

# MODELING OF SIX SIGMA PROJECT-GOALS, KEY-MATRICES AND BENEFIT-ACHIEVED WITH SEM

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## ABSTRACT

*The success of six-sigma is well established in different sections of business. Business organizations are able to improve qualitative as well quantitative output of the processes with six-sigma. The success of six-sigma operations depends on proper selection of project-goals. Every project uses one or more key-matrices to measure the success of the project. Improved value of key matrices consequently reflects into benefits to the organization. An organization implementing six-sigma, need to understand the relationship between project-goals, key-matrices and the associated benefits. This paper presents six such models and compares them based on fit-indices with structure equation modeling technique. Such models are of great value for small scale industries which are unable to implement six-sigma because of high training cost. This paper is of use for implementers and researcher of six-sigma. This is one of the foremost efforts to establish such kind of relationships between variables of six-sigma system.*

**Key Words:** Six-Sigma, Project-Goals, Key-Matrices, Benefits-Achieved, Structure Equation Modeling

## I INTRODUCTION

Six-sigma has been highly successful in all kind of business processes. It has been proved effective worldwide. Six-sigma is a direct extension of total quality management (Persico, 1992). Deming's philosophy of management is undergoing a positive revival with popularity of six-sigma (Maleyeff and Kaminsky, 2002). In the current times of economic recession and slowdown in demand, every corporation looks at any possible issue of cost cutting and wise deployment of scarcely available funds, so it is worthwhile to deliberate on six-sigma with intent rather than an impulse. In many business environments, the six-sigma culture is becoming a way of life (Harry and Schroeder, 2000). Six-sigma projects are identified based on business plan. Six sigma projects often begin with the determination of customer requirements and it is essential to set project goals based on reducing the gap between the company's deliverables such as quality, delivery time, reliability and customer expectations Banuelas et al., (2006). There is a need to identify how the project goals, key matrices and benefits achieved are linked. The objectives of this paper are:

- To study and understand relationship among project goals, key matrices and benefits achieved.
- To develop different feasible models among project goals, key matrices and benefits achieved are linked and to compare them.

## **II LITERATURE REVIEW**

Project selection is one of most critical and most commonly mishandled activity in launching six-sigma. Well selected and defined improvement project produces better and faster result where as only selected and defined projects produces delayed results and frustration. There are number of issues related to selection of appropriate six-sigma projects. The project selection process must incorporate three important voices: the voice of the process, the voice of the customer, and the voice of strategic business goals. Effective project selection is based on identifying the projects that best match the current needs, capabilities and objectives of organizations. Project selection is the process of evaluating individual projects or groups of projects, and then choosing to implement some set of them so that the objectives of the organisation will be achieved (Meredith and Mantel, 2003). Main selection criterion: customer impact, financial impact, top management commitment, measurable and feasible, learning and growth, connect to business strategy and core competence (Pande et al., 2000). Snee (2001) identified the important criteria for improving project selection which can produce significant financial impact for the organization. As per Antony (2004) main selection-criteria used in selection of projects are customer-impact, financial impact, learning and growth, connect to business strategy and core competence. Adams et al. (2003) propose seven main sources for identification of potential six sigma projects, including customers, suppliers, employees, benchmarking, developments in technology, extension of other six sigma projects and waste. Organisation should select six sigma projects in such a way that they are closely tied to the business goals and strategy (Ingle and Roe, 2001). Lynch and Soloy (2003) suggested the main project selection criterion as customer impact, financial impact, measurable and feasible.

Six-sigma is measurement based quality improvement methodology. Six-sigma projects are used to solve critical quality problems with appropriate measuring parameter. The parameters used to record improvements during six-sigma projects are known as matrices for six-sigma projects. A number of key matrices have been used by six-sigma project teams' worldwide. Manufacturing companies put more emphasis on CTQ's such as Scrape rate, FTY, COPQ, or capability index, whereas service-based companies due to their intrinsic characteristics put more emphasis on critical-to-service (CTS's) such as cycle time. Nevertheless, manufacturing and service organisations tend to adopt net cost saving as the main metric used to evaluate six sigma projects. On the other hand, metrics such as employees learning and design effectiveness are adopted by a small number of companies neither in manufacturing sector or service sector (Banuelas et al., 2006). The results of the study by Antony et al. (2005) revealed that the most commonly used six sigma metrics by participating SMEs were number of complaints and percentage scrap. The least commonly used metrics were first time yield (FTY) and throughput yield (TPY). In fact, these two metrics (FTY and TPY) are the fundamental metrics of six-sigma. The study by Antony (2004) reveals that the most common metrics used by the organisations employing six-sigma include: COPQ; defect rate; time to respond to customers' complaints; number of customer complaints; process yield; and process capability, etc.

The success of six-sigma project is measured in terms of benefit achieved through the project. A number of benefits have been reported in the literature by different authors. Six-sigma helps organization become ambidextrous by providing a switching structure that allows an organization to act more organically in coming up with new

improvement ideas and operate more mechanistically when implementing them (Daft, 2001). The success of this methodology within an organization creates significant momentum that can only lead to fundamental organizational cultural transformation (Mahesh et al., 2005). In 1988 Motorola was honored with the Malcom Baldrige award, and prior to this date in three consecutive years, Motorola had spent \$170 million on worker's education and training. As a result, Motorola saved \$2.2 billion in terms of cost of poor quality (Antony and Banuelas, 2002). A common language of variation significantly increases quality awareness and provides a framework for process improvements (Hu et al., 2005). As per Hoerl (2004), six-sigma is generic improvement methodology that can be applied anywhere. Having core set of tools is an advantage of six-sigma that brings speed and simplicity. Six-sigma does not require years of company-wide training before actual and significant improvements can be achieved (Mortimer, 2006). The benefits achieved from the successful completion of six sigma projects reported by the service companies: improved customer satisfaction; reduced defect rate in service processes; reduced variability of key service processes; improved culture with the attitude of continuous improvement of service process performance; reduced process cycle time and hence achieve faster service delivery; reduced service operational costs; and increased market share (Antony et al., 2007).

### **III RESEARCH METHODOLOGY**

The research methodology used to model the variables under study is Structure Equation Modeling (SEM). SEM as a method for measuring relationship among latent variables has been around since early 20<sup>th</sup> century originating in Sewall Wright's 1916 work (Bollen, 1989). It is a technique to specify, estimate and evaluate models of linear relationships among a set of observed variables in terms of a generally smaller number of unobserved variable (Shah and Goldstein, 2006). There are number of project goals, key-matrices and associates benefits from different six-sigma projects. The paper is based on modeling the identified variable of six-sigma through SEM. The research methodology consists of:

- i) Identification of six-sigma variables (project-goals, key-matrices and benefits-achieved) from literature survey.
- ii) Conducting a survey to know the status of six-sigma for identified variables.
- iii) Model the relationship among some of identified variables and validating them with the collected data.

### **IV MODEL DEVELOPMENT**

The objective of this paper is to establish relationship in six-sigma project-goals, key- matrices used in six-sigma projects and benefits-achieved through six-sigma projects. The 'key- matrices are used to measure the project-goals and they lead to different kinds of benefits. We have identified nine key-matrices, six project-goals and nine benefits to do this modeling and analysis, refer Figure 1. Three observed variables are used for every latent variable, which is consistent to the requirements of SEM. A ratio of fewer than three manifest/observed variables per latent variable is of concern because the model is statistically undefined in the absence of additional constraints (Long, 1983). A large number of MVs per LV also make it difficult to parsimoniously represent the measurement structure constituting the

set of MVs (Anderson and Gerbing, 1984). The SEM analysis was conducted by constructing a measurement model and a structure model. Measurement models analysis relationship among a set of observed variables and a predetermined number of latent variables. Having ensured that the scale is reliable, the measurement was evaluated and finalized. The data were analyzed using statistical software AMOS 16. Six models are proposed, analyzed with collected data to check their fitness. The multivariate normality assumption was not violated; therefore the maximum likelihood method of estimation was used (Schumacker and Lomax, 2004). The goodness for fit measures was used to assess overall model fit.

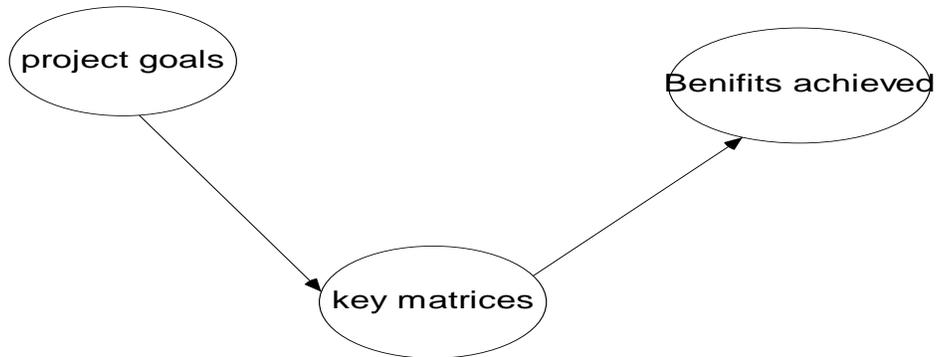
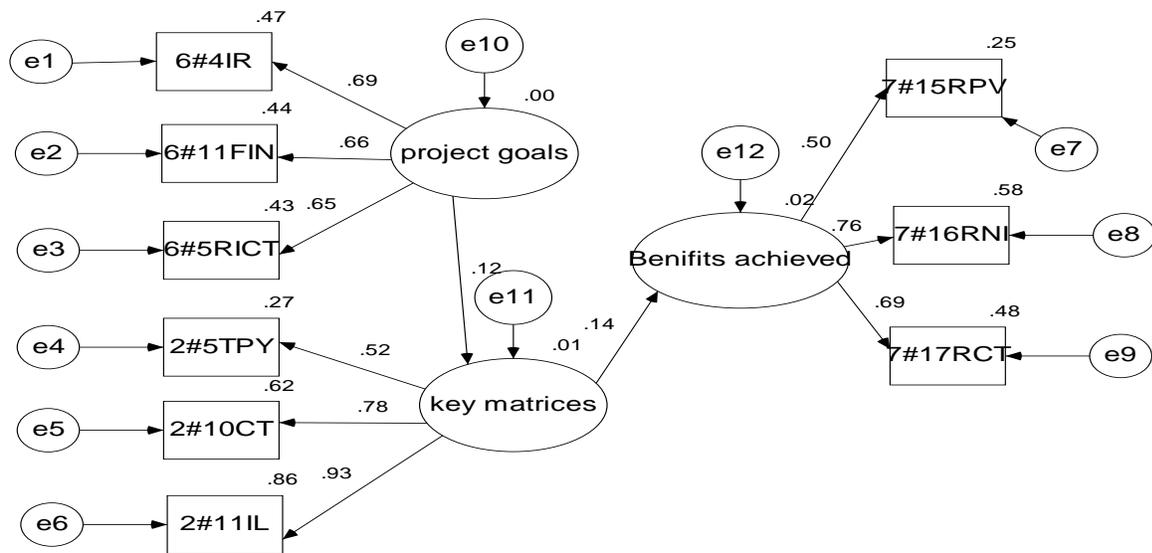


Figure 1: A model of benefits achieved through six-sigma projects

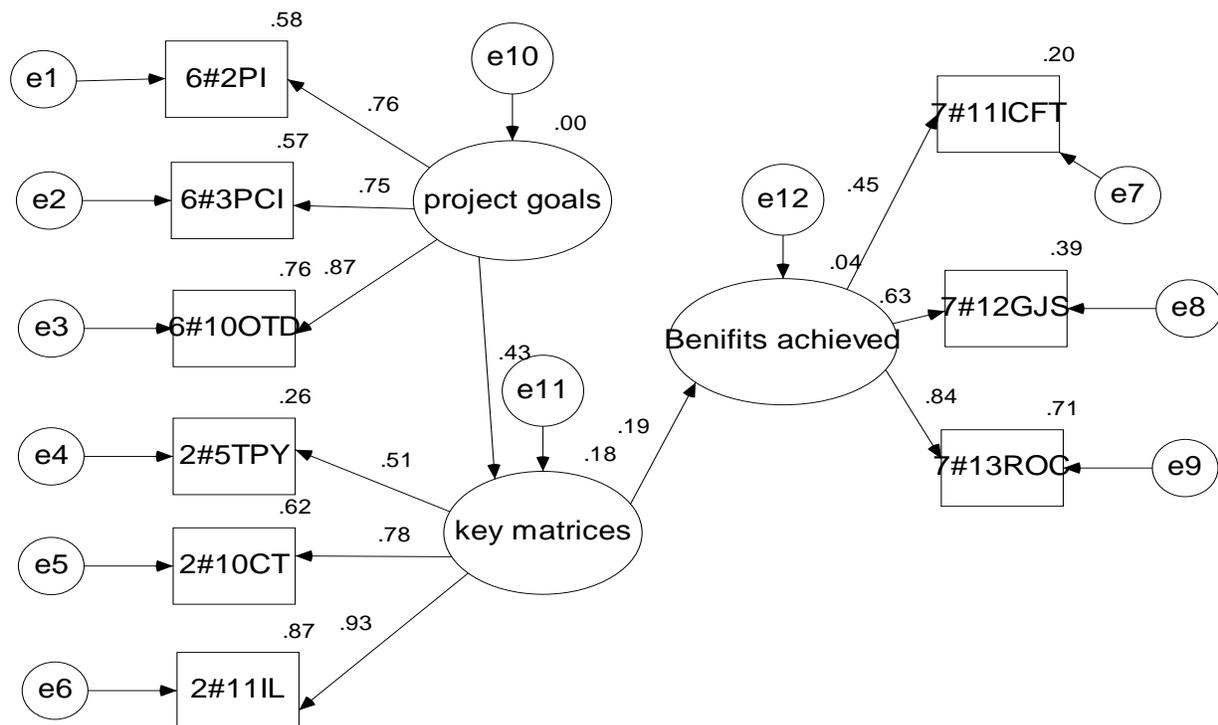


6#4: Inventory related, 6#11: On time delivery, 6#5: Reduction in cycle time, 2#5: Throughput yield, 2#10: Cycle time, 2#11: Inventory related, 7#15: Reduction in process variability, 7#16: Reduction in number of inspections, 7#17: Reduction in cycle time

Figure 2: Model A

#### 4.1 Model A

Figure 2 shows the output of the proposed model. Project goal is an unobserved variable measured with 3 observed variables. The observed variables used to measure project goals are ‘inventory related (6.4)’, ‘financial (6.11)’ and ‘reduction in cycle time (6.5)’. The value of Cronbach’s alpha for project goal construct is found to be 0.689, which is satisfactory. The loading of these factors are found to be 0.69, 0.66 and 0.65 for ‘inventory related (6.4)’, ‘financial (6.11)’ and ‘reduction in cycle time’ respectively. The key matrices used in the model are ‘throughput yield (2.5)’, ‘cycle time (2.10)’ and ‘inventory related (2.11)’. The value of Cronbach’s alpha for key matrices construct is found to be 0.761, which is also satisfactory. The loading by these factors are found 0.52, 0.78 and 0.93 for ‘throughput yield (2.5)’, ‘cycle time (2.10)’ and ‘inventory related (2.11)’ respectively on unobserved variable ‘key matrices’. The benefits achieved are measured with ‘reduction in process variability (7.15)’, ‘reduction in number of inspections (7.16) and ‘reduction in cycle time (7.17)’. The value of Cronbach’s alpha for project goal construct is found 0.674. The factor loading is found to be 0.50, 0.76 and 0.69 for ‘reduction in process variability (7.15)’, ‘reduction in number of inspections (7.16) and ‘reduction in cycle time (7.17) respectively. The value of path coefficient is 0.12 from project goal to key matrices whereas the value of path coefficient is 0.14 from key matrices to benefits achieved. Table 6.3 lists the goodness-of-fit indices results of model A (Chi-square/df =1.301, p=0.144, RMSEA= 0.058, CFI= 0.959, IFI=0.961). An alternative model B was then proposed.

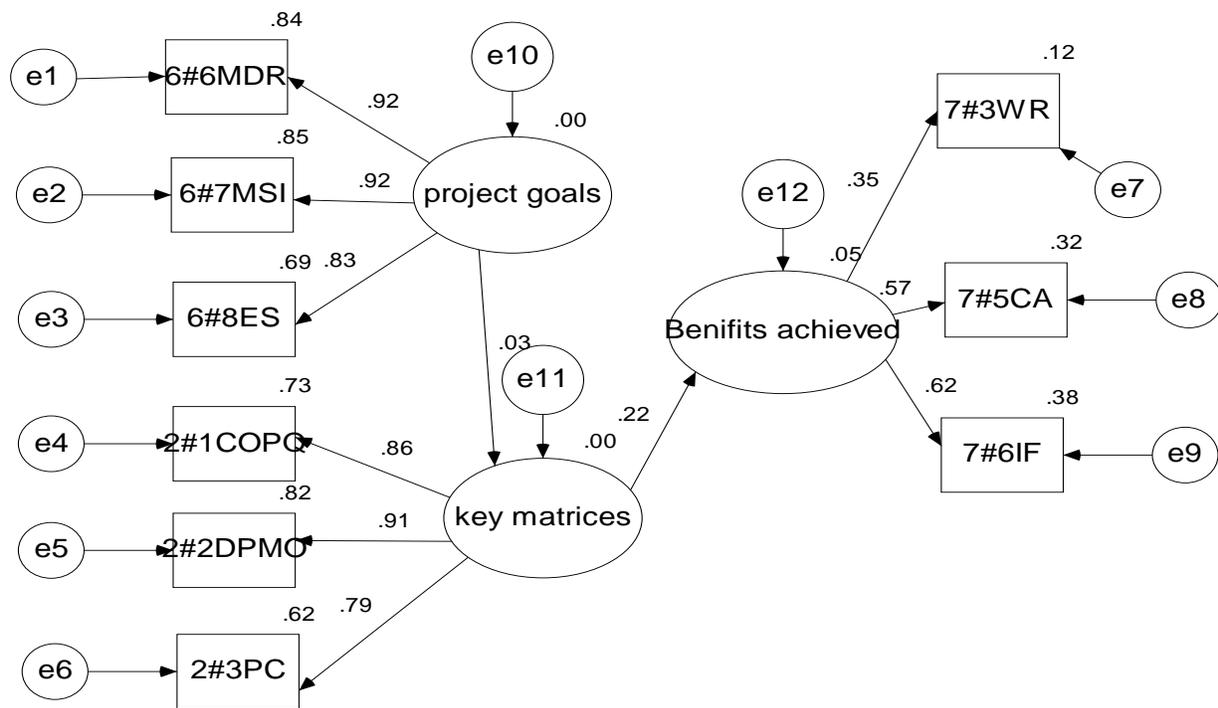


6#2: Wastage reduction, 6#3: Process capability improvement, 6#10: On time delivery, 2#5: Throughput yield, 2#10: Cycle time, 2#11: Inventory related, 7#11: Improved cross functional teams, 7#12: Greater job satisfaction, 7#13: Reduction in operational cost

Figure 2: Model B

### 4.2 Model B

Figure 2 shows the output of proposed model. Project goal is an unobserved variable measured with 3 observed variables. The observed variables used to measure project goals are ‘productivity improvement (6.2)’, ‘process capability improvement (6.3)’ and ‘on-time-delivery (6.10)’. The value of Cronbach’s alpha for project goal construct is found to be 0.832, which is satisfactory. The loading of these factors are found to be 0.76, 0.75 and 0.87 for ‘productivity improvement (6.2)’, ‘process capability improvement (6.3)’ and ‘on-time-delivery (6.10)’. The key matrices used in the model are ‘throughput yield (2.5)’, ‘cycle time (2.10)’ and ‘inventory related (2.11)’. The value of Cronbach’s alpha for key matrices construct is found to be 0.761, which is also satisfactory. The loading by these factors are found 0.51, 0.78 and 0.93 for ‘throughput yield (2.5)’, ‘cycle time (2.10)’ and ‘inventory related (2.11)’ respectively on unobserved variable ‘key matrices’. The benefits achieved are measured with ‘improve cross functional teams (7.11)’, ‘greater job satisfaction (7.12) and ‘reduction in operational cost (7.13). The value of Cronbach’s alpha for project goal construct is found 0.615. The factor loading is found to be 0.45, 0.63 and 0.84 for ‘improve cross functional teams (7.11)’, ‘greater job satisfaction (7.12) and ‘reduction in operational cost (7.13). The value of path coefficient is 0.43 from project goal to key matrices whereas the value of path coefficient is 0.19 from key matrices to benefits achieved. Table 6.3 lists the goodness-of-fit indices results of model B and shows even less support for model B than A (Chi-square/df =1.405, p=0.086, RMSEA= 0.067, CFI= 0.960, IFI=0.962). An alternative Model C was then proposed.

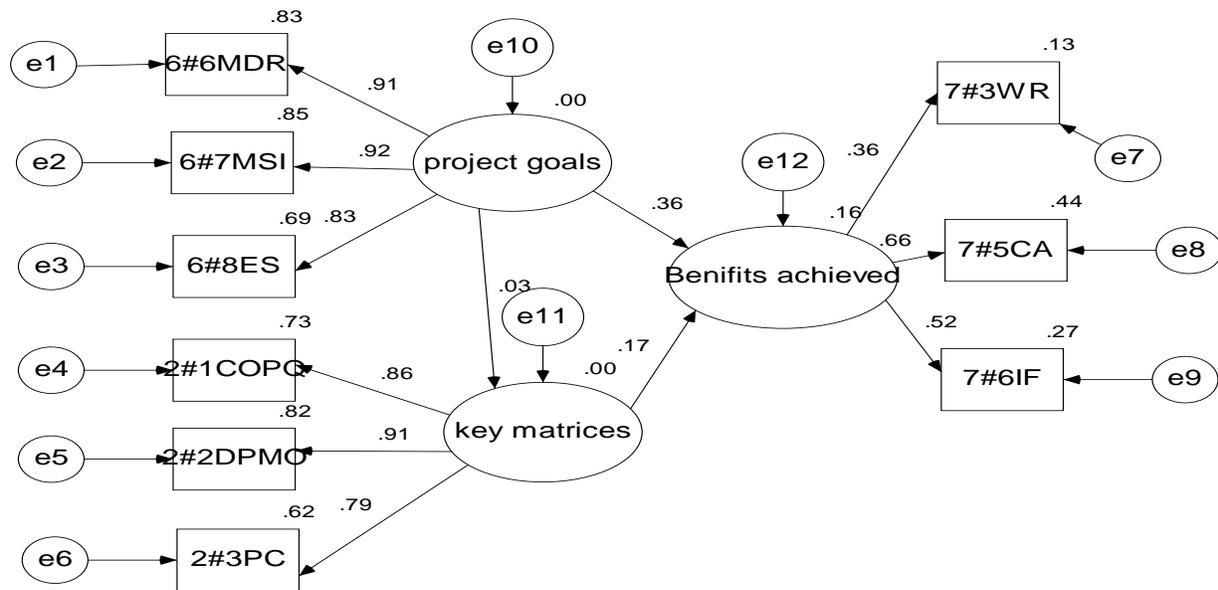


6#6: Maintenance downtime reduction, 6#7: Measurement system improvement, 6#8: Energy saving, 2#1: Cost of poor quality, 2#2: Defects per million opportunities, 2#3: Process capability, 7#3: Wastage reduction, 7#5: Competitive advantages, 7#6: Improve functionality

Figure 3: Model C

### 4.3 Model C

Figure 3 shows the proposed model. Project goal is an unobserved variable measured with 3 observed variables. The observed variables used to measure project goals are ‘maintenance downtime reduction (6.6)’, ‘measurement system improvement (6.7)’ and ‘energy saving (6.8)’. The value of Cronbach’s alpha for project goal construct is found to be 0.914, which is satisfactory. The loading of these factors are found to be 0.92, 0.92 and 0.83 ‘maintenance downtime reduction (6.6)’, ‘measurement system improvement (6.7)’ and ‘energy saving (6.8)’ respectively. The key matrices used in the model are ‘cost of poor quality (2.1)’, ‘defects per million opportunity (2.2)’ and ‘process capability (2.3)’. The value of Cronbach’s alpha for key matrices construct is found to be 0.886, which is also satisfactory. The loading by these factors are found 0.86, 0.91 and 0.79 for ‘cost of poor quality (2.1)’, ‘defects per million opportunities (2.2)’ and ‘process capability (2.3)’, respectively on unobserved variable ‘key matrices’. The benefits achieved are measured with ‘wastage reduction (7.3), ‘competitive advantage (7.5) and ‘improved functionality (7.6). The value of Cronbach’s alpha for project goal construct is found 0.707. The factor loading is found to be 0.35, 0.57 and 0.62 for ‘wastage reduction (7.3), ‘competitive advantage (7.5) and ‘improved functionality (7.6) respectively. The value of path coefficient is 0.03 from project goal to key matrices whereas the value of path coefficient is 0.22 from key matrices to benefits achieved. Table 6.3 lists the goodness-of-fit indices results of model C and shows better support for model C than B but less than A (Chi-square/df =1.327, p=0.127, RMSEA=0.061, CFI=0.978, IFI=0.978). An alternative model D was then proposed.

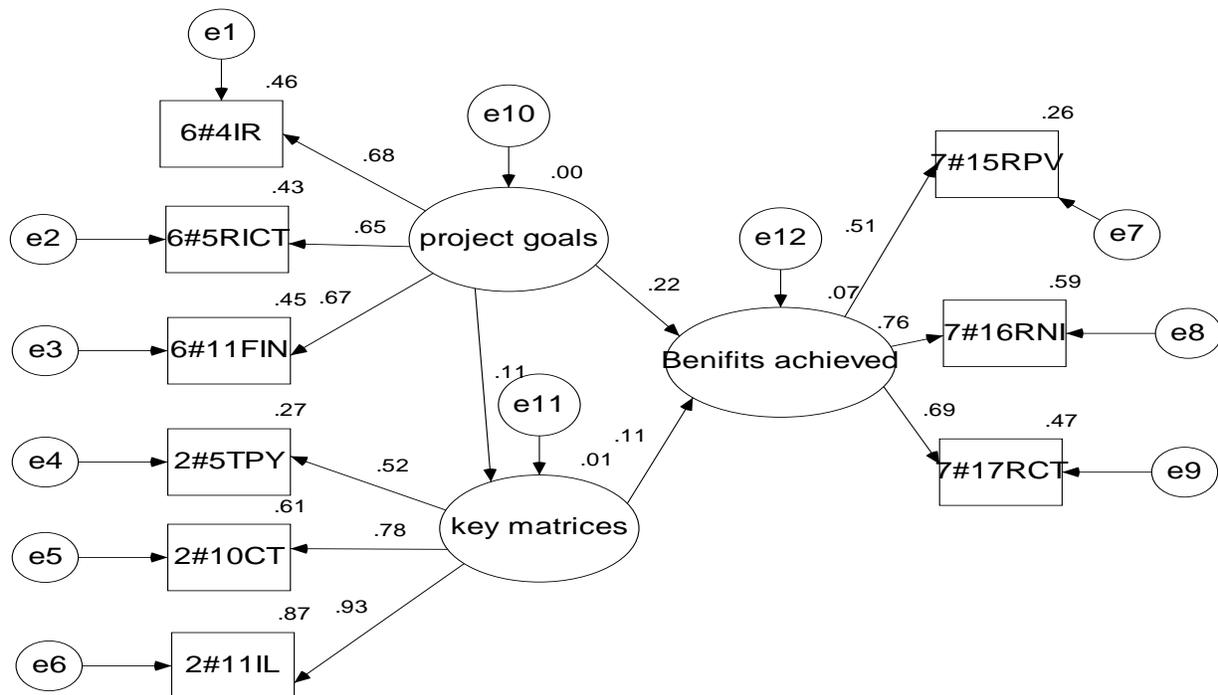


6#6: Maintenance downtime reduction, 6#7: Measurement system improvement, 6#8: Energy saving, 2#1: Cost of poor quality, 2#2: Defect per million opportunity, 2#11: Process capability, 7#3: Wastage reduction, 7#5: Competitive advantages, 7#6: Improved functionality

Figure 4: Model D

#### 4.4 Model D

Figure 4 shows the proposed model. Project goal is an unobserved variable measured with 3 observed variables. A new path is added from project goals to benefits achieved. The observed variables used to measure project goals are ‘maintenance downtime reduction (6.6)’, ‘measurement system improvement (6.7)’ and ‘energy saving (6.8)’. The value of Cronbach’s alpha for project goal construct is found to be 0.914, which is satisfactory. The loading of these factors are found to be 0.91, 0.91 and 0.83 ‘maintenance downtime reduction (6.6)’, ‘measurement system improvement (6.7)’ and ‘energy saving (6.8)’ respectively. The key matrices used in the model are ‘cost of poor quality (2.1)’, ‘defects per million opportunity (2.2)’ and ‘process capability (2.3)’. The value of Cronbach’s alpha for key matrices construct is found to be 0.886, which is also satisfactory. The loading by these factors are found 0.86, 0.91 and 0.79 for ‘cost of poor quality (2.1)’, ‘defects per million opportunities (2.2)’ and ‘process capability (2.3)’, respectively on unobserved variable ‘key matrices’. The benefits achieved are measured with ‘wastage reduction (7.3)’, ‘competitive advantage (7.5) and ‘improved functionality (7.6). The value of Cronbach’s alpha for project goal construct is found 0.707. The factor loading is found to be 0.36, 0.66 and 0.52 for ‘wastage reduction (7.3)’, ‘competitive advantage (7.5) and ‘improved functionality (7.6) respectively. The value of path coefficient is 0.03 from project goal to key matrices whereas the value of path coefficient is 0.17 from key matrices to benefits achieved and 0.36 from project goals to benefits achieved. Table 6.3 lists the goodness-of-fit indices results of model E shows less support than earlier proposed model D (Chi-square/df =1.263, p=0.174, RMSEA=0.054, CFI=0.966, IFI=0.968). An alternative model E was then proposed.

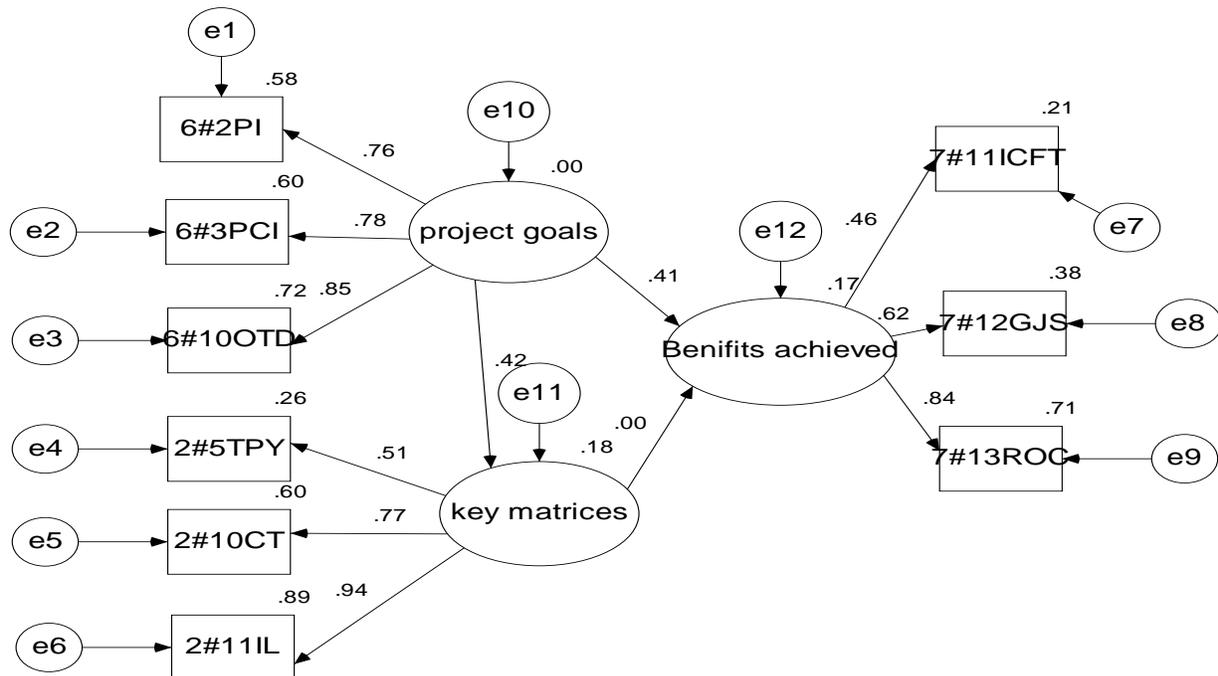


6#4: Inventory related, 6#11: On time delivery, 6#5: Reduction in cycle time, 2#5: Throughput yield, 2#10: Cycle time, 2#11: Inventory related, 7#15: Reduction in process variability, 7#16: Reduction in number of inspections, 7#17: Reduction in cycle time

Figure 5: Model E

#### 4.5 Model E

Figure 5 shows the proposed model. Project goal is an unobserved variable measured with 3 observed variables. A new path is used from project goals to benefit achieved. The observed variables used to measure project goals are 'inventory related (6.4)', 'financial (6.11)' and 'reduction in cycle time (6.5)'. The value of Cronbach's alpha for project goal construct is found to be 0.689, which is satisfactory. The loading of these factors are found to be 0.69, 0.66 and 0.65 for 'inventory related (6.4)', 'financial (6.11)' and 'reduction in cycle time' respectively. The key matrices used in the model are 'throughput yield (2.5)', 'cycle time (2.10)' and 'inventory related (2.11)'. The value of Cronbach's alpha for key matrices construct is found to be 0.761, which is also satisfactory. The loading by these factors are found 0.52, 0.78 and 0.93 for 'throughput yield (2.5)', 'cycle time (2.10)' and 'inventory related (2.11)' respectively on unobserved variable 'key matrices'. The benefits achieved are measured with 'reduction in process variability (7.15)', 'reduction in number of inspections (7.16) and 'reduction in cycle time (7.17). The value of Cronbach's alpha for project goal construct is found 0.674. The factor loading is found to be 0.50, 0.76 and 0.69 for 'reduction in process variability (7.15)', 'reduction in number of inspections (7.16) and 'reduction in cycle time (7.17) respectively. The value of path coefficient is 0.12 from project goal to key matrices whereas the value of path coefficient is 0.14 from key matrices to benefits achieved. Table 6.3 lists the goodness-of-fit indices results of model A and shows less support for model A (Chi-square/df =1.301, p=0.144, RMSEA= 0.058, CFI= 0.959, IFI=0.961). An alternative model F was then proposed.



6#2: Productivity improved, 6#3: Reduction in cycle time, 6#10: On time delivery, 2#5: Throughput yield, 2#10: Cycle time, 2#11: Inventory related, 7#15: Reduction in process variability, 7#16: Reduction in number of inspections, 7#17: Reduction in cycle time

Figure 6: Model F

#### 4.6 Model F

Figure 6 shows the proposed model. Project goal is an unobserved variable measured with 3 observed variables. A new path is added from project goals to benefits achieved. The observed variables used to measure project goals are 'productivity improvement (6.2)', 'process capability improvement (6.3)' and 'on-time-delivery (6.10)'. The value of Cronbach's alpha for project goal construct is found to be 0.832, which is satisfactory. The loading of these factors are found to be 0.76, 0.78 and 0.85 for 'productivity improvement (6.2)', 'process capability improvement (6.3)' and 'on-time-delivery (6.10)'. The key matrices used in the model are 'throughput yield (2.5)', 'cycle time (2.10)' and 'inventory related (2.11)'. The value of Cronbach's alpha for key matrices construct is found to be 0.761, which is also satisfactory. The loading by these factors are found 0.51, 0.77 and 0.94 for 'throughput yield (2.5)', 'cycle time (2.10)' and 'inventory related (2.11)' respectively on unobserved variable 'key matrices'. The benefits achieved are measured with 'improve cross functional teams (7.11)', 'greater job satisfaction (7.12)' and 'reduction in operational cost (7.13)'. The value of Cronbach's alpha for project goal construct is found 0.615. The factor loading is found to be 0.46, 0.62 and 0.84 for 'improve cross functional teams (7.11)', 'greater job satisfaction (7.12)' and 'reduction in operational cost (7.13)'. These factor loading are significant at  $p < 0.05$ . The value of path coefficient is 0.42 from project goal to key matrices whereas the value of path coefficient is 0.00 from key matrices to benefits achieved and 0.41 from project goals to benefit achieved. The meaning of this analysis is that project goals help to decide key matrices and achieve benefits in terms of successful projects but key matrices are not have direct significant relationship with benefits achieved. Table 6.3 lists the goodness-of-fit indices results of model F (Chi-square/df = 1.139,  $p = 0.289$ , RMSEA = 0.04, CFI = 0.987, IFI = 0.988).

**Table 1: Comparative structure models**

Model	p-value	Chi-square/df	RMSEA	CFI	IFI
A	0.144	1.301	0.058	0.959	0.961
B	0.086	1.405	0.067	0.960	0.962
C	0.127	1.327	0.061	0.978	0.978
D	0.293	1.136	0.039	0.991	0.991
E	0.174	1.263	0.054	0.966	0.968
F	0.289	1.139	0.040	0.987	0.988

All the models fulfill the measurement fit, because for all  $p > 0.05$ , Chi-square/df < 3, RMSEA < 0.08, CFI > 0.9 and IFI > 0.9. The models can be compared based on relative value of these fit indices. Smaller chi-square/df shows a better fit model, similarly smaller is better for RMSEA whereas value of CFI and IFI required to be closer to 1 for better fit model, refer Table 1.

#### V DISCUSSION AND CONCLUSION

All the models tested A, B, C, D, E and F are found fit with fit indices, however based on chi-square/df and other fit indices Model D found to be best. Model F is next best model followed by Model A. The meaning of this exercise is that 'benefit-achieved through six-sigma projects' have direct association with key-matrices and project goals. One can diagnose the process of improvement by understanding the relationship among the variables. The proposed models provide a new innovative way of thinking for cost and resource saving, especially for small and medium level of industries trying to improve quality. However, more such model can be developed for specific type of

industry to develop big solution space. The paper can be useful for implementing managers, engineers, researchers and business persons.

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# UBIQUITOUS DATA ACCESSING – INTERNET OF THINGS IN HEALTHCARE INFORMATION SYSTEM

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## ABSTRACT

*Internet of Things (IoT) is an emerging technology that is expected to discover new drugs and medical treatments. Its flexibility, adaptability, affinity, cost shrinkage, and high speed up features have high potential to lift the efficiency and quality of healthcare. Though, it is also important to understand specific risks related to security and privacy that this technology brings. This paper focuses on a Healthcare information system based on Ubiquitous Data Accessing (UDA) method. In particular, security and privacy challenges are identified in the proposed UDA-based healthcare information system. Moreover, a functional infrastructure plan is provided to demonstrate the integration between the proposed application architecture with the Internet of Things and cloud infrastructure.*

**Keywords:** *Internet of Things (IOT), Cloud Infrastructure, Healthcare Information System, Ubiquitous Data Accessing (UDA)*

## I INTRODUCTION

Internet of Things (IoT) is mainly to connect the world through multiple devices. Cloud refers to a network or an Internet. In other words, cloud is something, which is located at remote location. Cloud can afford services by network, i.e., over public networks or private networks such as Wide Area Networks, Local Area Networks or Virtual Private Networks. Applications namely e-mail, web conferencing, customer relationship management (CRM), all run in cloud. Hardware and software can play a major role in computing resources that are delivered to users from a Web-based service is referred to as Cloud Computing Technology. The residue of the paper is organized as follows. Section 2 we presents Internet of Things with cloud technology. Section 3 proposed the methodology of health care information system using Ubiquitous Data Accessing-Internet of Things. Section 4 we resolved proposed work. In section 5 concludes this paper.

## II DATA MODEL FOR IOT – BASED MEDICAL SERVICES

In emergency medical services, to improve the quality of healthcare services, delivering clinic information of patient at the point-of-care to physicians is critical [1]. However, medical records and clinic data are stored in different hospitals, it is sometimes difficult to gather clinic data of patient ubiquitously in case of emergency. In order to continue the ubiquitous content accessing, this paper proposed a resource model to locate and get clinic

data which are stored in heterogeneous hospital information systems. Then, a ubiquitous data accessing method is introduced based on the resource model. In the new method, clinic data of patient is defined as resource with unique URL address. Related clinic data of one patient is gathered together to form a aggregated resource, and could be connected by physician if authority is assigned to the physician. Finally, case study is discussed to explain the method of clinic data accessing through Internet from different healthcare units. The result shows that the patients record could be accessed more conveniently.

In healthcare service, doctors, patients, physicians play a major role and they also involved in an entire servicing. Doctors have to access the patient record from anywhere by storing it in a distributed manner. Patients also needs to about the doctors availability and the equipments status (busy/free). In order to help patient accessing doctors availability status, a resource model is needed for this accessibility.

### **III METHODOLOGY**

Now a day's the people in the world are sick with so many health problems and there are some problems which are unknown to the doctors also so in that situations the doctors need to know how to treat that patients, to overcome this type of problems we suggested a new era of technology called cloud computing in medical sciences [3]. Here the doctors has to prepare some document whenever he got any critical cases which he has ever seen and treated in that situation he has to make it a document that is how to treat that patient. There are some points that a doctor need to mention while documenting regarding a problem they are

- Ü Symptoms;
- Ü Analysis;
- Ü Treatment.

#### **3.1 Symptoms**

Here if the doctor found any disease that doctor has ever seen then, at first doctor has to mention the symptoms of that disease and make a note of it to inform other doctors, if any doctor faces the same disease cases. It is possible only if the other doctor is friend to him or he is a doctor in another hospital in the same city/region.

#### **3.2 Analysis**

After confirming all symptoms of the patient the doctor conclude that what type of disease it is and how it came and is it cures for normal treatment or patient has to take a special treatment for that disease all these concerns are analyzed.

#### **3.3 Treatment**

After analyzing all the things regarding the disease the doctor will start the treatment, here in this phase doctor will give medicines to the patient and the doctor has to mention what the medicines are given to the patient and the dosage of it. There are some points that the doctor has to follow while treating the patient they are. Mention the medicines and dosage which are given to the patient. Notice the patient while the treatment is going on whether is there any changes in patient body or health. Mention which type of treatment the doctor has given to the patient. To guide the patient, the doctor has to mention all the above while treating the patient.

## IV IMPLEMENTATION

### 4.1 Existing system

In the Existing system the doctors didn't use any cloud to inform about new diseases in patients so it is very difficult to cure and they don't know how to save people in the world from that disease because, if the disease found in other countries then the doctor in India may not know about that and they have to know only through media even though many people were died of that disease so the death rate is increasing enormously. Also in the existing system doctors didn't able to make decision in case of any emergency.

### 4.2 Proposed system

In this proposed system we are going to introduce cloud computing in medical sciences because it is very easiest way to know all the doctors over the world through the cloud about the diseases which are very recently found and how to cure it, by applying this we can reduce death rate. The doctors will give treatment for all the diseases regularly in general but there are some cases which are very difficult cure in such cases the doctor willing to cure that as soon as possible and at last he will cure it, in the same way if any doctor faces the same problem in the patient then it is very easy to inform to that doctor about the disease and how to cure it if the second doctor is friend of another doctor or both the doctors are in the same city, if the same problem is arises in another country then it is very difficult to inform that doctor about the treatment and how to cure it. For that ontology is used to access the information from the database. Active ontology plays a major role in many healthcare.

By Sharing the information on cloud the reputation of hospital and doctor will increase globally [4]. In the figure 2 accessing the ubiquitous data process is explained. Here the doctors, patients, nurses records are stored in database through the resource register. Isolated database is mainly to store the doctors record. Shared database is mainly to store the patients details. It can be accessed by both doctors and patients. Suppose patient wants to know about the availability of the doctor then the patient from the home itself find the availability. Here the resource sharing process is done by dividing the multiple tasks to execute the workflow process. After resource sharing, Emergency event is occurred. It can be done by decision maker.

In emergency medical service, Decision Support System (DSS) make decision based on ontology construction [5]. Here the collected information in databases is stored in the owl format. The active ontology displays an overview of the ontology class, including metrics on its contents [6]. The Constructed Ontology is created as follows

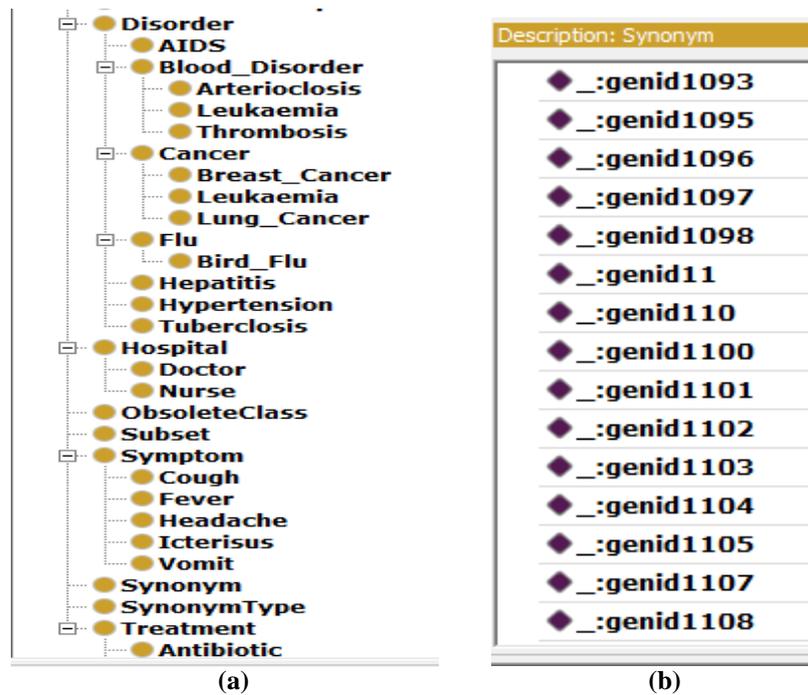


Figure 4: Medical Ontology Class construction

## V RESULT

Emergency medical rescuing process can involve multiple types of resources. The coordination of multiple resources is complex. In our method, the user use Internet of Things (IoT) platform to coordinate data across organizations through the tool named PROTÉGÉ [2]. Here the Protégé tool is used to denote the relationship. The solution for the disease can be retrieved from the Protégé tool result as follows

Table 1. Rehabilitation Process

Subject	Object
Vallecula	Brain_Part
Vasa_Vasorum	Blood_Vessel
Elastin_Fiber	Skin_Part
Extrahepatic_Bile_Duct	Bile_Duct
Splenic_Marginal_Sinus	Splenic_Sinus
Distal_phalanx_of_Foot	Foot_Phalanx

In existing system, Data models which can support data access, plays critical role in the architecture of the mobile Decision support systems. Here they faced the problem of accessing the heterogeneous IoT data. But in our proposed system, we satisfy the challenges in existing system. For this, we build ontology through the protégé tool. Here the Ontology's data model is used to reason about the objects in that domain and the relations between them.

## **VI CONCLUSION**

In this paper IoT technology is introduced in health care system. It is widely used for patients because there is no need to come to hospital and consult the doctor directly. Instead they get the solution for the disease through the system database or server. Here, we utilize the existing enhancement of security protocols for authenticating the treatment information. By using Internet of Things will reduce the time required for patient to become into normal stage (i.e) act of curing abnormal stage into normal stage. Internet of Things will create a major impact on healthcare, and contribute to an overall improvement in its quality. In future, new devices for remote patient-monitoring and communication systems have been implemented that needs to be flexible, on demand platform and infrastructure services for minimizing the expenses in buying and upgrading new software's as well as hardware's.

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# SUPPRESSION OF LEAKAGE CURRENT IN QUASI MULTILEVEL INVERTER BASED PHOTOVOLTAIC SYSTEMS FOR GRID CONNECTED APPLICATIONS

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## ABSTRACT

*The application of Transformer less cascaded multilevel inverter (CMLI) in Photovoltaic systems (PV) has led to low-cost and high efficient systems. However, removal of transformer would result in the failure of galvanic insulation which in turn lead to a physical connection between the PV panels and grid. The flow of leakage current due to the parasitic capacitance would result in higher losses, higher harmonic content, Electromagnetic Interference (EMI) and safety problems. So, the problem of Leakage current remains a threat in designing a reliable PV system. Comparing to the stand-alone PV system, the Grid connected PV systems are little complex because of the problem of synchronization of various MLI modules that are cascaded together. The outflow current problem has been rectified using appropriate PWM modulation strategy along with the filter solution in order to acquire the improved results. Thus the leakage current mitigation issue is expected to improve. Simulations are carried out using MATLAB/Simulink to verify the performance of the proposed method.*

**Keywords:** *Electromagnetic Interference (EMI), Leakage Current, Transformer Less Cascaded Multilevel Inverter (CMLI), Parasitic Capacitance, Pulse-Width Modulated.*

## I. INTRODUCTION

The renewable energy sources are gaining its importance in recent years due to the increasing power demand. In spite of numerous renewable energy sources, PV plays a vital role since sunlight is abundant throughout the year and also it act as a clean source of energy. The increasing customer demand and the incentives provided by the government has increased renewable energy generation globally. PV systems appears in two forms: either a stand-alone or a grid-connected system. The count of distributed PV system installations are increasing in the past decade. However the system cost and potential impacts on the safe operation of utility grid are the two main barriers for the successful implementation of PV systems. The problems related to grid integration are mitigated using power electronic controllers. The maximum power from could be harvested from the PV by employing cascaded multilevel inverters [2][5]. The usage of cascaded multilevel inverters as an Utility interface system for the renewable energy systems [2] will give a high quality output waveform when the switches are operated at low frequency [4]. The CMI topology features isolated DC inputs which helps to employ the maximum PowerPoint tracking at every strings. Unlike other inverters, Cascaded MLI does not require costlier semiconductor devices which have made CMI as an essential part of all commercial and

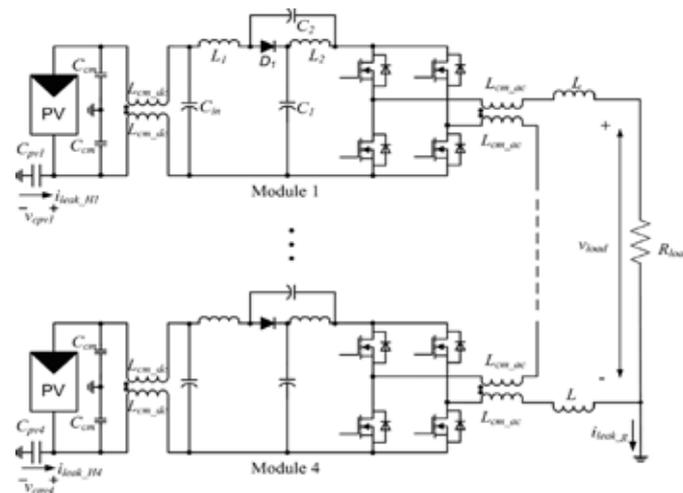
residential applications. A survey of CMI based PV systems is portrayed in figure 1. In large scale PV systems ,the CMI topology with modified features is integrated to a high frequency transformers where the point of common coupling voltage is high for the given frequency[5].The main objective of the transformer is to provide insulation by preventing dielectric breakdown and also to isolate the circulating leakage current paths.In small scale residential/commercial applications where the point of common coupling is low,transformerless CMI is preferred due to lesser cost and better efficiency. However the removal of transformer would result in insulation failure and creates galvanic connections between the PV panels and the grid.Another parameter which contributes to the output distortion is the presence of parasitic capacitance between the PV source and ground.parasitic effect of the capacitors would also lead to higher losses,electromagnetic interference and safety problems.Moreover the aforementioned problem would be highly pronounced in the grid integrated issues.The paper addresses the mitigation of leakage current in grid connected PV system where a qZSI module is employed in each module of the cascaded structure.Generally the leakage current suppression solutions are classified as (1)Topology solutions (2)Filter Solutions (3)Modulation solutions.Out of which,modulation solution is chosen to sort out the leakage current issue.The leakage current suppression solutions for transformerless inverters has been well explained[8].The bipolar modulation strategy is not preferred since the output quality is degraded eventhough the common mode voltage is maintained constant.Other topologies like full-bridge and modified full bridge topologies requires extra switching components on both AC and DC sides[14].Finally,filter solutions are prescribed in the existing paper,since the filters will provide a bypass loop thereby preventing the leakage current to flow outside into the active circuits.[13].Another main advantage of using this solution is that lesser number of switching components are used.The leakage current problems also prevails in many other application such as CMI-based AC drives[17],CMI based magnetic resonance imaging system[18],and paralleled boost rectifiers.The main problem of employing the modulation schemes in PV-CMI system since the parasitic capacitors are distributed on DC side.Applications where no capacitance are involved in the circulating loop,high frequency circulating currents can be mitigated by interphase inductors.Only low-frequency circulating current would be problematic in drive applications.However in PV-CMI swtching frequency noises will be dominant.

This paper first describes about qZSI based CMI-PV systems with a R load and then it discusses about the possible difficulties expected while connecting the same system to a grid.Also,it briefly explains the significance of qZSI usage in the cascaded modules.Finally,by incorporating the effective Pulse Width Modulation[PWM] techniques and by adjusting the duty cycles ,the system is optimised to work better with the grid connected application also.The appropriate filter design is adopted and applied to the aforementioned system in which each switches are operated at 100kHz.The main parameters which is modified here is modulation index and the duty cycle of the reference signal.Simulations are carried out for both the stand-alone system and a Grid-connected system inorder to validate the efficiency of the proposed system.

## **II. THE ISSUES IN GRID CONNECTED SYSTEM**

The Distributed generation [DG] networks contributes wide range of power quality problems like voltage fluctuations [sag, swell, interruptions], islanding problems when the power exceeds the set parameters. Moreover for a standalone system, interactions with the neighboring networks will be less. In larger DG network, the integration of many renewable energy sources will be a complex issue due to the communication

with the adjacent networks. However, the power quality problems could be eradicated using the power factor correction [PFC] methods, FACTS devices like STATCOM or SVC's on the inverter side. Also, other important factors that affect the PV cell performance are its Insolation and Energy, Power tracking, shading and dirt and temperature. It uses power from the central utility when required and supplies home-generated power back to the utility which is termed as a parallel system. Grid connected PV systems are gaining its importance due to high power conversion efficiency of the full bridge inverters. However, the full bridge inverters has its own drawbacks like high acoustic noise, switching losses and electromagnetic interference. Later, cascaded structure has emerged which produces high quality output waveform with low distortion, lesser stress on the switching components. But the leakage current issue is a result of the parasitic effect among the capacitors. This problem is greatly addressed by altering either the topologies or the modulation strategies. But the survey reveals that applying filters both at the AC and DC side of the network would be a cost effective and most reliable solution. Control strategies for the MLI are explained well in [10]. As for as the resistive load is concerned, the filters alone would be a convincing solution. But when grid is the constraint, then in addition to the filters, modulation adjustments are also expected in order to reduce the leakage current along with the grid integration issues. In the existing work, two filter solutions are suggested for leakage current suppression and is restricted to a R load alone. Suppression analysis is carried out using simple superposition theorem approach. The solutions are applied to two different circuits. Former is designed for the system with four cascaded quasi ZSI where each switches are operated at 100kHz [high frequency application]. Latter is designed for a PV system with two cascaded H-bridges inverter in which switches are operated at 10kHz [low frequency application]. Only the second solution is applied to the grid connected system while the first solution is restricted to the R load [12] since it has the minimum contribution to the total impedance of the leakage current loop at the switching frequency. In this paper, the same filter solution is adopted for qZSI circuit and it is interfaced with the grid without sacrificing the efficiency and THD. The second solution is not considered much, since the higher amount of circulating capacitances to reduce the filter inductance are required. Moreover the internal circulating current would not create remarkable change in the Inverter efficiency drop.



**Fig 1. Existing PV-CMI system**

The circuit analysis for the qZSI depends upon the two modes of the circuit (1) shoot through (2) non-shoot through states of the circuit which is described later part of the paper.

Higher the filter components, bulkier would the system. By effective usage of the quasi network, this can perform both buck and boost operation simultaneously. The control methods available in qZSI are (1) simple boost (2) maximum boost (3) maximum constant boost. In this paper, simple boost control strategy is adopted for the qZSI in order to obtain the buck/boost, inversion and power conditioning in the single stage with good reliability. The grid connected qZSI is shown in Fig.4. In order to achieve the better suppression of leakage current, the duty cycle of each qZSI module is adjusted such that the active or shoot through states are extended to a larger interval thereby the conduction of switches in the same leg would be more effective unlike the conventional ZSI.

### III. EXISTING AND PROPOSED SYSTEM

In order to reduce the leakage current, the filter solutions are adapted for two different applications and later these solutions are verified experimentally. But the solutions are restricted to special constraints. The high frequency filter solutions are restricted to the resistive load. So the modulation strategy is adjusted such the active states of the qZSI are extended thereby eliminating the dead time between two adjacent intervals [6] without sacrificing the efficiency. Both the existing and proposed are simulated using MATLAB. The results of existing and proposed system are compared and the results are found be better with the lesser THD.

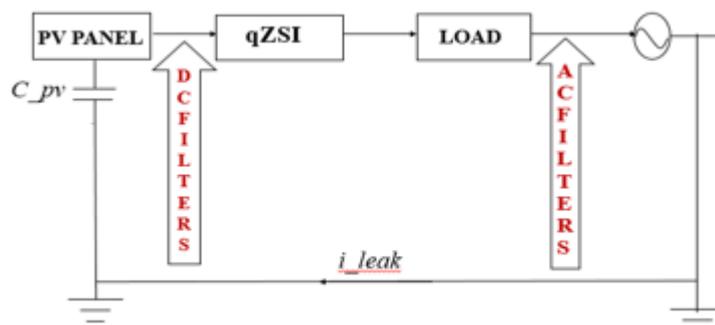


Fig 2. Block Diagram of the proposed system

### IV. CIRCUIT ANALYSIS

The main aim of applying filters to the CMI is to construct the by-pass loop thereby preventing the leakage current to flow outside. Two kinds of loops are involved in all PV-CMI networks. First loop consists of parasitic capacitor, Inverter Bridge, line inductor, and grid ground and is called as module-line leakage current loop. Other one loop is formed among the inverters and is called as intermodule leakage current loop. It provides a capacitive coupling path with negligible inductance which will result in the production of pulse wise leakage current in the loop. Due to this fact, even in transformer less topology, the intermodule leakage current loop exists. Also, it cannot be eliminated even if the transformer is placed at the output side [15]. Two main objectives of considering qZSI network instead of the cascaded H-bridge is to cope up with wide range of PV input and also it will provide a low impedance path for high frequency noises.

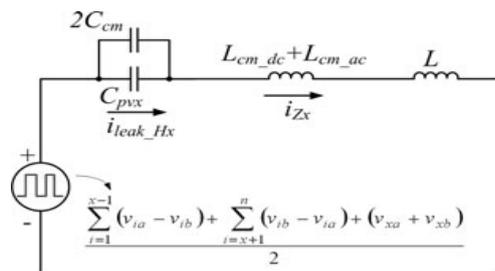
#### 4.1 Leakage current calculation

Analysis of the CMI network is carried out by considering a single intermodule leakage current loop and

applying superposition principle to the filter loop which is formed by adding dc-side common mode [CM] chokes  $L_{cm\_dc}$ , CM capacitors  $C_{cm}$ , and ac side CM chokes  $L_{cm\_ac}$  in each inverter module. Survey reveals that the CM output is mainly considered for determining the leakage current. The topological and modulation strategies are preferred mainly to maintain constant CM voltage. Unfortunately, it could not be achieved when a extra intermodule leakage current loop is formed .It is because that the Differential mode [DM] outputs would also contribute in such cases. The CM and DM mode voltages are given by

$$(1)$$

$$(2)$$



**Fig.3 Intermodule Leakage current loop**

Due to this aforementioned issue, a need for an alternative was expected which resulted in the filter solution. The impedance inside a single loop is expressed as

$$Z_i = \quad (3)$$

where  $i = 1, 2, \dots, n$  and  $Z_L = j\omega L$ .

Applying superposition theory, the current through the inductance  $L_{cm\_dc} + L_{cm\_ac}$  of the  $x_{th}$  inverter module is given by,

$$i_{z_x} = \sum_{i=1}^1 \frac{v_{1a}}{Z_{si}} \cdot \frac{Z_{pi}}{Z_x + Z_{pi}} + \sum_{i=2}^x \frac{v_{1a} - v_{(i-1)b}}{Z_{si}} \cdot \frac{Z_{pi}}{Z_x + Z_{pi}} + \sum_{i=x}^{n-1} \frac{v_{ib} - v_{(i+1)a}}{Z_{si}} \cdot \frac{Z_{pi}}{Z_x + Z_{pi}} + \sum_{i=n}^n \quad (4)$$

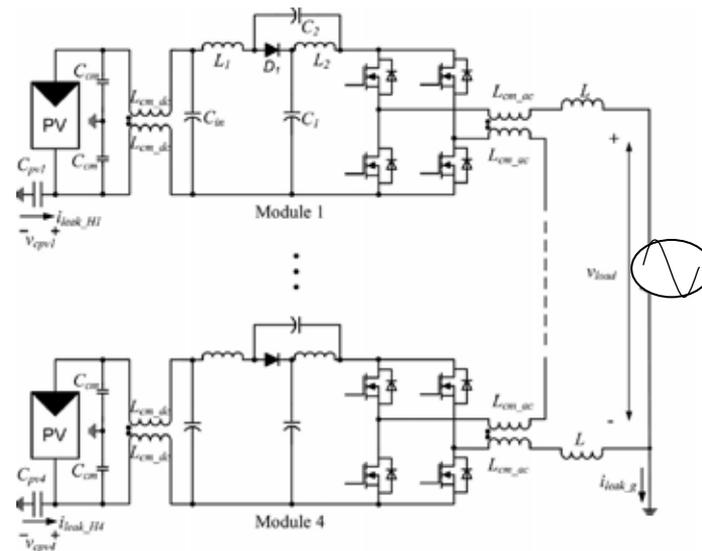
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Equation (4) can be simplified as

$$i_{z_x} = \frac{\sum_{i=1}^n v_i}{Z_x} \quad (5)$$

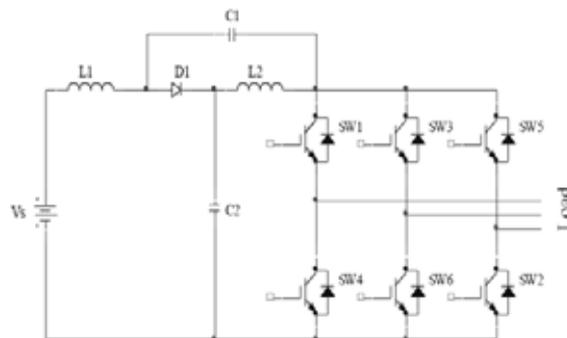
The leakage current expression  $i_{leak\_Hx}$  can be obtained from the tank circuit formed by  $L_{cm\_ac} + L_{cm\_dc} + L$  and  $C_{pvx} + 2C_{cm}$ ,

$$(6)$$



**Fig 4. Proposed PV-CMI circuit**

#### 4.2 qZSI network



**Fig 5. qZSI network**

qZSI circuit differs from traditional ZSI in the LC network between the source and the inverter. The presence of LC and diode network connected to the bridge modify the operation of the circuit, thereby shoot through states arise which is forbidden in traditional VSI. The modified network protects the circuit from damage during shoot-through and also qZSI network boosts the DC link voltage.

#### 4.3 Transformer less Appeal

Differences between standard and transformer less inverters are:

- Conventional inverters are built with an internal transformer that synchronizes the DC voltage with the AC output.
- Transformer less inverters use a computerized multi-step process and electronic components to convert DC to high frequency AC, back to DC and ultimately to standard frequency AC.
- It is capable of handling Dual MPPT inputs and has higher efficiency ratings.
- It is much lighter than inverters with transformers and cheaper.

## V. RESULTS AND DISCUSSIONS

Besides many advantages of the Transformer less inverters and qZSI, leakage current issue remains challenging in designing a reliable PV-CMI system simplified analytical models are derived and filters are employed along with the enhanced qZSI. The model is then simulated in MATLAB R2011a software. The presence of parasitic capacitance will make the leakage current to flow through the negative terminal of the PV side. The effect of leakage current through of both the existing and proposed system is shown in fig.6(a)&(b)

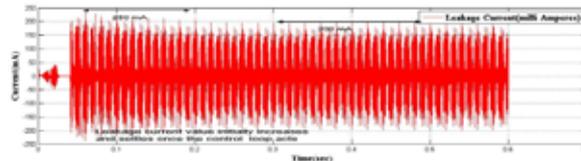


Fig 6(a) Leakage current in Existing system

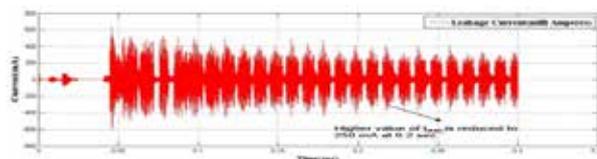


Fig 6(b) Leakage Current in Proposed System

Due to the impact of leakage current in the DC side of the network the PV side voltage and current would vary according to the magnitude of  $i_{leak\_Hx}$ . The PV side input current and voltage of the existing and proposed system is shown in Fig 7 (a)&(b)

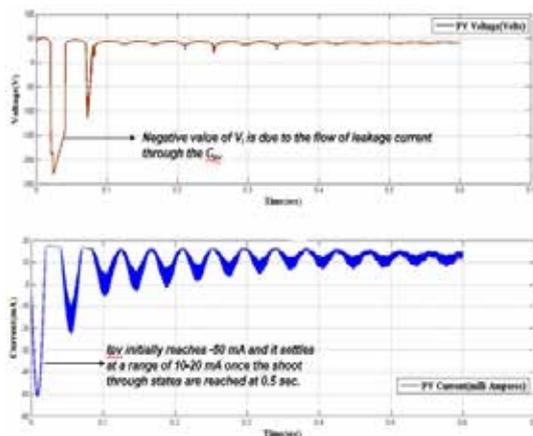


Fig 7(a) PV side inputs-Existing system

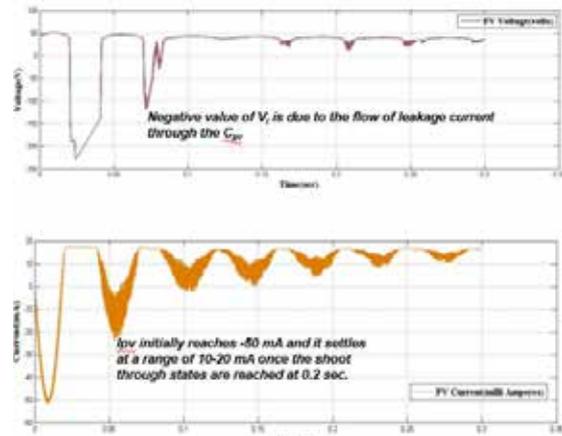
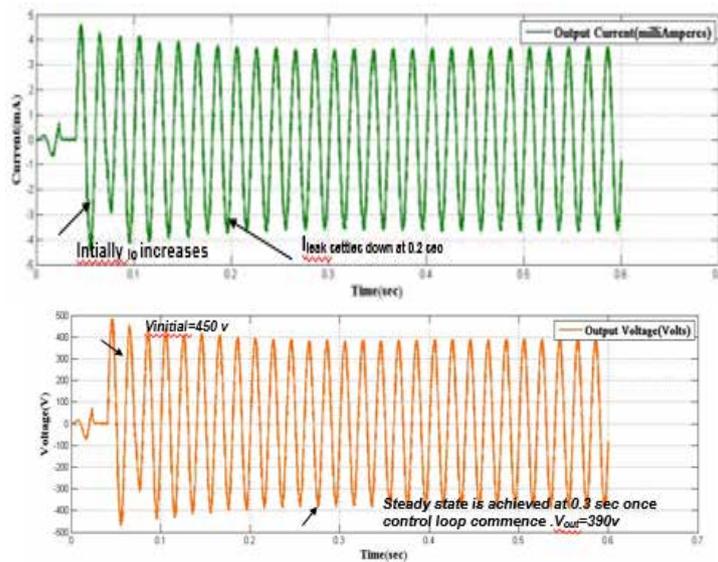


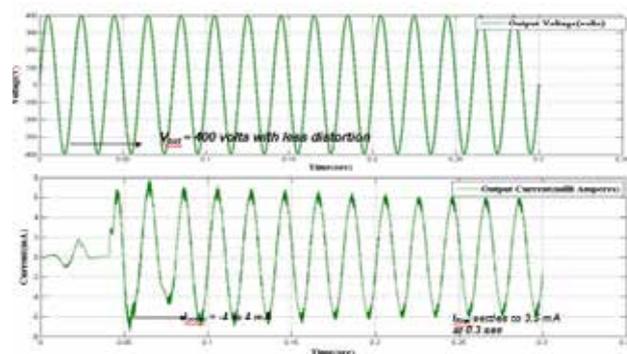
Fig 7(b) PV side inputs-Proposed system

Initially the negative current is higher for a system with power: 250W, input voltage range: 25-50V. The Output Voltage and Current of both the works are depicted in Fig8 (a) & (b).



**Fig.8(a)Output voltage and Current of Existing work**

Once the modulation cycle triggered, the effective shoot-through states would reduce the leakage current from 0.61mA which in turn bring down the values of PV array input and finally the THD of system falls to 4.71% which is an acceptable IEEE standards for harmonics 519. The THD is found to be better in proposed work and the comparison is shown in fig.9



**Fig.8(b)Output voltage and Current of Proposed work**

VIII.VII.

EXISTING SYSTEM	PROPOSED SYSTEM
1. Restricted to R load	Extended to grid applications
2. Filter solutions are focussed	Effective usage of Active states of qZSI
3. THD Analysis 5.13%	THD:4.71%

**Fig 9.Comparison of Existing&Proposed Work**

## VI. CONCLUSION

This paper first analyzed the qZSI based PV-CMI system which is restricted to operate only with R loads since the focus in the existing work was fully theoretical analysis of the filters in order to mitigate the leakage current. In this work, the same qZSI PV-CMI system is integrated to a grid with the same filter available in the base work. The main strategy changed here was the Duty cycle variations in the Quasi Z source network thereby eliminating the dead time and effective utilization of shoot through states could be achieved. Thus, the leakage current suppression is achieved in the grid connected applications by the proper selection of filters and the modulation techniques. The realization of hardware and applying the SL-qZSI strategy for single and three phase inverters to reduce THD could be the future work.

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# REUSABILITY OF SEARCH INDEX OVER ENCRYPTED CLOUD DATA ON DYNAMIC UPDATE

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## ABSTRACT

*Cloud computing is generating lot of interest to provide solution for data outsourcing and high quality data services. More and more institution, organizations are exploring the possibility of having their applications, data, IT assets in cloud. As the data and there by the cloud's size increases searching of the relevant data is expected to be a challenge. To overcome this challenge, search index is created to aid in faster search. However, search Index creation and computation has been complex and time consuming, leading to cloud-down time there by hindering the swiftness in reacting to data request for mission critical requirements.*

*Focus of this paper is to explain how in the proposed system, reusability of search index is helping to reduce the complexity of search index computation. Search index is proposed to be created using parameters like similarity relevance, user ranking. User ranking helps to guarantee why a phrase or a sentence or a key word is used frequently in the uploaded data. The proposed system ensures that the reusability of search index concept, highly reduces cloud down time while maintaining the security. The user requested file is retrieved from the cloud, using Two-round searchable encryption scheme supporting top-k multi-keyword retrieval.*

**Keywords:** *Cloud, Data Privacy, Search Index, Ranking, Homomorphic Encryption*

## I. INTRODUCTION

Cloud computing [1] is a recently evolved computing terminology or metaphor based on utility and consumption of computing resources. Cloud computing involves deploying groups of remote servers and software networks that allow centralized data storage and online access to computer services or resources. Though cloud computing promises to be a powerful technique to help users and user organizations reduce their infrastructure costs / improve efficiency, concerns regarding the security of the data and the data loss [3], has withheld organizations from embracing the technology whole heartedly.

To address this concern, users tend to encrypt their data on the cloud using advanced encryption algorithms. In cloud computing, data owners may share their data in the cloud with authorized users who in turn might want to retrieve only the data files they are interested in. Availability of required data at the right time and in the right format will be a key factor for gaining the acceptance of the end user. Currently, keyword based retrieval is one of the most popular ways to retrieve the file in the cloud. Earlier, there were methods or SSE schemes [4][5] which support only Boolean keyword search. i.e., whether a keyword exists in a file or not. Later on the key word search was enhanced to include multiple-keywords.

In multi keyword based search index using top-k[6][7][8], user Ranking plays an important factor. User ranking guarantee why something is mentioned a lot. Search index is created for the files based on the user ranking. User ranking [secure][9] is an input to the cloud server and the retrieval of relevant files/data is performed by the cloud server depending on the ranking and the relevance score of the respective files. Homomorphic encryption scheme is used to create a secure search index which is provided along with the encrypted files to the server.

Cloud server uses TRSE encryption scheme which ensures security over the data. In a practical cloud computing system, data update like adding or deleting files leads to a new challenge to searchable encryption scheme. For ex., with proliferation of data, data update may become frequent for newly added files and the frequency depends on the business need. In these scenarios, it is necessary to update the search index for the new files such that the retrieval of those may happen smoothly without any cloud downtime or any performance degradation. The search Index computation for addition of each and every file takes considerable amount of time and also may lead to some overhead costs and communication when the cloud is outsourced.



**Figure 1 - Cloud Server**

This paper introduces the concept of reusability of the search index, when dynamic updates like add, delete or update of a file / new file addition to the cloud server happens.

The Contributions can be summarized as follows:

- è The search index of the frequently searched words is maintained in the primary index and is re-used when any new files are getting added to the same category or group.
- è The frequently used words are scanned in the incoming file to the cloud server and if it approximately matches the existing search index, the same index is shared between the files instead of creating a new one
- è The search index for the low frequency words is maintained in a secondary index and can be moved to primary index if the frequency of usage increases
- è The search index of the deleted files are retained for a limited period of time during which a new file with similar keywords are uploaded, then the same search index is mapped for the new file

The search index reusability ensures the cloud downtime is reduced effectively. The benefits could be large when applied to thousands of files entering the cloud server and in multi-cloud architecture where multiple clouds participate.

## II. EXISTING SYSTEM

Existing system consists of three modules. Data Owner, Cloud server and Cloud User.

è Data Owner has X number of files to be uploaded to the cloud server. He encrypts the input files and the search index he creates for the file before uploading to the server.

§ The search index is calculated based on the parameter value (tf-idf) and its relevance score

§  $Tf(t_f)$  – Term Frequency : denotes the number of occurrences of the term t, in file f

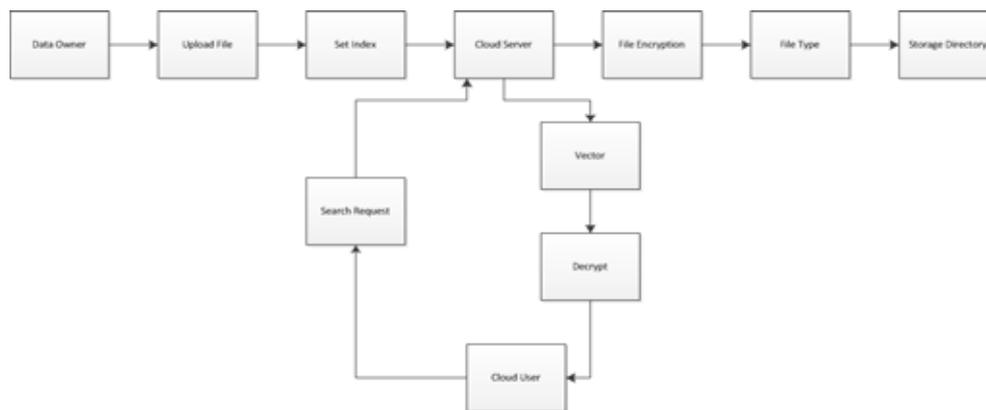
§  $Dft$  – Document frequency : refers to the number of files that contains the term t

§  $Idf_t$  – Inverse document frequency is defined as:

§  $Idf_t = \log(N/df_t)$ ,  $N$  denotes the total number of files

The tf-idf weighting scheme assigns to a term  $t$  a weight in file  $f$  given by  $tf-idf_{t,f} = tf_{t,f} \times idf_t$

The weights of the term that occur very frequently in the collection are diminished and the weights of the terms that occur rarely are increased [2]. Tf-idf depicts the weight of a single keyword on a file, to specify multiple keywords vector space model is employed. Vector space model [12] is an algebraic model for representing file as a vector. Each dimension of a vector corresponds to a separate term. The vector space model supports multi-term and non-binary distribution[2].



**Figure 2 - Existing System Architecture**

**Homomorphic encryption** is a scheme that allows specific types of computations to be carried out on the corresponding cipher text. The result is the cipher text of the result of the same operations performed on the plaintext. The encryption is modified to reduce the size of the cipher text without altering its homomorphism property. This method is used to encrypt search index and it involves four stages: KeyGen, Encrypt, Evaluate, and Decrypt. However, the actual files are encrypted using one of the symmetric encryption schemes, since the homomorphic encryption scheme is time consuming.

è Cloud server stores the files and its respective index in the data storage. When the data user requests with a multi-keyword query, it searches for the relevant files based on the keyword and provides the user with the terms and its ranking. The data user decrypts and requests for the highly scored files which in turn is provided by the server. The cloud server uses two round TRSE scheme for this purpose.

Data user requests for files in the cloud server using a multi-keyword query, which is retrieved based on ranking of the keyword in the search index.

## 2.1 Disadvantages

- è Search Index need to be created dynamically every time a file is updated and it involves a complex process since homomorphic encryption is used. This encryption scheme for search index is a time consuming one as KeyGen process involves creating secret key and public key every time for encryption and decryption.
- è Calculating Search index for every incoming file involves high user computation and is not efficient in a multi user / multi file scenario

è Resources currently employed by companies to create search index could be used in more productive ways

### III. PROPOSED SYSTEM

Proposed system concentrates on solving the disadvantages in the existing system by reusing and sharing the search index. This system can also be employed in large industries where data owners and cloud servers are trusted. The cloud server hosts third-party data and retrieve the stored data. Since data may contain sensitive information, the cloud servers cannot be fully entrusted in protecting data. The data owner uploads 'N' number of files and expects cloud server to provide keyword retrieval service to authorized users.



Figure 3 - Architecture of the proposed system

The proposed system comprises of the following modules.

#### 3.1 Creation of Search Index

- è The data owner creates the search index to calculate relevance factor which depends on user ranking
- è Tf (term Frequency), Dft (Document frequency) and Idft (Inverse document frequency) are included in the calculation of  $tf-idf = tf_{t,f} \times idft$  values
- è Vector space model [12] is used for representing multiple keywords as in the current system
- è The search index is encrypted using homomorphic encryption which allows complex mathematical operations to be performed on encrypted data and it includes four stages:
  - § KeyGen : The secret key and the public key are generated for encryption and decryption
  - § Encrypt : Cipher text is generated with the key generated from the KeyGen
  - § Evaluate : The binary addition and multiplication is applied to compute tf-idf

Decrypt: Method that satisfies homomorphism property

#### 3.2 Re-Using Search Index For The Dynamic Update Of Files

The drawback of the current system emerges when adding/removing of files to and from the cloud server. Search Index needs to be calculated for each entry of the file and the computation complexity of the search index is a time consuming activity. To avoid this, the proposed system plans reusing of the existing search index.

- è Addition of new files to the server(same domain) :

- § Check for the type/domain of the input files (e.g., security/storage)
- § The cloud server checks for the frequently occurring words in the document
- § Compare the keywords with the already existing Search index
- § If the words match, the same ranking/value could be re-used for the new file. This is achieved since the cloud server retrieves the file based on relevance criteria for the queried keywords
- è Addition of new files to the server(different domain) :
- § If the input file is completely different from the existing domains in the server, the cloud server could request the data owner to compute the search index
- è The highly searched keywords by the end user or data user is maintained or tracked in a file

### 3.3 Plan When A File Is Deleted

- è If a particular file that comprises of frequently used keywords is removed from the server, then the search index for the removed/deleted file can be maintained in the server for future use
- è The retention period to preserve the search index for the high frequent words depends on the business need
- è Primary and Secondary indices plays an important role here. While primary indices store the search index of the frequently used words in the immediate past (period depends on business need), the words that are not used frequently in the same period can be moved to secondary index

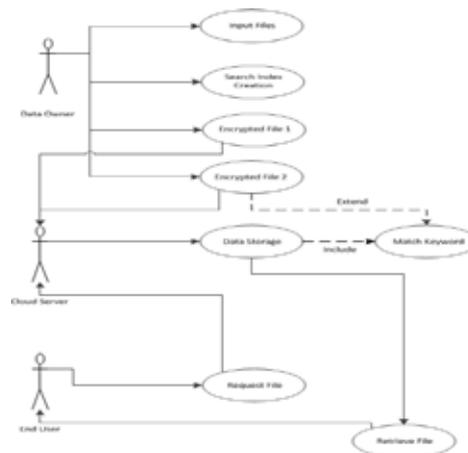


Figure 4 - Use Case Diagram

### 3.4 Advantages

- è Sharing the search index for multiple files could effectively manage the space for search index in the cloud
- è Cloud-down time could be reduced by re-using or sharing the search index which avoids the need for its frequent computation

Resources used for computation can be diverted to other requirements.

## IV. RELATED WORK

A Swaminathan et al. [7] explored secure rank-ordered retrieval with improved searchable encryption in the scenario of data center. They built a framework for privacy-preserving top k retrieval, including secure indexing and ranking. N.cao et al.[11] made the first attempt to define and solve the problem of top-k multi-keyword retrieval over encrypted cloud data. H.Hu et al. [10] employed homomorphism to preserve the data privacy. They devised a protocol for processing the nearest neighbor node using index query to preserve the data at both

client and owner perspective but the query with multi-keyword is not supported. Jiadi Yu et al.[2] made an attempt to produce the cipher text with small size using modified homomorphism. They built the search index using homomorphism which provided security but had to update the search index on dynamic update of the files. In this paper, the same method is used for creating search index but here the focus is on reusability and sharing of the search index which provides business benefits.

## **V. CONCLUSION**

In this paper, the problem of search index computation for every newly added file is resolved by reusing and sharing of the index which reduces resource requirement for search index computation. The sharing of search index also helps to manage the space effectively in the cloud server. Cloud down time will be made to zero when this technique is used effectively. The real business benefits are achieved in industries where large number of files are handled.

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# DESIGN OF ADVANCED DIRECT MEMORY ACCESS 2 FOR SECURE DIGITAL HOST CONTROLLER

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## ABSTRACT

*Portable storage devices are becoming popular and growing rapidly. These devices can store and acquire information wherever whenever you need. The aim of this project is to design Advanced Direct Memory Access2 (ADMA 2) that supports high capacity data transfer with greater Speed and reduced Power Consumption. The ADMA 2 Controller is a hardware feature that enables movement of blocks of data from peripheral to memory, memory to peripheral or memory to memory. This movement of data by a separate entity significantly reduces the load on the processor. ADMA 2 controller can be used to save power in a system by putting the Central Processing Unit in a low-power state and using the ADMA 2 controller (fewer gates/transactions) to move the data.*

**Keywords - SD Host Controller, DMA, ADMA 2, Verilog**

## I. INTRODUCTION

The need for portable digital storage in Embedded Systems is increasing rapidly. With the increasing consumer digital content, demand for high capacity digital storage is increasing rapidly. Today, portable storage media's are widely used in all mobile phones, digital cameras, camcorders, and in many multimedia devices. Secure Digital (SD) cards are designed for portable storage applications. They have many advantages over their predecessors. They have high storage capacity and built upon NAND flash technology. SD cards have security feature built in for protecting digital contents.

ADMA 2 transfers data directly between an I/O device and memory (memory to memory ADMA transfers are also possible). Whichever CPU is being used, it must have a ADMA 2 feature to determine when ADMA 2 is required, so that it can relinquish control of the address and data buses, as well as the control lines required to read and write to memory.

## II. SECURE DIGITAL HOST CONTROLLER (SDHC)

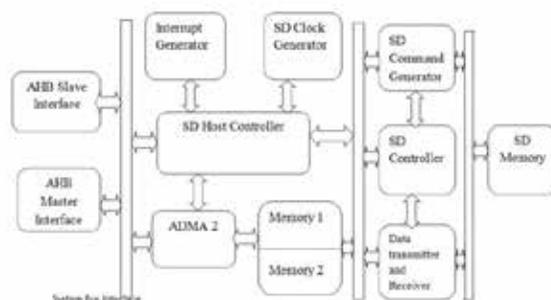
Secure Digital (SD) is the most widely used portable memory standard. Its ultra-compact and rugged architecture, simple interface, high security, low power consumption, reliable operation and interoperability have made it the de-facto solution for portable storage.

### 2.1 SD Bus Interface

In systems-on-a-chip and embedded systems, typical system bus infrastructure is a complex on-chip bus such as AMBA High-performance Bus. AMBA defines two kinds of AHB components: master and slave.

A slave interface is similar to programmed I/O through which the software (running on embedded CPU, e.g. ARM) can write/read I/O registers or (less commonly) local memory blocks inside the device. A master interface can be used by the device to perform DMA transactions to/from system memory without heavily loading the CPU. Therefore high bandwidth devices such as network controllers that need to transfer huge amounts of data to/from system memory will have two interface adapters to the AHB: a master and a slave interface. This is because on-chip buses like AHB do not support tri-stating the bus or alternating the direction of any line on the bus. Like PCI, no central DMA controller is required since the DMA is bus-mastering, but an arbiter is required in case of multiple masters present on the system. Internally, a multichannel DMA engine is usually present in the device to perform multiple concurrent scatter-gather operations as programmed by the software.

The Data transfers to and from the SD Memory Card are done in blocks. Data blocks are always succeeded by CRC bits. Single and Multiple block operations are defined. Data can be transferred using single or multiple data lines. The SD Host Controller is fully compliant to SD Host Controller Specification version 3.0 and Physical Layer Specification version 3.01. The standard register set is implemented. The Host Processor accesses the various registers and FIFOs in the Host Controller to transfer data between Host and SD Card.



**Fig 1.1: Basic block diagram of SDHC**

Every data transfer is preceded by corresponding command and response. Command is send by the Host Controller to the Card and Response is send back by the Card to the Host Controller. The block diagram of Host Controller is given in Figure 1.1

### III. DIRECT MEMORY ACCESS (DMA)

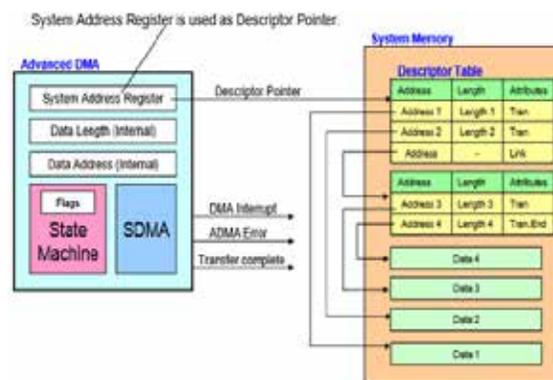
DMA is an essential feature of all modern computers, as it allows devices to transfer data without subjecting the CPU to a heavy overhead. Otherwise, the CPU would have to copy each piece of data from the source to the destination.

This is typically slower than copying normal blocks of memory since access to I/O devices over a peripheral bus is generally slower than normal system RAM. During this time the CPU would be unavailable for any other tasks involving CPU bus access, although it could continue doing any work which did not require bus access. A DMA transfer essentially copies a block of memory from one device to another. While the CPU initiates the transfer, it

does not execute it. For so-called "third party" DMA, as is normally used with the ISA bus, the transfer is performed by a DMA controller which is typically part of the motherboard chipset. More advanced bus designs such as PCI typically use bus mastering DMA, where the device takes control of the bus and performs the transfer itself. A typical usage of DMA is copying a block of memory from system RAM to or from a buffer on the device. Such an operation does not stall the processor, which as a result can be scheduled to perform other tasks. DMA is essential to high performance embedded systems. It is also essential in providing so-called zero-copy implementations of peripheral device drivers as well as functionalities such as network packet routing, audio playback and streaming video. The alignment process subjects the CPU to a heavy overhead. There are some applications, like video processing that require an efficient support for unaligned accesses, degrading the performance significantly.

#### IV. ADVANCED DIRECT MEMORY ACCESS 2 (ADMA 2)

ADMA 2 is one of several methods for coordinating the timing of data transfers between an input/output (I/O) device and the core processing unit or memory in a computer. ADMA 2 is one of the faster types of synchronization mechanisms, generally providing significant improvement over interrupts, in terms of both latency and throughput. ADMA 2 controller can generate memory addresses and initiate memory read or write cycles. It contains several processor registers that can be written and read by the CPU. These include a memory address register, a byte count register, and one or more control registers. The CPU then sends commands to a peripheral device to initiate transfer of data. The ADMA 2 controller then provides addresses and read/write control lines to the system memory. Each time a byte of data is ready to be transferred between the peripheral device and memory, the ADMA 2 controller increments its internal address register until the full block of data is transferred.



**Fig 1.2: Block diagram of ADMA 2**

The figure 1.2 shows the block diagram of advanced ADMA2. In ADMA2 operation a Descriptor Table is created in system memory by the Host Driver. 32-bit Address Descriptor Table is used for the system with 32-bit addressing and 64-bit Address Descriptor Table is used for the system with 64-bit addressing.

Each descriptor line (one executable unit) consists with address, length and attribute field. The attribute specifies operation of the descriptor line. ADMA2 includes SDMA, State Machine and Registers circuits. ADMA2 does not

use 32-bit SDMA System Address Register but uses the 64-bit Advanced DMA System Address register for descriptor pointer. Writing Command register triggers off ADMA2 transfer. ADMA2 fetches one descriptor line and executes it. This procedure is repeated until end of descriptor is found.

An Example of ADMA2 Programming

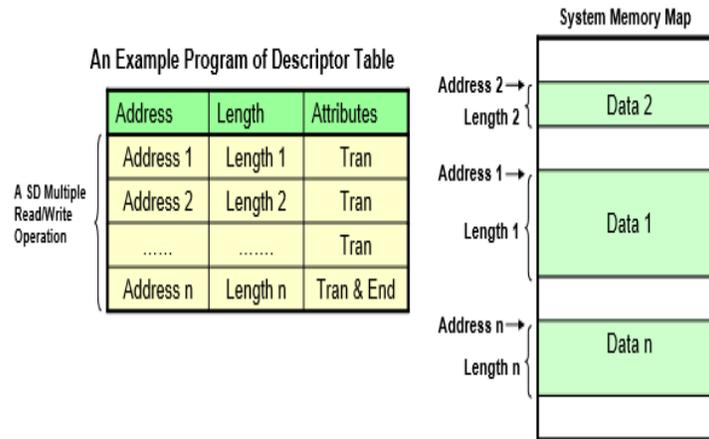


Fig 1.3: An Example of ADMA2 Data Transfer

Figure 1.3 shows a typical ADMA2 descriptor program. The data area is sliced in various lengths and each slice is placed somewhere in system memory. The Host Driver describes the Descriptor Table with set of address, length and attributes. Each sliced data is transferred in turns as programmed in descriptor.

4.1 ADMA2 States and its Operation

The figure shows various states of ADMA2 and the operation of all states. It also describes the condition when ADMA 2 fetches the descriptor line and transfers the data and the increment in the address. ADMA 2 adopts scatter gather DMA algorithm so that higher data transfer speed.

The Host Driver can program a list of data transfers between system memory and SD card to the Descriptor Table before executing ADMA. It enables ADMA to operate without interrupting the Host Driver. Furthermore, ADMA can support not only 32-bit system memory addressing but also 64-bit system memory addressing. The 32-bit system memory addressing uses lower 32-bit field of 64-bit address registers.

**ST\_FDS (Fetch Descriptor):** ADMA 2 fetches a descriptor line and set parameters in internal registers. Next go to ST\_CADR state.

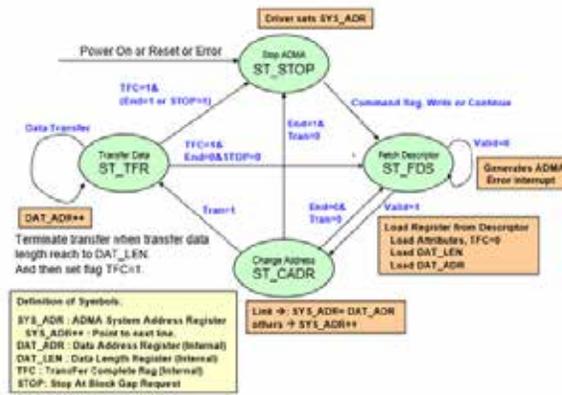


Fig 1.5: States of ADMA 2

**ST\_CADR (Change Address):** Link operation loads another Descriptor address to ADMA 2 System Address register. In other operations, ADMA System Address register is incremented to point next descriptor line. If End=0, go to ST\_TFR state. ADMA 2 shall not be stopped at this state even if some errors occur.

**ST\_TFR(Transfer Data ):** Data transfer of one descriptor line is executed between system memory and SD card. If data transfer continues (End=0) go to ST\_FDS state.

**ST\_STOP (Stop DMA):** After Power on reset or software reset. All descriptor data transfers are completed. Error occurrence during ADMA2 transfer may stop ADMA2 operation and generates ADMA 2 Error Interrupt. Error Status registers hold state of ADMA 2 stopped. The host driver can identify error descriptor location by following method. If ADMA 2 stopped at ST\_FDS state, the ADMA 2 System Address Register points the error descriptor line. If ADMA 2 stopped at ST\_TFR or ST\_STOP state, the ADMA 2 System Address Register points the next location of error descriptor line. By this reason, ADMA2 shall not stop at ST\_CADR state. ADMA 2 allows an I/O device to communicate directly to the main memory bypassing CPU in order to speed up memory operations..

V. SIMULATION RESULTS

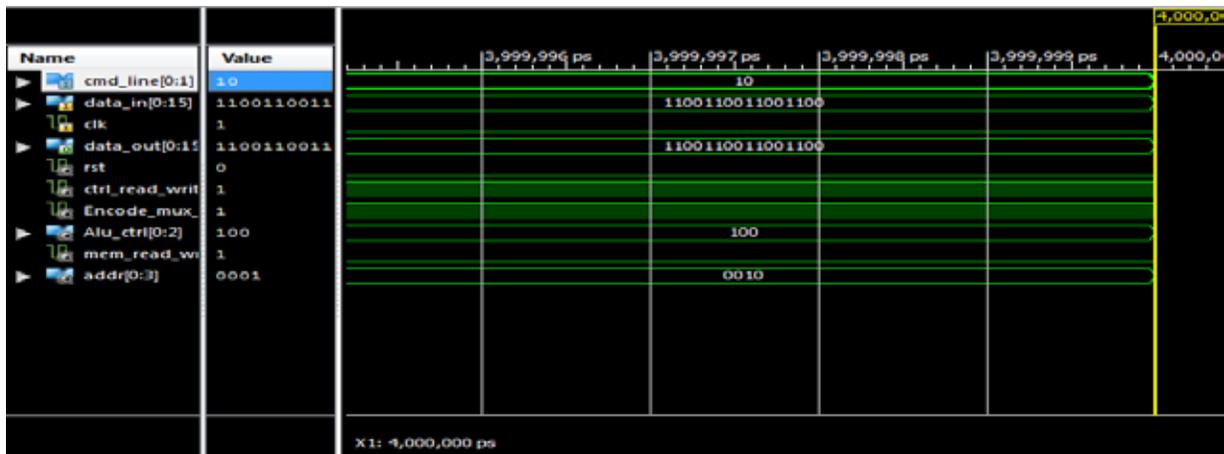


Fig 1.6 Write function for command line 10.

In figure 1.6 read operation is completed. It is said to perform write operation as the command line is changed from 01 to 10.

## VI. CONCLUSION

The battery operated device which is one of the fastest growing electronic industries, in which speed of data transfer is becoming a major issue. With the proposed design of secure digital host controller intellectual property, we can achieve a high speed data transfer without compromising power. Simulated results for data transfer in ADMA 2 which provides high capacity data transfer with the reduction in load on Host CPU is obtained.

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# A HYBRID ALGORITHM FOR EFFICIENT CONGESTION CONTROL IN WIRELESS SENSOR NETWORKS

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## ABSTRACT

*As applications in Wireless Sensor Networks (WSNs) are evolving, congestion control remains an open and, in several cases, a critical problem. A lot of research has been performed on this issue and two general approaches seem to be the most prominent for its solution: traffic control and resource control. Each of these two methods presents specific advantages and disadvantages under different scenarios. In this paper we present HRTC, a dynamic scheme capable of bridging these two methods for congestion control and provide the best solution, based on the prevalent network conditions.*

***Index Terms- Wireless Sensor Networks, Congestion Control, Traffic Control, Resource Control, Hybrid Solution***

## I. INTRODUCTION

Congestion is a problem that affects all types of networks. Especially for the low-powered, unreliable Wireless Sensor Networks (WSNs), the occurrence of congestion could negatively affect not only the performance of the network (throughput, delay, packet loss), but also its lifetime as well as its mission. Currently, research converges in two methods for the solution of the problem of congestion in WSNs: traffic and resource control [1].

Traffic control (TC) is the method that has been employed by the majority of congestion control algorithms in WSNs the last few years. Algorithms that employ this method, attempt to limit the data rate of the sources until congestion is mitigated [2]–[12]. On the other hand, algorithms that employ resource control (RC) take advantage of the dense and redundant placements of nodes on the field and create alternative and multiple paths in order to avoid the congested regions. Both methods present specific advantages and disadvantages under different scenarios and network conditions. TC is more efficient than RC in cases where transient congestion occurs, as well as in cases where the network is sparsely deployed. On the other hand, RC, although in general it exhibits better attitude than traffic control, in terms of throughput and power consumption it presents the disadvantage that it can only function in fields where alternative paths can be created (i.e. placements where nodes are densely deployed [13]).

In particular, in [14] the authors show that when RC applies, the throughput of the sink is higher, while there is more balanced energy consumption in the network. Conversely, there is an increment in the end-to-end packet delay from the source to the sink, since packets need to bypass the congested node which is normally part of the shortest path from the source to the sink, using alternative paths. Similar studies show [15] that the lifetime of the networks can be severely degraded in cases where heavy data load exists and a congestion control algorithm that adopts traffic control method is employed. The reason lies on the fact that this type of algorithm constantly

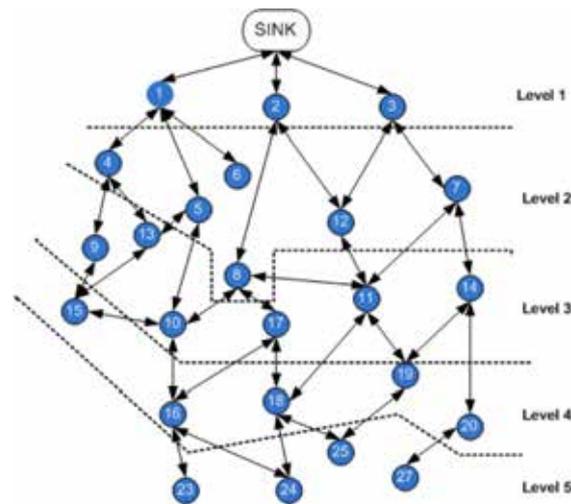
utilizes the shortest path to the sink and this drives the network to the creation of routing holes(network becomes disconnected).

In this work we present HRTC, an algorithm that provides a complete solution to the congestion problem. By complete, we mean that the nodes in the network are able to understand whether they can apply resource or traffic control, at any level. Thus, if RC cannot be applied, the source node applies TC until it achieves congestion alleviation. In particular, by applying this hybrid scheme, the network gives priority to RC and in case it is not able to so, it applies TC. The obvious advantage of this scheme is the fact that the assumptions made in RC algorithms like [13], [16], [17], that the network needs to be densely deployed, is canceled. The rest of the paper is organized as follows. In Section II we present the proposed hybrid algorithm, then we evaluate its performance in comparison with pure traffic and resource control algorithms in Section III and we finally close with the conclusions in Section IV.

## **II. HYBRID RESOURCE AND TRAFFIC CONTROL METHOD- HRTC**

The basic design philosophy of HRTC is based on the fact that the conditions in WSNs are possible to change dynamically. Thus, it is possible for a densely deployed network to initially exist, but after some time this to transform into a network full of routing holes or disconnected parts either due to network issues, like heavy traffic, or other issues like destruction of nodes due to physical phenomenon's (rain, flooding etc.). In either case, the target of this work is to find a solution that maximizes the efficiency of the network in terms of throughput and lifetime, using effectively the available network resources. The application of the aforementioned congestion control methods should be seamless, attempting to minimize any extra overhead to the network. Hence, we propose a hybrid algorithm that aims to exhibit only the positive traits of both individual methods. In this algorithm, when a node faces congestion, it attempts to inform the **source node** from which it receives packets with the lowest data rate, to suppress its data rate. To achieve this, it transmits a backpressure message, hop-by-hop, to the source. We intentionally choose to limit the transmission of the source node with the lowest data rate, since we prefer to keep serving the nodes with higher data rate(s) in order to affect throughput the least. Now, when each node in this reverse hop-by-hop path receives this packet, it checks whether it can apply **resource control** before the message reaches the source. If it can, it applies RC and stops transmitting this backpressure message. Otherwise, it keeps transmitting the backpressure message and if finally this message reaches the source, it (the source) applies traffic control. Thus, it adjusts its data rate and simultaneously adds a specific bit in each packet header it transmits indicating that its data rate is throttled. Since the network dynamics are constantly changing, the nodes that receive packets from this source node are now aware that its data rate is throttled. Therefore, if they are able to apply a resource control method again, they ask the source node through a subsequent backpressure message to transmit with a full data rate. When the source node receives this second message, it removes this specific bit and transmits in full data rate. Then, the specific node that initiated this new transaction receives the full flow of packets and splits the traffic between the initial node and the alternative path. Hence, even if the duration of the event is very small the overall gains of the network are high.

Fig. 2.1 illustrates how this mechanism functions.



**Fig. 2.1. Initial Network Connectivity.**

We consider that node 14 is the congested node. This node receives packets from nodes 19 and 20, which are connected to sources 25 and 27. We also consider that node 19 transmits packets to node 14 with a lower data rate than node 20. In such a case, the congested node (node 14) informs through a backpressure message node 19 to limit its transmission in order to alleviate its congestion situation. When node 19 receives this backpressure message, it checks whether it can create alternative paths to the sink (resource control). If it can, it creates this alternative path and stops transmitting the backpressure message to the source (node 25), solving the issue locally. Otherwise, it forwards the backpressure message to the source (node 25) and the source reduces its data rate by applying a traffic control mechanism. Concurrently, the source, adds a bit in the packet header of the subsequent packets it transmits, indicating that its data rate is throttled. In this case, if also another node receives these packets (e.g. node 18) and is able to handle this data rate without a problem, it asks the source to transmit with full data rate and the throughput increases again. In the next paragraph we explain how a node is capable to understand whether it can apply a “resource control” method or not.

## **2.1 Understanding of Whether A “Resource Control” Method can Be Applied**

Nodes that apply resource control take advantage of the plethora of unused nodes in the network and try to establish alternative paths towards the sink, in order to forward the excess traffic. Algorithms that apply resource control for congestion control [13], [16], [17], argue on the importance of the existence of an efficient topology control scheme. Topology control is required since it reduces the connections between the nodes while, concurrently, it provides the required number of redundant paths. Thus, this hybrid scheme should definitely employ a topology control algorithm. A very simple topology control scheme is to place nodes in levels from source to sink. This scheme has been employed in [16] and [17] and results show that it is a simple yet efficient scheme.

Moreover, it should be assured that there is always at least one available path from source to sink. This precondition did not appear in previous efforts that apply resource control method [13], [16], [17] since in those cases it was assumed that the network was densely deployed and available paths always existed. In the cases we examine we consider any node placement. Thus, in a sparse placement it is possible that paths from the source (or splitting node) to the sink are not always available. To secure this precondition we “borrow” the “flag decision” mechanism, proposed in the DAIPaS [17] algorithm, but with a significant variation. In the DAIPaS algorithm the flag decision mechanism assured that there was always at least one available node in a level higher than the congested node. In this case, it is not enough to assure that there is always one node available at

a higher level above the congested node, since it is possible, in sparse placements have one available node a level above, but not an available path towards the sink. Hence, this issue cannot be solved locally. Thus, we consider that each node sets its flag field to "TRUE" when it is sure that there is a least one available path (not just a node in a level higher than itself) to the sink. To enable this, the "Flag Decision" algorithm is altered. Specifically, according to the DAIPaS [17] algorithm flag field is set to "TRUE" when the following conditions are satisfied:

- The buffer occupancy is above the pre-specified limit.
- The remaining power of the node is above the prespecified limit.
- There is at least one node available to accept packets at a level higher than this node.

In the case of the HRTC algorithm, the third condition "at least one available node" is changed to "at least one available path". To assure that there is at least one available path, the process is reverse and begins from the nodes that communicate directly with the sink. Nodes that communicate with the sink, set their flag to "TRUE". This means that they have enough free space in their buffer to receive packets, their power is sufficient, and they can definitely communicate with this sink. This condition, ("TRUE Flag") is communicated to the nodes that are a level lower than them using a backpressure message. These nodes are now sure that if they have a packet to forward, they can safely forward it through the nodes that are at a level higher than themselves and have their flag field set to "TRUE". This procedure iterates in a backward fashion. Thus, each node that has in its neighbor table at least one node in a level higher than itself, with its flag set to true, is aware that it has at least one available path to the sink.

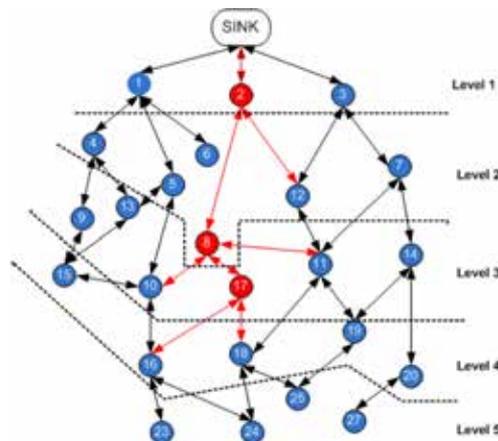


Fig. 2 2. Network Connectivity after failure of Node 2.

### III. PERFORMANCE EVALUATION

To evaluate the performance of this hybrid scheme, a series of simulations have been performed using the Prowler [18] simulator, a probabilistic wireless network simulator. Prowler provides a radio fading model with packet collisions, static and dynamic asymmetric links, and a CSMA MAC layer serving as a contention based MAC protocol. For comparison, we compared this hybrid scheme with a pure resource and a pure traffic control scheme.

To perform the simulations we have used the radio propagation model provided by Prowler. The transmission model is

Given by:

$$P_{rec,ideal}(d) \leftarrow P_{transmit} / (1 + d^\gamma) (1)$$

Where,  $2 \leq \gamma \leq 4$ . Equation (1) presents an ideal transmission function with no errors. In order to provide realistic conditions to our simulations we add fading effects to the radio propagation model according to

$$(2): Prec(i, j) \leftarrow Prec, ideal(d_{i,j})(1 + a(i, j))(1 + \beta(t)) \quad (2)$$

Where  $P_{transmit}$  is the signal strength at the transmitter and  $Prec, ideal(d)$  is the ideal received signal strength at distance  $d$ . Variables  $a$  and  $\beta$  are random variables with normal distributions  $N(0, \sigma_a)$  and  $N(0, \sigma_\beta)$ , respectively.

A node  $j$  can receive packets from node  $i$  if  $Prec(i, j) > \Delta$  where  $\Delta$  is the threshold

#### A. Simulator Setup

30 nodes were uniformly deployed in a 100m x 100m field. The average radio range of transmission for each node is a radius of 10m. In our simulations we employed the default values of Prowler simulator, a choice made by several authors [19]–[22]. Specifically, we set  $\sigma_a = 0.45$ ,  $\sigma_\beta = 0.02$  and the reception threshold is set to  $\Delta = 0.1$ .

Also we set

$p_{error} = 0.05$ . This parameter ( $p_{error}$ ), models the probability of a transmission error caused for any other reason. These values add fading effects to the ideal transmission function. In particular, they model an imperfect circle.

we present HRTC, an algorithm that provides a complete solution to the congestion problem. By complete, we mean that the nodes in the network are able to understand whether they can apply resource or traffic control, at any level. Thus, if RC cannot be applied, the source node applies TC until it achieves congestion alleviation. In particular, by applying this hybrid scheme, the network gives priority to RC and in case it is not able to so, it applies TC. The obvious advantage of this scheme, is the fact that the assumptions made in RC algorithms like that the network needs to be densely deployed, is canceled.

The rest of the parameters we employ represent the Mica-Znode and the most important of them are presented in Table I.

TABLE I  
SIMULATION PARAMETERS.

Max Data Rate (kbps)	250
Transmission Power (dbm)	2
Receive Threshold (dbm)	-74
Transmission Current (mA)	17.4
Receive Current (mA)	19.7
Packet Size (bit)	1024
Buffer Size (Bytes)	512K
MAC layer	CSMA/CA

### 3.1 Results

In the first scenario, sources transmit at maximum data rate and we plot the throughput of the sink until the end of the lifetime of the network (throughput reaches zero).

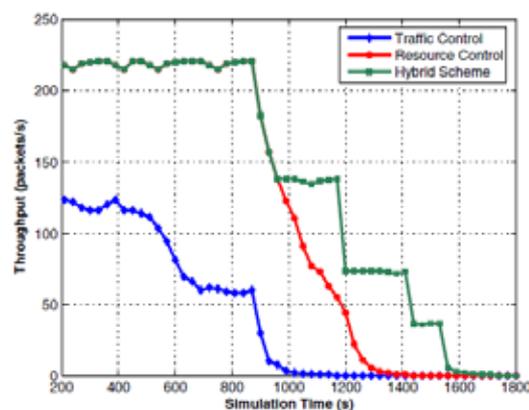


Fig. 3.1. Sink Throughput

Studying the results of Fig. 3.1, we notice that when the traffic control method is applied, the throughput of the network is almost half in comparison with the results of the resource control method, while the throughput reaches zero in less time. This is an indication that traffic control is not an effective congestion control method in terms of throughput since it reduces the data rate of the sources. Furthermore, the fact that packets travel through the shortest path to the sink, it drains the power of the nodes that create this path and routing holes are created. Thus the lifetime of the network is reduced. When the resource control method is applied, throughput is maintained at much higher levels. The reason lies on the fact that the data rate of the network is not reduced and the excess data are being transferred to sink through alternative paths. Moreover, we notice that the lifetime of the network is extended since there is uniform utilization of the power of the nodes. When the hybrid algorithm applies, the throughput as well as the lifetime of the network is extended even more. This can be explained by the fact that when the resource control method is used and the network exhausts its alternative paths (when it reaches the end of lifetime), sources keep transmitting at the maximum data rate. In this case, the power of the remaining paths is exhausted quickly and the network ceases its operation. But, if at the moment that no more alternative paths exist, the algorithm switches to the traffic control method, the throughput is reduced (and diminishes) in a more linear way and the lifetime of the network extends even more. To reinforce the previous results we present in Table II the percentage of the remaining energy of the nodes when the network is unable to transmit a single packet to the sink.

**TABLE II**  
PERCENTAGE OF NODES REMAINING ENERGY (%).

Traffic Control	14.2
Resource Control	6.1
Hybrid Scheme	4.3

According to Table II when operating under traffic control, there is still 14.2% remaining energy to the nodes which cannot be used, since routing holes have been created and the source node cannot find any routing path to forward data to the sink. On the other hand, when resource control is used this percentage falls to 6.1%, which indicates that the resource control method can uniformly utilize the energy of the nodes and extend the lifetime of the network. However, at the point where the resource control method cannot find any alternative paths to the sink, nodes apply the traffic control method (Hybrid Scheme), and the network is able to utilize almost 2% more energy. This percentage is able to extend the lifetime of the network as well as to increase the throughput at the sink.

Finally, in Fig. 3.2 we vary the data rate of the source and monitor how each scheme behaves. The results presented in this figure show the conditions in the network after the occurrence of congestion, when these methods have been called by the application. The traffic control method maintains the data rate of the source stable, thus the average throughput does not alter. The resource control method increases the average throughput, since with higher data rate at the source there are more packets available in the network and since there are available alternative paths, the excess data can be forwarded to the sink. At the same time we note that when the data rate reaches 200 packets/s and more, the hybrid scheme presents better attitude since the traffic control method complements the inefficiencies of resource control method when there are no more alternative paths.

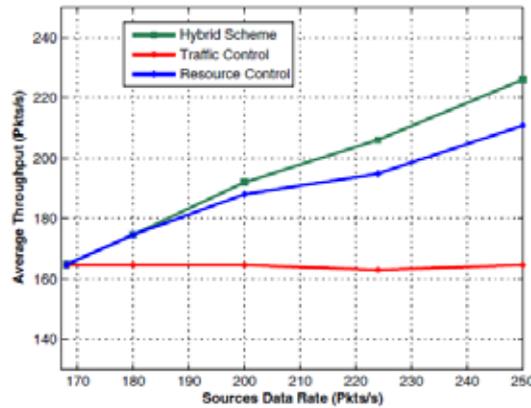


Fig. 3.2. Average Throughput Varying Source Data Rate

#### IV. CONCLUSIONS

In this paper we proposed HRTC, a hybrid scheme for congestion control in WSNs. This scheme attempts to complement the resource control method with traffic control. In particular, when resource control is unable to be effectively applied in a specific network instance, the algorithm employs the traffic control method. The advantage of this hybrid solution lies on the fact that due to the frequent variations that take place in WSNs topologies and node placements, each node is able to figure out which congestion control method is the most appropriate to apply at any moment, giving priority to resource control that extends network lifetime as well as throughput. Simulation results verify the efficiency of this hybrid scheme in terms of throughput and network lifetime.

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# AN EMPIRICAL STUDY ON SERVICE QUALITY DESTINATION DIMENSIONS AND ITS IMPACT ON SATISFACTION OF TOURISTS

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## ABSTRACT

*The objectives of this study is to explore various tourism services offered by tourist destinations Jaipur and Agra, to measure satisfaction of tourists by identifying the impact of quality tourism product on overall satisfaction of tourists visiting Jaipur and Agra. In order to evaluate the impact of service quality destination dimensions on the satisfaction of tourists, four hypotheses were developed and on the basis of these defined hypotheses a study model was developed. A data of 200 tourists including domestic and international visiting Jaipur and Agra was collected through self-constructed structured questionnaire. The data were analyzed using a series of multiple regressions to determine the relationship between service quality and tourist satisfaction. The findings confirmed that service quality directly impacted tourist satisfaction throughout destination facilities, destination accessibility, destination attraction and safety at destination. It was observed that there is a strong association between the service quality dimensions at destination like facilities at destination, accessibility of destination, attractions at destination, and safety at destination. For further research, another study can be conducted among other tourist groups in other destinations in order to confirm the study's survey.*

**Keywords:** *Service Quality, Tourist Satisfaction, Tourist perception.*

## I INTRODUCTION

The first conscious and organized efforts to promote tourism in India were made in 1945 when a committee was set up by the Government under the Chairmanship of Sir John Sargent, the then Educational Adviser to the Government of India (Krishna, A.G., 1993). Thereafter, the development of tourism was taken up in a planned manner in 1956 coinciding with the Second Five Year Plan. The approach has evolved from isolated planning of single unit facilities in the Second and Third Five Year Plans. The Sixth Plan marked the beginning of a new era when tourism began to be considered a major instrument for social integration and economic development. Tourism industry in India is growing and it has vast potential for generating employment and earning large amount of foreign exchange besides giving a fillip to the country's overall economic and social development. But much more remains to be done. Eco-tourism needs to be promoted so that tourism in India helps in preserving and sustaining the diversity of the India's natural and cultural environments. Tourism in

India should be developed in such a way that it accommodates and entertains visitors in a way that is minimally intrusive or destructive to the environment and sustains & supports the native cultures in the locations it is operating in. Moreover, since tourism is a multi-dimensional activity, and basically a service industry, it would be necessary that all wings of the Central and State governments, private sector and voluntary organizations become active partners in the endeavor to attain sustainable growth in tourism if India is to become a world player in the tourism industry.

Service quality is an approach to manage business processes in order to ensure full satisfaction of the customers which will help to increase competitiveness and effectiveness of the industry. Quality in service is very important especially for the growth and development of service sector business enterprises. It works as an antecedent of customer satisfaction. With the increase of the importance of service sector in the economy of Bangladesh, the measurement of service quality became important. ISO standards are one of the measurement tools of service quality, where quality is defined as the totality of features and characteristics of a product, process or service. Private Banks dealing in retail banking Industry is consequently put into lot of pressures due towards increase in global competition. Different strategies are formulated to retain the customer and the key of it is to increase the service quality level. Typically, customers perceive very little difference in the banking products offered by private banks dealing in services as any new offering is quickly matched by competitors.

## **II TOURISM INDUSTRY IN INDIA**

Travel and tourism is the largest service industry in India. It provides heritage, cultural, medical, business and sports tourism. The main objective of this sector is to develop and promote tourism, maintain competitiveness of India as tourist destination and improve and expand existing tourism products to ensure employment generation and economic growth. In this section, we provide information about various tourist destinations, modes of travel, accommodation and approved travel agents. The role of the Government in tourism development has been redefined from that of a regulator to that of a catalyst. Apart from marketing and promotion, the focus of tourism development plans is now on integrated development of enabling infrastructure through effective partnership with various stakeholders. Tourism development in India has passed through many phases. The development of tourist facilities was taken up in a planned manner in 1956 coinciding with the Second Five Year Plan.

The Tourism sector of Indian economy is at present experiencing a huge growth. The Tourism sector of Indian economy has become one of the major industrial sectors under the Indian economy. The tourism industry earns foreign exchanges worth 21,828 crore. Previous year the growth rate of the tourism sector of Indian economy was recorded as 17.3%. The growth in the tourism industry is due to the rise in the arrival of more and more foreign tourists and the increase in the number of domestic tourists. Tourists from Africa, Australia, Latin America, Europe, Southeast Asia, etc are visiting India and there are growing by the thousands every year.

Indian Tourism offers a potpourri of different cultures, traditions, festivals, and places of interest. There are a lot of options for the tourists. India is a country with rich cultural and traditional diversity. This aspect is even reflected in its tourism. The different parts of the country offer wide variety of interesting places to visit. While the international tourism is experiencing a decelerated growth, the Indian counterpart is not affected.

### III REVIEW OF LITERATURE

**Gupta (1983)** analysed the income and employment effect of tourism in the state of Jammu and Kashmir. He forwarded the suggestion that aggressive promotional campaigns should be launched at national and international level to popularize its potential as a tourism destination.

**Parasuraman et al. (1988)** introduced the SERVQUAL model to measure service quality including 22 items in five dimensions: reliability, tangible, responsiveness, assurance, and empathy. These dimensions have specific service characteristic link to the expectation of customers. The SERVQUAL scale was developed in the marketing context and this was supported by the Marketing Science Institute (**Parasuraman et al., 1986**).

**Sharma (1990)** highlighted the problems faced by tourists coming to Shimla. He said that although Himachal Pradesh has lot of natural scenery and beautiful places, yet it hasn't been able to do justice to its tourist attractions.

**Ducker (1991)** says that service quality is defined as what the customer gets out and is willing to pay for "rather than" what the supplier puts in.

**Bagri (1995)** discussed the growth and development of Buddhist tourism. He outlined the entire life drama of Lord Buddha and growth of Buddhism in India. His study mainly concentrated on the Buddhist places of Uttar Pradesh. The author felt that government has not concentrated on developing resources on Buddhist sites.

**Bhat (2002)** examined the impact of tourism on income generation and asset creation. He found out that the impact of tourism is more effective on households living in the vicinity of developed tourist nodes.

**Sharma and Lal (2009)** studied the trends and patterns in global tourism and analysed the development of tourism in India. The authors analyzed the tourism trends in India and highlighted its location advantage and other favorable features.

**Nagar (2010)** examined the influence of destination personality and image on tourist loyalty. She conducted the study on tourists visiting hill stations in northern India and selected Patnitop in Jammu and Kashmir as the sampling area. She concluded that destination personality has a positive impact on tourist loyalty.

**Karim and Geng-Qing Chi (2010)** confirmed that destinations' food image influenced travellers' visit intention positively.

### IV BROAD OBJECTIVES OF STUDY

*The broad objectives of study are as follows:-*

- (1) To explore and identify the tourism facilities available in Jaipur and Agra.
- (2) To assess tourists' perceptions towards quality tourism services provided at historical sites of Jaipur and Agra.
- (3) To measure tourist satisfaction by examining the impact of quality tourism product on overall tourist satisfaction

### V HYPOTHESES OF STUDY

**The following Hypotheses were formulated as follows:-**

**Here HO represents Null Hypothesis and HA represents Alternative Hypothesis.**

**Hypothesis 1**

**H01:** There is no significant relationship between facilities offered at destination with that of the satisfaction of tourists.

**HA1:** There is significant relationship between facilities offered at destination with that of the overall satisfaction of tourists.

### Hypothesis 2

**H02:** There is no significant relationship between accessibility of destination with that of the overall satisfaction of tourists.

**HA2:** There is significant relationship between accessibility of destination with that of the overall satisfaction of tourists.

### Hypothesis 3

**H03:** There is no significant relationship between destination attractions with that of the overall satisfaction of tourists.

**HA3:** There is significant relationship between destination attractions with that of the overall satisfaction of tourists.

### Hypothesis 4

**H04:** There is no significant relationship between safety at destination with that of the overall satisfaction of tourists.

**HA4:** There is significant relationship between safety at destination with that of the overall satisfaction of tourists.

### Hypothesis 5

**H05:** There is no significant relationship between various dimensions of service quality with that of the overall satisfaction of tourists.

**HA5:** There is significant relationship between various dimensions of service quality with that of the overall satisfaction of tourists.

## VI STUDY MODEL

From the study model the equation of overall satisfaction of tourists is derived as follows:-

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + E$$

In the above equation,

Y	=	Overall Satisfaction of Tourists
X <sub>1</sub>	=	Available Facilities at Tourist Destination
X <sub>2</sub>	=	Accessibility of Tourist Destination
X <sub>3</sub>	=	Attraction of Destination
X <sub>4</sub>	=	Safety at Destination



**Fig. 1: Study Model**

## VII RESEARCH DESIGN

The study is exploratory in nature. A systemized and organized study was done to reach the desired objectives of the study. The responses obtained from the respondents i.e. tourists (Domestic and International) visiting Jaipur and Agra analyzed using various statistical techniques. This study is restricted to tourists (Domestic and International) visiting Jaipur and Agra. The importance of this study is that it focuses on identifying the various destination dimensions affecting the overall satisfaction of tourists visiting Jaipur and Agra.

### Sources of Data

To cater the need of the research, the researchers have used primary data through structured Questionnaire and as far as the secondary data is concerned that was obtained from various reports of department of tourism of Government of India and State Governments, World Tourism Organization, web sites, and journals etc. to explore the tourism facilities available at various tourists destinations at Jaipur and Agra. The data was collected from tourists (Domestic and International) visiting Jaipur and Agra.

### Sampling Technique

Simple random sampling technique was used to gather data from the respondents, because of which respondents diverged from every age group, gender, professions, religions, marital status, states and countries etc. but were restricted only to tourists (Domestic and International) visiting Jaipur and Agra.. The questionnaire was intricately designed to tap the demographic variables including age, education, gender, marital status, and tenure of visit of the respondents. It also gathered information about the factors responsible for development of Tourism.

### Data Collection Technique

Primary data were collected from various tourists (Domestic and International) visiting Jaipur and Agra. There were 243 respondents but only 200 were used for this study as rest of the 43 are summarily rejected due to partially filled questionnaire. Out of these 200 respondents, there were 138 domestic tourists and 62 were International tourists visiting Jaipur and Agra. Self-constructed structured questionnaire was used to interview the various tourists (Domestic and International) visiting tourist destinations at Jaipur and Agra.

### Statistical Tools Used

IBM SPSS 20 (Statistical Package for the Social Sciences), for data analysis which included regression analysis and for the reliability the Cronbach's Alpha was calculated and sample adequacy was tested on KMO and Bartlett's Test.

### About the Questionnaire

A self-constructed well-structured questionnaire is used for the collection of data. It is designed in such a manner to explore the general opinion of various tourists (Domestic and International) visiting various tourist destinations of Jaipur and Agra. The questionnaire was divided into six parts: First part contains questions related to the demographic profile of tourists, Second part contains 21 items related to the facilities available at tourist destinations of Jaipur and Agra, Third part of the questionnaire contains 7 items related to the accessibility at tourist destinations of Jaipur and Agra, Fourth part of the questionnaire contains 2 items related to the attractions at tourist destinations of Jaipur and Agra, Fifth part of the questionnaire contains 4 items related to the safety of tourists at destinations visited by tourists, Sixth part of the questionnaire contains 4 items related to the satisfaction of tourists visiting various tourist destinations of Jaipur and Agra. So, overall service quality measured on 38 service quality dimensions. The questionnaire was developed on five point likert's scale.

## VII DATA ANALYSIS AND INTERPRETATION

### 7.1 Reliability Analysis

Reliability Statistics			
Part II	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items
	0.932	0.914	21
Part III	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items
	0.885	0.872	7
Part IV	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items

		<b>Items</b>	
	0.707	0.698	2
<b>Part V</b>	<b>Cronbach's Alpha</b>	<b>Cronbach's Alpha Based on Standardized Items</b>	<b>No. of Items</b>
	0.914	0.897	4
<b>Part VI</b>	<b>Cronbach's Alpha</b>	<b>Cronbach's Alpha Based on Standardized Items</b>	<b>No. of Items</b>
	0.791	0.782	4
<b>Whole Questionnaire</b>	<b>Cronbach's Alpha</b>	<b>Cronbach's Alpha Based on Standardized Items</b>	<b>No. of Items</b>
	0.846	0.833	38

**Table 1: Reliability Statistics**

In order to check the reliability of the questionnaire, the Cronbach's Alpha test was applied. The value of Cronbach's alpha is found to be 0.932 in second part, 0.885 in third part, 0.707 in fourth part, 0.914 in fifth part and 0.791 in sixth part of the questionnaire, which is well above than 0.6. Also the overall value of Cronbach's alpha is 0.846. As the value of Cronbach's Alpha is more than 0.6, which consider the instrument to be reliable for the study. Therefore, the high Cronbach's Alpha coefficient in this study represents a high consistency and reliability among statements in questionnaire.

## 7.2 Validity Analysis

### KMO and Barlett's Test

Part – II	<b>Kaiser-Meyer-Olkin Measure of Sampling Adequacy.</b>		<b>0.852</b>
	<b>Bartlett's Test of Sphericity</b>	Approx. Chi-Square	8635.731
		Df	205
		<b>Sig.</b>	<b>0.000</b>
Part – III	<b>Kaiser-Meyer-Olkin Measure of Sampling Adequacy.</b>		<b>0.872</b>
	<b>Bartlett's Test of Sphericity</b>	Approx. Chi-Square	11820.631
		Df	190

		<b>Sig.</b>	<b>0.000</b>
Part - IV	<b>Kaiser-Meyer-Olkin Measure of Sampling Adequacy.</b>		<b>0.924</b>
	<b>Bartlett's Test of Sphericity</b>	Approx. Chi-Square	<b>8731.098</b>
		Df	<b>195</b>
		<b>Sig.</b>	<b>0.000</b>
Part - V	<b>Kaiser-Meyer-Olkin Measure of Sampling Adequacy.</b>		<b>0.914</b>
	<b>Bartlett's Test of Sphericity</b>	Approx. Chi-Square	<b>8781.852</b>
		Df	<b>185</b>
		<b>Sig.</b>	<b>0.000</b>
Part - VI	<b>Kaiser-Meyer-Olkin Measure of Sampling Adequacy.</b>		<b>0.884</b>
	<b>Bartlett's Test of Sphericity</b>	Approx. Chi-Square	<b>7735.062</b>
		Df	<b>205</b>
		<b>Sig.</b>	<b>0.000</b>

**Table 2: KMO and Bartlett's test of Sphericity**

Kaiser-Meyer-Olkin test was done to measure the homogeneity of variables and Bartlett's test of sphericity was done to test for the correlation among the variables used. From table 2, it is found that the value for Kaiser-Meyer-Olkin Measure of Sampling Adequacy was more than 0.6 in all the parts of questionnaire, as it is 0.852 in part II, 0.872 in part III, 0.924 in part IV, 0.914 in part V, 0.884 in part VI of the questionnaire. Also Bartlett's Test of Sphericity has significant value less than 0.05 at 5 % level of significance in all the parts of questionnaire. Thus it is concluded that instrument is accepted for the study.

### Mean and Standard Deviations of Service Quality Destination Dimensions

<b>VARIABLES</b>	<b>SERVICE QUALITY DESTINATION DIMENSIONS</b>	<b>MEAN</b>	<b>S.D.</b>
<b>INDEPENDENT VARIABLES</b>	Facilities at Destination ( $X_1$ )	3.69	0.88
	Accessibility of Destination ( $X_2$ )	3.21	1.03
	Attraction at Destination ( $X_3$ )	3.54	0.86
	Safety at Destination ( $X_4$ )	3.46	0.82

<b>DEPENDENT VARIABLE</b>	Satisfaction of Tourists (Y)	3.62	0.78
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**Table 3: Mean and Standard Deviations of Service Quality Destination Dimensions**

**Table 3** indicates the means and standard deviations of service quality destination dimensions. The Facilities at destination is having the highest mean value of 3.69 in a scale of 5, indicating the importance of facilities at destination and the dependent variable satisfaction of tourist having a mean value of 3.62 which is considered as a very good satisfaction.

**Karl Pearsons Coefficient of Correlation (Satisfaction of Tourists)**

		Y	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>
Pearson Correlation Coefficient	X <sub>4</sub>	0.924	0.831	0.827	0.471	1
N		38	38	38	38	38
Sig. (2 – tailed)		<b>0.021*</b>	<b>0.032*</b>	<b>0.037*</b>	0.731	-
Pearson Correlation Coefficient	X <sub>3</sub>	0.724	0.482	0.418	1	0.471
N		38	38	38	38	38
Sig. (2 – tailed)		<b>0.016*</b>	0.825	0.631	-	0.731
Pearson Correlation Coefficient	X <sub>2</sub>	0.838	0.882	1	0.418	0.827
N		38	38	38	38	38
Sig. (2 – tailed)		<b>0.000*</b>	<b>0.000*</b>	-	0.631	<b>0.037*</b>
Pearson Correlation Coefficient	X <sub>1</sub>	0.926	1	0.882	0.482	0.831
N		38	38	38	38	38
Sig. (2 – tailed)		<b>0.000*</b>	-	<b>0.000*</b>	0.825	<b>0.032*</b>

Pearson Correlation Coefficient	Y	1	0.926	0.838	0.724	0.924
N		38	38	38	38	38
Sig. (2 – tailed)		-	<b>0.000*</b>	<b>0.000*</b>	<b>0.016*</b>	<b>0.021*</b>

**Table 4: Coefficient of Correlation of Satisfaction of Tourists**

From Table 4, it is quite clear that satisfaction of tourists visiting Jaipur and Agra is found to be significantly associated with the factors like Facilities at destination, Accessibility to destination, Attraction at destination and safety at destination. However there is some association in some variables while some have no relationship at all.

## VIII HYPOTHESIS TESTING

### Hypothesis 1:-

**H01:** There is no significant relationship between facilities offered at destination with that of the satisfaction of tourists.

**HA1:** There is significant relationship between facilities offered at destination with that of the overall satisfaction of tourists.

### Regression Analysis – Impact of Facilities at destination on satisfaction of tourists

Independent Variable	Dependent Variable: Satisfaction of Tourists					
	R	R <sup>2</sup>	F	$\beta$	T	Sig.
X <sub>1</sub>	0.926	0.857	206.82	0.748	15.08	<b>0.000*</b>

**Table 5: Impact of Facilities at Destination on Satisfaction of Tourists**

From table 5, it is clear that there is significant relationship between the facilities offered at tourist destination with that of the satisfaction of tourists. Here the value of R<sup>2</sup> is 0.857 which means that 85.7% of the variance in tourist satisfaction are explained by the facilities at tourist destination. Also beta value is 0.748 and p value is 0.000. Since p value is significant at 5% level of significance so the null hypothesis is rejected and the alternative hypothesis is accepted. Thus, there is significant relationship between facilities offered at destination with that of the overall satisfaction of tourists.

### Hypothesis 2:-

**H02:** There is no significant relationship between accessibility of destination with that of the overall satisfaction of tourists.

**HA2:** There is significant relationship between accessibility of destination with that of the overall satisfaction of tourists.

**Regression Analysis – Impact of Accessibility at destination on satisfaction of tourists**

Independent Variable	Dependent Variable: Satisfaction of Tourists					
	R	R <sup>2</sup>	F	$\beta$	t	Sig.
X <sub>2</sub>	0.838	0.702	227.85	0.745	15.09	0.000*

**Table 6: Impact of Accessibility at Destination on Satisfaction of Tourists**

From table 6, it is clear that there is significant relationship between the accessibility at tourist destination with that of the satisfaction of tourists. Here the value of R<sup>2</sup> is 0.702 which means that 70.2% of the variance in tourist satisfaction are explained by the accessibility of tourist destination. Also beta value is 0.745 and p value is 0.000. Since p value is significant at 5% level of significance so the null hypothesis is rejected and the alternative hypothesis is accepted. Thus, there is significant relationship between accessibility of destination with that of the overall satisfaction of tourists.

**Hypothesis 3:-**

**H03:** There is no significant relationship between destination attractions with that of the overall satisfaction of tourists.

**HA3:** There is significant relationship between destination attractions with that of the overall satisfaction of tourists.

**Regression Analysis – Impact of Attraction at destination on satisfaction of tourists**

Independent Variable	Dependent Variable: Satisfaction of Tourists					
	R	R <sup>2</sup>	F	$\beta$	t	Sig.
X <sub>3</sub>	0.724	0.524	73.85	0.552	8.042	0.000*

**Table 7: Impact of Attraction at Destination on Satisfaction of Tourists**

From table 7, it is clear that there is significant relationship between the attractions at tourist destination with that of the satisfaction of tourists. Here the value of R<sup>2</sup> is 0.524 which means that 52.4% of the variance in tourist satisfaction is explained by the attraction of tourist destination. Also beta value is 0.552 and p value is 0.000. Since p value is significant at 5% level of significance so the null hypothesis is rejected and the alternative hypothesis is accepted. Thus, there is significant relationship between attractions at destination with that of the overall satisfaction of tourists.

**Hypothesis 4:-**

**H04:** There is no significant relationship between safety at destination with that of the overall satisfaction of tourists.

**HA4:** There is significant relationship between safety at destination with that of the overall satisfaction of tourists.

**Regression Analysis – Impact of Safety at destination on satisfaction of tourists**

Independent	Dependent Variable: Satisfaction of Tourists
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Variable	R	R <sup>2</sup>	F	$\beta$	t	Sig.
X <sub>4</sub>	0.924	0.854	256.52	0.782	16.239	<b>0.000*</b>

**Table 8: Impact of Safety at Destination on Satisfaction of Tourists**

From table 8, it is clear that there is significant relationship between the safety at tourist destination with that of the satisfaction of tourists. Here the value of R<sup>2</sup> is **0.854** which means that **85.4% of the variance** in tourist satisfaction is explained by the Safety at tourist destination. Also beta value is 0.782 and p value is **0.000**. Since p value is significant at 5% level of significance so the null hypothesis is rejected and the alternative hypothesis is accepted. **Thus, there is significant relationship between safety at destination with that of the overall satisfaction of tourists.**

#### Hypothesis 5:-

**H05:** There is no significant relationship between various dimensions of service quality with that of the overall satisfaction of tourists.

**HA5:** There is significant relationship between various dimensions of service quality with that of the overall satisfaction of tourists.

#### Regression Analysis – Impact of Service Quality Dimensions on satisfaction of tourists

Service Quality Dimensions	Dependent Variable: Satisfaction of Tourists					
	R	R <sup>2</sup>	F	$\beta$	t	Sig.
	0.782	0.611	266.58	0.778	16.952	<b>0.000*</b>

**Table 9: Impact of Service Quality Dimensions on Satisfaction of Tourists**

From table 9, it is clear that there is significant relationship between the service quality dimensions at tourist destination with that of the satisfaction of tourists. Here the value of R<sup>2</sup> is **0.611** which means that **61.1% of the variance** in tourist satisfaction is explained by the Service quality dimensions at tourist destination. Also beta value is 0.778 and p value is **0.000**. Since p value is significant at 5% level of significance so the null hypothesis is rejected and the alternative hypothesis is accepted. **Thus, there is significant relationship between service quality dimensions at destination with that of the overall satisfaction of tourists.**

#### IX SUMMARY OF HYPOTHESIS

S. NO.	HYPOTHESIS	NULL HYPOTHESIS	ALTERNATIVE HYPOTHESIS
1.	<b>Facilities at Destination</b>	Rejected	<b>Accepted</b>
2.	<b>Accessibility at Destination</b>	Rejected	<b>Accepted</b>
3.	<b>Destination Attractions</b>	Rejected	<b>Accepted</b>

4	<b>Safety at Destination</b>	Rejected	<b>Accepted</b>
5	<b>Service Quality Dimensions</b>	Rejected	<b>Accepted</b>

Table 10: Summary of Hypothesis

### MODEL DEVELOPED: E-M TOURIST DESTINATION SATISFACTION MODEL

On the basis of above study and analysis, the model is developed and is named on the name of authors as **E – M Tourist Destination Satisfaction Model** already validated by correlation, regression equation as well as hypotheses is as follows: -

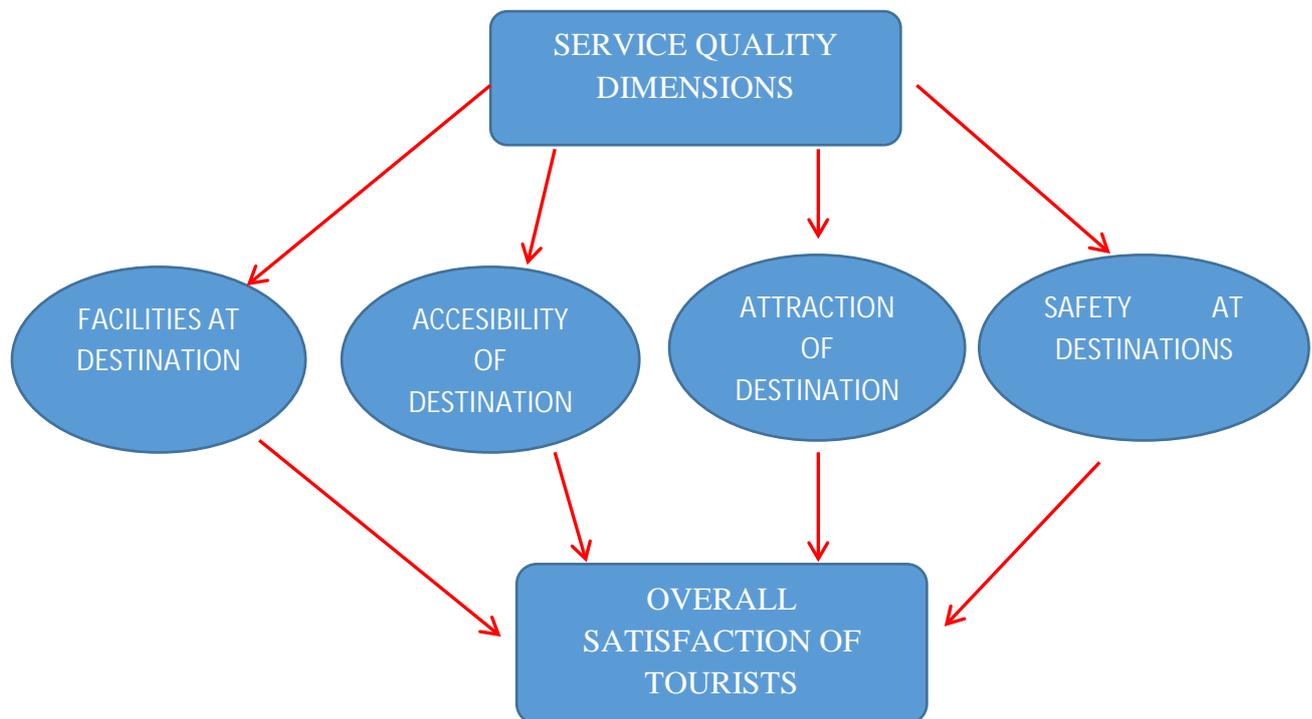


Fig 2: E – M Tourist Destination Satisfaction Model

**Assumptions:** It is to be presumed that satisfaction of tourists affected by other factors also apart from given above and it depends on personal desire to visit a particular tourist destination. While constituting this model it is assumed that other factors are kept constant due to which the satisfaction of tourists may have been affected which can be considered as one of the limitation of this model.

### X CONCLUSION

This study is considered to be important to be valuable for destination management, development of tourism and development of business opportunities in Jaipur and Agra in the tourism sector by evaluating the level of quality of current services offered to the tourists. There is a strong association between the service quality dimensions at destination like facilities at destination, accessibility of destination, attractions at destination, and safety at

destination. For further research, another study can be conducted among other tourist groups in other destinations in order to confirm the study's survey.

## **XI RECOMMENDATIONS**

**On the basis of the results obtained from statistical analysis, the following can be recommended:**

1. The tourism department have to pay more attention in increasing and improving the quality of services offered at the tourist destination as there is a significant relationship between facilities at destination and satisfaction of tourists.
2. As safety is one of the most important concern for any tourist, government should pay more attention to security and safety of the tourists in order to attract more tourism which will help in generating government revenues.

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# PROPOSED SURVEY ON QUALITY OF SERVICE BASED RESOURCES OVER MANET

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## ABSTRACT

*We are aware of energy consumption. we need to see how each node can switch its state from power mode to active modes and vice versa. Adhoc network enforces certain constraints on the communicating nodes, which widely incorporates the node mobility which results in a constantly changing topology of the network, as it is MANET network in limited bandwidth, limited processing power due to its size and cost constraints. In this paper we will propose a new solution which perform communication with resource management and effective resources availability for Adhoc networks connected on the idea of Wi-Fi hotspot.*

**Keywords:** Flow Chart, Flexibility, MANET, QoS, Scatternet

## I. INTRODUCTION

### 1.1 Overview

As we have seen that there are numerous number of challenges with service provider over network but we find that the biggest challenge is the congestion in the traditional network. However, there are many challenges over manet and mobile networks above those in traditional networks. Due to this reason, a set of QoS techniques are required to use for manet networks than for wired networks. There are some additional challenges, as well as several techniques for overcoming them, are explained.

when a victim node tries to find out a central or immediate neighbour, before sending its data, the victim node will try to find the energy level of each neighbour and energy needed for each transmission, based on these standards, the victim node will choose the neighbour for transmission. Hence this proposal would be great helpful to MANETs.

### 1.2 Objective

As we are using Wi-Fi hot spot but before explaining that we will get lightens some of the features of Bluetooth. As it is well known that Bluetooth was emerged as a dominant level for less-power, low-range, wire-less communications. Bluetooth 1.1 Core Specification includes a number of mechanisms that can influence the QoS by the application of Bluetooth. The specification 1.2 give more possibilities and also attempts to simplify some bit of the L2CAP QoS section as some new traits are added in to it. This is observed truly that the parameters influencing the application of quality of service do not contained at single location in Bluetooth.

We reviewed many papers which presents the same approach which we want to do in MANET such as formatting the Bluetooth network in scatternet and such we are doing it in MANET. We can classifies these approaches as light scatternet-route approach and the traditional big scatternet approach. While in the case of the big scatternet approach, the scatternet formation is different from the routing function as it is executed in the data link layer. We require a routing protocol to develop a multi hop path between sources to destination in a

scatternet . we require the end to end route structure and the on demand development process of the scatternet routes to encourage the integration of the scatternet development and the scatternet routing.

When we merge these two functions, they allow us to link their control packets and we easily get free from unnecessary traffic. This is mainly useful to power restraint MANET enabled devices like Bluetooth [1]. This concept will be used in MANET via Wi-Fi hot spot.

The problem of distributed scatternet formation rises from a conference scene of an adhoc network formation. As we take example that assume large number of members in chamber who want to build an adhoc network by using their own devices which are having bluetooth. Every member pushes start button and hold back for the device to display on the screen a network connection constructed message. When this message flashes, the user will effectively interchange information with other member present in that room. T. Salonidis et al. have presented the Distributed topology construction protocol [5].

The description of application contains the components of an effective connection in the formation of protocol. Now we are going to explain some of the features of DTCP.

The formation of the network connection must be accomplished in dispense manner. In the process every device initiates functioning non-simultaneously of their own and originally it does not know anything related to the number of nodes.

The protocol should give guarantee to a connected MANET after its completion. "Connected" means that there should be at last one route in the network between any of the two nodes.

The detain in the network set-up must be less so that it is acceptable by the user. These features must be fulfilled and the distributed MANET development of design basics, simple and rapidly protocol:

- One bridge node link(connect) only two manet
- If we are having fixed no. of bridge nodes, we can then design it in a restraint of less no. of MANETs.
- The MANET must be entirely linked
- Two manets include one bridge node only

## II. DESIGN AND IMPLEMENTATION

For designing firstly we are having one adhoc network. After tethering all the mobile devices are connected with each other via Wi-Fi hot spot. All the devices which are connected via hotspot must possess same SSID and different MAC. The whole process is done at foreground not at the background which permit it to consumes less energy.

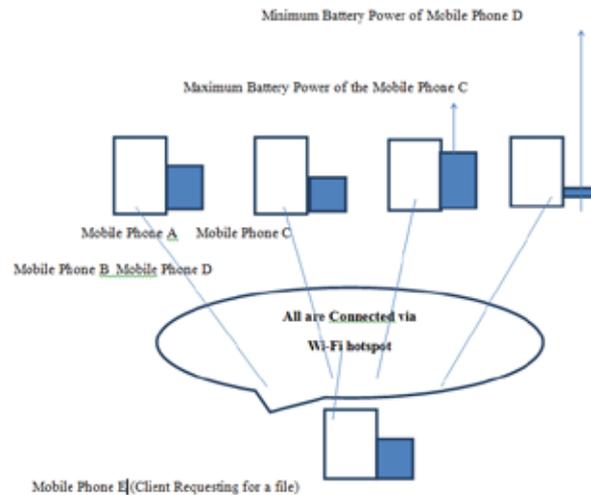
In the entire process, mobile phone which we have is acting as a client in which socket programming is performed for fetching the file. It sends the request to the master for sending that file but if the power back up of the master is not satisfactory or sufficient then the client's request is broadcasted to the other nodes that are present in that adhoc network. Now the node which is having sufficient power back up will act as a master and sends the file to the client.

So, it passivate the low energy node and activate the one having high energy node. We apply a simple security algorithm on this network . It will becomes only secure but not highly secured. So that, whatever message or file we send over a network do not get lost or accessed by any unwanted user user.

Now, in the figure 3.3 we are explaining how the whole process is going on, which are connected in an adhoc network and which are working as a master or clients. Each node is having its own battery power which is

shown in the figure. We are having five nodes A, B, C, D and E. Node E is acting as a client and requesting for a file from the Master. Suppose Node D is a Master, but having low energy power. So, Node D broadcast that request to the all other nodes which are present in that Adhoc network and now the other nodes will serve the client, so that file do not get lost and received by the client for sure.

Now the one which is having high Energy Power will act as a Master and fulfill the client's request. So, the new Master is N

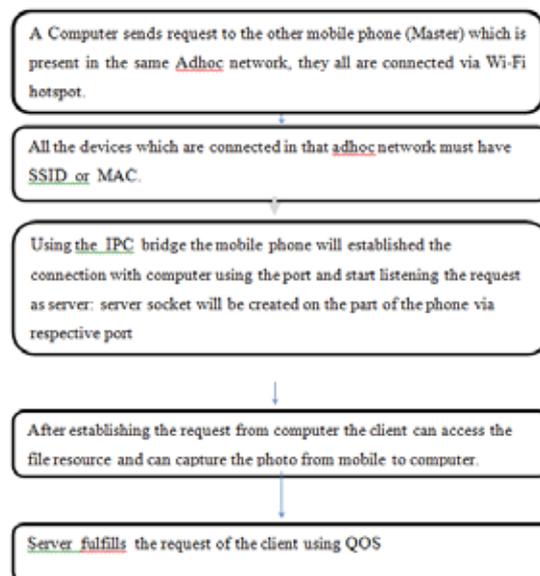


**Figure 3.4: Implementation of The Project**

Some objectives or design goals which we kept in our mind while designing the system:

- Greater flexibility
- Scalable to wide range of business models.
- Increased revenue potential.

### III. FLOW CHART



**Figure 3.5: Flow diagram**

#### IV. CONCLUSION

This paper entitles to fulfil the requirement of service based resource'quality and it also works on the implementation to decrease the consumption of power.

#### ACKNOWLEDGEMENT

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# IMPACT OF UNCERTAINTY FACTORS IN CONSTRUCTION PROJECTS

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## ABSTRACT

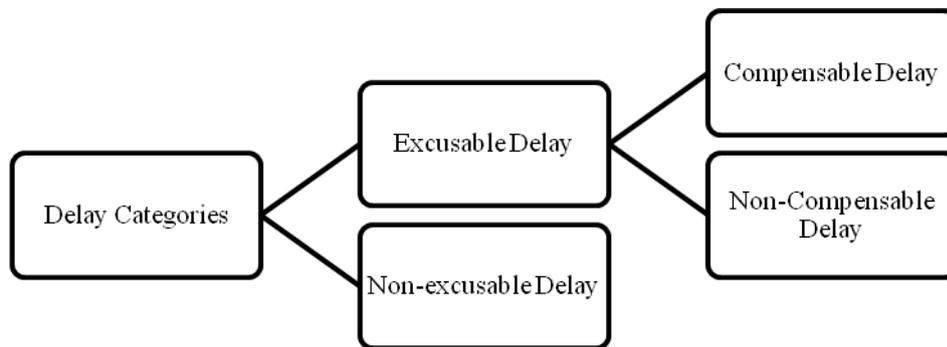
*Research on uncertainty in construction has emphasized the importance of incorporating uncertainty factors in project cost and time forecasts. Delays are always measured as expensive to all parties concerned in the projects and very often it will effect in clash, claims, total desertion and much difficult for the feasibility and it slows the growth of construction sector. For analyzing the causes of delay, an evaluation on construction project's time performance was conducted. The main intention of this study is the identification of factors of delay and their effects on the successful completion of project. However, little attention has been paid to identification and quantification of the specific factors. The present paper focuses on an assessment of the effect of uncertainty on the outcomes of planning. The factors influencing the planning of the construction projects which then ultimately causes delays in the projects. This paper mainly focuses the important uncertainty factors that cause delays in construction projects. Literature reviews and interviews are used as a tool for identifying the uncertainty factors. Totally 18 uncertainty factors were identified and the root causes for the top factors will be found and recommendation and suggestion will be provided to the companies.*

**Keywords :** *Construction Industry; Delays; Planning; Relative Importance Index; Root Causes; Uncertainty.*

## I. INTRODUCTION

Planning is a bridge between the experiences of the past projects and the proposed actions that produces favorable results in the near future. It can also be said that it is a preliminary precaution by which we can reduce undesirable effects or unexpected happenings and thereby eliminating confusion, waste of resources, and loss of efficiency. Planning includes prior determination of activity, specification of uncertainty factors, forces, effects and relationships necessary to reach the desired goals. Planning should be done logically, effectively, thoroughly and honestly to have a chance to succeed. The previous experiences of projects provide basic planning logic. Then difference between previously completed projects and current projects shall be known to make any exceptional features in the basic planning logic. These differences can be undesired client requirement, out of the way location, possible external or internal delaying factors. The construction delay is a universal evident reality not only in India however all the countries faced this global fact. Construction delay can be defined as execute later than intended planned, or particular period, or letter than specific time that all the concerned parties agreed for construction project. Delay in project is counted as a common problem in construction projects. On large level there is no suspicion that the development of country depends upon its achievement of its advance

plain with elevated construction contents. There is a Famous dictum “when the construction industry prospers everything prospers”. Terry Williams (2003) discovered that there are units 3 basic ways that classify delays.



**Fig 1-types of delays**

The project’s success depends on meeting objectives within time and budget limits. Tools and techniques play important role in project management. The major factor of construction problems is project’s delay. Delay means loss of income according to and for the owner or client. In case of contractor, delay leads to the higher costs due to longer working time, labor cost increase and higher fabrication costs. On time completion of project is an indicator of efficiency. But there are many uncertainty factors and variables resulting from various sources affecting construction projects. Delays are one of the biggest problems which construction firms face. The problem of delay in the construction industry is a global phenomenon. Keeping construction projects within estimated costs and schedules requires sound strategies, good practices, and careful judgment. However, to the have an aversion to of owners, contractors and consultants, many projects experience extensive delays and thereby exceeds initial time and cost estimates.

## II. OBJECTIVES OF STUDY

The focal objectives of this study include the following:

1. To identify the uncertainty factors that influences the planning and causes delays in construction projects in Indian scenario.
2. To rank uncertainty factors that causes delays by RII (relative importance Index) method and to find out the root causes for these factors.
3. Mitigation for the top 5 uncertainty factors and implementing the solution in construction projects.

## III. LITERATURE REVIEW

A numerous of studies have been carried out to determine the causes of delays in construction projects.

Ali S. Alnuaimi and Mohammed A. Al Mohsin(2013)<sup>[1]</sup> a field study was conducted on a number of construction projects in muscat area to identify problems resulting from delays in completion of construction projects. The data collected was classified into two groups of the project, the first group includes the project constructed during the period 2007-2008 and the second group comprised projects constructed during the period 2009-2010. Percentage of delays have been calculated for each project constructed in these periods and both the period where compared. It was founded that 40 percent projects in both groups have experienced delay in completion.

Alwi and Keith (2003)<sup>[2]</sup> have identified the important causes of delays in building Construction projects in Indonesia. A detailed questionnaire survey was carried out targeting 89 respondents from large contractors and 23 respondents from small contractors. The respondents were asked to predict the level of effect the 31 potential delay causes on their projects. Major critical delay factors were grouped into six major groups. The results showed that the large and small contractors generally agree on the importance ranking of the individual delay factors. In relation to the groups of the delay variable, however, result showed that there is no agreement between the two groups of contractors. The results of this study is professional management group was ranked the highest and the external groups were ranked the lowest by large contractors. Whereas, the small contractors ranked the design and documentation group as the highest and the execution group as the lowest.

Enas Fathi Taher and R.K.Pandey (2013)<sup>[3]</sup> they have identified and ranked delay causes in the planning and design phases. A well structured questionnaire was sent to engineers at the Architect/Engineering companies for public construction projects in India. This study has identified the delay causes and analyzed the importance and the frequency of delays using the relative importance index. Analytical results shows that changes in client's requirement are the main cause of delays in both planning and design phases. The factors that were affecting have been categorized into contractor related delay, client related delays and material related delays and labour related delays. This literature has suggested good management and management of these causes can minimize the delays of the projects.

Hitendra R. Gavhale (2013)<sup>[4]</sup> they have evaluated specific schedule impact scenario on a single project Mumbai Metro Rail Project (MMRP) is taken as case study. The source of delay cost of delay and methods to mitigate delays were studied. The questionnaire survey covering delays and disputes was developed and presented to construction professionals. Questionnaire covers various factors influencing delays attributed to client, contractor, consultant, material related, labour related, equipment and other external factors. The responses to questionnaire were analyzed by Rank Index(I). The survey results implies the effect of delays in time overrun of the project, cost overruns, disputes, arbitration, Litigation and total abandonment and have recommended some suggestions for minimizing the effect of delays in projects.

Kasimu A. M (2013)<sup>[5]</sup> the study focuses on specific causes of delay like insufficient coordination and inefficient communication between involved parties in construction projects. Questionnaire survey has been used as a tool to carry out this study. The results of factors are analyzed based on mean value criterion and standard deviation (SD). Some factors are improper planning of activities, lack of effective communication, design errors, shortage of material supply like steel, concrete etc, slow decision making, financial issues, shortage of materials, cash-flow problems during construction, site accidents, quality assurance and control and political influence and economic condition. This study implies in adequate planning, coordination and effective monitoring of the construction projects by an experienced and qualify professional will reduce the impact of delays.

Megha Desai (2013)<sup>[6]</sup> they have worked on identification and ranking of causes of delay in residential construction projects in Indian context. Totally 59 causes were identified under 9 major group. A questionnaire survey was conducted and the causes of delays are ranked by two different techniques Relative importance index and important index based on degree of severity and degree of frequency. Results shows us that out of top 10 factors totally 5 factors are common in ranking by both methods. The result shows some factors are original

contract duration is too short for completing, shortage of labours, delay in material delivery, low productivity level of labours, delay in progress payments by owner. Labour related factors were the ranked first and external factors are ranked last.

Remon Fayek Aziz (2013)<sup>[7]</sup> this research works attempts to identify, investigate and rank factors perceived to affect delays in the construction projects with respect to their relative importance to proffer possible ways to coping with this phenomenon. Totally, ninety-nine (99) factors were short-listed to be part of the questionnaire survey and were identified and categorized into nine (9) major categories and they were consultant related factors, contractor related factors, design related factors, equipment related factors, external related factors, labour related factors, material related factors, owner related factors and project related factors. The data were analyzed using Relative Importance Index (RII), ranking and simple percentages.

S.M.Renuga and Balasubramanian Malathi (2013)<sup>[8]</sup> they have identified the critical factors influencing delay and their impact on project completion. In this study they have concentrated in Resource (Manpower, Material and Equipment) related delay in construction projects. For this research, a questionnaire survey method was adopted to find the impact of critical factors that leads to resource related delays in construction projects. The survey results in this literature they have identified top ten critical factors using Relative Importance Index (RII) in each of the categories (Manpower, Material and Equipment) and provided some recommendations to reduce the impact of the resource related delays in construction projects.

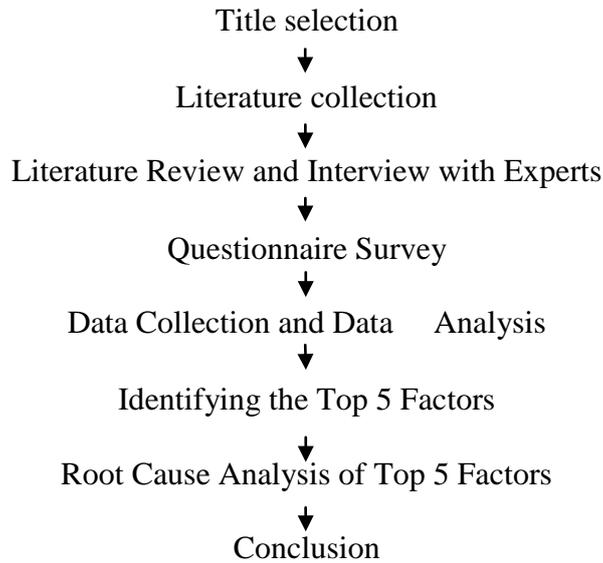
Towhid Pourrostan and Amiruddin Ismail (2012)<sup>[9]</sup> they have identified the causes and effect of delays in Iranian construction projects. Projects investigated in this study include residential, office and administration buildings and roads. A questionnaire survey was conducted to solicit the causes and effect of delay from consultant and contractors viewpoint. This survey has identified 10 most important cause of delay from a list of 28 different cause of delay and 6 different effect of delay. This survey have identified some factors are delay in progress payment by client, change orders by client during construction, poor site management, slowness in decision making process by client, financial difficulties by contractors, late in reviewing and approving the design documents by client, problem with subcontractors, ineffective planning and scheduling of project by contractor, Mistakes during construction and weather condition the survey also implies the effect of delays in time overrun, cost overrun, disputes, arbitration, Litigation and total abandonment. Relative Importance Index (RII) has been used for ranking the causes and spearman rank correlation coefficient is used for studying the strength of relationship between two sets of ranking. This literature has highlighted factors and the need to reduce delays by client, consultant and contractors.

#### **IV. RESEARCH METHODOLOGY**

The research methodology contains two phases. The first phase included a literature reviews and interviews. The literature review was conducted through books and international management journals. As the outcome of this phase, 18 uncertainty factors causes of delays for construction projects were identified. These causes are :Approval, Materials related, Labours related , Equipment related, Financial issues & Cash flow, Mistakes during construction, Government policies, Client related, Contractor related, Prefeasibility studies, Deviation in drawings/Design related, Weather condition & Environmental factors, accidents, quality control/assurance,

economic condition, Agreement issues, Adaption of advanced technology and Activity path depending the frequency of occurrence there are importance scale.

The second phase includes the ranking of the uncertainty factors which are causes of delays in construction projects. These factors are ranked by Relative Importance Index (RII) and the top 5 uncertainty factors are identified and their root causes for delays will be founded out and suggestion and recommendation will be given accordingly to factors.



**Fig 4.1 - Working Methodology**

#### 4.1 Data Analysis

The data analysis will be done by relative importance index technique Relative Importance Index technique: S.M.Renuga and Balasubramanian Malathi[1] used the Relative Importance Index method to determine the relative importance of the various cause of delays. The same method is going to be adopted in this study. The five-point scale ranged from 1(not much) to 5 (very important) will be adopted and will be transformed to relative importance indices (RII) for each factors as follows:

$$RII = \frac{\sum W}{A * N} \quad (1)$$

Where, W is the weighting given to each factor by the respondents (ranging from 1 to 5), A is the highest weight (i.e. 5 in this case), and N is the total number of respondents.

The RII value had a range from 0 to 4 (0 not inclusive), higher the value of the RII, more important was the causes of delays.

The RII was used to rank the different uncertainty factors that cause delay. These ranking made it possible to cross-compare the relative importance of the uncertainty factors as perceived by the respondents.

#### 4.2 Questionnaire Survey

Questionnaire were completed at the meeting with the project manager, planning engineer this method had the added benefit of making clarification to respondent about the uncertainty factors and gives chances to surveyor

to explore possible uncertainty factors influencing the construction projects. Totally 44 surveys were completed and the consolidated results of these uncertainty factors in means of importance scale are carried out by relative importance index method (RII).The uncertainty factors are ranked according to the RII values and the top 5 uncertainty factors are identified and they are listed in Table 2.

**Table 1 Survey Results According to RII**

Uncertainty Factor	Importance scale					Total	RII	Rank
	5	4	3	2	1			
Approval	13	13	12	4	2	44	0.74	2
Material related	6	6	14	8	10	44	0.554	10
Labour related	7	5	10	11	11	44	0.536	11
Equipment related	3	5	19	8	9	44	0.531	12
Financial issue & Cash Flow	17	10	11	3	3	44	0.759	1
Mistakes during construction	0	4	16	12	12	44	0.454	14
Government policies	3	8	11	13	9	44	0.522	13
Client related	11	14	9	6	4	44	0.7	4
Contractor related	2	9	12	14	7	44	0.531	12
Pre-feasibility studies	6	8	18	10	2	44	0.627	7
Deviations in Drawings/Design related	11	14	12	3	4	44	0.713	3
Weather condition & Environmental factors	3	4	12	13	12	44	0.477	15
Accidents	2	4	9	17	11	44	0.445	16
Quality assurance/control	8	10	15	8	3	44	0.654	6
Economic condition	5	10	14	12	3	44	0.609	8
Agreement issues	6	2	14	16	6	44	0.536	11
Adaption of advanced technology	8	7	9	8	12	44	0.559	9
Activity Path/CPM	9	15	7	6	7	44	0.659	5

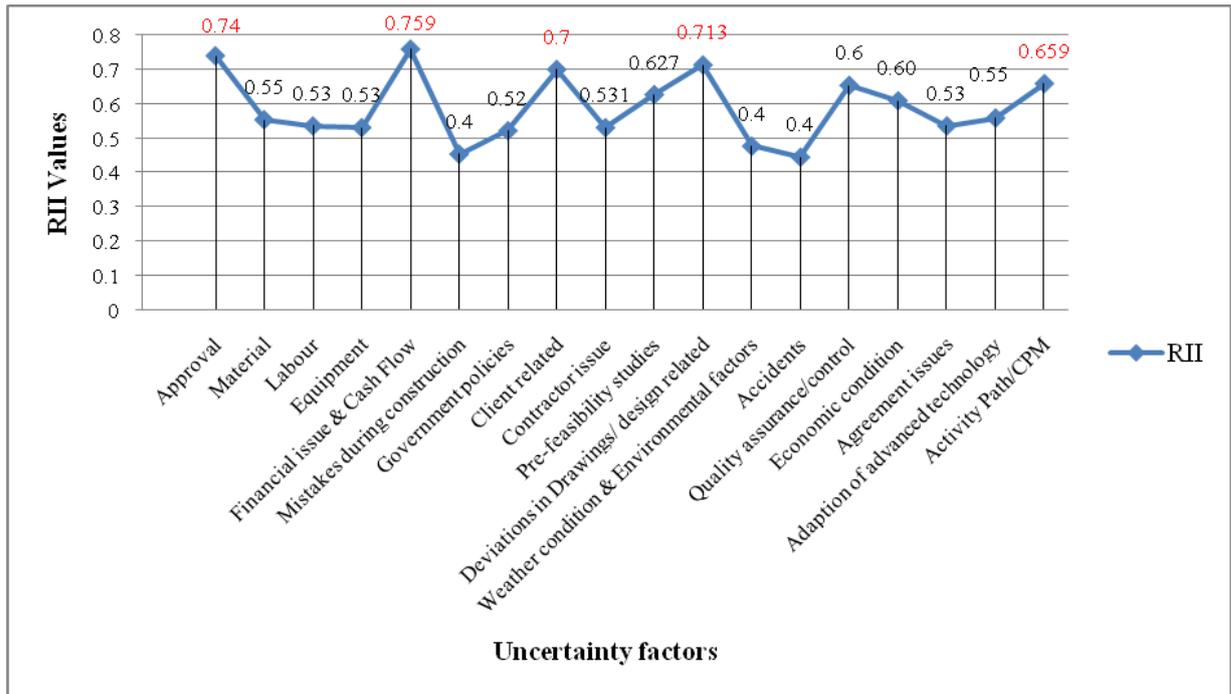


Fig 4.2.1 relative importance index value for uncertainty factors

Table 2 Top 5 uncertainty factors according to RII

Delay Factors	RII
Financial issue & Cash Flow	0.759
Approval	0.74
Deviations in Drawings/ Design Related	0.713
Client Related	0.7
Activity Path/CPM	0.659

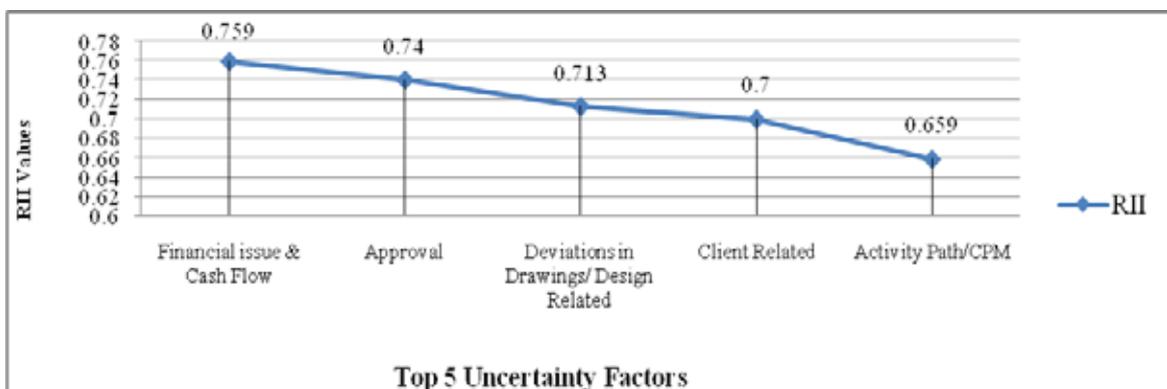


Fig.4.2.2 relative importance index value for top 5 factors

## V. SUMMARY

Present study outlines the major uncertainty factors which represent the causes of delay in construction projects in India. Based on the literature study and from the interview of experts, 18 uncertainty factors were identified are Approval, Materials related, Labours related, Equipment related, Financial issues & Cash flow, Mistakes during construction, Government policies, Client related, Contractor related, Prefeasibility studies, Deviation in drawings/Design related, Weather condition & Environmental factors, accidents, quality control/assurance, Economic condition, Agreement issues, Adaption of advanced technology and Activity path/ CPM. With the help of questionnaire survey the top 5 uncertainty factors were identified and the top factors are Financial issue & cash flow, Approvals, Deviations in drawing/Design related, Client related and Activity path/ CPM. Further methodology is suggested to work out root causes for these uncertainty factors and the ways to mitigate the delays in the next phase.

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# COMPARATIVE STUDY OF INTELLIGENT TECHNIQUES FOR SOLVING OPF PROBLEM

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## ABSTRACT

*In the present day scenario, of electrical power system engineering mainly encompasses the problem like optimal power flow. Optimal power flow problem are becoming increasingly stressed, and more difficult to operate. So, it is mandatory to overthrow these problems. This paper focuses on intelligent techniques and their comparative study for solving the optimal power flow problem. These techniques includes Artificial neural network (ANN) , Fuzzy logic (FL) , Genetic algorithm (GA), Particle swarm optimization (PSO) , Ant colony optimization (ACO), Differential evolution (DE) , Artificial bee colony (ABC). This paper first accord a brief review to these techniques then observations on the pros and cons and lastly shows a comparison of all Intelligent Techniques.*

**Keywords:** *Ant colony optimization (ACO), Artificial bee colony (ABC), Differential evolution (DE), Genetic algorithm (GA), Intelligent techniques (IT), Optimal power flow (OPF)*

## I INTRODUCTION

In present day scenario, power engineering require peculiar tools to optimally analyze, monitor and control different conditions of power systems operation and planning. The OPF is the backbone tool that has been extensively researched. The OPF problem is optimized to find the minimum fuel cost of all generating units while maintaining an acceptable system performance in terms of limits on power outputs of generators, bus voltage and line flow. Initially its introduction, uses and methods are given by Carpentier [1] and its definition as OPF by Dommel and Tinney [2]. OPF has been widely used in power system operation and planning. After the electricity sector restructuring, OPF has been used to assess the spatial variation of electricity prices and congestion management and pricing tool [3]-[4]. The OPF is a non-linear, large scale, non-convex, static optimization problem with both continuous and discrete control variables. The OPF problem is non-convex, due to the presence of the non-linear (AC) power flow equality constraints. The existence of discrete control variables such as transformer tap positions, switchable shunt devices and phase shifters, more complicates the problem solution. Researchers have attempted to apply most optimization techniques to solve OPF. Various [5]-[7] conventional optimization techniques were developed to solve the OPF problem. Some most popular i. e. linear programming, generalized reduced gradient method, quadratic programming and the Newton method. Some of these techniques have good convergence characteristics, but due to the following drawbacks:

- Due to presence of qualitative constraints, weak manipulation.
- Poor convergence.
- They can find only a single optimized solution in a single simulation run.

- If number of variables are large, these techniques becomes slow.
- For solution of a large system, calculation becomes more complex.

So it is important to develop new and more general and reliable techniques for dealing with non-linear OPF problem. For solving these types of problems intelligent methods are very useful. Intelligent methods for solving non-linear hard optimization problems have become a very popular research topic in recent years. There are many papers were published based on these techniques. Suharto, M.N. Hassan [8] presents OPF using evolutionary computation techniques in 2011, Metwally [9] also presents a comparative study of some of these techniques in 2008 etc. The purpose of this paper is to present a comparative study of these intelligent techniques for solving the optimal power flow problems.

### 1.1 Optimal Power Flow Problem

OPF is formulated mathematically as a general constrained optimization problem.

Minimize a function

$$F(u,x) \quad (1)$$

$$\text{Subject to } h(u,x) = 0 \quad (2)$$

$$\text{And } g(u,x) \geq 0 \quad (3)$$

Where,  $u$  is the set of controllable quantities in the system and  $x$  is the set of dependent variables.  $F(u,x)$  is an objective function which is scalar. Equality constraints (2) are derived from conventional power balance equation. Inequality constraints (3) are the limits on control variables  $u$  and the operating limit on the other variables of the system.

## II INTELLIGENT TECHNIQUES

It is the science of making intelligent computer program. Intelligent techniques are based on artificial intelligence. These computing techniques are able to work with problems and information which are too large or complicated for humans to handle, peculiarly in a timely fashion. This expertise management system will explain these techniques, the discrepancy between them, and how they help organizations manage knowledge. There are many definitions but most of them can be classified in to the following four categories:

- Systems that think like humans
- Systems that act like humans
- Systems that think rationally
- Systems that act rationally.

### 2.1 Artificial Neural Network( ANN)

ANN is an interconnected group of artificial neurons that uses a mathematical model or computational model for information processing based on a connectionist approach to computation. Basic concept of ANN “An ANN is a computational model defined by four parameters: type of neurons, connection architecture, learning algorithm, recall algorithm.

Selvi, V.A.I. [10] presented, In the deregulated power systems, it is important to know the value of Available Transfer Capability for the smooth operation of the power system. ATC is commonly calculated using repeated load-flow simulations of the interconnected transmission network. This paper presents an ANN based approach for online-ATC estimation for both bilateral and multilateral transactions. The proposed approach uses Feed forward neural network trained by Back Propagation Algorithm (BPA) for estimating ATC under normal and contingency condition. The scheduled method is tested on IEEE 24 bus Reliability Test System (RTS) and results are compared with Repeated Power Flow (RPF) results. The experimental results show the suitability of proposed method for on-line ATC estimation.

Sasaki, H.[11] present how to solve power system generation expansion planning by ANN, specially the Hopfield type network. In the first place, generation expansion planning is formulated as a 0-1 integer programming problem and then mapped onto the modified Hopfield neural network that can handle a large number of inequality constraints. The neural network simulated on a digital computer can solve a fairly large problem of 20 units over 10 periods. Although the network cannot give the optimal solution, the results obtained are quite encouraging.

## **2.2 Fuzzy Logic (FL)**

FL technique is derived from fuzzy set theory dealing with reasoning that is approximate rather than precisely deduced from classical predicate logic. FL is able to create rules by inferring knowledge from imprecise, uncertain, or unreliable information. Programmers use imprecisely defined terms, which are known as membership functions. These membership functions are a series of IF-THEN rules; however, fuzzy logic code requires fewer IF-THEN rules than traditional code, which makes it simpler to use and to write. The computer asks the user all questions, then combines the membership function readings in a weighted manner, and finally makes a decision based on the user's answers to all questions

Zhu. J [12] presented comprehensively deals with various uncertain problems in power system operation such as uncertainty load analysis, probabilistic power flow, fuzzy power flow, economic dispatch with uncertainties, fuzzy economic dispatch, hydrothermal system operation with uncertainty, unit commitment (UC) with uncertainties, VAR optimization with uncertain reactive load, and probabilistic optimal power flow (P-OPF). Probabilistic analysis and fuzzy theory can be used to analyze the uncertainty load. A method of obtaining a stochastic model is to take a deterministic model and transform it into a stochastic model by (1) introducing random variables as inputs or as coefficients or as both; and (2) introducing equation errors as disturbances. The economy of UC of power systems is influenced by approximations in the operation planning methods and by the inaccuracies and uncertainties of input data.

N.P. Padhy [13] presented an efficient hybrid model for congestion management analysis for both real and reactive power transaction under deregulated Fuzzy environment of power system. The proposed model determines the optimal bilateral or multilateral transaction and their corresponding load curtailment in two stages. In the first stage classical gradient descent OPF algorithm has been used to determine the set of feasible curtailment strategies for different amount of real and reactive power transactions. In second stage, fuzzy decision opinion matrix has been used to select the optimal transaction strategy.

### 2.3 Genetic Algorithm

GA is a search algorithm based on mechanism of natural selection and natural genetics. The objective of genetic algorithm is to find the optimal solution to a problem. the program is designed for problem solving based off the evolution process. The program continually re-adjusts, reorganizes and even mutates to continually find a better solution.

Zhu. J [14] Security-constrained economic dispatch (SCED) is a simplified optimal power flow (OPF) problem. It is widely used in the power industry. This chapter introduces several major approaches to solve the SCED problem, such as linear programming (LP), network flow programming (NFP), and quadratic programming (QP). Then, nonlinear convex network flow programming (NLCNFP) and the genetic algorithm (GA) are added to tackle the SCED problem. It also provides the implementation details of these methods and a number of numerical examples. The chapter presents a new NLCNFP model of economic dispatch control (EDC), which is solved by a combination approach of QP and NFP. It also presents a two-stage economic dispatch (ED) approach according to the practical operation situation of power systems. The first stage involves the classic economic power dispatch without considering network loss. The second stage involves ED considering system power loss and network security constraints.

Kilic, U. ; Ayan, K.[15] Optimal reactive power flow (ORPF) is one of the known problems of the power systems. Many numerical and heuristic methods were used to solve this problem so far. As seen from these studies in literature, heuristic methods are more effective and faster than numerical methods. This case is to make more attractive and mandatory the using of heuristic methods in optimal power flow solution of High Voltage Direct Current (HVDC) systems. In this study, ORPF solution of multi-terminal HVDC systems is accomplished by using the genetic algorithm (GA) that is one of the heuristic methods. A new approach is used in opposition to the current-balancing method used mostly in literature for the first time. The proposed approach is tested on the modified IEEE 14-bus test system. The obtained results are compared to that reported in the literature to show validity and effectiveness of the new approach.

### 2.4 Particle Swarm Optimization (PSO)

PSO is a population based stochastic optimization technique inspired by social behavior of bird flocking or fish schooling. It basically work in three steps :

- Evaluate
- Compare
- Imitate

An organism , a bird in PSO evaluate its neighbors , compare itself to other in the population and then imitates only those neighbor who are superior.so they behave with two kind of information i.e. own experience , and other is knowledge of how other individual performed.

Zhu, j.[16] selects several classic optimal power flow (OPF) algorithms and describes their implementation details. These algorithms include traditional methods such as Newton method, gradient method, linear programming, as well as the latest methods such as modified interior point (IP) method, analytic hierarchy process (AHP), and particle swarm optimization (PSO) method. The goal of OPF is to find the optimal settings of a given power system network that optimizes the system objective functions such as total generation cost, system loss, bus voltage deviation, emission of generating units, number of control actions, and load shedding

while satisfying its power flow equations, system security, and equipment operating limits. The phase shifters are adjusted sequentially and their direction of adjustments are governed by the impact on the primary objective function of minimal line overload, in the search technique. This chapter focuses on applying PSO methods to solve the OPF problem.

Anumod, D.M. ; Devesh Raj, M.[17] describes optimal power flow based on particle swarm optimization in which the power transmission loss function is used as the problem objective. Although most of optimal power flow problems involve the total production cost of the entire power system, in some cases some different objective may be chosen. In this paper, to minimize the overall power losses four types of decision variables are participated. They are i) power generated by power plants, ii) specified voltage magnitude at control substations, iii) tap position of on-load tap-changing transformers and iv) reactive power injection from reactive power compensators. Particle swarm optimization (PSO) is well-known and widely accepted as a potential intelligent search methods for solving such a problem. Therefore, PSO-based optimal power flow is formulated and tested in comparison with quasi-Newton method (BFGS), genetic-based (GA-based) optimal power flow. For test, a 6-bus and 30-bus IEEE power system are employed. As a result, the PSO-based optimal power flow gives the best solutions over the BFGS and the GA-based optimal power flow methods.

Jong-Bae Park *et al.* [18] suggested a Modified Particle Swarm Optimization (MPSO) for economic dispatch with non-smooth cost functions. A position adjustment strategy is proposed to provide the solutions satisfying the inequality constraints. The equality constraint is resolved by reducing the degree of freedom by one at random. Dynamic search-space reduction strategy is devised to accelerate the process. The results obtained from the proposed method are compared with those obtained by GA, TS, EP, MHNN, AHNN and NM methods. It has shown superiority to the conventional methods.

## 2.5 Ant Colony Optimization (ACO)

ACO is a class of optimization algorithm modeled on the actions of an ant colony. It is a probabilistic technique useful in problems that deals with finding better path through graphs. It is based on the ideas of ant foraging by pheromone communication to make path.

I.K.Yu *et al.* [19] presented a novel co-operative agents approach, Ant Colony Search Algorithm (ACSA)-based scheme, for solving a short-term generation scheduling problem of thermal power systems. The state transition rule, global and local updating rules are also introduced to ensure the optimal solution. Once all the ants have completed their tours, a global pheromone-updating rule is then applied and the process is iterated until the stop condition is satisfied. The feasibility of the algorithm in large systems with more complicated constraints is yet to be investigated.

Libao Shi *et al.* [20] presented ant colony optimization algorithm with random perturbation behavior (RPACO) based on combination of general ant colony optimization and stochastic mechanism is developed for the solution of optimal unit commitment (UC) with probabilistic spinning reserve determination. Total production fuel costs, start-up costs of units in stage ,the penalty cost imposed when any of constraints are violated and the total accumulated cost from stage 0 to stage t. are included in objective function. The security function approach is also applied to evaluate the desired level of system security.

R.Meziane *et al.* [21] used ACO to solve the allocation problem involving the selection of electrical devices and the appropriate levels of redundancy to maximize system reliability of series-parallel topology, under performance and cost constraints. A universal moment generating function (UMGF) approach is used by the ACO to determine the optimal electrical power network topology.

## 2.6 Differential Evolutionary (DE)

DE is a method that optimizes a problem by iteratively trying to improve a candidate solution with regard to a given measure of quality. Such methods are commonly known as meta-heuristics as they make few or no assumptions about the problem being optimized and can search very large spaces of candidate solutions. However, meta-heuristics such as DE do not guarantee an optimal solution is ever found.

Nayak, M.R. ; Krishnanand, K.R. ; Rout, P.K.[22] presents an algorithm for solving optimal power flow problem through the application of a modified differential evolution algorithm(MDE). The objective of an optimal Power Flow(OPF) is to find steady state operation point which minimizes total generating unit (thermal) fuel cost and total load bus voltage deviation from a specified point while maintaining an acceptable system performance in terms of limits on generator real and reactive power outputs, bus voltages, transformer taps, output of various compensating devices and power flow of transmission lines. Differential Evolution (DE) is one of evolutionary algorithms, which has been used in many optimization problems due to its simplicity and efficiency. The proposed MDE is in the framework of differential evolution owning new mutation operator and selection mechanism. To test the efficacy of the algorithm, it is applied to IEEE 30-bus power system with two different objective functions. The optimal power flow results obtained using MDE are compared with other evolutionary methods. The simulation results reveal that the MDE optimization technique provides better results compared to other methods recently published in the literature as demonstrated by simulation results.

Jithendranath, J. ; Babu, B.Y.[23] presents a significant evolutionary based algorithm for solving conventional Optimal Reactive Power Dispatch (ORPD) problem in power system. This problem was designed as a Multi-Objective case with loss minimization and voltage stability as objectives and Generator terminal voltages, tap setting of transformers and reactive power generation of capacitor banks were taken as optimization variables. Modal analysis method is adopted to assess the voltage stability of system. The above presented problem was solved on basis of efficient and reliable technique among all evolutionary based algorithms, the Differential Evolution Technique. The proposed method has been tested on IEEE 30 bus system where the obtained results were found satisfactorily to a large extent that of reported earlier.

## 2.7 Artificial Bee Colony (ABC)

It is a meta-heuristic algorithm and simulates the foraging behavior of honey bees. The ABC algorithm has three phases:

- Employed bee
- Onlooker bee
- Scout bee

The solution of the optimization problem is represented by the location of a food source and the quality of the solution is represented by the nectar amount of the source (fitness).

Sumpavakup, C. ; Srikun, I. ; Chusanapiputt, S.[24] Optimal Power Flow (OPF) is one of the most vital tools for power system operation analysis, which requires a complex mathematical formulation to find the best solution. Conventional methods such as Linear Programming, Newton-Raphson and Non-linear Programming were previously offered to tackle the complexity of the OPF. However, with the emergence of artificial intelligence, many novel techniques such as Artificial Neural Networks, Genetic Algorithms, Particle Swarm Optimization and other Swarm Intelligence techniques have also received great attention. This paper described the use of ABC, which is one of the latest computational intelligence to solve the OPF problems. The results show that solving the OPF problem by the ABC can be as effective as other swarm intelligence methods in the literature.

**III TABLE**

**3.1 The given table shows the advantages and disadvantages of all the AI techniques:**

Intelligent Techniques	Advantages	Disadvantages
Artificial Neural Network	<ul style="list-style-type: none"> <li>• Can be used for classification or regression.</li> <li>•Able to represent Boolean Functions (AND, OR, NOT).</li> <li>•Tolerant of noisy inputs.</li> <li>• Instances can be classified by more than one output.</li> </ul>	<ul style="list-style-type: none"> <li>• Difficult to understand structure of algorithm.</li> <li>• Too many attributes can result in Over fitting.</li> <li>• Optimal network structure can only be Determine.</li> </ul>
Fuzzy Logic	<ul style="list-style-type: none"> <li>• Different stochastic relationships can be identified to describe properties.</li> <li>•Accurately represents the operational constraints and fuzzified constraints are softer than traditional constraints.</li> </ul>	<ul style="list-style-type: none"> <li>• Piori knowledge is very important to get good results.</li> <li>• Precise solutions are not obtained if the direction of decision is not clear.</li> </ul>
Genetic Algorithm	<ul style="list-style-type: none"> <li>• Can be used in feature classification and feature selection</li> <li>• Primarily used in optimization always finds a “good” solution (not always the best solution)</li> <li>• Can handle large, complex, non-differentiable and Multimodal spaces.</li> </ul>	<ul style="list-style-type: none"> <li>• Computation or development of scoring function is Nontrivial.</li> <li>• Not the most efficient method to find some optima, rather than global</li> <li>• Complications involved in the representation of training/output data.</li> </ul>

	<ul style="list-style-type: none"> <li>• Efficient search method for a complex problem space.</li> <li>• Good at refining irrelevant and noisy features selected for</li> </ul>	<ul style="list-style-type: none"> <li>• High computation time.</li> <li>• Cannot be applied on continuous variables.</li> </ul>
Particle Swarm Optimization	<ul style="list-style-type: none"> <li>• Solve complex optimization problem which are non-linear, non-convex, non-differentiable and multi model.</li> <li>• Fast convergence speed.</li> <li>• Used to solve bi-objective generation scheduling.</li> <li>• Minimum total cost of power generation. <ul style="list-style-type: none"> <li>• Simple concept, easy implementation, relative robustness to control parameters and computational efficiency.</li> <li>• PSO algorithm can be realized simply for less parameter adjusting.</li> <li>• PSO has the flexibility to control the balance between the global and local exploration of the search space.</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• The candidate solutions in PSO are coded as a set of real numbers. But, most of the control variables such as transformer tap settings and switchable shunt capacitors change in discrete manner. Real coding of these variables represents a limitation of round-off calculations may lead to significant errors.</li> <li>• Slow convergence in refined search stage (weak local search ability).</li> </ul>
Ant Colony Optimization	<ul style="list-style-type: none"> <li>• Positive feedback for recovery of good solution.</li> <li>• Distributed computation which avoid premature convergence.</li> </ul>	<ul style="list-style-type: none"> <li>• It is mainly used only for finding the shortest route in transmission network.</li> </ul>
Differential Algorithm	<ul style="list-style-type: none"> <li>• It is applicable in continuous variables.</li> <li>• The method of differential evolution can be applied to real-valued problems over a continuous space with much more ease than a genetic algorithm.</li> </ul>	<ul style="list-style-type: none"> <li>• It has mutation and crossover but do not have the global best solution in its search equations.</li> </ul>

Artificial Bee Colony	<ul style="list-style-type: none"> <li>• Applicable for both continuous or discrete variables.</li> <li>• Simplicity, flexibility and robustness.</li> <li>• Use of fewer control parameters compared to many other search techniques.</li> <li>• Ease of hybridization with other optimization algorithms.</li> <li>• Ability to handle the objective cost with stochastic nature.</li> <li>• Ease of implementation with basic mathematical and logical operations.</li> </ul>	<ul style="list-style-type: none"> <li>• Data clustering.</li> <li>• Generalized assignment.</li> <li>• Discrete optimum design of truss structure.</li> </ul>
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**3.2 This table shows the comparative study of intelligent techniques:**

Features	ANN	FL	GA	PSO	ACO	DE	ABC
Based on	Neurons	Fuzzy set	Chromosomes Or biological systems	Nature inspired or based on social behavior of birds	Action of an ant colony	Same as GA, uses multi-agents to carry out search	Action of bees for searching of food
Applicable to	Non-linear physical series	Continuous variables	Discrete variables only	Continuous variables only		Continuous variables only	Both continuous or discrete variables
Evolution operator	No	No	Crossover and mutation	no	no	Crossover and mutation	No
New solution produce by	Adjusting weight		Crossover	Updating velocities	Pheromone trail	crossover	By its parents
Modification done by			Mutation process			Mutation process	Same as DE and GE, By whole solution in the

							population is removed.
Solution obtained		Best optimal result in non-inferior domain	No guarantee to find the optimum, but able to find good solution	Gives optimal solution	Gives optimal solution	Do not have global best solution in contrast with PSO	Better performance in term of global optimization
Control parameters	Training set, fine tuning set, test set		Crossover rate, mutation and generation gap	Cognitive and social factors, inertia weight		Crossover rate, scaling factor	Maximum cycle number(MCN), colony size (SN)

#### IV CONCLUSION

In this paper an attempt has been made to review various intelligent techniques used to solve OPF problems. The major advantage of the AI methods is that they are relatively versatile for handling various qualitative constraints. AI methods can find multiple optimal solutions in single simulation run. So they are quite suitable in solving multi-objective optimization problems. These techniques mainly used to solve Bi-objective generation scheduling, optimal reactive power dispatch and to minimize total cost, to solve Security constrained OPF, Contingency constrained OPF e. t. c. of a deregulated system are explored out. A lot of work has been done on these techniques, there still remain significantly challenging tasks for the research community to address for the realization of many existing and most of the emerging area in technology. In particular, there are great opportunities in examining a new approach/algorithm. For this it requires collaboration of researchers from different communities like artificial intelligence e. t. c. Intelligent techniques are among the most powerful techniques for optimization which is going to have a wide impact on future generation computing.

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