Conceptual Modeling and Simulation Approach for Evaluation of Information Technology Investments

A Case Study of Electric Distribution Companies in Central America

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Abstract

Keywords: Simulation Approaches, Conceptual Modeling, Information Management, Workflow Management, IT Investment, Electric Distribution Company (EDC), IT Strategy.

At the present time the majority of Electricity Utilities are market oriented and deregulated in Central America. In this new frame, the Electric Distribution Companies (EDCs) will face an organizational and technological challenge.

The decision to acquire a new Information technology (IT) poses a number of serious evaluation problems to EDCs.

Common problems with the methods for evaluation were that they were unable to take account of the full range of potential benefits, especially Intangible benefits.[4]

There is a lack of an IT strategy for coming needs and for developing cost-effective IT investment in the EDCs. Currently the EDCs do not have a formal methodology for IT investment evaluation.

What is need is a range of measures which deal with the quantitative, qualitative, and process-oriented aspects of measuring IT investment payoff.[4]

The different types of systems and the wide range of objectives suggest that a wide range of evaluation methods is needed.

This Paper presents a simulation approach for evaluating IT investment in a typical EDC, based on the conceptual Information Workflow Model.

The main conclusions of this paper are based on exploratory case studies, carried out in Nicaragua, Panama, Costa Rica and El Salvador.

During the process simulation it is generated valuable information about the Activities, Entities, Resources, and Costs aspects involved in the EDC operation and Decision Process for IT investment .

I. INTRODUCTION

This paper is based on empirical data from four exploratory case studies about the Organizational and Technological status of the Electric Distribution Companies in Central America. Case Studies were carried out in four countries: Nicaragua, Panama, Costa Rica and El Salvador.

In a deregulated energy market, the EDCs will have to learn how to meet a more open market and higher demands for profitability. Greater efficiency is called for. Costs must be cut and more effective use of the available personnel must be made. Cut-down periods in electrical distribution must be made short as possible.

IT has changed the way in which Electric Distribution Companies are doing business and the way in which they compete. IT is also seen as a fundamental method of gaining strategic and competitive advantage. As a result, IT is playing an increasingly important role in a new Deregulated Electricity Market.

A review of the current literature offers several representative IT investment evaluation methods.

The evaluation methods for tangible benefits are designed to compare costs of investment alternatives or attempt to provide procedures for the quantification of benefits and risks. Such methods tend to rely on the help of technical personnel to provide management with accounting data for evaluation.[5]

While methods for intangible benefits put emphasis on the process of obtaining agreement on objectives through a process of exploration and mutual learning.[5]

Such methods tend to rely on a thorough understanding of the opportunities and the threats of failure of the IT investment.

The past approaches may be classified as mathematical/formal, meta-model, rational-economic, activity versus function-based, strategic, value-based, and hybrid (multi-objective multi-criteria decision model).

The different types of organizations and systems and the wide range of objectives suggest that is needed a wide range of evaluation methods, some suitable for evaluating one type of organizations or systems and some suitable for other types.[5]

We can conclude that existing evaluation methods are considered to be unsatisfactory and are not applied widely or consistently. In this paper it is proposed an alternative approach for evaluating IT investment, using conceptual modeling and simulation methodology.

This paper proposes the conceptual modeling and simulation technique in order to evaluate in a multidimensional way the IT investment payoff in a typical EDC. An Information Workflow model and preliminary theoretical conclusions from simulation essays are presented.

II. CASE STUDIES' DESCRIPTION

A case study from a research strategy point of view may be defined as an empirical inquiry that investigates a contemporary phenomenon within its real life context that is not clearly evident, and in which the multiple source of evidence are used.[Yin]

A substantial amount of time and attention was devoted to the issue of methodology because the author sees this as the fundament on which the validity and credibility of the case studies' research stands.

II.1 The Main Research Objective

The main objective of the case studies was to obtain evidence as to how EDCs formulate, implement, and evaluate IT investment decisions and how to link IT investment to organizational performance and Management business decisions and strategies.

II.2 Evidence Collected

Case Studies were achieved by using a series of unstructured interviews which allowed informants the opportunity of supplying information on a wide range of issues related to Information Technology, decision making, and implementation activities, organizational performance, and business strategies.

The information was obtained from diverse types of documents, archives, interviews with key personals and managers related to the processes and activities of interests, observations of the researcher, and interaction between technical-operators and researcher.

Evidence collected includes issues such as technical papers, interim reports, published reports, records of the interviews, internal reports such as technical, financial, organizational, strategic plans and other important documentation.

Some of the EDCs were not prepared to submit any evidence at all. The particular reports for each case study and outsider's impressions about EDCs, were prepared in order to use them as part of the condensed case study report.

II.3 Choice of Participants

It was decided to empirically explore actual management practice in the formulation, implementation, and evaluation of IT

investment in the EDCs. The author studied 20 Electric Organizations. The organizations chosen include private and state Electric Generation Companies as well as Electric Distribution Companies in Four Central American Countries.

All the personals and managers, consultants, academics, practitioners, etc. with whom the author had discussions throughout the focus of the research, were very enthusiastic and helpful about the subject. Many of them were very pleased to be involved in this kind of research.

In addition to the case study participants, the author interviewed some consultants and external practitioners, in order to establish their views concerning the general practice of IT investment in the Electricity Industry.

II.4 Findings from Case Studies

The results of the case studies performed in EDCs, confirm that existing methods, including investment analysis, are considered generally unsatisfactory in identifying all available benefits or adequately quantifying and qualifying the outcomes of IT investment.

Most of the studies were fragmented in their approach, i.e. they look at a single issue from a single point of view. There is little or no effort to acquire a holistic view of information technology evaluation in the Electricity Industry.

Most of the Managers of the EDCs believe that their current project justification process fails to identify all tangible and intangible benefits. They openly admitted that their current project justification processes overstate the benefits in order to get approval.

The top issues which the Managers of the EDCs, currently face, are benefits management, and alignment of IT with business strategy and objectives.

At the present time most of the IT investments in the EDCs are gut-feeling investments and in some cases, the General Manager has the total authority to approve all IT investments.

Some of the EDCs measure benefits only in financial terms but not considering hidden costs. Cost-benefit analysis (CBA), Net Present Value (NPV), and return on investment (ROI) were the most commonly mentioned appraisal techniques for deciding upon IT investments in EDCs.

There is a lack of an IT Strategy for coming needs and for developing cost-effective investment in Information Technology.

There is a lack of an evaluation methodology on the current operational status, experiences or migration plans to invest in Information Technology.

EDCs should decide how they will treat IT investment appraisal and how they want to balance the different perspectives of benefits. They noted that IT investment cannot be isolated from the business strategy.

III. CONCEPTUAL MODELING

III.1 Conceptual Modeling of a Typical EDC

Conceptual models can be used for many different purposes, in information systems development, in requirements determination, as well as in enterprise development.[6]

In this paper the Conceptual Modeling is used to formulate a model of a typical EDC as seen from the object and process perspectives, including static structural aspects as well as dynamics and rules.

The EDCs are considered as a complex enterprise characterized by a diversity of processes and sub-processes, where hardware, software and human factors are involved.

The acceptance and conclusions coming from the proposed model and simulations are used for defining, in an iterative and dynamic way, a more valid and *credible conceptual* model of the EDCs. The professionals involved in the EDC operation are the main source to validate the results.

Investigating an EDC from the process perspective involves asking questions like: What processes are performed in the enterprise?, Do all processes contribute to the goals of the enterprise?, Does this process create value for the customer?, are the processes performed efficiently?, etc.[6]

Investigating an EDC from the object perspective involves asking questions like: what phenomena, objects, and concepts exist in the organization and in its environment? What properties do objects have? How are objects related to each other? How do they come into existence, how do they change, and how do they cease to exist? Which events influence objects?.[6]

We look for objects in the enterprise, their properties and inter-relationships, as well as for their behavior over time.

The proposed conceptual model provides a common language and terminology that can be used to reason about EDCs and its operational and Information Systems.

The general structure of the EDC's model consists of nine main processes, Each of these processes consists of sub-process and activities.

The formulated model and simulation approach proposed in this paper for EDCs, will allow the examination of each solution in the context of entire utility organization.

In this way, the decision to implement an IT Investment solution will be based not only on technical merits but also economics and management of data issues associated with it.

III.2 Information Workflow Model

The dynamic Map of the current operation of a typical EDC is the core of the proposed conceptual model for ITI. The model here presented have been adapted following the definitions of processes, activities, resources and entities in the simulation tool Simprocess II.5.[1]

The result is a model with embedded processes, where each process contains a set of sub-processes and activities. In The first layer is showing the EDC with its nine main processes and theirs relationships.

A typical EDC must be viewed as an integrated networks of Information Workflows (a collection of coherent sequences of interactions) of entities (flow objects), with rich interdependence between the individual units.

Information workflow model allows representation of processes, resources, products, costs, and services in a dynamic model. The model of an EDC, when simulated, mimics the dynamic operations of the all organization, while displaying an animated picture of the information workflow.

In order for enterprise personnel to perform their task efficiently and accurately, they need to exchange information with various departments within the organization and also with external dependencies.

The process is defined as a collection of activities and sub-processes. An activity is the basic step in a model, where an operation is performed and an entity is the flow of any type of objects (e.g. data, information, reports, commands, SCADA measures, etc.) from process to process. The resource is defined as an agent that is required to perform an activity (e.g. software, computers, engineers, fuel, People, etc.) and the cost could be attached to any activities.[2]

The business process is defined as a series of activities that add value to a product or service, i.e. make it more valuable to a customer.

As basic activities of the process were used: Generate, Dispose, Delay, Transform, Branch, Merge, Get and Free Resource, Assemble, Assign, Batch an Unbatch, Copy, Gate, Join, Split, Synchronize and Replenish Resource.[1]

The major processes in the workflow model are: Substation; Distribution Dispatch; Control Center; Distribution and Transmission maintenance; Operation; Distribution Liners; Primary and Secondary

Distribution Systems. Each process consists of many activities, resources and costs.

The model of the EDC was created "AS-IS", which reflect the current state of the operation and functionality. The essays strategy is to modify the "AS-IS" model in order to arrive at "TO-BE" model, using simulation techniques and tools.[2]

III.3 Validity and Credibility of the Conceptual Model

We confirmed that the use of an integral tool for mapping the operation of the EDCs is very welcome from the people involved on it, specially when the model and the simulation are animated and hierarchical presented.

The main reason for such acceptance is that the current model is attending the workflow operation of the EDC “As Is” and no theoretical relationship is presented. The model is accepted as valid in the same magnitude as the entities of each interviewed persons was seen in action inside of his/her process.[2]

The users can check the topology of the information workflow and then run a discrete event simulation to evaluate performance measures such as resource utilization or bottleneck in any level of the processes.[2]

From the case studies, we can notice that when a not integral view of an organization is presented, the technological, organizational and administrative processes, often stress upon performance and accuracy of individual process. This implies the assumption of independence, that these processes contribute separately to throughput and that the contributions can be measured separately.[2]

The concept of information workflow model was crucial to the smooth and colloquial like understanding of the dynamic nature of the EDCs as a complex organization. We defined the workflow model as a collection of coherent sequences of interactions, which complete the various responses that a process can make to an input or specified function.

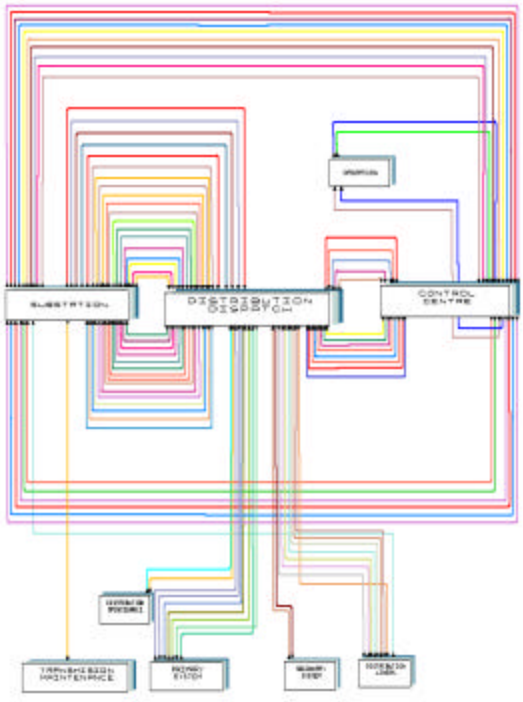

Figure1. Conceptual Model of a Typical EDC

IV. SIMULATION APPROACH

A Simulation tool Simprocess II.5 was used to run Simulation essays of the Information Workflow model of a typical Distribution Company. The Simprocess II.5 is experimented as a dynamic and object oriented simulation tool to represent the typical EDC.

During a simulation it was generated statistical reports about the Activities, Entities, Costs, and Resources of a typical EDC. The generated statistics can be used to determine where any of the processes need to be improved and what changes are necessary for evaluating different management policies and each set of alternatives.

The interactions of resources with processes, products, and services over time result in a large number of scenarios and outcomes that are impossible to comprehend and evaluate without a the simulation technique.

Powerful resource and hierarchical process modeling functions of process simulation

allow visualization and evaluation of alternatives before making strategic decisions like IT investment.

Simulation is a means of experimenting with a detailed model of a typical EDC, to determine how the organization will respond to changes in its structure, environment, technology, or any strategic decision.

Process Simulation allows for experimenting with a model of the EDC, to better understand processes (operations, functions, use of the resources, costs, etc) with a goal of improving performance, solve bottleneck, minimize risk, evaluate performance, productivity, quality of services, and IT investment payoff.

In order to improve any of the processes in the proposed model, it is necessary to develop critical effectiveness, efficiency, and adaptability measurements and targets.

Process *effectiveness* is how well the process meets the requirements of its end customers. Process *efficiency* is the output per unit of input. It is a measure of how many resources the process uses to provide the output. Process *adaptability* is the flexibility of the process to handle future, changing customer expectations and today's special customer requests[3].

Although process simulation focuses on analysis and improvement of *efficiency* measurements, it also provides indirect benefits for process *effectiveness* and *adaptability* measurements[3].

Thus, the simulation essays show that it is possible to use a combination of both qualitative and quantitative evaluation methods, taking into consideration Tangible and Intangible benefits for evaluating the IT investments.

V. CONCLUSIONS

The aim of this research was to develop exploratory cases studies of EDCs in Central America, and to create a simulation methodology for evaluating IT investment payoff for Electric Utilities.

The findings suggested by the case study research is perceived to be useful and the conceptual model and simulation approach imply a list of principles that will assist EDCs in achieving success with their formulation, implementation and evaluation of IT investment projects.

The main conclusions of the research are considered under the following headings:

Guidelines for Measuring IT Investment Payoff in a Typical EDC

1.-Adopt a multidimensional view of the IT Investment payoff measurement issue[4]

2.-Identify and embrace non-quantitative measures of IT investment payoff. [4]

3.-Be open to using a number of approaches to measuring IT investment payoff at the same time. [4]

4.-Measure IT investment payoff at various levels of the organization. [4]

5.-Measure IT investment payoff separately for different types of IT. [4]

6.-Develop an Information workflow model of the whole organization.

7.-Apply a simulation methodology and tools for evaluating pre- and post-investment alternatives (scenarios) and for multidimensional measure of the IT investment payoff.

How EDCs Define IT investment Needs

The EDCs sometimes identified IT investments as flashes of commercial insight and sometimes they identified an IT investment target, because of some drivers like a management decision, customer demand, quality of service or business modeling.
It can be concluded that EDCs have to be more systematic about the identification of their investment needs. They have to identify reasons or drivers for that important decisions.

How EDCs Measure the Impact of IT Investments on their Performance

Most of the EDCs achieved an informal analysis of the impact of IT investment.
They concerned the impact as part of the benefits that EDC gained from the IT implementation.

In this paper is proposed a systematic and dynamic approach for measuring quantitative and qualitative benefits of IT investment.

How to Fit IT and Business Strategies

It is clear from the case study research and simulation trials, that setting IT investment strategy is not an easy matter to formulate and to implement. How to adapt the IT investment strategy into the organization's current business strategy is not always easy. Just Conceptual Modeling and Simulation techniques will allow to EDCs, an exhaustive analysis for a variety of scenarios.

Which Criteria have to be Used by EDCs for Evaluating IT investment

Most of the EDCs do not use a specific evaluation method but a combination of visual processes to evaluate the IT investment. Some of these criteria involve benefits, that EDCs identifies like new opportunities, competitive advantage, new business opportunities, etc.

The final validation procedure is regarded as useful in that it confirmed the usefulness of the conceptual model and simulation approach to practitioners. It was not possible to present in this paper the explicit numerical and statistical results and quantitative analysis because of limitations in the number of pages.

This paper proposes a multidimensional simulation approach for a complete evaluation of IT pre and post-investment.
The conceptual modeling and simulation approach is considered by the author as a new starting point for the future research on IT investment evaluation.

The research was focused just on the Electric Distribution Companies, but in a future research work, it will be possible to look at different types of industries.

Acknowledgement

The author would like to sincerely acknowledge the personnel and managers at the EDCs, for all the valuable information and time spent during interviews and technical visits.

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Biography

Enrique Silva: He received his M.Sc. degree in Physic and Mathematics in 1987 from Bielorusian University. He is a titular professor in the Simulation Department of the National University of Engineering, Nicaragua. Since 1996 , he has been working towards his PhD degree at the Department of Industrial Control Systems, Royal Institute of Technology, Stockholm, Sweden. His current research focus is: Application of Conceptual Modeling and Simulation Techniques for Evaluating of IT Investment Payoff in the Electric Utilities.