Executive Summary

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.

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. 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.

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. What type of Information Technology investments can lead to productivity, performance and quality 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 literature survey and the analysis of the status of Information Technology (IT) in the Indian Power Sector indicated that the adoption of IT in the power generation is not wide spread. Although there have been substantial investments in power generation capacity, these are not accompanied by a clear strategy for enhancing operational efficiencies through adoption of IT systems. So it is evident that power generation sector needs to adopt IT systems to enhance the productivity of operations.
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

1. To identify the areas of information technology that has influenced the productivity.
2. To find the areas of performance which are influenced by the adoption of information technology.
3. To examine the specific areas of quality and project management which are influenced by the adoption of information technology.
4. To assess the impact of the investments in information technology by KPCL

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

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.

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.

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.

The hypotheses used for the research work are:

H₀₁: Use of IT has not resulted in better productivity of the organization.
H₁₁: Use of IT has resulted in better productivity of the organization.
H₀₂: IT has not enabled improvement of performance of the organization.
H₁₂: IT has enabled improvement of performance of the organization.
H₀₃: IT has not resulted in improvement of quality of the organization.
H₁₃: IT has resulted in improvement of quality of the organization.
H₀₄: Use of IT has not resulted in better project management of the organization.
H₁₄: Use of IT has resulted in better project management of the organization.
H₀₅: IT usage does not vary by project location.
H₁₅: IT usage does vary by project location.
H₀₆: IT usage has not impacted the performance of KPCL.
H₁₆: IT usage has moderately impacted the performance of KPCL.

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

• 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.


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.

The study used arithmetic mean to represent the central tendency of the population. The dispersions are measured by standard deviation, skewness and kurtosis. The results indicated that there is a homogeneity of the series and the distribution represented the mean. Pearson coefficient, Regression analysis are used to measure the relation between IT usage and investment and business benefits.

In order to understand the variation in the usage of IT in project locations of KPCL, ANOVA is conducted. The dimensions used were Productivity, Performance, Project management and quality management in different project locations of KPCL.

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 from 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.

**Analysis of the research findings**

• 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 headquarters. 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.
- 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.
- In KPCL, packages like IIMS has resulted in reducing the material procurement cost.
- 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.
- 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.

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 the study indicates that integration of processes gives greater benefits.

• **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.

• **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.

• **Application Rationalization** - The applications are built over a period of time in KPCL 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.

• **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 final outcome of the research is development of the conceptual model for the deployment of information technology solutions in Power generation Companies. 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.

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.

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