

## The Impact of Investment in Information Technology on the productivity of Power Generation Companies

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### 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 in IT are made, what types of Information Technology investments can lead to performance improvements and how to measure the effective usage of Information Technology. The main focus of the article is to understand the different kinds of investments and how to measure the investment in power sector.

**Keywords:** *Information technology investments, Information Technology Business Performance, Power generation companies.*

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### 1. Introduction

Information Technology (IT) has a great potential to make the value chain of an enterprise competitive. As Porter(1996) has highlighted that the influence of information technology spreads across all the elements of the value chain of an enterprise. The primary impact of this influence has to do with the improvement of the efficiency of activities or the reconfiguration of 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 IT systems are used to make operational improvements as well as provide 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 area of focus for researchers for some time. 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 study the impact on the economy as well. The conclusions of these researches are varying,

with some bringing out the positive impacts and some indicating not so positive impacts. The underlying causes cited 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, approaches to measuring the performance etc. of this sector have been under scrutiny. The power sector is considered to be very critical for the economic development of the country. With liberalization spreading across many spheres of the Indian economy, the power sector has been under scrutiny due to its ability to hasten economic development.

Improvements in the power sector need to take place at multiple levels. As has been recognized widely, the most critical elements 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 for bringing in operational excellence in the power sector, the first step would be to formulate the constituents of 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 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

## **2. 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 that require IT investment in the power sector are-

- **Performance Improvement:** Performance Improvement areas include reducing cost inefficiency across all the areas of operations and enhancing customer satisfaction
- **Meeting management and regulatory requirement:** IT can fulfill management and regulatory requirement areas in terms of effective Management Information System for decision making, accountability, service and the building of 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 billed 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 center. In distribution, the IT initiatives are mostly centered in billing, collection, theft control and customer care. These companies have also successfully used spot billing, call centers and MRI

billing. In power distribution companies, Information Technology has been used in 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.

### **3. 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. Similarly the investment can be in core operational areas and in support functions. There are multiple options for each of these and there are Power Systems specific IT applications and solutions as well.

- The core functions - Some of the Systems for core operations in power Generation consist of 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, etc.

- Support activities/functions- Systems for support operations in power generation consists of the following functions: efficiency management, bank guarantee management system, consultancy and training, corporate communications, legal, secretarial and administration, employee retirement benefits and pensions, healthcare for employees, ash utilization, etc.
- The Information Technology infrastructure - The IT infrastructure required for effective operations of the IT systems and applications are networks environment, data center and disaster recovery centers, data Storage, high performance servers, client side hardware, security systems, systems management of network and servers, etc.

### **4. Literature Review**

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 to the King and Schrems (1978). Their classification on IT performance mainly surrounds transactional benefits such as record keeping and calculating efficiencies. Bailey (1982) was among the first to shift this 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) 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(Datta, 2003), the framework classifies benefits in terms of the dimensions given in the figure 1.

- **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 refer to the reliability of business processes and dimensions which are revealed through first hand data collection. Examples of operation quality measures include reduced training time, improved information exchange, service quality etc (Laudon, 2007; Barua, 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,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)

## 5. Hypotheses

Productivity of an organization is based on the appropriate usage of resources. Thus appropriately used IT can lead to improved productivity and business performance. The IT investments provide the means to enhance the operational, operational quality, strategic, financial and maintenance productivity of the organization. Thus, we proposed:

**H<sub>1.1</sub> :** Use of IT has resulted in better productivity of the organization.

The productivity dimensions which have a statistical relationship are included in five hypotheses.

**H<sub>1.1.1:</sub>** Use of IT has resulted in better operational productivity.

**H<sub>1.1.2:</sub>** IT usage has improved operational quality productivity.

**H<sub>1.1.3:</sub>** IT usage has changed strategic productivity.

**H<sub>1.1.4:</sub>** IT usage has resulted in better financial productivity.

**H<sub>1.1.5</sub>** IT usage has enabled better maintenance productivity.

## 6. Research Methodology

The methodology developed for the research study based on the survey of literature consisted of the development of a questionnaire and data collection formats and an analysis to assess the relationship between Information Technology investments and business performance.

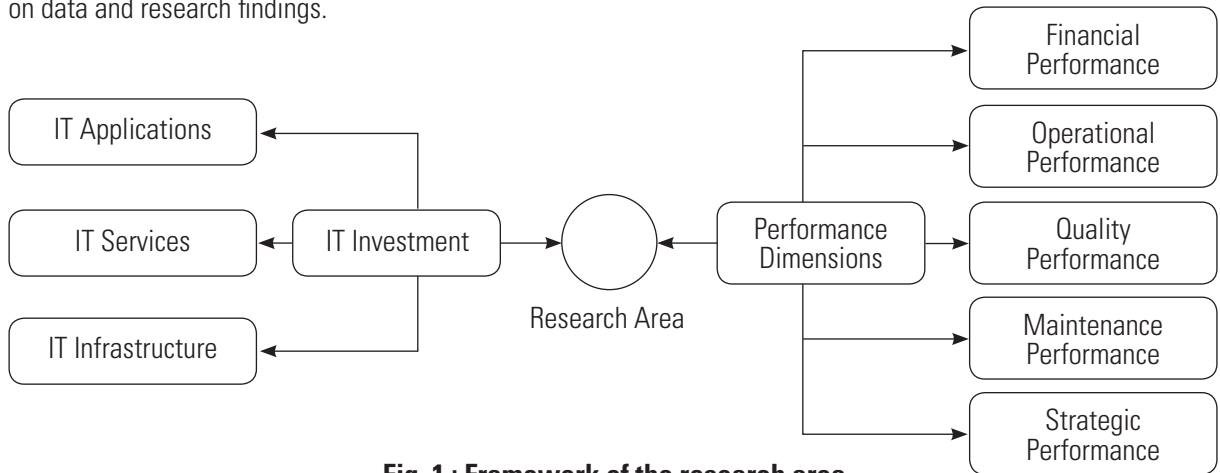
The organization chosen for the study was selected based on the following considerations: diversity of operations in terms of power generation- it operates hydro, coal, oil , diesel based thermal and wind power stations; large scale operations in terms of installed capacity; distributed organization with operations in multiple locations; maturity in terms of adoption of information technology.

The key activities carried out to address the research objectives were:

- Identification and assessment of the IT investments made in different operational areas .
- Formulation of hypothesis based on the literature survey on the impact of IT systems on the performance of the utility.
- Assessment of the performance of the utility using the user perspective framework
- Formulation of key research findings and recommendations for further actions.

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.

- Development and administration of questionnaire to get feedback/perception on the impact of IT on business performance.



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

The methodology used to assess business performance consisted of

- Identification of the functional areas using IT systems
- Formulation of a questionnaire based on the research hypothesis – both open ended and closed ended questionnaire
- Pilot test of the questionnaire in select locations and with select respondents to assess the relevance and practicability of the questionnaire, and refinement of the questionnaire based on the feedback.

- Analysis of the results of questionnaire and the results of the feedback to build a correlation between the impact of IT and business performance of power generation utility.

For the research framework, chi square value was found to be relevant, since it indicated the absolute fit of the model to data.

## 7. Analysis and Results

In order to test the reliability of the overall instrument, Cronbach's coefficient was computed using data on the productivity dimensions. The reliability coefficients are shown in Table 1.

**Table 1: 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	47.99	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

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

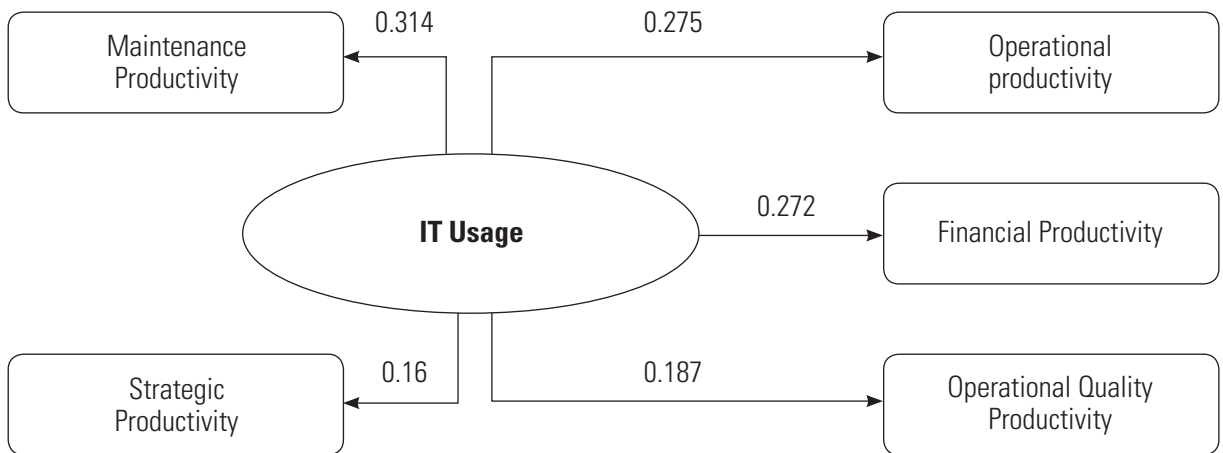
- To measure the operational productivity, the variables used are better visibility, marginal procurement, vendor management, marginal cost of production, total cost of ownership and inventory turnover.
- Operational quality measures include – adding value to existing customer relationship, improved 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.

### 8. Major Findings of the Research

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



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

Based on the figure. 2, it can be inferred that power generation utility has reaped business benefits in terms of performance by the impact of information technology usage.

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.

## 9. Recommendations of the study

Based on the analysis of results, understanding the capability of the IT systems, the needs of the Power Sector and global practices; the following recommendations were drawn by the researcher.

- **Integration of business processes** - The results from the research data indicate that integration of processes provides 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 has the potential to bring more users and geographical locations of the organization into the IT fold. When 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, the building of 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 standard policies for IT systems, such as – development, deployment and usage.
- **ERP Adoption** : Integration can be attempted wherever the current architecture of IT systems enable integration, but an alternate procedure that could be adopted by the utility would be the evaluation of the possibilities for deploying integrated systems like ERPs.

### 9.1 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.
- Even though IT investments happen 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.

## 10. 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 their relationship to IT investments has been established. The results so obtained by deploying the framework have the potential to become a tool for the strategic planning of IT investments.

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