Impact of investments in Information Technology on the Performance of Power Generation companies: The case of a Power Generation Company in India

Dr Padmalatha N A[a] , Dr Kadambini Katke[b] , Sumitha Javali[b]

Abstract

The power sector is considered very critical for the economic development of the country. Because of this criticality, it is essential that the sector continuously achieves 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. Although there have been substantial investments in power generation capacity, the impact of the investment is not as expected. It is important to understand, before any such investments on IT are made, what type of Information Technology investments can lead to performance improvements and how to measure the effective usage of Information Technology. The focus of the article is to understand the different kind of investments and how to measure the investment in power sector.

Keywords: Information technology investments; Information technology business performance; Power generation companies

[a]Dr Padmalatha N A	[b] Dr Kadambini Katke	[c] Sumitha Javali
Faculty Member,	Faculty Member,	Faculty Member ,
Dayananda Sagar College of Arts, Science and Commerce, Bangalore	Dayananda Sagar College of Arts, Science and Commerce, Bangalore	Dayananda Sagar College of Arts, Science and Commerce, Bangalore
Shavige Malleshwara Hills, Kumaraswamy Layout, Bangalore, India - 560 078	Shavige Malleshwara Hills, Kumaraswamy Layout, Bangalore, India - 560 078	Shavige Malleshwara Hills, Kumaraswamy Layout, Bangalore, India - 560 078
Tel No: +91 80 42161715	Tel No: +91 80 42161715	Tel No: +91 80 42161715
Telefax: +91 80 26660789, 42161764	Telefax: +91 80 26660789, 42161764	Telefax: +91 80 26660789, 42161764
E-mail: hegde_padmalatha@yahoo.com	E-mail: kadambini_katke@yahoo.com	E-mail: sumithajavali@gmail.com

1. Introduction

Information Technology (IT) has a great potential to make the value chain of an enterprise competitive. As Porter(1996) has highlighted the influence of Information Technology spreads across all the elements of the value chain of an enterprise. The primary impact of this influence is in improving the efficiency of the activities or in reconfiguring the activities of a value chain. The improvement in the efficiency of the activities of a value chain leads to operational excellence and the reconfiguration of the activities of a value chain leads to strategic differentiation. Overall since the usage of IT systems is to make operational improvement as well as strategic differentiation, the impact of this on the performance of the enterprise is expected to be positive.

The study and assessment of the impact of information Technology on different aspects of business performance has been the focus area of researchers for sometime. The general trend of this research activity has been to look at the impact at the firm level as well as at the sectoral level. In some instances attempts have been made to even study the impact on the economy as well. The conclusions of these researches have been varying, with some bringing out the positive impacts and some indicating not so positive impacts. The underlying causes sited for these differences too have been many.

The power sector of India has been largely under the direct control of government. Like most areas of government, the management techniques, approach to measuring the performance etc. of this sector has been under scrutiny. The power sector is considered very critical for the economic development of the country. With liberalization spreading many spheres of Indian economy, the power sector has been under scrutiny for its ability to hasten the economic development.

The improvements in the power sector need to take place at multiple levels. As has been recognized widely, the most critical element would be at the policy level. However it has been widely understood that although policy changes would drive management, investment and capacity enhancement of the power sector, it is equally important to encourage operational excellence of the power sector separately.

To understand the needs of bringing in operational excellence in the power sector the first step would be to formulate what would constitute operational excellence. It has been widely understood that one of the drivers for operational excellence is the spread of Information Technology. So the second critical element of driving operational excellence would be to understand the penetration of Information Technology and its impact on performance.

Over the past decade, the use of information technology in the power sector has moved from a mere electronic data processing covering only certain areas of the operations, to several areas of operations as well as to integration of business processes and production. It is now increasingly being adopted as an integrated /interfaced enterprise –wide system touching almost all operational areas and using information and communication technologies for real-time management of networks and delivery system

Information Technology (IT) in Power Sector

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. These general areas for IT investment in the power sector are for

- 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 fulfil management and regulatory requirement areas in terms of effective Management Information

System for decision making, accountability, 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.

The keys areas of improved productivity of power sector are optimizing business operations using IT, effective data acquisition & control processes, leveraging Customer Relationship Management for increasing debt recovery, narrowing the gap between the volume billed to the utility and that to the consumer, managing unbilled and ghost accounts, improving the effectiveness of meter reading. Productivity improvement also involves managing employee costs and staff deployment ratio in terms of fieldwork and office work.

In power generation sector, operations management, management reporting for financial performance and asset management have seen considerable IT intervention. The areas that need to be addressed for effective usage of IT are fuel and environmental management. In power transmission sector, IT has been used in management of the network operation, and for management & monitoring systems primarily in the load dispatch centre. In distribution the IT initiatives are mostly cantered on billing, collection, theft control and customer care. These companies also have successfully used spot billing, call centre and MRI billing. In power distribution companies, Information Technology has been used for customer relationship management and financial management. The areas that could use IT effectively are demand forecasting, facility management and load management.

The key issues in the use of IT in power generation companies relate to inadequate research on usage of IT systems, heavy 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.

There is a need for focus on comprehensive IT strategy to address performance improvement and cost effectiveness. Process improvement and change management for more effective use of IT in generation is also required. A clear IT strategy focused on achieving business performance through adoption of IT systems, formal project management and review process is required to be in place. Lack of preparedness and poor process system are common causes of failure. In addition, lack of focus on understanding the solutions available and learning from the success of companies in other sectors is also a reason for lack of adoption of IT systems in these companies. Because of these factors full system use, future extension and technology innovations are restricted.

The investment options for IT systems in power generation

Information Technology investment can be made in different ways. There are investments in Information Technology applications, software development, and IT infrastructure which is required to run the software/applications effectively. The other area of

investment is for services associated with IT. There are multiple options for each of these and there are Power Systems specific IT applications and solutions as well.

The IT investment in core operational areas and in support functions of a state owned Power Generation Company is given in Table1. Though we do not have good benchmark against which to evaluate the investment in power generation companies, the steady rate indicates the reliance on IT to improve the efficiency and effectiveness in power generation.

Table 1
IT investment: 1990-2008

Year	Budgeted capital expenditure on information technology in crores	Actual capital expenditure on information technology in crores	Year	Budgeted capital expenditure on information technology in crores	Actual capital expenditure on information technology in crores
1991-92	0.22	0.41	2000-01	6.04	1.08
1992-93	1	0.19	2001-02	2.03	1.34
1993-94	1	0.36	2002-03	2	0.03
1994-95	1	0.16	2003-04	10	1.38
1995-96	1	0.08	2004-05	10	.05
1996-97	1	0.69	2005-06	6	0.51
1997-98	2.5	0.57	2006-07	4.41	1.41
1998-99	2.58	2.67	2007-08	7.7	2.48
1999-00	2.53	0.04			

- The core functions - Some of the Systems for core operations in Power Generation supports the following functions: Corporate Planning, Project Planning, Scheduling and Execution, Engineering, Procurement and Commissioning, Corporate Contracts and Purchases, Plant level Procurements and Materials, Plant Operations, Plant Maintenance, Fuel Management, Finance Accounts and Costing, Enterprise Asset Management.
- Support activities /functions - Some of the Systems for support activities/functions consists of the following functions: Efficiency Management, Bank Guarantee Management, Consultancy and Training, Corporate Communications, Legal,

Secretarial and Administration, Employee Retirement benefits and Pensions, Healthcare for employees, Ash Utilization.

- The Information Technology infrastructure - The IT infrastructure required for effective operations of the IT systems and applications are networks environment, Data centre and disaster recovery centres, Data Storage, High performance servers, Client side hardware, Security Systems, Systems Management of network and servers

2. Background

There are a number of factors which must be focused on for deciding the performance of the firm. Research has shown that firms which are more focused can expect greater benefits from IT investments. One of the earliest evidenced researches on IT investments can be traced into Kin and Schemes[ ]. Their classification on I performance mainly surrounds transactional benefits such as record keeping and calculating efficiencies. Bailey (1982) was among the first to shift their perspective towards operational quality rather than efficiency by developing a measure for IT related user satisfaction.

However, it was the work by Porter and Miller(1985) research that first raised the awareness that IT could be used to leverage a firm's strategic and competitive presence. However, while financial and operational measures are important they are not enough to address the effectiveness of IT investments. Hence, a comprehensive approach which measures financial, operational, maintenance, strategic and operational quality benefits from the IT investments must be examined.

As given in the previous research, the framework classifies benefits in terms of the dimensions given in the Figure below.

- Financial Performance: The Generally Accepted Accounting Practice (GAAP) based accounting and financial measures are designed to provide reliable quantifiable factors by which organizational performance can be measured. Examples of Operational measures include Return On Investment (Brynjolfsson and Hitt,1991)
- Operational Performance: Operational Benefits measures are marked by the ability to deliver significant cost advantage from the operational use of IT systems. Examples of Operational processes include inventory turnover, capacity utilization (Barua et al. 1995)
- Operational Quality Performance: Operational Quality processes refers to the reliability of business processes and dimensions are revealed through first hand data collection. Example of operation quality measures include reduced training time, improved information exchange, service quality etc.(Laudon and Laudon, 2007 and Barua et al.,1995).
- Strategic performance: Strategic performance measures are used by executives to enhance the organization's objectives. Examples of strategic performance

measures include decision making, Process Innovation, Value addition etc.(Laudon and Laudon,2007)

- Maintenance Performance: Manufacturing facilities are becoming more information enabled. Maintenance benefits of information technology usage include Management of maintenance inventory, Understanding the cost of maintenance, Planning of maintenance personnel etc. (Tukral,2008)

This research study intends to find answers to these questions in a systematic fashion by developing frameworks as indicated in the fig1.

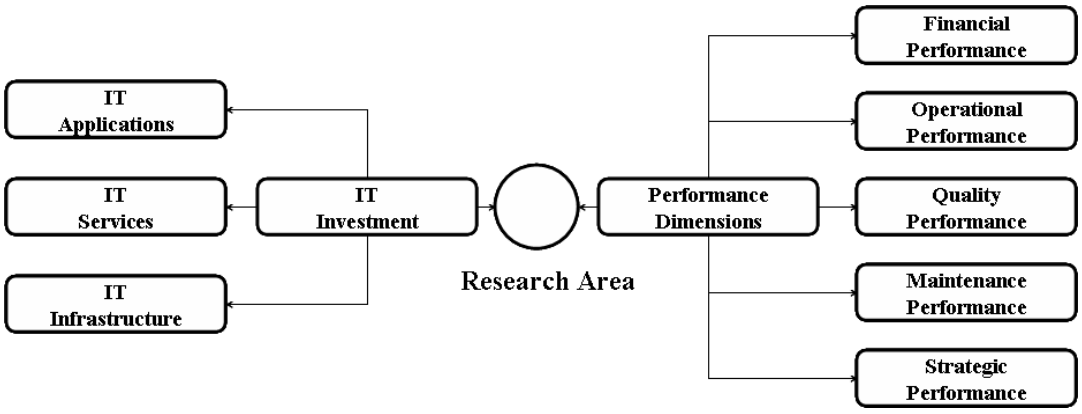

Fig. 1: Framework of the research area
Source: Author

To measure the operational productivity, the variables used are better visibility, marginal procurement, vendor management, marginal cost of production, total cost of ownership and inventory turnover.

- Operational quality measures include adding value to existing customer relationship, improved work environment, adding value to existing supplier, improved information exchange, secured information exchange, reduced training time and improved service quality.
- Strategic productivity variables are management planning, decision making, value addition, organizational flexibility, organizational capability, identify/ tap geographical areas.
- Financial productivity is measured by analyzing cash flow, accounting transaction error reconciliation, preparation of financial statements, understanding of operational costs, management of working capital, understanding of working account payable, management of account receivable.
- To measure the maintenance productivity , the variables used are- Preventive maintenance of Plants/Machinery, Management of maintenance inventory, Improved the uptime of plants/machinery, understanding the costs of maintenance, safety of maintenance operations, Planning of maintenance personnel, Better planning and scheduling of maintenance of plants/machinery and managing operational and maintenance expenses.

3. Hypotheses

Organizational performance measures are used to measure the productivity core and support functions.

3.1. Operational Productivity Measures: Productivity measures are marked by the ability to deliver significant cost advantage to power generation utility from the use of information technology. Examples of operational processes include inventory turnover, capacity utilization (Barua et al., 1995)

Therefore, we expected that

H1: Use of IT has resulted in better operational productivity.

3.2. Financial Measures: Financial measures are designed to provide a reliable measure by which organizational financial productivity can be credibly evaluated. These measures reflect a direct impact (e.. eliminating transaction error, management of working capital, management of account receivable, management of capital assets) and an immediate impact (e.g. analysing cash flow, Faster preparation of financial instruments). Therefore,

H2: IT usage has resulted in better financial productivity.

3.3. Operational Quality Measures: Operational quality is achieved through the definition of quality goal, monitoring the process that can achieve quality and reviewing the process. Operational quality in this research refers to the reliability of business processes and human resource services. Examples of such measures include organizational work environment, improvement in information exchange and improved service quality. (Laudon and Laudon, 2007)Thus, our third hypothesis was:

H3: IT usage has improved operational quality productivity.

3.4. Maintenance Productivity Measures: Maintenance productivity measures are designed to improve the core activity of equipment maintenance, reduce the time involved in carrying out the maintenance activity and provide better tracking and maintaining of the equipment. Examples of measures include understanding of maintenance, management of maintenance and planning of maintenance. (Tukral.2005) Therefore,

H4: IT usage has enabled better maintenance productivity.

3.5. Strategic Productivity Measures: Strategic measures are the variables for superior strategic position of the organization. Strategic measures try to reflect to what extent power utility has been able to create value propositioning for the employees in the organization.(Laudon and Laudon, 2007)

Therefore, we expected that

H5: IT usage has changed strategic productivity.

4. Methodology

4.1. Pilot Study

Before conducing the survey, the instrument was given to review for its appropriateness to the firm's power generation. These comments resulted in refinement of the instrument in terms of its length, readability and clarity.

4.2. Samples and Collection

This study employed a six instrument field survey of state owned power generation organization. The organization was chosen for the study based on the following considerations: diversity of operations in terms of power generation; large scale operations in terms of installed capacity; distributed organization with operations in multiple locations ; maturity in terms of adoption of information technology.

The number of persons to be enumerated has been decided on the basis of the total size of the population and the breakup of the working population. The sample consisted of 134 users and was justified on the basis of soundness of sampling theory in ensuring randomness and sub sampling across hierarchies. Kelvin Mayor Olkin(KMO) test was conducted for the data set and the computed value was found to be 0.516, which is an indication of sampling adequacy for the study.

4.3. Reliability of the scale

In order to test the reliability of the overall instrument, Cronbach's coefficient was computed using data on the productivity measures. The reliability coefficients are calculated and given in Table 2.

Table2

Reliability statistics for study variables(134)

Group Name	**Mean**	**Variance**	**Standard 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	47.990	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

All of the five multi-scale constructs used have coefficients of 0.7 and higher- indicating all the constructs have good reliability.

5. Research findings and Discussions

All hypotheses in the theoretical model were statistically significant as shown in fig 2. The claim that operational, financial, strategic, operational quality and maintenance productivity were positively affected by information technology was fond to be significantly supported. Although, the relationship between maintenance productivity and IT usage deserves special attention. Furthermore this and operational productivity experienced a greater impact to IT usage.

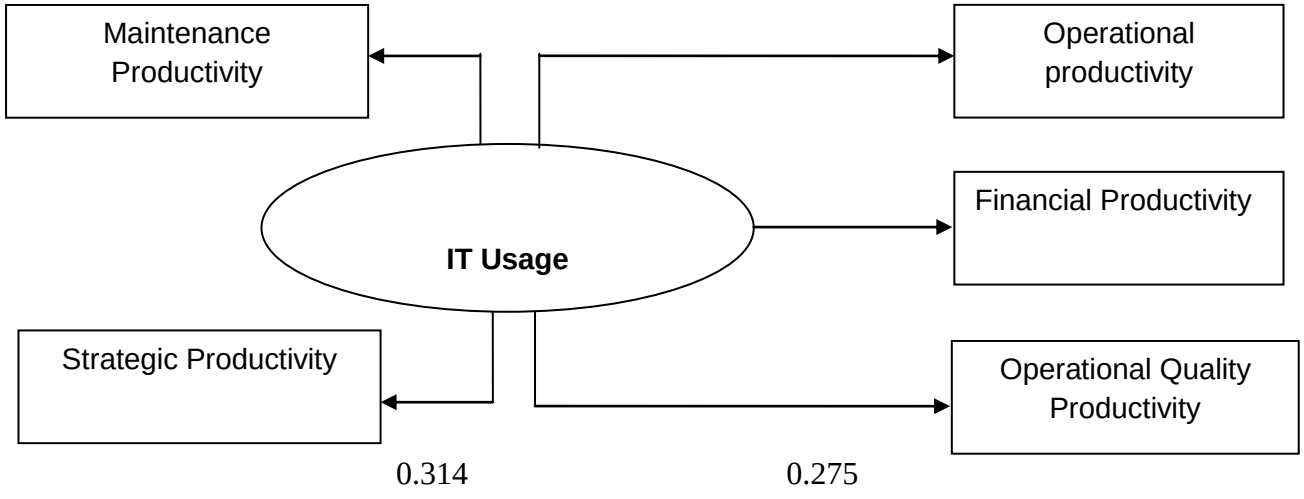

Fig.2. IT usage and Productivity
Correlation is significant at the 0.05 level (1-tailed)
Source: Author

Consequents of productivity dimensions are given below:

- **Financial Productivity-**Financial system packages 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 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.

6. Suggestions for improvements

Based on the analysis of results, understanding the capability of the IT systems , need of the Power Sector and global practices the following suggestions are drawn by the researcher.

- **Integration of business processes** - The results from the research data indicates that integration of processes gives greater benefits. 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.
- **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.
- **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.
- **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, which can be attempted, but the better way for the utility will be to evaluate the possibilities of deploying integrated systems like ERPs.

7. Limitations of the research

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 the utility, 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.

8. 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.

9. Conclusion

In this paper, an attempt has been made to establish the need for effective mechanisms make the different kinds of Information Technology related investments in the Power sector. It has been observed from the literature that power utilities have made major gains in terms of productivity through the use of information technology investments. To achieve overall efficiency in the sector it is very important that the Power generation sector also adopts IT effectively, especially in the field of energy generation management. Based on the research findings and assessment of different frameworks used by many researchers, a framework to measure the performance of power generation companies and establishing their relationship to IT investments has been proposed. The results so obtained by deploying the framework have the potential to become a tool for strategic planning for IT investments.

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