DHĀRANA
BHAVAN'S INTERNATIONAL JOURNAL OF BUSINESS
Vol.8, #1 (2014) 28-63 ISSN 0974-0082

Impact of Information Technology on Power Management in Karnataka with Special Reference to KPCL

- N.A. Padmalatha*

Introduction

The power sector is considered very critical for the economic development of the country. Because of this criticality, it is essential that the sector need to continuously achieve high degree of productivity and efficiency in its operations. Adoption of Information Technology is one of the key drivers to achieve productivity and efficiency improvements.

India is a rare example of a large country where the electricity supply industry continues to function essentially like a group of government departments. The most problematic area in the electricity sector has been the operational and financial performance of the State Electricity Boards (SEB). Since the State has been directly regulating most SEB activities, they are prone to political interference of varying degrees as suited to populist objectives. From day-to-day operational matters to tariff setting, all are susceptible to such interventions.

Despite the economic reforms introduced in 1991, India's power industry has not been able to reach an adequate level of electricity supply. In 2003-2004, India had an energy shortage of 7.1% and a peaking shortage of about 11.2% and in 2010-2011, peak electricity supply fell short by 9.8% and there was an overall shortage of 8.5% in supply.

There are multiple reasons for this level of performance of this sector. These can be classified as internal and external factors. Typically, the internal factor relates to operational characteristics of the power sector and the external factors bring out the influence of government policy on this sector.

Internal Factors

- **Excess manpower:** Excess manpower is attributed to influence the productivity of performance. Typically in India it is highlighted that overstaffing occurs in all areas and most prevalent in support functions.
- **Poor organization of functions and tasks:** This is a reflection of how the internal functions are managed in the Indian power sector. This is reflected in capacity utilization, deployment of manpower and cost to construct a plant.
- **Lower capacity utilization:** Plant Load Factor for SEB is 60 percent compared to 71 percent for private and central government – owned plants. Three major reasons to explain the low PLF are poor maintenance, time taken for maintenance and unable to get coal.

**This is synopsis of Ph.D. thesis of the author. The Symbiosis International University, Pune awarded Ph.D. degree in 2014. The thesis was prepared under the guidance of Dr. N.S. Viswanath.*

- **Inefficient deployment of manpower:** Poor internal organization also leads to lower productivity through overstaffing in operations and maintenance. This is prevalent in SEBs and to a lesser extent in central government plants. This leads to lack of viable investments and viable scale.
- **Construction overruns:** SEBs take an average of over 5 years to construct a large coal plants, versus 3-4 years of best practice Indian plants. Lack of funds, delays in tendering and antiquated engineering, procurement and construction practices are main reasons for construction overruns.
- **Over-engineering:** Redundancies and an absence of standardized plant designs are the two main examples of over-engineering. Many of the plants in India have redundancies such as boiler feed pumps (2 X 100 per cent rating or 3 X 50 per cent rating, versus 2 X 60 per cent used internationally).

External Factors

Poor corporate governance in the form of government ownership, primarily at SEBs, is the main external factor leading to low TFP in both generation and T&D. In generation, SEBs have the longest construction overruns and the lowest capacity utilization, leading to a capital productivity in generation of 57 per cent against best practice of 85 per cent of US levels. Similarly, they employ an average of four persons per MW, compared to 1 person per MW at even the old private sector plants. In T&D, as mentioned earlier, thefts from SEBs are about 20-25 per cent compared to 2-3 per cent in best practice private sector companies. A poor regulatory framework, coupled with poor implementation, is the second factor responsible for low productivity. Some secondary factors, such as government monopoly in the coal sector, excessive bureaucracy, and a non-level playing field for private sector capital goods producers, also contribute to low TFP.

Factors limiting output growth

All productivity barriers impact output indirectly, as raising productivity leads to a specific good becoming less expensive in real terms. In addition, some of the barriers mentioned above impact output directly. Government monopoly on distribution, for example, limits new generation capacity, as private players are unwilling to sell to bankrupt electricity boards. Thus, financial closure is extremely difficult to obtain. Similarly, poor governance of the government-owned SEBs causes large financial losses; the net impact is that the SEBs have no money to build new plants. Finally, the lack of a regulator leads to uneconomical tariffs. This last factor has also partly contributed to the poor financial health of some of the SEBs.

It has been widely researched and published by leading management thinkers like Michael Porter and Michael Hammer that investments in Information Technology are critical to enhance the productivity of companies and this productivity improvement can be realized by careful investments only.

Like in all other businesses, the Information Technology investments in power sector vary from company to company. However, these investments can be categorized into three general areas.

- Performance Improvement :Performance Improvement areas includes reducing cost inefficiency across all the areas of operations and for enhancing customer satisfaction
- Meeting management and regulatory requirement: IT can fulfill management and regulatory requirement areas in terms of effective MIS for decision making, accountability and service and building a strategic approach to regulatory management along with the collection and management of data.
- Servicing the changing industry structure: The changing industry structure in terms of unbundling and network management emphasis also requires the intensive use of IT.

In Power Generation companies, operations management, management reporting and asset management have seen considerable IT intervention. The areas that need to be covered are fuel and environmental management. The key issues in the use of IT in power generation relate to focus on plant control systems, non-existent operational performance systems, poorly used control system data for performance analysis, low commercial orientation

despite high data availability, and strategic focus to use IT for managing complex demand or managing the capital cost through effective project management etc.. There is a need for a comprehensive IT strategy to address requirements of performance improvement, cost management and project management in power generation companies. Inadequate research on usage of IT systems for productivity enhancement in power generation companies is another area requiring attention.

As the Indian economy gets liberalized, it is likely that the power sector too would undergo transformation. This transformation would be primarily at the policy level, at the operational level in terms of adoption of operational improvement techniques and also likely to be in the application of Information Technology to address operational and strategic requirements. It is expected that the above transformational initiatives will lead to improvement in the performance of this sector.

The Problem Statement

India is a rare example of a large country where the electricity supply industry continues to function essentially like a group of government departments. And the most problematic area in the electricity sector has been the operational and financial performance of the State Electricity Boards (SEBs). Since the State has been directly regulating most SEB activities, they are prone to political interference of varying degrees as suited to populist objectives. From day-to-day operational matters to tariff setting, all are susceptible to such interventions.

Despite the economic reforms introduced in 1991, India's power industry has not been able to attract enough private investment from domestic and foreign companies to reach an adequate level of electricity supply. In 2003-2004, India had an energy shortage of 7.1% and a peaking shortage of about 11.2%.

While India's installed power generation capacity was 112,058 MW as of March 31, 2004, the country still needs an additional 100,000 MW to meet the growing demand for electricity over the next 8-10 years. According to industry estimates, domestic and foreign private companies will need to invest a total of about $100 billion in power projects to bridge this deficit.

As mentioned earlier, the power sector has to address both the internal factors and the external factors to enhance its performance. The internal factors would lead to operational excellence as mentioned earlier. It is quite evident that the external factors would generally lead to more competition, regulation and investment. However as Michael Porter highlights, competition alone would not enhance the productivity and competitiveness of an industry in a country. So it would be very critical to look at the mechanisms to enhance the productivity of the power sector in India through operational excellence as well.

The literature survey and the analysis of the status of Information Technology in the Indian Power are not wide spread. Although there have been substantial investments, these are not accompanied by a clear strategy for enhancing operational efficiencies or enhancing customer satisfaction.

What type of Information Technology investments can lead to performance improvements and how to measure the effective usage of Information Technology remains one of the key research topics. This understanding is critical in the formulation of strategy for Information Technology investments. The essential thing would be to relate the usage of Information Technology to increase productivity performance. This has been addressed differently for different sectors. This understanding is essential for any exercise of formulating an Information Technology Strategy.

Literature Review

Six types of literature have been reviewed as a precursor to the research and the findings of this assessment is used to build the framework for the research.

- Infrastructure components – the Information Technology components in which investments are typically made to get business benefits
- Benefit framework – the services realized through Information Technology and delivered to customers,

suppliers and employees through which the business benefits are realized

- Management framework – the mechanisms for integrating the business strategy, IT strategy and IT trends & possibilities, for decision making on investments in Information Technology.
- Integrated frameworks – the mechanisms to combine all the three aspects of the IT investments – benefits, investment in infrastructure and the management drivers, into comprehensive decision making tools
- Quality management and project management framework- The mechanisms to assess the influence of IT on quality of operations and project management effectiveness.
- Information technology usage- nature of usage of IT by business organizations in general and power industry in particular in terms of processes covered, nature of solutions deployed etc.

Infrastructure components

The literature in this category indicated the IT infrastructure can be categorized into seven major components based on nature and purpose. The different research articles reviewed bring out nature of the different components and their typical trends. The components included hardware platforms, operating system platforms, software applications, data management, networking and telecommunications, internet platforms and service providers. The articles provided an excellent guidance to analyze how the different IT components are inter related and how typically investments are made in these. These articles provided insights into how to look at or plan IT investments, without looking into how these will impact the business operations. The ideas in this set of publications/articles are used to assess the investments made by KPCL in Information Technology systems.

Benefit Framework

Productivity with its multiple dimensions is the fundamental measure of technology's contribution to business performance. The wide range of research publications reviewed as a part of the research work highlight how to measure the impact of information technology investments on organizational performance using the different dimensions of productivity. These articles explore the use of tools like efficiency measurement, unconventional productivity measures, objectives driven measurement, portfolio approach, value chain analysis, measurement of quality, balanced scorecard etc to assess the productivity of IT investments. A careful assessment of these research findings revealed that many of the productivity measures can be used for measuring the performance of the power generations sector as well.

Management framework

One of the key challenges of management of business organizations is to ensure consistency across different types of decisions and aligning them with the business strategy of an organization. While investments in Information Technology are increasingly considered as a strategic investment, how to integrate this investment decision with other elements of a business strategy and capital investment process has been the focus of many research studies. This research studies focus on different elements like measuring performance improvements, improvements in the cost of products & services, capturing the actual costs of investments and the resulting value, mechanisms to assess investment effectiveness, incorporating strategic possibilities in decision, holistic planning to include Information Technology as a part of the business plan, etc. The findings from these research reports are used to understand how to incorporate the results of the assessment to make key recommendations.

Integrated Framework

The ultimate challenge for investments in information technology is to create the right mix of investments and use the limited source while providing the maximum benefits. Prior to funding, the organization must be able to answer the question "What will we get for our money?" Proper analysis will include not just the estimated spending over the system/ initiative, but it will also include the evaluation of potential business benefits, future options and relative risks. Many times investment decisions need to be made rationally and analytically, even when it cannot be made on the strengths of numbers alone. Decision analysis models,

Return on Management (ROM), boundary values or spending ratios, Parker's Model, Portfolio approach, Balanced scorecard approach are some of the models researched and documented to provide insights on how to link Information Technology Investment decisions with business benefits. Most of the research study has been in sectors like banking, finance and manufacturing and from different circumstances. It is evident that many findings from these reports have the potential to be applied to make investment decisions in the power generation sector as well.

Specific Measures of Business Performance

The usage of Information Technology is expected to influence different areas of a business especially on the operations and customer management. The two areas of interest specifically from the view point of power generation companies are the quality of operations and the project management effectiveness. Some of the research literature reviewed as a part of the current work, looks into how to measure quality of operations, how these things are related to business performance and what are the factors influencing quality of operations. Similarly, the tools and techniques used in project management, the measures of effective project management and how project management influences overall business performance are researched and documented. The findings of these research studies are highly relevant in the context of the current research since the performance of the power generation companies is expected to be heavily influenced by quality of its operations and how effectively it manages its projects for new capacity addition.

Information Technology Usage in Value Chain

The earliest work which brings out the role of Information Technology on the competitiveness of business organizations and how different elements of a value chain can be organized differently by using Information Technology is by Michael Porter (Porter 1985). The article brings out how "Dramatic reductions in the cost of obtaining, processing, and transmitting information are changing the way we do business". The article highlights that the Information Technology changes industry structure and, in so doing, alters the rules of competition, creates competitive advantage by giving companies new ways to outperform their rivals and it spawns whole new businesses, often from within a company's existing operations. Ever since that, there has been numerous research works on how to use Information Technology to alter the competitive advantage of the companies. The literatures reviewed include the usage of IT in banking, manufacturing and many service industries. The ideas from these set of research work are relevant to understand how to link the competitive positioning of companies with the deployment of Information Technology in reconfiguring the value chain of the companies. Although may not be highly applicable to highly regulated government controlled power generation companies, the ideas are relevant to understand the creative possibilities of Information Technology in power generation companies.

IT Solutions used in Power Generation

An assessment of the IT solutions used by different power generation companies indicated that specialized software or packaged solutions with a library of best practices and processes, have been developed by the leading suppliers of IT solutions/software and deployed in many power generation companies. One class of solutions are Enterprise Resource Planning (ERP) solutions covering key processes like Financial management, Materials Management, Project management, Maintenance & operations management, Asset management, analysis of operational data etc.

The highlights of the review of the literature are

- There are different approaches for identifying IT investments, for assessing business performance and for linking business performance to IT investments.
- There is a broad acceptance that Information Technology investment needs to be treated as a strategic investment and needs to be closely tied to business strategy
- Since information technology impacts a business in multiple direct and indirect ways and there are a wide variety of ways in which investments in IT systems can be carried out, it is a complex exercise to isolate these benefits and link them to specific IT investments.

- The variety of methodology developed by different researchers is generally context driven each one with its strengths and limitations.
- It is not prudent to pick one methodology and apply it to another situation and it is evident that it is impossible to choose one method which can be directly used in the context of this research.
- It is critical to use the lessons from the different research work / models/methodology and adopt them to this research work with context driven modifications, instead of using any of them directly.
- There are a variety of information technology measures available, each addressing different measures of IT business value and many of them generic in nature and can be adopted easily for this research work.
- There is no comprehensive research or methodology or careful investigation of how IT investments need to be carried out and how to assess their impact on the business performance of power generation companies.
- There are multiple ways in which a power generation company can make IT investments and the broad trend is to use enterprise resource planning (ERP) solutions which offer centralization and integration of business processes at its core value proposition.

Research Objectives

Based on this assessment of the status of IT in the Indian power sector and the critical operational requirements of the power generation companies in India, the research is aimed to analyze the different elements that will lead to the improvements in the performance of the power generation sector. The following objectives were set for the research study

- To identify the different types of investments in information technology by power generation companies
- To analyze the trends in information technology
- To examine the specific areas of performance which are influenced by the adoption of information technology

Some of key activities envisaged in the beginning and executed as part of the research were

- Reviewing the literature on this topic in a systematic fashion and developing framework/models for the research study
- Formulation of hypothesis for the research study
- Application of the frameworks and models to analyze the above mentioned objectives and test the hypothesis
- Gathering data through questionnaire and field study against different parameters envisaged in the framework/model and testing the hypothesis
- Analyzing the data and the findings and formulating the conclusions and recommendations

The research was envisaged to be a case study based exercise. The focus of the research has been detailed assessment of the impact of IT investments on the operations of Karnataka Power Corporation Limited (KPCL) – the state owned power generation organization in the state of Karnataka. KPCL was selected as the unit of study based on the following considerations

- Diversity of operations in terms of nature of power generations – it operates hydro electric, coal and diesel based thermal and wind energy stations
- Large scale operations in terms of installed capacity
- Distributed organization with operations at multiple locations
- Maturity in adoption of Information Technology – has been computerizing its operations since last two decades and has automated many of its operations

While investigating the operations of KPCL against the above mentioned objectives, the critical step has been assessing through careful review of published literature on what has been done by different researchers. The focus of the literature review has been to understand

- What constitutes investment in Information Technology?
- How are benefits of Information Technology measured by different industries?
- How do companies link the benefits to investments?

- What are the specific operational parameters against which businesses measure benefits of information technology?
- What are the operational parameters against which power generation companies measure their business performance?
- What are the frameworks used by management for decision making while investing in Information Technology?

Methodology

The methodology developed for the research study based on the survey of literature consisted of two basic streams of assessment. It consisted of development of questionnaire and data collection formats and analyzing them to assess the relationship between Information Technology investments and business performance.

- User Perspective: The structured survey of users of the Information Technology systems users to find out the impact on performance as perceived by them. This is the qualitative aspect of the research study.
- Business Results: Collection and analysis of the data on performance of the organization over the years on different parameters and assessing their relationship to Information Technology investments. This is the data driven assessment of the performance. The data on business performance is used for this purpose.

The reason for this two pronged approach to assess the impact of Information Technology on the business performance of KPCL are

1. Since the IT investments are gradual, it is likely that the IT investments would not have given any dramatic or clearly visible change in business performance over a very short period of time.
2. Since a large of employees have been in the organization for a long period and have firsthand experience of seeing the changes in business performance over a period of time and are in a position to decipher the specific changes due to IT investments, the user survey also has been used to assess the impact of IT on business performance

The key activities carried out to address the research objectives were

- Identification and assessment of the IT investments made by KPCL in different operational areas and the nature of these IT systems
- Formulation of hypothesis based on the literature survey on the impact of IT systems on the performance of KPCL
- Assessment of the performance of KPCL using the user perspective framework
- Assessment of the performance of KPCL using the business results framework
- Analysis of the results and Correlation of the results of the two approaches
- Formulation of key research findings and recommendations for further actions.

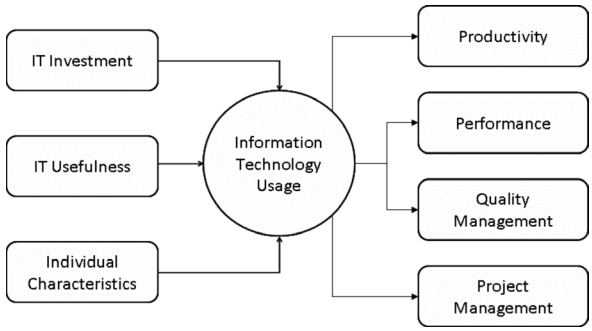

Fig 1: Framework of the research
Source: author

This research study intends to find answers to these questions in a systematic fashion by developing frameworks as indicated in the figure 1, gathering data, analyzing them and formulating the conclusions based on data and research findings.

Adoption of multiple sources of data validated research conclusions and confirmed the subjective perceptions. Multiple measures to understand the impact of information technology are: Analysis of actual data, Analysis of the perceived data and Observation and Interview of the respondents.

The methodology to assess business performance based on the user perspective consisted of

- Identification of the functional areas of KPCL using IT systems

- Formulation questionnaire based on the research hypothesis – both open ended and closed ended questionnaire
- Pilot test of the questionnaire in select location and with select respondents to assess the relevance and practicability of the questionnaire and refinement of the questionnaire based on the feedback.
- Identification of key executives of KPCL who are the users or key beneficiaries or key persons within the business processes automated by IT systems. Identification of the respondents in terms of rank, functional area and location.
- Development and administration of questionnaire to get their feedback /perception on the impact of IT on business performance
- Analysis of the results of questionnaire and the results of the feedback to build correlation on the impact of IT on business performance of KPCL.

The approach to assess business performance based on the analysis of the business results consisted of

- Identification of the functional areas of KPCL using IT systems
- Identification of business parameters of a power generation company which are likely to be influenced by these business processes.
- Collection of data on the actual business performance of KPCL against these values. This study included study of secondary data for selected years (1990-2010).
- Analysis of the data on business performance and establishing the correlation between the results and IT investments.

KPCL with its inception in 1970 set its sight on "growth from within" for meeting growing industry needs and reaching out to touch the lives of a common man. The organization is a technical IT savvy power sector company among the public sector.

- KPCL has been making IT investments over a period of time. The investments have been gradual since the inception of KPCL in terms of the technology platform, coverage of business processes, degree of automation and adoption by users. The investment pattern indicated the implementation of technology was gradual. For example some of the time lines for different IT systems are
  - 1993- Renewal of Fuel management Systems
  - 1996- Operation of VSAT Connectivity.
  - 2005- On-line Processing of Applications.
  - 2010- Using CAD 2010 Version
- A large number of key executives who are either beneficiaries or the direct users of the IT systems have been long term employees of the organization and have seen the growth and spread of IT systems over this period. More than 70% of the key users have spent more than thirty years in the organization.

KPCL has made investments in developing and deploying different Information Technology solutions. The key investments in IT systems are in the following areas

Systems for operations: Fuel Management System, Integrated Stores and Inventory Management System, Unit Generation Monitoring System, Project Generation Monitoring System, Plant Monitoring System

Systems for managing the finance: Cash & Compilation Management System, Fixed Asset Management System, Stores Accounting System, Bank Guarantee System, Provident Fund System

Systems for support activities/functions: Human Resource Management System, Hospital Management System, In-house Training system, Disciplinary Proceedings system.

Some of the key characteristics of the Information technology systems at KPCL are

- The systems cover both core operations and support functions
- Most of the activities at the corporate office are automated
- Most of the senior executives are active users of IT systems
- Most of the software solutions or modules are stand alone solutions addressing the requirements of specific business process

- Most of the solutions are run centrally and accessed by users in different locations through the network
- There a few software applications which are designed to integrate the business processes like the inventory management
- The usage of IT systems is not uniform across all the different locations of KPCL

Based on the understanding of the operations of KPCL and the assessment of the research literature in this field, a set of hypothesis hypotheses were formulated iteratively on the impact of IT on the performance of KPCL. A set of variables based on literature were identified to assess the performance of KPCL, these were tested for applicability at KPCL and modified based on the experience of using them at KPCL and the final set of hypothesis was formulated.

Hypotheses

The hypotheses of this research study are on the relationship between the investment / adoption of Information Technology in managing the companies in the power sector and the performance of these companies. These hypotheses are applicable for both the streams of research work – user perspective and business results, and reconciled against each other for final validation. Each of the final six hypotheses used for the research work are investigated in detail using a series of sub-hypotheses to explore the relationships between IT investments and business performance. The details of the sub hypothesis are the essence of the framework used for this research work.

Using these hypotheses and the research framework, this study identified the different types of investment in Information Technology in KPCL, analyzed the trends in the usage of Information Technology and examined the specific areas of performance which has been impacted by Information Technology and the areas that can be improved by the better, more or increased adoption of Information Technology.

The hypotheses used for the research work are:

H1: IT usage/investment has enabled the productivity of the organization.

H2: IT usage/investment has enhanced performance of the organization.

H3: Usage/Investment of IT has resulted in quality management.

H4: IT usage/investment has resulted in project management of the organization.

H5.: The benefits of IT varies by project location.

H6: Impact of information technology is moderate.

Research Framework

Some of key highlights of the research framework developed and used for the research work are:

Dimensions and Variables

- The parameters are identified from the review of literature, and refined iteratively by testing them in the field at KPCL
- The spread or investments in Information Technology (IT) are measured by dimensions like IT investment, IT usefulness, Individual Characteristic and Organizational Characteristics.
- The impact of Information Technology on business performance of KPCL are measured using multiple dimensions like Productivity, Performance, Quality of operations and Project Management performance
- The Productivity Dimension has been elaborated by using multiple parameters like Operational Productivity, Operational Quality Productivity, Strategic Productivity, Financial Productivity and Maintenance Productivity.
- Variables included for measuring the Performance Dimensions are Strategic measure, Organizational Support, Communication, Management Benefit and Performance Benefits Measures.
- Parameters considered for measuring the Project Management are Integration Management, Scope Management, Time Management, Cost Management, Quality Management, Human Resource Management, Communications Management, Risk Management and Procurement Management.
- The information and data of KPCL on many

measurable and recorded parameters are used to assess the business performance and validate them against the user perspectives.

Key Activities using the user perspective model

The key activities carried out as a part of the research work to assess the impact of Information Technology on the performance of KPCL using the user perspective model.

- Development and administration of questionnaires consisting of 153 open ended and closed ended questions. These questionnaire reflect the hypothesis and research framework developed based on the literature review
- The framework of the questionnaire included the dimensions and measures of the dimensions for information technology usage.
- Based on the understanding of the IT systems of KPCL the sample of persons to administer the questionnaire is taken from corporate, middle level and operational level. Stratified random sampling is used
- In an attempt to understand the impact over the years, the study included years of experience in the organization as one measure. 73% of respondents have 30 years of experience in the organization (20-29 years- 39% and 30-40- 34%).
- The sample indicated respondents who have understood the issues and problems of information technology, individuals who have experienced the real-life event in the organization
- As many as 137 Sample were taken which included 70 from Bangalore, 20 from Sharavathi generating Station, 19 from Raichur Thermal Power Station , 7 from the Yelahanka diesel generating unit and 21 from Varahi Underground Generating Station.
- All the functional departments were part of the research investigation. Among the respondents, 49% are engineers, 12% are assistant engineers,10% are systems analysts, 15% are human resource personnel, 7% are Operation & maintenance personnel and 7% are accounts personnel.
- Four semi-structured interviews and discussions with Functional heads of F&A (Finance and Accounts), HR (Human Resource), System Analysts and Company Secretary were carried out.
- The response to the questionnaire were compiled and analyzed using statistical analysis tool like SPSS
- All of the multi-scale constructs have coefficients of 0.7 and higher, indicating all the constructs has good reliability.
- Other than administering the questionnaire among the key stake holders, the research activity also included visit to the different operational units to meet and interview the users of IT systems.
- It also included study of the operations of the organization at Sharavathi Generating Station, Raichur Thermal Power Station, Varahi Underground Generating Station and Diesel generating Station during the year 2010.
- As a part of the assessment of the operations, the stake holders among Operations and Maintenance Engineers, Stores and Purchase Personnel, Executive Engineers, Functional Heads (Finance and HR), Assistant Engineer and Junior Engineers were interviewed.
- The site visit also focused on seeing the actual usage of the IT systems in the different operations of the organization.

Validity of the Research

Reliability and validity of the survey instrument is tested in terms of face validity (if the questions seem to measure what they purport to), content validity and reliability. On recommended by several researchers, multi-item scale were used. Multi-item scale can better specify the construct domain, average uniqueness of individual items, make fine distinctions between people and have high reliability. The five dimensions and the variables used multi-item scale.

Face Validity: Face validity provides a basic support for the appearance of measurement and variables. The survey research achieves face validity because its use of factors for the measurement in Power Sector are verified by pilot study by KPCL Experts.

Content Validity: Content Validity which measures the appropriateness of items in the construct domain. This is achieved in this research from referent literature or via "a panel of experts who are well versed with the domain".

Reliability: The reliability relates to the consistency and stability of a test. Reliabilities (Cronbach's a lpha coefficients) were calculated and shown in table 1). All of the 16 multi –scale constructs used have coefficients of 0.7 and higher- indicating all the constructs have good reliability. (Nunnaly, 1994).

Group Name	Mean	Variance	Std deviation	Cronbach's Alpha
Operational Productivity	29.096	16.86	4.11	0.773
Maintenance Productivity	33.462	45.99	6.78	0.863
Financial Productivity	47.99	46.96	6.85	0.874
Operational quality Productivity	28.710	20.82	4.56	0.790
Strategic Productivity	25.050	16.52	4.06	0.846
Perfomance Dimension	32.76	17.73	4.21	0.816
Total Quality Management	88.731	164.11	12.81	0.805
Integration Management	12.688	5.02	2.24	0.831
Scope Management	16.59	9.42	3.07	0.916
Time Management	8.1042	2.30	1.52	0.845
Cost Management	29.136	28.88	5.37	0.924
Quality Management	8.25	2.88	1.70	0.913
1HR Management	12.240	6.77	2.60	0.806
Project Communication Management	20.457	17.71	4.21	0.888
Project Risk Management	15.188	14.26	4.00	0.901
Project Procurement Management	51.411	72.70	8.53	0.945

Table 1.0: Reliability Statistics

Key Activities using the Business Results model: These activities carried out as a part of the research work to assess the impact of Information Technology on the performance of KPCL using the business results model.

- Based on the hypothesis and the research framework a list of parameters to assess business performance are identified
- The list is of parameters is modified using the filters like availability of information, mechanisms to measure them and the usage of IT systems by the underlying processes of KPCL.
- The timelines and period to collect the data is formulated based on the years of introduction of IT systems in the underlying business process.
- Formats are prepared and refined based on field experience to collect the data and information.
- The information and data collected are analyzed using statistical tools like SPSS.
- Some of the key parameters used for assessing the performance of the business were - IT Expenditure, Cost of Power generation, Inventory carrying costs, Sales Income, Profit after tax, O & M Expenses, Generation data, Plant Maintenance Information, Peak electric load, Capacity Addition, Plant Load factor over the years.

Research Tools Used

The study used arithmetic mean to represent the population. The variations are measured by standard deviation, skewness and kurtosis. The study involves establishing the relation between business benefits and IT usage and investment. Pearson coefficient is used to measure the magnitude of relationship.

Pearson Correlation- Is used for evaluating the relationship between

- Connect time and frequency of usage as the independent parameter and business-benefits as dependent parameter.
- Investment in expenditure in computers, peripheral equipments and financial performance as independent parameter and business results as dependent parameter.

ANOVA- Having understood the relationship, ANOVA is used to understand the variations in usage of IT usage in project locations of KPCL.

Mean-Mean is the most popular and widely used measure for representing the central tendency of the data.

Standard Deviation- Standard deviation is used for measuring the variation.

Skewness-Dispersion measures the lack of symmetry. It is measured by Karl Pearson's coefficient of skewness. In practice, the value of this coefficient lies between -1 to +1.

Kurtosis: Dispersion is measured by kurtosis.

Multiple Regression Analysis- The aggregate impact of IT investments on predicted variables such as sales, Profit After tax, Earnings Per Share, Value of failures and Plant Load Factor is done using multiple regression analysis. The impact of IT usage on business benefits are also conducted to establish the relation between IT usage and performance.

Execution of the Research

The research design adopted for this study provides the development of an inductive and deductive understanding of impact of information technology in KPCL. The data collection for this research commenced in December, 2009 and was completed at the end of December 2010. The research design as indicated in figure 2. SPSS base 16 is used to analyse issues such as cross-tabulation, descriptive, reliability and analysis of the hypotheses. Microsoft Excel is used for cause and Effect analysis.

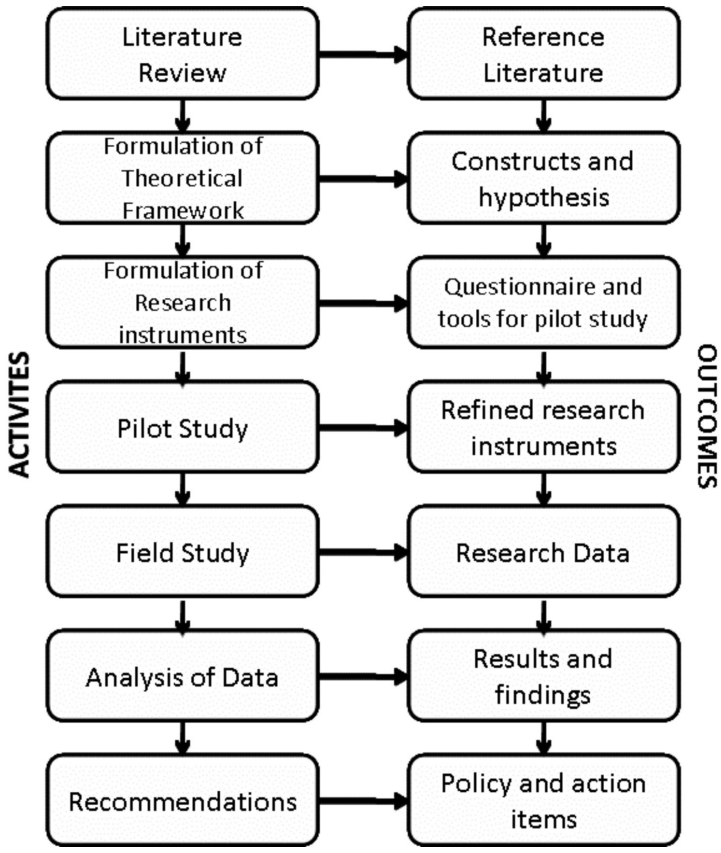

Fig 2: Systematic Description of Research Design and Methodology
Source: Author

Major Findings of the Research

The results of statistical analysis of the performance of KPCL impacted by Information Technology are

- **Financial Productivity** - Financial system packages in KPCL have helped the organization in reconciliation of accounting transaction, faster preparation of half yearly and yearly financial statements, Understanding of operational costs, understanding of working account payable and better management of account receivable.
- **Strategic Productivity** - IT applications have increased the value addition for the organization, organizational capability for process innovation and increased the organizational flexibility.
- **Operational Productivity** - IT Systems have enabled better visibility of inventory, Better management of material procurement, better vendor management and vendor performance rating and reduced marginal cost of production.

- **Operational Quality Productivity** - IT applications in KPCL have resulted in efficient human deployment, greater communicative capability and better training using presentation packages.
- **Maintenance Productivity** - The use of IT has resulted in preventive maintenance of plants/ machinery, improved management of breakdown of plants, improved management of maintenance of inventory and improved the uptime of plants/ machinery.
- **Performance** - IT usage has resulted in better performance of the organization. It has contributed to the better achievement of strategic goal and better employee satisfaction.
- **Total Quality Management** - IT systems in KPCL has resulted in clarity of work and better instruction of work, which enhanced the quality of the process.
- **Project Management** - Use of IT has resulted in integrating the project plan for a coherent document, better identification of tasks and better management of contracts.
- The usage of IT varies in different project locations. IT usage across the dimensions like maintenance productivity, performance, quality, project scope management, time management, cost management, project quality and project risk varies.
- **Business Results based on secondary data** – Statistical analysis confirmed that lower inventory carrying costs, increased sales income, higher plant load factor, higher generation performance have resulted by the investment in IT.
- **Correlation with the business benefits** - Regression analysis conducted before and after 2000 (1991-2000 and 2000-2008) confirmed that investment in IT has made an impact on sales, PAT, EPS and PLF. However, evidence available shows that there is no significance in terms of capacity addition. Hence, the critical parameters connected with KPCL are statistically positive and having a significant relationship.

Research findings based on observations

- The general conclusion has been that usage of IT in KPCL has resulted in enhancing the productivity. Performance, total quality management and Project management
- The results of the study indicated that the perception of the benefits of usage of IT in KPCL is more in terms of value-addition and validation.
- Most of the IT systems in KPCL are stand alone systems, covering the specific activities related to one or two functional areas.
- KPCL has invested in building an organization wide network to connect the computers across the organization and connect the different users located in different places to use the same IT systems. KPCL has adopted an approach of building or developing the IT systems as demanded by the business requirements.
- The interview with the respondents showed that the KPCL invested in information technology based on the need.
- The public sector organization like KPCL has its own limitation / obligations which any kind of technology requires time to resolve.
- A combination of custom in-house applications, packaged software and stand alone applications built by the user has resulted in poor integration and visibility of the information.
- Service Provider's presence in not well in more remote locations which has resulted in lesser usage of IT in real time.
- KPCL diversified investments in IT based on the needs of the business over the years, hence, the impact of IT over the years were studied instead of any cutoff years.
- Because of certain constraints of the sector, the solutions deployed and the internal systems, the complete potentials or possibilities of IT are not completely harnessed by the power generation company.

Interpretation of the results of analysis and observations

- Results show that financial system packages in KPCL have helped the organization by providing support for the financial planning, budgeting and monitoring.

- At the project level, information systems have helped in managing the uniformity across the units. It has helped in better visibility, faster operation and reduced the cost of procurement of material.
- The information technology has helped in secured and reliable transfer of information across business units to the head quarters. In a couple of places the deployment of real time systems like SCADA are found to be effective in decision making on power generation related activities.
- IT applications in KPCL have resulted in efficient human resource deployment. In addition, greater communicative ability allowed businesses to interact with others via simple tools such as email or advanced tools such as video conferencing.
- Storing maintenance information is vital for power generation utility. For example, power utility run by diesel fuel needs maintenance every 8 months. KPCL does not use any specialized packages for processing operation and maintenance information. Also at the plant level all the tripping outage and generation information is stored in Excel or log book.
- The maintenance of spare parts ensures uninterrupted production. Replenishing the inventory can be done through different ways of computer supported approaches such as decision support system, off the shelf packages etc.
- IT usage has resulted in effective inventory management by providing the visibility of inventory information to the other stake holders who need to use the inventory. Inventory visibility allows companies to be informed about their inventory in order to make the effective supply chain. By capturing, aggregating and providing visibility to inventory quantities throughout the stores, optimum inventory level is maintained across the units.
- In KPCL, packages like IIMS has resulted in reducing the material procurement cost. According to Operations and Maintenance staff "Systematic procurement of the materials has resulted in analyzing and co-ordinating of materials among all the departments.". As per the orders of the Government of Karnataka, E-procurement is mandatory for buying goods or services of an amount larger than rupees ten lakhs. This service is being used in different locations in KPCL very effectively.
- FMS, IIMS and Stores Accounting systems are widely used both in Bangalore office and project locations for storing vendor details. While FMS, keeps account of coal suppliers. Stores Accounting System keeps accounts of other suppliers, calculates the payment details etc.
- It is found that usage of application systems such as integrated inventory management system in stores have made the analysis of need based material better. This in turn resulted in systematic procurement, which in turn resulted in reduced total costs.
- Further, payment details are maintained in better manner, which has helped the organization to meet the objectives.
- Better Process Design, Better employee satisfaction, Increased level of decision making capability, better user satisfaction and reduction in the shortage of coal, better process design etc. are evident in certain pockets of the organizations.
- In order to understand the variation in the usage of information technology, ANOVA was conducted. The results showed that impact of information technology, which is measured by frequency of information technology usage and connect time is not uniform across the organization. In KPCL, applications such as CAD, STADD, FMS are widely used tools in certain locations. And also, usage of routine IT tools such as Internet access, e-mail and collaboration tool such as video conferencing is not uniform because of certain technical reasons.
- Power generation is done in KPCL using hydel, Thermal, wind and solar PV projects. For Power generation using thermal the usage of IT is comparatively more than hydro projects.
- It is also evident there has been a steady increase in the investment in IT systems, indicating the reliance of the utility on IT to improve the efficiency and effectiveness in the operations of KPCL.

- The impact of the IT systems on the performance of KPCL are due to following key characteristics of the IT systems.
  - Automation of activities/data storage as seen in fuel management system, integrated inventory management system and cash and compilation management system.
  - Centralization of information within a functional area as seen in human resource management system, bank guarantee system or the provident fund system.
- While the research results highlight moderate impact of IT on business performance across many functional areas, the variation in impact across different functional areas is visible when the IT systems are used to integrate the business processes. The impact is average when the IT systems are stand alone and vary when they are not. A case in point is the process integration through IT systems as seen in the fuel management system and inventory management system.
- While the coverage of IT usage is not uniform both in terms of access and solution deployment, the impact of the IT systems as per user perspective as well as business results has been higher when there is access and solution deployment.
- The critical impact of Information Technology other than automation of processes is in facilitating decision making. In the KPCL too the impact is seen to be higher when the IT systems facilitate decision making through provisioning of timely and accurate analytical reports.
- The impact of IT systems is seen to be higher when the adoption of IT is system is accompanies by redesign of the underlying process or when the processes have adopted best practices potential of IT systems.
- There are too many IT solutions and applications deployed at KPCL, developed and deployed as per the needs of respective business users. Whenever the users have to use multiple sources of information as dictated by the solutions, for decision making, as against the integrated solutions, the impact of IT systems on business performance seems to be affected negatively.

Recommendations of the Study

Based on the analysis of results, understanding the capability of the IT systems, need of the Power Sector and global best practices the recommendations are drawn by the researcher. To enable KPCL to harness IT systems capability more effectively and to generate greater value to its business the following recommendations are formulated.

- **Integration of business processes** - The results from various literatures indicates that integration of processes gives greater benefits. There are instances in KPCL itself where a combination of custom in-house applications, packaged software and stand-alone applications built by the user have resulted in poor integration of the business processes and poor visibility of the information. While automation is perceived to be the key objective of deploying any IT system, the integration of business processes through IT is considered to be the next cycle of investment. There are many areas where KPCL can derive value by integrating the business processes. Some of possible areas of integration of the business processes through IT at KPCL are
  - Integration of maintenance operations and asset management.
  - Integration of procurement with inventory and vendor management.
  - Integration of provident fund system with HR and payroll processes.
  - Integration of project management with asset management and with finance systems.
  - Integration of payroll, inventory, accounts payable and asset management with finance.
- **Expansion of coverage:** While integration of business processes and the IT systems facilitate centralization of data and information, expansion of coverage intends to bring more users and geographical locations of the organization into the IT fold. When the IT systems are expanded to cover more users and geographical locations, business value is derived through – user control of data, Elimination of multiple sources of data entry, increase in the accuracy and

reliability of the data. The underlying theme for expansion should be to provide access to users who generate and use the data. Some of possible areas where expansion of the IT systems makes significant sense in the case of KPCL are

- Expansion of Human resource Information system to all the employees such that some of the key information about the employees is entered and owned by the respective employees.
- Expanding the vendor management system to the vendors such that some of the information about the vendors is entered and maintained by the respective vendors themselves.
- Another dimension of expansion is to bring in the locations of the actual business activities into the system like for example expanding the project management system to all the project locations and thereby all the people involved in project management.

- **Analytical Enhancement -** Other than process automation and business process integration, the key objective of building any information technology system within a commercial organization is to facilitate informed decision making. While expansion and integration increase the possibilities of data analysis, building analytical capabilities itself should be one of the key drivers of IT investments. KPCL has built some basic analytical capabilities into most of the systems deployed in the organization. The typical outputs of these analyses will be used mainly by the respective functional users for decision making within their own functional areas. It is recommended that analytical capabilities are expanded to multiple functional areas.
- **Application Rationalization -** Application rationalization or the rationalization of IT applications, is one of the approaches to address this set of issues. Although it is not the intended objective of the research, it is recommended that KPCL should seriously explore the possibilities of using this technique for the following reasons
  - There are multiple applications in the organization built on different platform and catering to different user requirements.
  - These applications are built over a period of time with all the likelihood of some of them being already on outdated platforms or technology.
  - With most of the applications being developed in-house and undergoing incremental changes as demanded by the business users, it is very likely that these applications would have been heavily depended on a few developers or IT executives.
- **Policy for standardization -** as the footprint of the Information Technology systems increases within an organization and the number of users of the IT systems increases, it is critical to formulate standards policies for IT systems – development, deployment and usage. A close look at the role of Information Technology in KPCL, prompts to make some suggestions to this effect. Some of the possible areas are
  - Data security, information security and accessibility to organizational data.
  - Standardization for technology platforms, interfaces between different applications for data/information exchange to reduce multiplicity of platforms and non standard interfaces.
  - Development of organizational wide mechanisms to measure business benefits and standardize the policies for information technology investments.
- **ERP Adoption:** Wherever the current architecture of IT systems enable integration, that can be attempted, but the better way for KPCL will be to evaluate the possibilities of deploying integrated systems like ERPs. The key reasons for this are
  - ERPs would offer built in capabilities for integrating business processes.
  - The centralization of data can be easily achieved.
  - The ERP platform would offer the technology standardization possibilities.
  - Some of the globally popular ERP solutions bring in the advantages of best practices in many different process like costing, inventory management, HR, plant maintenance, etc.

The final outcome of the research is development of the conceptual model for the deployment of information

technology solutions in Power generation Companies. The IT deployment model is formulated by using

- The strategic requirements of power generation companies.
- The operational requirements of power generation companies.
- The strategic and operational challenges facing the power generation companies.
- The possible process and functional areas of power generation companies which can be redesigned or automated using IT systems.
- Key characteristics of IT systems which has the potential to enhance the impact on the performance of power generation companies.
- The knowledge of the functional processes of power generation companies and their influence on the overall performance of the enterprise.
- The understanding of the possibilities of deployment of IT systems in power generation companies.

The constraints of implementing enterprise wide IT systems in power generation companies. The IT deployment model, is developed by understanding the typical business requirements of the IT systems to positively influence strategic and operational requirements of business organizations. These are mapped into the four quadrants as shown in the figure 3. The four grid model indicates the relationship between operational excellence and strategic excellence are developed.

- **Strategic Alignment** - Achieving strategic excellence by crafting innovative strategies and backing them with excellence in operations as well.
- **Planning, Measurement and Analysis -** Developing creative and rigorous business plans based on the measurement and external business performance, market positions etc.
- **Operations and IT Systems -** Focusing on improving the operational performance of the enterprise by excellent management techniques or deployment of IT systems for facilitating effective operations management.
- **Performance Improvement in business Effectiveness -** Deployment of continuous improvement in operational activities.

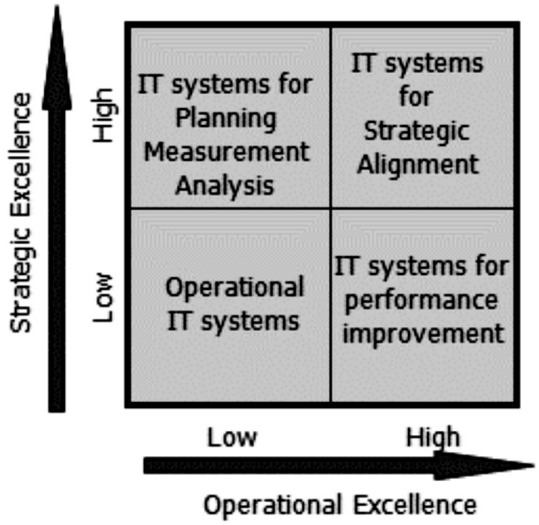

Figure 3: IT Deployment Model
Source: author

The next step involved understanding the business requirement of the Indian Power generation companies, which is a combination of strategic requirement and operational requirement.

Strategic requirements are derived by having an understanding of the industry drivers, industry structure and the strategic focus of the power generation systems. Some of the factors driving the Indian Generation sector are rapid growth and expansion, growth rate, complex projects with multiple partners, major gap between demand and supply etc. Industry structure is analyzed by Porter's five forces model and Strategic focus involves focus on business process design, organizational structure and processes, sustainability through environmental management practices etc. Operational IT requirement of Indian Power Generation are asset management, capacity management, manpower deployment and management of quality of operations.

Using this understanding, finally the IT deployment model is formulated. This model intended to address the following questions

- Deployment Strategy – What IT systems should be deployed for achieving different business objectives

- Deployment Approach – How the IT systems should be deployed in terms of coverage, processes and approach.
- Deployment Phasing – When the different IT systems should be deployed in terms of what should come first and what next.

The following are the IT systems which will impact the strategy of the organization:

- Power Corporations focusing on Strategic Alignment need to focus on activities such as Redesigning the organizational functions and tasks, Managing effective capacity Utilization, Ensuring right engineering, Business focus, Productivity Improvement.
- Operations focusing utilities must focus on activities such as effective deployment of man power, Knowledge Management, Operations Practices Enhancement, Capital Budgeting, management Information Systems, Plant Operations etc.
- The focus of Performance Improvement Systems are looked from the Key Process Indicator s (KPI) of financial, operational, Customer and employment concern and employee and Training Perspective (Kaplan & Norton). Accordingly, the corporations can have measures such as operational expenses, maintenance cost, fuel cost, Percentage increase in production capacity, Percentage increase in capacity utilization, number of regular penalties, number of injury accidents, number of employee benefits available.
- Planning, Measurement and Analysis systems include having MIS system in place, integrated MIS Policy, MIS interface with digital control system, management of regulatory requirements etc.

The following are the limitations of the Research:

- When developing the framework, several important external factors influencing the IT investments such as policy changes in the government, initiatives by external stakeholders were identified.. These factors were not considered.
- The weights agreed on for measures of IT business-value may change when the IT adoption changes
- As indicated by Clemons,1991, user adoption, future benefits and competitive impact are difficult to forecast based on the information technology usage.
- Even though IT investments are happening from the inception of KPCL, the data on business performance over select period has been taken for analysis to find out the trends over a period of time. However, similar approach have been used by researchers of the IT impact study.

Scope for further research

The power sector unlike many other sectors has very strong operational linkages between the upstream and downstream players in terms of potential to influence the performance of other entities in the value chain. The transmission company operations have strong operational linkages to influence the operational performance of the generation company as well as the distribution company. Similarly the performance of the generation company and the distribution company has strong potential to impact the other two entities. This linkage is reflected in the IT investments as well. For example the IT systems for managing the load and maintenance schedules of a power generation company will be more effective if it has linkages with the IT systems of transmission and generation companies to understand the demand and load patterns. Hence, the research highlights how each of the research outputs can be used in these companies and makes the IT investment impact the business operations of power transmission and distribution companies.

Conclusion

The major contribution of the research is the formulation of a methodology that would facilitate to measure the impact of IT on business performance. It also provides a practical management tool to address the question of assessing the business performance in a power sector using IT. The research highlights certain key issues that require managerial attention for subsequent action. Finally, it provides an IT deployment model for future investments in power generation.

To conclude, this study has endeavored to contribute to the growth of knowledge by understanding the IT systems in Power generation organizations and

developed an IT deployment model for further research. The main objective of the research was to understand the IT systems in KPCL, which involved developing a framework for measuring the IT systems and propose areas for improvement. The impact model developed for Power Generation sector is comprehensive, accurate and holistic, which will address the IT usage and IT investment questions and gives value-proposition to Power generation systems.

REFERENCES

1. Andrew McAfee, Erik Brynjolfson., 1997, "Investing in the IT-That makes a competitive difference", Management Science.
2. Alexis Leon, "Enterprise Resource Planning", Tata McGraw- Hill Publishing Company Limited, ISBN 0-07-463712-6.
3. Anieah Barua, Charles H Kriebel, Tridas Mukhopadyay,1995," Information Technologies and Business Value: An analytic and empirical investigation", Information Systems Research, Volume 6, Issue 1.
4. Anutosh Maitra, Rahul Walawalkar, Anil Khanna, "An assessment of information technology for power sector", Tata Infotech Limited .
5. Barbara Farbey, Frank Land, David Targett, 1992, "Evaluating investments in IT", Journal of Information Technology, Vol 7, pp.109-122
6. Bailey D.E., 1982, "Methods of Social Research", New York, USA.
7. Bernard C.M. Cheng, 2008, "Quantifying Sustainablility for Industry: A NewZealand Electricity Power Sector Case Study", Thesis, Auckland University of Technology.
8. Brenda Whittakar, 1999," What went wrong? Unsuccessful information technology projects", Information Management and computer Security, pp. 23-29.
9. B.V. Chowdary, 2005," Information Technology in the Caribbean Manufacturing firms: An Industrial Survey, Global Journal of Flexible Systems Management, Vol 6.
10. Buss, M.D.J., 1983, "How to Rank Computer Projects.", Harward Business Review.
11. Butler Cox, 1990, "Getting Value from Information Technology", Research Report.
12. Chip Gliedman, Adam Brwn, Sept. 29, 2004, "Defining IT Portfolio Management", Forrester.
13. Clemons Eric K., Weber Bruce W, 1990, "Strategic Informaton Technology Investments: Guidelines for Decision Making", Journal of management information system.
14. Craig Symons, April 12, 2004, "The IT Balances Scorecard: Operational Excellence Metrics", Forrester Best Practices.
15. Donald R. Cooper, Pamela S. Schindler, "Business Research Methods", Tata McGraw - Hill Edition 2003, ISBN 0-07-053247-8.
16. Daniel J. Power, September 1983, "The Impact of information management on the organization: Two Scenarios", MIS Quarterly.
17. Denis Leonard, Rodney McAdam, 2003, "An evaluative framework for TQM dynamics in organization", International Journal of Operations and Production Management, 652-677.
18. Detmar Straub, Moez Limayem, Elena Karahanna – Evaristo, August 1995, "Measuring System Usage: Implications for IS Theory Testing", Management Science, Vol 41, No 8.
19. Dilrukshi, Welikala, Sohal, Amrik, Welikala And, Dilrukshi and Sohal, Amrik S., 2008, "Total Quality management and employees", Total Quality Management and Business Excellence.
20. Dinesh Kumar August 2007, "Implementing IT Solutions", POWER LINE.
21. Edward Deming W., 1992, "Out of the crisis", Cambridge University Press.
22. Eric Brynjolfsson, Lorin M. Hitt, August 1991, "Beyond the Productivity Paradox".
23. Eric Brynjolfsson, 2000, "Changes in organizational Structure and Performance".
24. Everett E. Adam, Jr. Ronald J Ebert,1992,

"Production and Operations Management: Concepts, Models and Behavior", 5th Ed.., PHI Pvt. Ltd., ISBN -81-203-0838-7.

25. Gerald Matlin, Septembet 1979, "What is the value of investment in information systems?", MIS Quarterly.
26. Geunjoo Lee, Ph.D., February 1999, "The Performance impacts of information technology in public organizations: The case of state governments", Indiana University .
27. Gloria Barczak, Erik Jan Hultink, and Fareena Sultan, 2008, "Antecedents and Consequences of Information Technology Usage in NPD: A comparison of Dutch and U S Companies", The Journal of Production and Innovation management.
28. Grasso, 2009, "Physical Asset Planning", Dissertation.
29. Harris, S.E. and J.L.Katz, 1988, "Profitability and information capital intensity in the Insurance Industry", Proceedings of the Twenty –first Annual International Conference on System Sciences.
30. Himani Thukral, April, 2008, "Right Solution: Transco Successfully implements ERP", Power Line.
31. Hiroshi Ono and Madeline Zavondy, January 2004, "Gender differences in Information Technology Usage", Working Paper.
32. James A O'Brien, George M. Marakas, 2007, "Managing Information Systems", ISBN: 0-07-062003-2.
33. James Bacon, September 1992, The use of decision criteria in selecting Information Systems/ Technology Investments, MIS Quarterly.
34. Jed Dempsey, Robert E. Dvorak, Endre Holen, David Mark, and William F. Meehan III, 1997, "Escaping the IT abyss", The McKinsey Quarterly, No.4.
35. J. F. Nel, 2004, "Information Technology Investment Evaluation and Measurement Methodology (ITIEM) - A Case Study and Action Research of the dimensions and measures of the IT-Business Value in Financial Institutions", Dissertation, Queensland University of Technology.
36. John Hauer, Tom Overbye, Jeff Dagle, Steve Widergren, 2007, "Advanced Transmission Technologies", National Transmission Grid Supply Issue Papers.
37. Jum C. Nunnally, "Psychometric Throry', McGraw Hill, Inc, 567890 MP 743210.
38. Kenneth J. Calhoun, James T.C. Teng, Myun Joong Cheon, 2002, "Impact of national culture on information technology usage behavior: an exploratory study of decision making in Korea and the U S A", Behaviour and Information Technology, Vol 21, No 4.
39. Kenneth C. Laudon, Jane P. Laudon, 2007, "Management Information Systems", ISBN 81-7758-941-5, Pearson Education Inc.
40. King, JL., Schrems. EL, 1978, "Cost-Benefit Analysis in Information Systems", ACM Computing Survey.
41. Kling. R, March 1980," Social analysis of Computing: Theoretical perspectives in recent empirical research", ACM Computing Surveys.
42. K.V. Narasimha Murthy and Antonette D'Sa, 2002, "Karnataka's Power Sector & Suggested Ways Forward Report", International Energy Initiative.
43. Lehr, Lichtenberg, 1999, "Knowledge economy, information technologies and growth".
44. Luigi Paganetto, Leonardo Becchetti, David Andres, 2004, "The impact of IT investment on Productivity and efficiency", Knowledge Economy.
45. Magnus Gammelgard, September 2007, "Business value assessment of IT investments". Royal Institute of technology.
46. Manish Agarwal, July 2007, "View Point", Power Line Report.
47. Matlin, G., 1979, " What is the value of investment in information system?", MIS Quarterly, Volume 3, Number 3, 1979.

48. Martin D J Buss, January-February 1983, "How to rank computer projects", Harward Business Review, PP.118-125.

49. Mayadhar Swain, March 2007, "Cost Effective small hydro power plants", ELECTRICAL INDIA.

50. McFarlan, F.W., January-February 1974 "Portfolio approach to information systems", Harward Business Review.

51. Michael Hammer, July – August 1990 "Reengineering Work: Don't Automate, Obliterate" Harvard Business Review.

52. Michael E Porter and Victor E Millar, July-August 1985 "How Information Gives You Competitive Advantage" Harvard Business Review.

53. Michael E Porter, November – December 1996," What is Strategy" Harvard Business Review.

54. Michael J. Earl, 1989, "Management Strategies for Information Technology", Prentice Hall.

55. Miller J. 1989," Information Systems effectiveness: the fit between business needs and system capabilities: In Proceedings of the Tenth International Conference on Information Systems, Boston.

56 MO ADAM Mohamood and Gary J Mann, Summer 1993,"Measuring the organizational impact of information technology investment: An exploratory Study", Vol 10, No 1, PP 97-122.

57. M.S. Shashikala, M.S. Balasundaram, Dr. K.L. Puttabuddhi, Dr. Bhargav and S.V. Ramachandra, May 2008, "Power Quality and Reliability Costs Using Demand Side Management", Electrical India.

58. Narsi Santhanam, 2010, "Status of KPCL's solar PV power plants in Karnataka", EAI Report.

59. Nedda Gabriela Olazabal, 2002, "Banking: The IT Paradox" The Mckinsey Quarterly, No.1.

60. N.M. Lokhande & V.S. Jape, May 2008, "Energy Conservation Measures", Electrical India.

61. Neumann & Sprauge R.L., 1994 "Competitive advantage, Strategis Resources, and information technology: An empirical study", International conference on Information systems.

62. Parker, M, Benson R.J. & H.E. Trainor, 1988, "Information Economics : Linking Business Performance to Information Technology", ISBN 013465014, Prentice-Hall

63. Patrica Joan Reed, 1998, "Impact of information technology on decision-making in the workplace", University of Toronto.

64. Paul A. Strassmann, September-October 1976 "Managing the costs of information", Harward Business Review. PP 133-142.

65. Peter Weil, 1992, "The relationship between investment in information technology and Firm Performance: A Study on the valve manufacturing sector", University of Melbourne, Information Systems Research.

66. Peter Weill, Mani Subramani, Marianne Broadbent, IT infrastructure for Strategic Agility, Working Paper, April 2002.

67. Peter G.W. Keen, March 1981, "Value Analysis: Justifying Decision Support Systems", MIS Quarterly.

68. Pratim Datta, December, 2003, "Where all the flowers gone? A modular systems perspective of IT infrastructure design and productivity", Dissertation.

69. Pooria Assadi, 2005, "Evaluation of information technology investments in the wood industry".

70. Rajiv Goyal, P.N. Jha, Dinesh Kumar, S. Mohan Ram, Jayant Sinha, August 2007, "Getting IT Enabled", POWER LINE, August 2007.

71. R.P. Mohanty, Lakhe R.R, 'Total Quality Management: Concepts, Evolution and Acceptability in Developing Countries', 1994, International journal of quality and reliability management, Vol 11, Issue 9.

72. Remenyi D., A. Money and A Twite, 1995, "The effective measurement and management of IT costs and benefits", Oxford Publications.

73. Ralph Stair, George Reynolds, 2008, "Principles of

Information systems: A Managerial Approach", ISBN: 81-315-0320-8.

74. R.C. Bansal, April 2008, "Power Restructuring", Electrical India.

75. Reya Ramdev, September 2011, "Technology Improvements", Power Line.

76. Richard I. Levin, David S Rubin, 1997, "Statistics for managers", 7th Edition, Prentice- Hall, Inc., ISBN 81-203-1235-X.

77. Ritu Agarwal and Elena Karahanna, December 2000, "Time flies when you're having fun: cognitive absorption and beliefs about information technology usage", MIS Quarterly, Vol 24 No 4.

78. Robert E. Dvorak, Endre Holen, David Mark, and William F. Meehan III, 1997, "six principles of high performance IT" The Mckinsey Quarterly, No.3.

79. Robert S Kaplan and David P Norton, January-February 1996, "Using the balanced Scorecard as a Strategic Management System", Harvard Business Review.

80. Rodney McAdam and John McLean, July 2002, "The Strategic "pull" and operational push" of total quality management in UK regional electricity service companies.

81. Rolf-Dieter Kempis and J.rgen Ringbeck, 1998, "Manufacturing's use and abuse of IT" The Mckinsey Quarterly, No.1.

82. S.P. Gupta, M.P.Gupta, 2005," Business Statistics", Sultan Chand & Son, Fourteenth Edition, ISBN 8054-327-7.

83. Sarv Devaraj, Rajiv Kohli, March 2003, "Performance Impacts of Information Technology: Is Actual Usage the Missing Link", Management Science/Vol.49, No 3.

84. Sarv Devaraj, Rajiv Kohli, 2000, Information technology Payoff in the Health-Care Industry: A Longitudinal Study, Journal of Management Information Systems, Volume 16, Issue 4.

85. Stiroh, 2003, "IT Investment and Firm Performance in U.S. Retail Trade".

86. Soh, C and L.M.Markus, 1995, "How IT creates business value: A process theory synthesis", 16th International conference of Information Systems, Amsterdam, Netherlan.

87. Turban, Rainer, Potter (2003), Information Technology, John Wiley & Sons, Inc. ISBN 9814-12-691-8

88. V.J. Gosbell, March 2000, "Harmonic distortion in the electric Power system", Technical note.3.

89. Vinod Kumar Garg, N.K. Venkitakrishnan, Prentice-Hall of India, ISBN- 978-81-203-2254-7.

90. Ward, J.P. Taylor and C. Bruce, 1996, "Evaluation and realization of IS/IT benefits: an empirical study of current practices.", European Journal of Information System.

91. Ward J., Griffiths, P and Whitemore, P, 1990," Strategic Planning for information systems", John Wiley & Sons.

92. William Davig, Steve Brown, Terri Friel, Kamblz Tablbzadeh, 2003, "Quality management in Small Manufacturing", Industrial Management and Data Systems, PP 68-77.

93. Wilfred W.Wu, Number 1, 2006, "Changes in MIS research: status and themes from 1989 to 2000", International Journal of Information Systems and Change Management", Vol1.

94. Yin, R.K., 1994, "Case study research: Design and methods (2nd ed.).", Thousand Oaks: Sage Publications..

95. ----------, August 2007, "Integrated Approach", POWER LINE.

96. ----------, August 2008, "IT Roadmap: Power Companies increasingly turn to IT Sector ", Power Line.

97. ----------. August 2008. "Bringing in change", Power line.

98. Proctor, 1995, "Business Modelling on a personal computer", Management Decision, PP 38-43.

99. Keen, 1993, "Decision support systems: Putting thory into practice", Prentice –Hall, PP 57-73.

100. McFarlan F.W., McKenney J L, 1983, "Corporate Information Systems Management".

101. Earl M.J., 1994, "The new and old of business process design", Strategic Information Systems, PP 21-32.

100. The Planning Commission of India, various reports on the Indian economy and five year plans.

101. McKinsey Global Institute, various reports on India and its different sectors.

102. McKinsey Quarterly 2001 No.4, reports on India and its different sectors.

103. PMBOK, Project Management Institute, 2000 Edition.

104. Reports, Orissa Power Transmission Corporation Limited (OPTCL) and GRIDCO, 2007.

105. IT Task Force Report for Power Sector, Infosys report for the Ministry of Power review, 2002.

106. Technology: Enabling the Transformation of Power Distribution, CSTEP and Infosys Report, 2009.

107. Wikipedia.org

108. Reliance review of energy markets, 2004.

Webliography

The websites provided references which are available on-line and helped in better understanding of the research work. The information were retrieved during the month July, 2011.

1. www.karnatakapower.com - The official website of KPCL, which provides project information, financial information, technical information and technical details of the projects.

2. www.indiaenergypotal.org - The Indian Energy Portal website provides insight into Indian as well as global energy scenarios in terms of resources, demands, supply and installations, reforms and restructuring.

3. www.powermin.nic.in - The official website of the Ministry of Power, Government of India provides information on Indian electricity scenario, acts and notifications, research and training, energy conservation measures and most importantly new government policies and programmes. The website provided complete information about policies such as tarisff policy, rural electrification policy, amendments etc l.

4. www.cercind.gov.in - The central electricity regulatory commission (CERC) website gives information regarding electricity tariffs and transparent policies regarding tariffs. Various reports of market monitoring such as Short-term Power Market, Latest regulations, Analysis of various reports were also available in the website.

Information Retrieval: July, 2011