remote control based on Zigbee protocol. Remote control is used to set the desired temperature of heating system. The two temperature nodes are placed in appropriate diagonal location in the room and send the value of room temperature to the heater node. Heater node takes the average of the two sensor nodes and provides feedback to heater system. This is an intelligent network in which heater node intelligently maintains the room temperature by generating error signal with set value from remote and received average value from sensor nodes. Then value of K_P, K_I, K_D is calculated by using PID and hybrid Particle Swarm Optimizing (HPSO) algorithm and adjust the voltage levels of heating element. Heater node is capable to communicate with sensor nodes upto 30 meters and with remote control upto 100 meters. It is observed that upto 16.94% energy can be saved by using proposed system.

Keywords: Heater node, intelligent network, PSO, PID, remote control, sensor node, Zigbee

1. Introduction

Considering the papers published in the field of level control with dimmer circuits in control system with different algorithms, it is observed that, to achieve optimum values of control system parameters, HPSO is better option to implement it on real hardware. Yusoff et. al. narrates, an integrated wireless sensor network with wasp mote and meshlium gateway is designed to save energy by controlling light intensity by pulse width modulation [1]. Kok-Hua Teng et. al. describes, an android smart phone as remote control to control wireless LED dimming system. Control signal is generated with smart phone which is decoded by microcontroller to generate PWM signal, to control brightness of LED [2]. Shun-Chung Wang et. al. explains, a dimming system forT5 fluorescent lamps with

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the help of EMI filter, an active power factor correction, inverter and dimming system [3]. Jinsoo Han et. al. narrates, a Zigbee based system with IR code learning, to control home appliances in a room to reduce power consumption. A room architecture is proposed which is controlled by IR remote control [4]. Ivan Vilovic et. al describes, PSO is good to tackle the problems which are nonlinear, non-differentiating able and multimode domain. PSO is initialized with a group of random particles (solutions) and then searches for optima by updating generations. Particles profit from the discoveries and previous experience of other particles during the exploration and searches for higher objective function values [5]. Andru, L et.al narrates, street light monitoring and control system by using JN5148 wireless module with dimming circuit. For vehicle detection two methods are proposed one using PIR sensor and another Doppler sensor, among which results of Doppler method are better [6]. Li Lian et.al discribes, integrated system for street light control with combination of Zigbee and GPRS. It reduces the power consumption [7]. D. Ibrahim et.al describes, the design of temperature control with various control strategies using microcontroller with the help of feedback control [8]. erˆome Henri et.al discuss, the need of some iterative computer algorithm to optimize the energy performance. For this purpose PSO/HJ identifies more accurately the global minimum for function [9].

In this paper an intelligent network is proposed, in which heater node intelligently maintains the room temperature by generating error signal with set value from remote and receive average value from sensor nodes .

2. Proposed System

For experimental set up of proposed system 2KW heater is placed in a room size of 20*10*10 cubic feet, with two sensor nodes placed diagonally in the room corners and one remote control. Sensor nodes are placed to collect temperature data, of the room and send it to controller unit of heater node through Zigbee modem. At heater node an error signal e(t), is generated, from the average of temperature collected by sensor nodes (as feedback signal f(t)) and pre-set temperature value by remote control r(t) as shown in fig.2.4.

Error signal e(t) is taken as input to PID controller and the optimum values of K_P (proportional constant), K_I (Integral constant) , K_D(Derivative constant) is calculated with the help of HPSO and then according to these values dimming level of dimmer circuit is set, to maintain the required temperature value. RTC is used to provide exact time of temperature data received and EEPROM is to store the data for future use.

Further, to find out the constant values with PID, transfer function of system is prime issue, which is given by equation (1) [12]

$$C(s)= (1*e^{-\tau_D s})/ (\tau s+1) \quad (1)$$

Here

τ_D = delay time

τ=rise time

2.1 Remote Control, Sensor node and Heater node

Hardware is developed for the experimental set up by choosing appropriate modules w.r.t their features. Description of modules used in the development of the system is given in table 1

Table 1- Brief description of modules used

S.No.	Device/Module	Make/ Model no.	Specifications and working
1.	LCD	Sunrom model no.3013 [11]	16x2 LCD is used in remote control to display set temperature
2.	Atmega8/16	Atmel	It is a low-power CMOS 8-bit microcontroller based on the AVR RISC architecture. For remote control, sensor nodes Atmega 8 and for heater node Atmega 16 is used.
3.	Zigbee	Sunrom model no.1195 [11]	It is wireless module, having two way data communication availability. It operates on license free 2.4 GHz band. It can be interfaced in UART mode with controller.
4.	Switch Array		4x4 matrix keypad is used.
5.	Temperature sensor	Sunrom model no.3001 [11]	LM35, Calibrated directly in Celsius (Centigrade), Linear + 10.0 mV/ C scale factor

6.	RTC	Sunrom model no. 1246 [11]	It is Interfaced to board is simple I2C mode
7.	EEPROM	Atmel IC24LC16	It is Interfaced to board is simple I2C mode
8.	Dimmer	Sunrom model no1289 [11]	It is used to control the speed or level of appliance
9.	Heater		2KW for experimental set up
10.	Power supply		For remote control and sensor node, 9V battery is used with 7805 regulator to achieve 5V and LED is connected as indicator.

Fig.2.2 shows Structure diagram of remote which is used for feeding the input by user. It comprises of controller (Atmega8), Display unit(LCD 16x2), Switch array, battery(9V/200mAh) as power source, Zigbee(2.4Ghz). The required temperature is set with the switch array, and displayed on display unit and transmitted to the heater node through Zigbee.

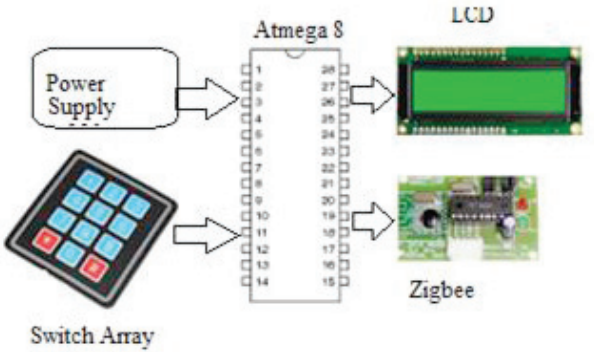

Fig.2.2 Structure diagram of remote control

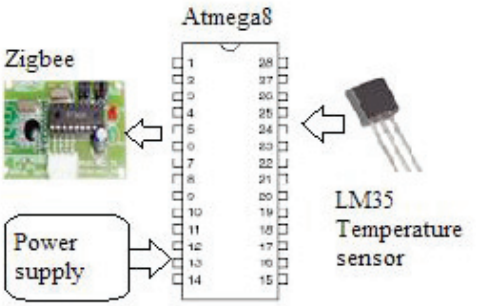

Fig.2.3 Structure diagram of sensor node

Fig.2.3 shows the structure diagram of sensor node. It comprises of temperature sensor (LM35), Zigbee, power supply (battery 9V/200mAh) and LCD(16x2). This node senses the room temperature and send it to heater node through Zigbee. Processing unit is microcontroller Atmega8.

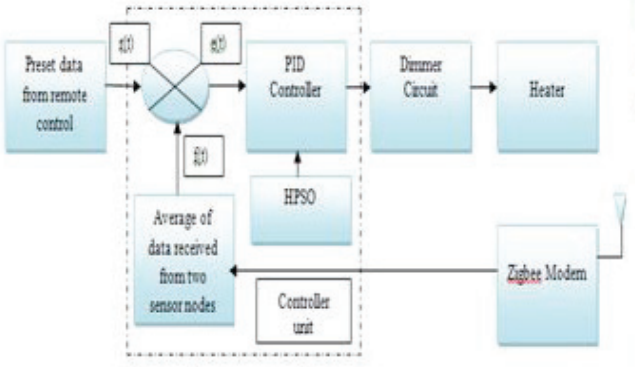

Fig.2.4 Block diagram of controller part of heater node

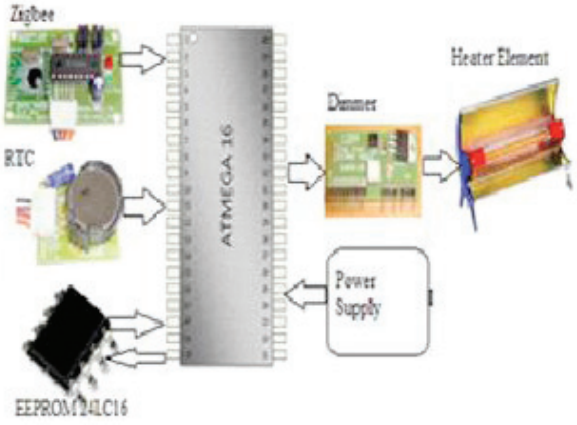

Fig.2.5 Structure diagram of heater node

Fig.2.4 shows internal block diagram for controller part of heater node. It comprises of PID controller, arrangement to calculate error signal e(t) and HPSO algorithm, to get optimized values of K_P,K_I,K_D. Fig.2.5 shows structure diagram of heater node, which comprises of heater (2KW), RTC (DS1307), EEPROM (24LC16), dimmer (MOC3021+MOSFET,256 level), controller(Atmega16), Zigbee and power supply (12V/1A adapter).

3. Simulation and Algorithm

Simulation has been done before its hardware implementation to check its proper working and feasibility. Fig.3.1 shows Proteus simulation model for the system including remote control and heater node and Fig.3.2 shows Proteus simulation model for sensor node.

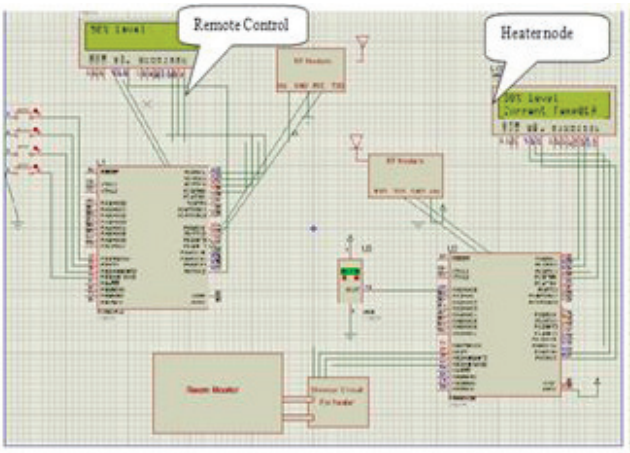

Fig.3.1 Proteus simulation model for the remote control and heater node

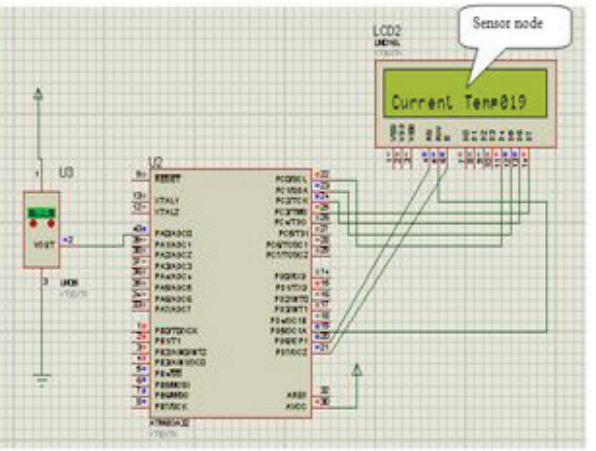

Fig.3.2 Proteus simulation model for sensor node

3.1 Algorithm for PID controller with HPSO

PSO shows good results for finding optimum value with hardware implementation, but face some problem when local optimum value is trapped, it can be observed when gbest is not changed for say k iterations, it can be solved by using SA algorithm for gbest value . To solve it HPSO is used in the proposed system it includes SA (Simulated Annealing) algorithm with PSO [10].

1. Initialize the particle positions and velocities having input as ,heater transfer function , & PSO constants with no. of particles
2. Evaluate the fitness value of system with unit step response
3. Calculate system constraints for each particle and total error
4. Compare the individual fitness value of each particle to its previous value, if it is better than previous one, replace with new value i.e. local best position otherwise don't change
5. The position of particle having lowest error is global best value
6. Update position and velocity of particles.
7. If no improvement of the global best solution occur during the last *K* iterations
8. Apply SA to fast search for best value.
9. Again update position and velocities of particles with gbest values.
10. Go back to step (3) and repeat all steps until system constraints are met

```
n = 50;          % Size of the swarm " no of birds "
bird_setp=50;   % Maximum number of "birds steps"
dimension= 2;          % Dimension of the problem
c2 =1.3;          % PSO parameter C1
c1 = 0.14;        % PSO parameter C2
w =0.9;           % pso momentum or inertia
velocity=w*velocity+c1*(R1.*(L_b_position-c_position)) +c2*(R2.*(g_b_position-c_position)); and
c_position = c_position + velocity;
```

After applying HPSO transfer function of heater system is as given by equation (2)

$$C_{(HPSOPID)}=3.082+.0212/s+9.813s \qquad (2)$$

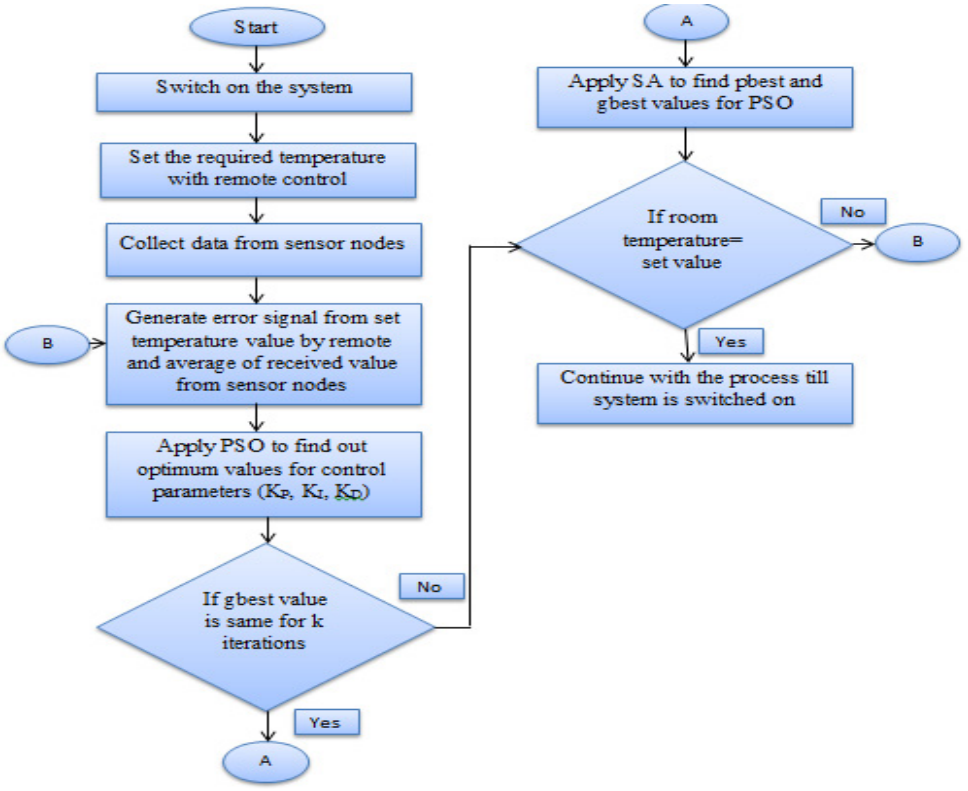

Fig.3.3 flow chart for the proposed system

4. **Experimental set up**

Hardware has been implemented and controller was programmed with the optimized values K_P, K_I and K_D with HPSO algorithm and the constant present temperature is observed in the test room of size 20*10*10 cubic feet.

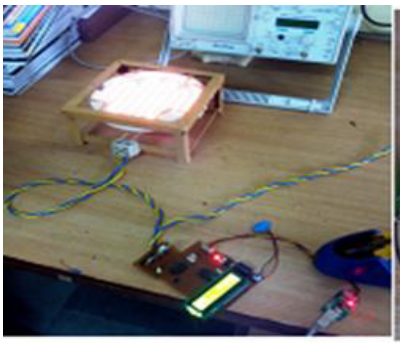

Fig.4.1 Developed heater node

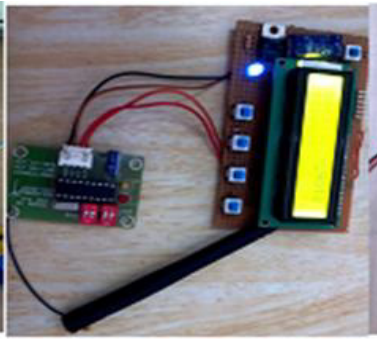

Fig.4.2 Developed remote control

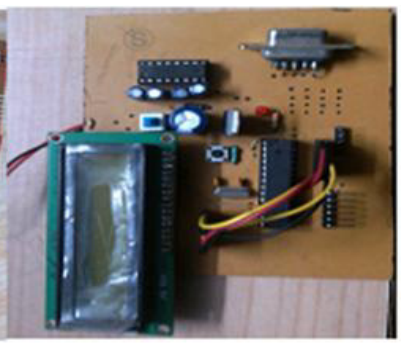

Fig.4.3 Developed sensor node

Fig.4.1 shows developed heater node, which is used to collect temperature data form two corners of the room. Fig.4.2 shows developed remote control by which room temperature can be set to a required value. Fig.4.3 shows developed heater node which is controlled with the help of proposed algorithm

5. **Results and Discussion**

The table2 shows the % saving in power and maintenance of constant temperature of the test room after using the HPSO algorithm.

Table-2

S.No.	Time Duration	Temperature (To be maintained at 30^0C)	Power Consumption in (KW)
1.	10:30 AM to 11:00 AM	29^0C to 30^0C	1.02
2.	11:01 AM to11:15 AM	30^0C	.470
3.	11:16 AM to 11:30 AM	30^0C	.380
4.	11:31 AM to 11:45 AM	30^0C	.380
5.	11:46 AM to 12:00 Noon	30^0C	.250
6.	12:01 PM to 12:30 PM	30^0C	.490
		Total	2.99

The performance of the system is enhanced From Table 2, it is verified that if heater is set for a specific temperature (near to 30^0 C) and power consumption is compared with conventional heater for same temperature, (it is assumed that heater should be switched off for time duration to be set on specific temperature and consumption is of 3600 W) then % power saving is given by: Saving= (3.6kW-2.99kW)/3.6kW=.1694 and % saving is of 16.94.

The data collected from the two sensor nodes are averaged by the Heater node and used as feedback signal. The so generated error signal is used to control the temperature of the room. It is observed that the test room is maintained at pre-set temperature of 30^0C.

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ZigBee and Bluetooth Network based Sensory Data Acquisition System

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Abstract

In this era of modernization, lots of systems have been introduced by which the human effort has been limited to a certain level. In this Paper a data acquisition system has been proposed for factories and industries or environment monitoring, which will measure the certain parameters like temperature, humidity, the level of gases present in atmosphere, motion of any person near the restricted areas at a time and transmit these parameters to the control room wirelessly as well as to the concerned person of the area by the latest smartphone/ tablets. Through the smartphone, the person can give command to the control room in case of any parameter crosses a certain level. The data is collected from sensor nodes to the control room node using ZigBee network and then retransmit the desired data to smart phones, tabs and PCs using Bluetooth network. Sensor node contains analog output sensors like temperature , gas and Digital output sensors like sound and metal. The LCD is used to display the sensor parameters. The RF modem is used to transmit the values to the control room node using star and mesh network topologies. The control room node contains ZigBee transceiver module to receive the information and Bluetooth modem to make available the desired data to the smart phones, tabs and PCs. The ZigBee and Bluetooth network are working at 9600 baud rate and 2.4GHz frequency in ISM band. The ZigBee nodes are capable to transmit the information upto 100meteres and for long distance communication, multi-hopping is used. Bluetooth modem is capable to transmit the information upto 30 feet distance.

Keywords: Bluetooth; Smart phone; wireless sensor network; ZigBee

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1. Introduction

Papers on systems used for monitoring the environmental parameters for different purposes like disaster management, green house monitoring, animal monitoring etc. have been studied and from the literature it can be inferred that ZigBee based monitoring systems are low cost, low power reliable systems and can be used for data collecting and monitoring. Further optimizing techniques are studied to find out the algorithm for data optimization. The wearable computing devices are the latest technology used for monitoring purposes in order to cater for the rural peasants who as end user need not be aware of the complexity of the computing devices.

From the literature available it is found that systems have been proposed which monitored the factory zone temperatures, humidity and air quality using smart phones and also the electric load. The system also detects the vibrations of operating machinery. For the intelligent monitoring ZigBee and Wi-Fi protocols are used. The integrated system is fabricated by 32 bit ARM core Arduino-Duo module. The Android APP and web-based platform are used to show measurement results. The system will transfer results to a specified cloud device using the TCP/IP protocol and Fast Fourier Transform (FFT) approach is used to analyse the power loads in the factory zones [1]. Michael Friedewald et al describes the technical, legal and social challenges that have to be addressed. Ubiquitous computing is considered as a technological path of innovation. The article concludes about efforts necessary to make ubiquitous computing applications economically sustainable and socially compatible in order to tap its full potential[2]. Kulkarni, R.V**.** et. al have narrated about Wireless sensor networks (WSNs)challenges, failures, and computational constraints [3]. Gyou-tae Park et. Al describes an intelligent gas safety management system to monitor the flow and pressure of gas, earthquake, temperature, smoke and leak of methane. The system communicates with a wall-pad including a gateway by zigbee network in buildings and report to server [4]. V.Vanitha et al narrates an extended service oriented architecture (ESOA) which provides customizable sensor network and manages application to overcome the limitation of sensing systems like robustness, complexity etc. The system is offering improvement in service oriented architecture of embedded systems[5]. Chengbo Yu et.al. narrates an environment monitoring system and discusses the reason of choosing ZigBee technology as communication module in Wireless Sensor Networks. The system uses CC2430 board and verifies the correctness and feasibility[6]. Peng Jiang et. al describes a water environmental monitoring system based on a wireless sensor network. The system consists of three parts: data monitoring nodes, data base station and remote monitoring center. The system has accomplished the online auto-monitoring of the water temperature and pH value environment of an artificial lake [7]. Dr.S.S.Riaz Ahamed. et al has discussed about ZigBee IEEE 802.15.4 standard for data communications. It is concluded that ZigBee is low power, low cost, wireless mesh networking standard which provides network, security, and application support services[8]. Luis Ruiz-Garcia et al Paper shows study of the technical and scientific state of the art of wireless sensor technologies and standards for wireless communications in the Agri-Food sector. The paper focuses on Wireless Sensor network RFID including ZigBee module. Future trends of wireless communications in agriculture and food industry are also discussed [9]. Mitsugu Terada et al describes a ZigBee sensor network for data acquisition and monitoring . A ZigBee module is connected via a USB interface to a Microsoft Windows PC, which acts as a base station in the sensor network. Data collected by sensors are sent to the base station PC. The data are recorded in the hexadecimal number format by device control software [10].

In this Paper a data acquisition system is proposed for factories and industries or environment monitoring, which measures the certain parameters like temperature, humidity, the level of gases present in atmosphere, motion of any person near the restricted areas at a time and transmit these parameters to the control room wirelessly as well as to the concerned person of the area by the latest smartphone/ tablets/wearable device.

2. Hardware Development

The system comprises a transmitter section, a receiver section and a tablet/smart phone.

2.1Transmitting/Receiving sections

Fig 1 shows block diagram of the transmitter section with power supply, temperature sensor, metal sensor, gas sensor, PIR sensor and sound sensor, which gives the measured data to the Arduino micro-controller and it transmits the data to the receiver section using ZigBee module. Fig 2 shows the block diagram of the receiver section. Arduino Mega micro-controller in the receiver section which, collects the data came from the transmitter section using ZigBee module and further transmit it to Bluetooth terminal of smart phone. Serial interface to PC is also

provided to collect the data from ARDUINO mega board, on PC screen using terminal v1.9.

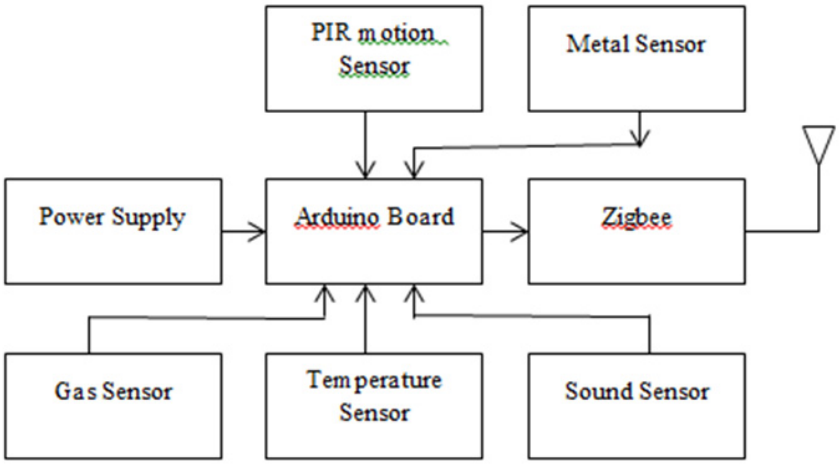

Fig 1Block diagram of Transmitting node

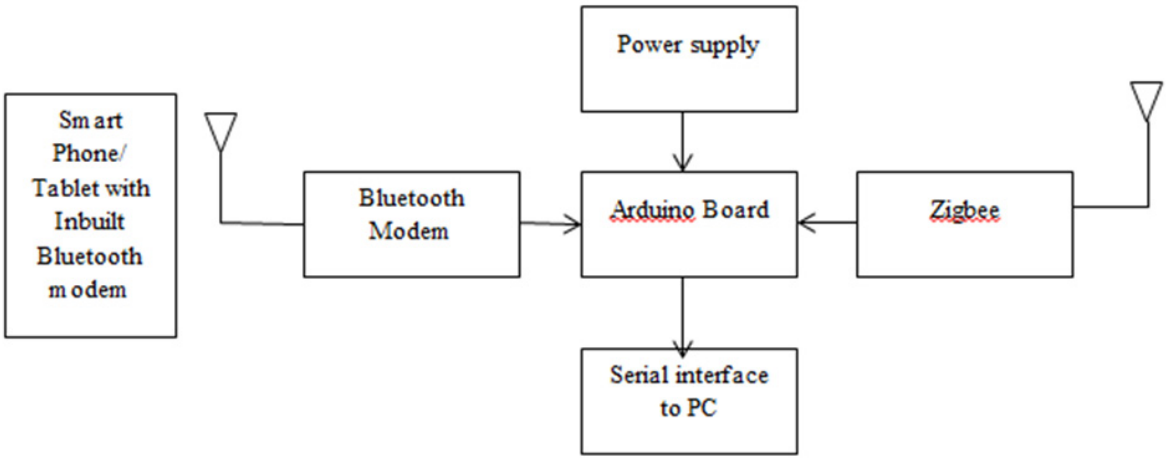

Fig 2 Block diagram of receiving node

Table 1 gives brief description of the modules which are used to develop hardware for the system.

Table 1

S.No.	Device/Module	Make/ Model no.	Specifications and working
1.	Sound Sensor	Sunrom model no.1148 [11]	It detects sound at preset time duration and also has adjustable output time duration
2.	Metal sensor	Sunrom model no. 1139 [11]	Detects metal objects upto the range of 7cm
3.	Motion sensor	Sunrom model no. 1133 [11]	It is wireless module, having two way data communication availability. It operates on license free 2.4 GHz band. It can be interfaced in UART mode with controller.
4.	Gas Sensor	Sunrom model no. 1105[11]	Used in gas leakage detecting equipment for detecting of LPG, iso-butane, propane, LNG combustible gases.
5.	Temperature	Sunrom model	LM35, Calibrated directly in Celsius (Centigrade), Linear + 10.0

	sensor	no.3001 [11]	mV/ C scale factor
6.	Zigbee	Sunroom model no. 1124[11]	RF data modem working at 2.4 Ghz frequency. Receives and Transmits serial data of adjustable baud rate of 9600/4800/2400/19200 bps at 5V or 3V level for direct interfacing to microcontrollers.
7.	Arduino Uno		It is an open source design
8.	Power supply	Sunrom model no1289 [11]	It is used to control the speed or level of appliance
9.	Bluetooth modem	Sunrom model no.1179 [11]	This module enables you to wireless transmit & receive serial data. Bluetooth It has protocol-2.0, Range 10 meters, Frequency-2.4 Ghz, ISM, Modulation-GFSK
10.	Power supply		This module is basically designed to achieved 5V/500mA

3. Software Development

Programming is done in Arduino 1.0.5 in 'C' language. The Arduino has been programmed to test the hardware as well to achieve the goal of WSN application, which involved the following steps-Coding/debugging, compiling, burning and evaluation. Blue Term is used to capture the real time data in smart phone via bluetooth. Blue Term is a free app for android and you can found it in the Google Play market. Terminal emulator for communicating with any serial device using a bluetooth serial adapter.

3.1Simulation

Fig.3 shows Proteus simulation model for the system, as simulation is done before hardware implementation to check the feasibility.

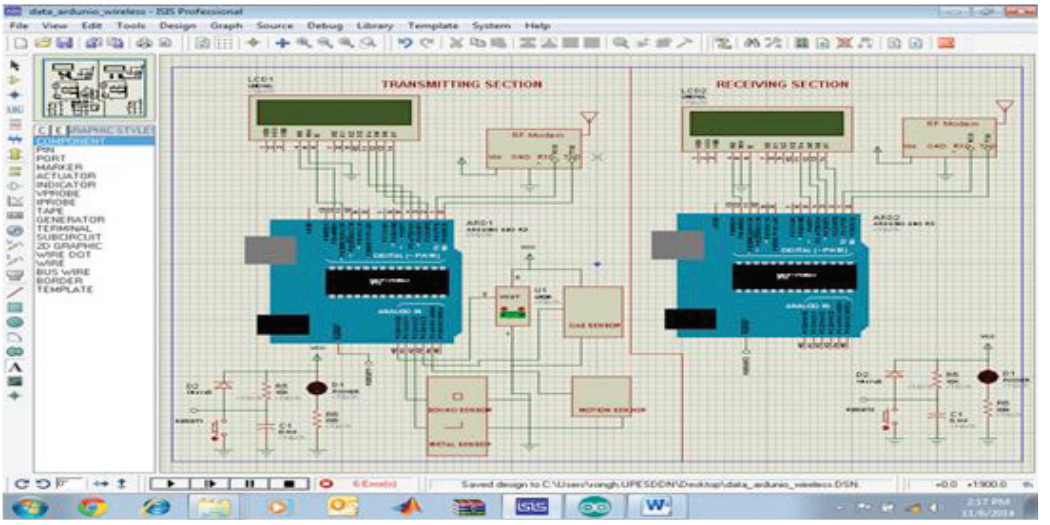

Fig 3 Proteus Simulation Model for the system

4. Results and Discussions

The primary goal of this paper is to develop a wearable device for early warning in the restricted area, displaying various physical parameters like temperature, hazardous gases, sound, metal useful for agricultural farmer by wirelessly measuring them . the system is based on based on zigbee and Bluetooth wireless protocol.

Such a system has many advantages, especially when the restricted areas are to be kept intrusion free. It will also useful for farmers for getting all information about the environment in a single piece of device which is easily operable by anyone. This system is a reliable communication system without breakdown because of the use Personal Area Network. All the data can be read by the smart device without interruption and delay because of the efficient use of communication algorithm in the control node. Employing embedded technology, based on Arduino,

the Wireless Sensor Nodes are designed and implemented. One such node is shown below in fig 4 which is transmitting section for sending sensory data. The results show that the temperature and gas sensor data given by the sensor node is accurate. The data received from sound and metal sensors are also found to be accurate. The RF module Zigbee operated at 2.4GHz ISM band really help for secure data transmission.

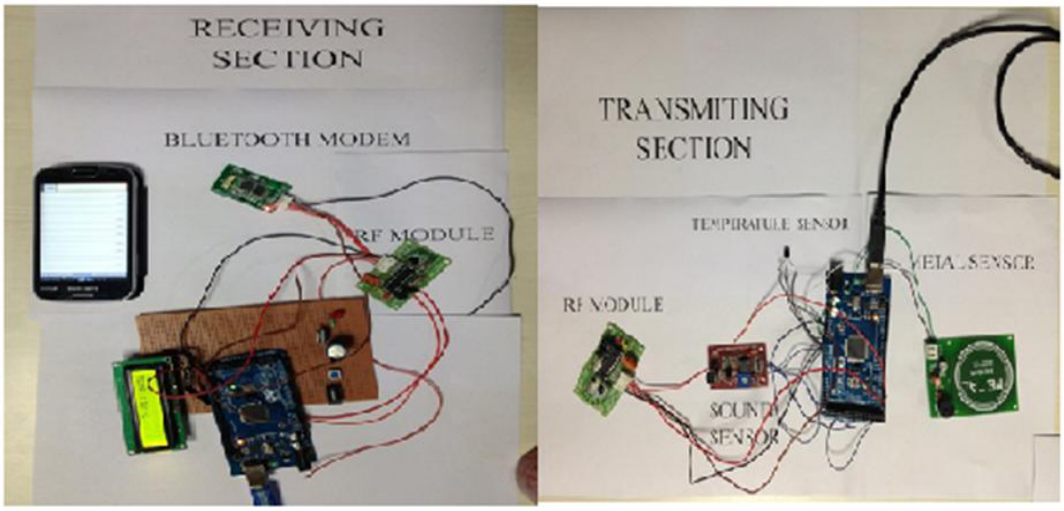

Fig 4 View of Transmitting section and Receiving section

The fig 4 shows the receiving section. The temperature in degree centigrade and gas data in ppm is continuously observed on the monitor of the base station. Thus, the control room could get the temperature of different places and the presence/absence of hazardous gases in a particular area which could be useful to the farmer for having prior information about the environment thereby increasing the yield. The system works with great reliability. The data received from the sound and metal sensor also correspond to actual intrusion by unwanted objects.

The fig 5 shows the data logging of data's received from the various sensors. This smart phone will receive data from the field through the central node. The smart phone will be available to the farmers for monitoring various environmental parameters. The farmers will also get the early warning signals if there is any unwanted intrusion in the agricultural field thereby securing the area against the harmful transpassing.

Fig 5. Smart phone as data logger

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