
Enterprise Productivity and ERP – The Research Design

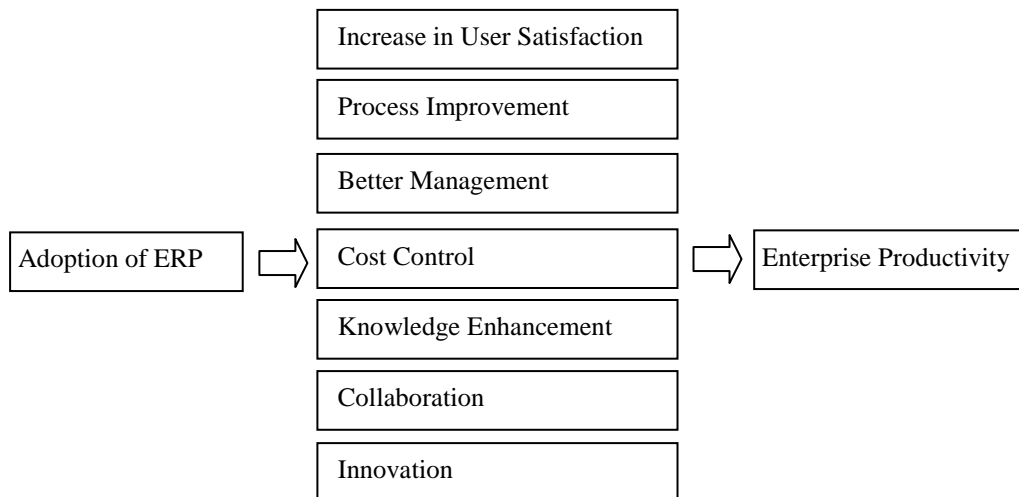
2.1 Introduction

A systematic approach to research gives it credibility and ultimate acceptance which we refer to as the research design. It is a detailed outline of how an investigation will take place. A research design will typically include how data is to be collected, what instruments will be employed, how the instruments will be used and the intended means for analyzing data collected (“Research Design”, 2014). Thus, the research design needs to be meticulously planned and executed keeping in mind the objectives and scope of the research study. The function of a research design is to ensure that the evidence obtained enables us to answer the initial questions of the researcher as unambiguously as possible.

2.2 Operational Definition of Enterprise Productivity

An operational definition, when applied to data collection, is a clear, concise detailed definition of a measure. The need for operational definitions is fundamental when collecting all types of data. They help us to relate ideas to concrete, measurable events in the world. The present study requires the operationalization of the term ‘Enterprise Productivity’. From the study of relevant literature as put forward in the first chapter (Sections 1.5 – 1.10), Enterprise Productivity in the context of the study is defined as “the increase in user satisfaction, process improvement, better management, cost control, knowledge enhancement, collaboration and innovation brought about by adoption of Enterprise Resource Planning (ERP) software in the enterprise”.

Illustration 2.1: Operational Definition of Enterprise Productivity



The operational definition of Enterprise Productivity as defined is used to conduct the study and answer the research questions which have been specified in section 2.7 of this chapter.

2.3 Various Types of Costs

The operational definition of Enterprise Productivity in the context of the study puts a significant emphasis on cost control. It is thus imperative to factor in the various types of costs associated with an enterprise. Six different costs have been considered, which were selected by reviewing existing literature on costs and their relevance to the costs incurred in a refinery. The costs that have been considered are explained in the following sub-sections. The ordering sequence of the definitions is as per their appearance in the questionnaire (Appendix 1).

2.3.1 Operational (Operating Costs)

Operational costs are the expenses associated with administering a business on a day to day basis. Operating costs include both fixed costs and variable costs. Fixed costs, such as overhead, remain the same regardless of the number of products produced; variable costs, such as materials, can vary according to how much product is produced (“Operating Costs”, 2014).

2.3.2 Opportunity Costs

Opportunity costs, in economic terms, are the opportunities forgone in the choice of one expenditure over others. The concept of opportunity cost allows economists to examine the relative monetary values of various goods and services. Explicit Opportunity costs are opportunity costs that involve direct monetary payment by producers. Implicit Opportunity Costs (also called implied, imputed or notional costs) are the opportunity costs implied by the uses to which

the actor (i.e., firm) allocates their existing (owned) resources, or factors of production (“Opportunity Costs”, 2014).

2.3.3 Infrastructure Costs

Infrastructure Costs are costs that arise from having property, plant, equipment and a functioning organization.

2.3.4 Coordination Costs

Coordination costs are the costs that are due to imperfect information and opportunistic behavior of organizational actors, i.e., the factors contributing to uncertainty in the organization. Internal Coordination Cost is generated by the need to support hierarchical structure (management, control system, rule establishment and maintaining, etc.). External Coordination Cost is the cost due to presentation and establishment of a contingent claims contract (Cordella, 2001).

2.3.5 Bargaining Costs

Bargaining costs are the costs of negotiating, documenting, and enforcing an agreement with suppliers, vendors, etc. These are the costs required to come to an acceptable agreement with the other party to the transaction, drawing up an appropriate contract and so on. Direct Bargaining Costs are the bargaining costs associated with formal procedures that need to be adhered to while drawing up the contract. Indirect Bargaining Costs are the bargaining costs associated with

factors like the communication process, flow of information, etc. required for the drawing up the contract.

2.3.6 Quality Costs

Quality Costs or Cost of Quality is a means to quantify the total cost of quality-related efforts and deficiencies. It was first described by Armand V. Feigenbaum in a 1956 Harvard Business Review article. The quality costs that are defined are Prevention Costs, Appraisal Costs, Internal Failure Costs and External Failure Costs. Prevention Costs arise from efforts to keep defects from occurring at all. Appraisal Costs arise from detecting defects via inspection, test, audit, etc. Internal Failure Costs arise from defects caught internally and dealt with by discarding or repairing the defective items. Finally, External Failure Costs arise from defects that actually reach customers.

2.4 Overview of the Refineries of Assam

As of 2015, India has 23 refineries. Out of these 23 refineries, 10 are controlled by Indian Oil Corporation Limited (IOCL). Two of the ten refineries are subsidiaries. Total refining capacity as on 31st March, 2015 for the ten refineries of IOCL is 65.7 MMTPA (Million Metric Tonnes Per Annum). IOCL is about to commission its 11th refinery at Paradip with a refining capacity of 15 MMTPA. With refining as its backbone, Indian Oil is the largest refiner of India (IOCL, 2015). Assam has four refineries – three belonging to IOCL and the fourth one is an independent company. Each of these has some unique characteristics. Digboi Refinery is the oldest refinery in India and Guwahati Refinery is the first public

sector oil refinery of India. Bongaigaon Refinery which was originally called the Bongaigaon Refinery and Petrochemicals Limited (BRPL) was amalgamated with Indian Oil Corporation on March 25, 2009. Numaligarh Refinery is an independent undertaking of the company Numaligarh Refineries Limited (NRL). Table 2.1 gives information about the year of establishment, processing capacity and the major products of the four refineries of Assam.

Interestingly, Numaligarh is not only the youngest refinery; it has also the highest processing capacity amongst all the refineries present in Assam. As per the 2014 – 15 Annual Report of Numaligarh Refinery Limited, Bharat Petroleum Corporation Limited (BCPL) holds 61.65 percent of shares, Oil India Limited (OIL) holds 26 percent and Government of Assam holds the remaining 12.5 percent in the refinery. As on 1st January, 2015, it had 884 employees on its rolls. With a capacity utilization of 93 percent, it earned a Profit after Tax (PAT) of Rs. 718 crores in the financial year 2014 – 15. IOCL earned a PAT of Rs. 5273 crores in 2014 – 15. Refinery wise data for the refineries under IOCL are not available and as such is not mentioned here. All the four refineries have been using ERP, more specifically, SAP.

The capacities of the refineries of Assam are small in comparison to many of the other refineries in India including those operated by IOCL. The refining capacity of the four refineries taken together is only 5 MMTPA. In fact, Digboi Refinery has the smallest capacity with respect to all the refineries of IOCL.

Table 2.1: Basic Information on the Refineries of Assam

Name of the Refinery	Year of Establishment	Processing Capacity (In MMTPA)	Major Products
Bongaigaon Refinery	February 20, 1974	2.35	Liquefied Petroleum Gas (LPG), Naphtha, Motor Spirit (MS), Superior Kerosene Oil (SKO), High Speed Diesel (HSD), Light Diesel Oil (LDO), Low Sulphur Heavy Stock (LSHS), Light Viscosity Fuel Oil (LVFO), Raw Petroleum Coke (RPC), Calcined Petroleum Coke (CPC), Needle coke and solvents (Petrosol and Bonmex-II)
Digboi Refinery	December, 1901	0.65	Distillates, Heavy ends and excellent quality wax, MS and HSD complying with BS-III grade.
Guwahati Refinery	January 1, 1962	1.0	LPG, MS, Aviation Turbine Fuel (ATF), SKO, HSD, LDO and Raw Petroleum Coke
Numaligarh Refinery	July 9, 1999	3.0	LPG, Naphtha, MS, ATF, SKO, HSD, RPC, CPC, & Sulphur

Data Source: <https://iocl.com>, <http://nrl.co.in>

2.5 Problem Statement and Objectives of the Study

The conclusion of the previous chapter (Section 1.12) elucidates the necessity of the present study in terms of deficiency of work with respect to ERP implementations in the refineries of Assam and considerable investments made.

Following it, the problem statement may thus be defined as:

“How successful has Enterprise Resource Planning (ERP) been in the refineries of Assam in terms of enhancing Enterprise Productivity from the perspective of the users of ERP?”

While the problem formulation serves to describe the aim of the thesis, the objectives provide an accurate description of the specific actions that will be taken in order to reach this aim. The overall objective of the study is stated as:

“To understand the effectiveness of Enterprise Resource Planning (ERP) on Enterprise Productivity from ERP user’s perspective in the Refineries of Assam”

The overall objective is detailed through the following specific objectives:

1. To understand the concept of Enterprise Productivity from the point of view of the Enterprise Resource Planning (ERP) users in the refineries of Assam.
2. To understand the use of productivity indicators for Enterprise Productivity analysis due to Enterprise Resource Planning (ERP) implementation from ERP user’s perspective in the refineries of Assam.
3. To develop a Measurement Framework for Enterprise Productivity analysis due to Enterprise Resource Planning (ERP) implementation from ERP user’s perspective in the refineries of Assam.
4. To make a comparative analysis of the impact of Enterprise Resource Planning (ERP) implementation on Enterprise Productivity from ERP user’s perspective in the refineries of Assam.

5. To understand the impact of Enterprise Resource Planning (ERP) implementation on Enterprise Productivity from ERP user's perspective in the refineries of Assam.

The above objectives have been studied and conclusions drawn during the course of this study. The discussions are in the subsequent chapters of this thesis.

2.6 Approach of the Study

The research study is descriptive in nature which is attained through an empirical study. Descriptive research is undertaken to describe the situation, community, phenomenon, outcome or programme. The main goal of this type of research is to describe the data and characteristics about what is being studied. The findings of descriptive studies are largely of a diagnostic nature, i.e., the studies indicate the existing symptoms of a particular situation without establishing the causality of the relationship. Descriptive studies usually have one or more guiding research questions but generally are not driven by structured research hypotheses. The descriptions may lead to interesting insights and lead to hypothesis formulation as is the case with this study.

Research questions have thus been formulated as given in the next section. The data source is primary as the study objectives require data which is not available from secondary sources. The primary data has been collected through the use of a structured questionnaire. Questionnaires are usually viewed as a more objective research tool that can produce generalisable results (Harris and Brown, 2010).

Looking at the nature of the research and sample size of the respondents, questionnaire method was used for the collection of the primary data.

A sample survey was done to collect the primary data. A sample survey involves the selection and study of a sample of items from the population. The population for the study consists of the SAP users in the four refineries of Assam. The word universe is sometimes used in survey research, and means exactly the same in this context as population. The sampling unit is the SAP user. Sampling technique used is Convenience Sampling. The primary data collected is both qualitative as well as quantitative. The data collected belongs to the data categories: Categorical (Nominal), Ordinal and Ratio. Examples of the various categories of data are:

- Categorical: Employee Grade, Department, Gender, SAP Application User Level
- Ordinal: Importance Level of ERP (SAP)
- Ratio: Age, Experience

Empirical research can be defined as "research based on experimentation or observation (evidence)". The word empirical means information gained by experience, observation, or experiment. Empirical methods help in understand and responding more appropriately to dynamics of situations as well as help in integrating research and practice. The objectives of empirical research are:

- Going beyond simply reporting observations.

- Promoting environment for improved understanding.
- Prove relevancy of theory by working in a real world environment (context).

The study follows a qualitatively driven approach/design with quantitative data/method added to supplement and improve the qualitative study by providing an added value and deeper, wider, and fuller answers to the research questions. It is thus a mixed method of research.

The refineries in the state of Assam are spread over a large geographical area. It is a time consuming process to visit each of the refineries multiple number of times to collect the required data. Also, it is difficult to personally meet the respondents because of their hectic work schedules. Obtaining security clearances to enter the refineries specially the production areas is also a tedious affair. Because of these factors, the questionnaire was administered online. The online questionnaire also helps in automated data entry and seeing to it that respondents answer all questions which they are supposed to answer mandatorily.

First of all, a definition for Enterprise Productivity was operationalized. Based on the operational definition, the questionnaire was designed to collect the data. The questionnaire has a total of 18 questions divided into three sections. Section 1 has eleven questions designed to collect information about the respondent. Section 2 has four questions to collect information about the awareness level of the respondents regarding Enterprise Productivity. Section 3 has three questions to

collect information on the user’s perspective on productivity issues as a result of the use of ERP (SAP) system. A 5-point Likert-type scale is used for those questions where the respondents have to respond to the degree of acceptance of items. Unlike a simple “yes / no” question, a Likert-type scale allows us to uncover degrees of opinion. Having a range of responses helps us to more easily identify problem areas. The Likert-type scale used is unipolar with the following five labels: Very Important, Important, Neutral, Not Important and Not at all Important. The scale thus used is a balanced rating scale with an odd number of categories and a neutral point. The detailed questionnaire has been put up as an appendix in Appendix 1.

The departments of the refineries have been grouped into Technical and Non-Technical departments based on the type of work performed in the refineries. There are 27 (twenty seven) technical departments and 20 (twenty) non-technical departments. It is strictly based on the nomenclature used in the refineries. The classification is used in data analysis.

Table 2.2: Technical and Non-Technical Departments in the Refineries of Assam

Technical Departments	Non-Technical Departments
Developmental Maintenance	Commercial
Electrical Maintenance	Commercial (Warehouse)
Engineering Services	Co-ordination
Fire & Safety	Corporate Communications

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Technical Departments	Non-Technical Departments
Health, Safety & Environment (HSE)	Corporate Communications & Corporate Social Responsibility (CC & CSR)
Information Systems (IS)	Corporate Planning
Integrated Information Systems (IIS)	Executive Director /General Manager's (ED/GM) Secretariat
Inspection	Finance
Instrumentation	Finance & Accounts
Instrumentation Maintenance	Human Resource
Maintenance	Internal Audit
Maintenance Planning	Legal
Maintenance Civil ¹	Marketing
Maintenance Mechanical ²	Marketing & Corporate Planning (CP)
Medical	Marketing Operations
Numaligarh Refinery Marketing Terminal (NRMT)	Materials
Operation	Materials & Contract
Production	Personnel & Administration
Projects	Training & Development
Power and Utilities (P&U) ³	Vigilance
Quality Control (QC)	
Technical Services	
Technical Services & Inspection	
Total Productive Maintenance (TPM)	

¹ In Numaligarh Refinery, this Department is called Civil Maintenance

² In Numaligarh Refinery, this Department is called Mechanical Maintenance

³ In Numaligarh Refinery, this Department is called Power & Utility

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Technical Departments	Non-Technical Departments
Township & Estate	
Township & Infrastructure	
Utility	

Data Source: Compiled from the data provided by the IS/IIS Department of the Refineries

The refineries under Indian Oil Corporation (IOC), namely the Bongaigaon, Digboi and Guwahati Refinery have significantly less number of departments in comparison to the stand-alone Numaligarh Refinery. Also, the number of technical departments in comparison to the non-technical departments is higher as the refineries are in the production domain. This is reflected in Table 2.3.

Table 2.3: Classification of Departments in the Refineries of Assam

Name of the Refinery	Technical Departments	Non-Technical Departments	Total
Bongaigaon Refinery	15	7	22
Digboi Refinery	14	7	21
Guwahati Refinery	14	6	20
Numaligarh Refinery	21	14	35

Data Source: Compiled from the data provided by the IS/IIS Department of the Refineries

The total number of SAP User Licences in use in the four refineries of Assam is 1210 (one thousand two hundred and ten) as per data made available by the concerned refineries on different dates. The dates have been mentioned in the footnotes. This constitutes the population of the study. As already mentioned in Section 1.4, the total licenced users of 1210 exclude the ESS (Employee Self

Service) users. A detailed break-up of the SAP user licences in the refineries of Assam is given in Appendix 2.

The questionnaire was made available to the respondents online through Google Docs. The link was mailed to all the SAP users, the list of which was made available for the purpose of the study. SAP users in the context of the study are those who have been provided with a login id for using the SAP software.

The data was collected during February 13, 2014 to July 17, 2014. Reminder mails were given to increase the number of responses during that period. A total of 239 responses were obtained as detailed in Table 2.4 giving a response rate of 19.75 percent. The study is based on the 239 respondents and this constitutes the sample for the study. Sampling method is thus convenience sampling. A convenience sample is simply one where the units that are selected for inclusion in the sample are the easiest to access. Irrespective of the disadvantages (limitations) of convenience sampling, it had to be used for the study. It is because permission was given to conduct the research but a list of all employees in the organization was neither provided nor could be obtained, which is needed to use a probability sampling technique such as simple random sampling or systematic random sampling.

Table 2.4: Responses Obtained from the Refineries of Assam

Name of the Refinery	Total Number of SAP User Licences	Total Number of Responses	Response Rate
Bongaigaon Refinery	343	51	14.87%
Digboi Refinery	268	81	30.22%
Guwahati Refinery	271	52	19.19%
Numaligarh Refinery	328	55	16.77%
Total	1210	239	19.75 %

Data Source: From the data collected

The data analysis has been done with the help of MS Excel 2010. Being a descriptive study, the data has been presented with the help of tables and charts. Co-relation coefficient, phi coefficient (Φ) and Cramer's V have been used for measuring the degree of association amongst different variables while Average Weighted Score has been used for calculating overall ranks.

2.7 Research Questions

A research question is a statement that identifies the phenomenon to be studied. Research questions are developed before the start of a study. They make the theoretical assumptions in the framework more explicit; most of all, it indicates what the researcher wants to know most and first. The proposed study aims at studying the post implementation effect of ERP implementation on enterprise productivity. Considering the study objectives and keeping in mind the descriptive nature of the study, the research questions are constructed as below:

1. Has ERP implementation increased productivity in the refineries of Assam?
2. Has ERP implementation led to Business Process Reengineering (BPR) resulting in more productivity in the refineries of Assam?
3. Has ERP implementation brought information efficiencies and synergies leading to increased productivity in the refineries of Assam?

2.8 Scope of the Study

The scope of a study refers to the parameters under which the study is operating. The study is based on the four refineries located in the state of Assam, India. As such, the scope of the study is confined to these four refineries only. The study has helped us to know the effectiveness of ERP on Enterprise Productivity from user's perspective only. This study is thus based on opinions of respondents and is subjective to a certain extent.

The study throws light on the impact of the implementation of ERP on the productivity of the refineries as enterprises. The refineries being large enterprises, the study is reflective of large enterprises only and not Small and Medium Enterprises (SMEs). Further, these are primarily manufacturing enterprises and as such the study does not reflect of enterprises engaged in other activities like services.

2.9 Limitations of the Study

Limitations are the shortcomings, conditions or influences that cannot be controlled by the researcher that place restrictions on the methodology and conclusions. The following are the limitations of the study:

- (i) The method of sampling that had to be used, i.e., convenience sampling. This sampling technique being a non-random sampling technique has inherent flaws. It does not guarantee representativeness and there is always the danger of bias. No statistical tests of significance based on the sampling may be performed.
- (ii) All respondents did not have the background knowledge for the questions asked. This had an effect on their responses which undermined the accuracy of the responses.
- (iii) Some of the emails that were sent bounced because of various reasons. This had an effect on the final sample size and the data that could be collected and ultimately analyzed.
- (iv) The process of ERP implementation and productivity issues in each of the refineries is not the same. To bring about uniformity in the study, certain aspects of ERP implementation and its impact on Enterprise Productivity like the time required for SAP implementation, scale of deployment, and people involved had to be left out.

2.10 Ethical Considerations

There are several reasons why it is important to adhere to ethical norms in research. First, ethical norms promote the aims of research, such as knowledge, truth, and avoidance of error. Second, since research often involves a great deal of cooperation and coordination among many different people in different disciplines and institutions, ethical standards promote the values that are essential to collaborative work, such as trust, accountability, mutual respect, and fairness. Third, many of the ethical norms help to ensure that researchers can be held accountable to the public. Fourth, ethical norms in research also help to build public support for research. Finally, many of the norms of research promote a variety of other important moral and social values, such as social responsibility, human rights, animal welfare, compliance with the law, and health and safety (Resnik, 2011).

Discussions about ethical principles in social science research and perhaps more specifically transgression of them, tend to revolve around certain issues that recur in different guises which are grouped into four main areas (Diener and Crandall as cited in Bryman, 2008, p. 118):

- Whether there is harm to participants?
- Whether there is a lack of informed consent?
- Whether there is an invasion of privacy?
- Whether deception is involved?

All permissions were obtained from the administration of the concerned refineries to carry out the study. Respondents were contacted by means of email ids provided by the respective refineries. All respondents were informed of the purpose of the study and assured of confidentiality and anonymity. The findings of the research have been recorded in such a way that respondents may not be identified. The time duration required for filling up the questionnaire was duly given. Participation of respondents was voluntary and no coercion or deception was used to elicit responses from them. It was hoped that, with these ethical measures in place, respondents would feel comfortable about sharing their experiences and perspectives openly and without fear of any repercussions.

The work of others have been cited or credited, whether published or unpublished and whether it had been written work, an oral presentation, or material on a website. False statements or omissions that distort the research record have been avoided. A clear and complete record of data acquired has been maintained. Research integrity has been maintained.

2.11 Conclusion

The preparation of the research design is a formidable task. The details of the study and how it will be carried out have to be clearly explained as part of the research design. It is easily comprehensible that the quality of the research work to a large extent depends on the depth and clarity of the research design.

The sections in this chapter give a broad overview of the present study. The operational definition of Enterprise Productivity has been given. A small introduction to the refineries of Assam where the study has been conducted is presented. The definition of some costs has been given which are used in the preparation of the questionnaire. Besides these, the problem statement and study objectives, the approach of the study, research questions and scope of the work was suitably explained. Ethical considerations have been specified.

The limitations of the work have been detailed. The work can be vastly improved if these limitations can be taken care of. Convenience sampling is best avoided but had to be used. Since the population is fairly limited, random sampling techniques like simple random sampling or systematic random sampling would have given better results and made the study more robust. More statistical methods and data technique analysis could have been applied on a random sample. For this, the cooperation of the refineries in terms of giving the complete SAP user data is a must. Use of secondary data, specifically financial data which if made available can make the study more insightful. This is because financial parameters are important to the study of Enterprise Productivity.