Chapter 1

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1.1 Background

The Small and Medium Industries (SMEs) in India have accepted ERP as one of their key strategic drivers of business growth. Over the last decade, there have been considerable interests from SMEs to implement ERP for not only streamlining their core business processes but also for generating more business (Christofi et al., 2013). Enterprise Resource Planning (ERP) systems contain different business applications, such as general ledgers for accounting, payroll for human resources, supply chain management (inventory and procurement), manufacturing, sales and distribution and management information system (Wright and Wright, 2002). ERP vendors are making all possible efforts to capitalise the interest of SMEs by releasing scalable, all inclusive and affordable solutions (Panorama, 2014).

Organizations implementing ERP systems can receive various benefits due to the fact that an ERP system gives an integrated view of the organization’s business functions. In other words the company gets the advantage of faster, consistent, standardized information flow across its length (organizational hierarchy) and breadth (functional departments). Further a company’s can access a variety of business data in real time due to the single database setup of ERP which provides timely and relevant information (Saini et al., 2012).

ERP projects have often found to be complex and risky and many reasons contribute to its success or failure. In the past, there have been alarming stories of failure or abandonment of the whole ERP project leading to irrevocable losses to large corporations. The Chaos Report of 2009 revealed that successful projects (completed on time, budget and scope) constituted only 32% of all projects succeeding, while 44% were challenged (overruns on time, cost and scope) and 24% failed (cancelled prior to completion or delivered and never utilized). These numbers denoted that there has been a diminution in the success rates when compared with the earlier work. It is rather
discouraging to note that the 2009 figures represented the highest failure rate since 2000 (Standish Group, 2009).

The large corporations churning out billions of dollars are already outfitted with the state-of-the-art information technology enablers that are placed to streamline, integrate and optimize business operations. On the contrary, such enablement of information technology is very low in the SME segment. Most of these units are still using manual processes and spreadsheets based IT enablement in their core business procedures. The SMEs are inherent with certain genetic limitations such as a low capital base, limited generation of excess funds for re-investment due to tight working capital cycle, lack of awareness of business opportunities, inadequate exposure to the international environment, limited geographical diversity of markets, outdated technology and inadequate infrastructure facilities. Amongst other expectations one of the strong drivers of growth for the SMEs is the need for modern and affordable technology. The study results are based on a survey conducted on a sample of 540 units spread across the tier – I, II and III cities with the objective of analysing the SMEs perception in India about the Union Budget 2014-15 by the newly formed government. It is found that SMEs suffer from the dearth of effective information systems (FirstBiz-Greyhound Knowledge Group SME Survey, 2014).

SMEs implementing ERP makes significant efforts in terms of investments in time, resources and capital. In the recent past research interest is high to examine the impact of the business performance and organisational changes that ERP investment could possibly bring in (Bohorquez and Esteves, 2014). The implementation, results in significant process changes and ROI can be comprehended in terms of the benefits that the company can produce. The improved business processes in post implementation stage are proven to increase the company’s ability to bring in financial performance but there are several issues and challenges faced by SMEs in their effort to narrow down the gap between their operations and ERP (Malhotra and Temponi, 2010). Implementing ERP is a capital intensive investment for which there is no certainty about the yield on investment. Agreeing to a study the probability of ERP failure ranged from 40 to 60 percent and
another subject area identified the failure rate between 60 to 90 percent (Langenwalter, 2000, Ptak and Schragenheim, 2000). Many researchers in the past have also analyzed that ERP implementation could fail due to various internal and external factors affecting the organization’s very existence (Ribbers, and Schoo, 2002, Soh et.al 2000, Willis and Willis, 2002). It is yet more complicated and challenging for SMEs to implement ERP because of their limitations to expertise, reach, and ERP availability options, finance (both investment and costs) and in total are vulnerable to various risks that can go to failure par irrevocable in nature (Austin and Nolan, 1998).

The history of ERP implementation has revealed that on one side many companies have managed to achieve significant operational efficiency through ERP adoption, on the other side many other companies have failed in ERP adoption and experienced declining business performance (Davenport, 1998; O’Leary, 2000). The findings of the past research works are alarming to the extent that at least 90% of ERP implementations have time and cost overruns and about half of the implementations fail to realize the expected business results (Holland and Light, 1999; Umble et al., 2003; Al-Mashari et al., 2003). Hence, here arises several thought provoking questions: Why is ERP adoption so risky? What factors contribute to the risk of failure where these factors originate from? Are organizations matured enough to read and handle the risks embedded in the ERP adoption life cycle. ERP implementation is spread across a longer time horizon and gets completed in certain predefined sequential phases. It becomes necessary to understand that success is not only about implementing the ERP systems, but also in the usage of ERP system into the operational routine of an organization. According to (Bingi et al., 1999; Park and Kusiak, 2005) only then an ERP enabled organization can realize accurate, real-time information which is reliable and consistent, have integrity, and contain no mistakes.

It is imperative to have the knowledge about the risk factors that affect throughout the ERP adoption life cycle so as to support the companies, particularly the small and medium ones to gain confidence in not only implementation and operating such systems but also in realizing the desired business advantages. Many research studies on ERP (Nah
et al., 2001; Hong and Kim, 2002; Bradford and Florin, 2003; Ehie and Madsen, 2005; Kim et al., 2005; Enrique et al., 2005; Soja, 2006; Wu and Wang, 2006) identified several critical success factors (CSFs) and extensively analysed their relevance and implications for both large as well as small and medium enterprises. Nevertheless, in comparison only few fields have sought to distinguish risk factors in ERP implementation (Sumner, 2000; O'Leary, 2000; Wright and Wright, 2002; Musaji, 2002; O’Leary, 2002; Huang et al., 2004; Hunton et al., 2004; Zeng and Skibniewski, 2013).

1.2 Statement of Research Problem and Research Questions

The quantum of research literature that exists for ERP adoption risks for SMEs is found to be limited and specifically from the SMEs clusters in the Indian setting. This research is undertaken to capitalize the immense potential and scope for exploring the risk perception of the SMEs during the end-to-end ERP adoption lifecycle, which encompassed all the stages right from planning for the ERP initiative to extending the functionality of usage to the partners in the supply chain. This research also addressed the pertinent need for identifying, defining, categorizing and measuring the various risks that affect the ERP adoption life cycle in SMEs by means of developing and testing through a risk assessment model. Interestingly, it is found that research on ERP systems are aplenty from the developed world context, namely USA and Europe, while not much research work has been done from the developing world context specifically for the Indian context. Hence this research focuses on the SMEs operating in India. The researcher thinks that the result of this work will give significant results both academically and industrially towards reducing the research-knowledge gap. The contextual scope of this research is limited to the small and medium enterprises operating in the auto-component cluster in Pune in Western India. Though there are risk assessment methods readily available, they may require advanced computing platforms and call for high-end technological knowledge to understand, adopt and interpret them. These capabilities may not be available to SMEs from both an affordability and requirements perspective. A gap exists between the SMEs and their larger counterparts in these two perspectives. Our inquiry is an effort to bridge the gap in enabling the SMEs to
involve in the appraisal procedure and thereby quantify their collective perception towards ERP adoption risks. Hence technologically our scope is restricted to creating a viable model that captures and quantifies the responses to ERP risks. The research problem is stated as “Investigate into the various risks associated with the different phases of ERP adoption in SMEs and create an assessment model to quantify the risks associated with the phases of ERP adoption and implement this model using fuzzy petri-nets.”

1.3 Research Objectives

The aim of this research is to bestow to the existing and growing body of knowledge in the field of ERP adoption in SMEs and offer an end-to-end risk assessment model. Such a model will cover and assess the risks that are spread across the entire ERP adoption life cycle. Keeping in mind the research problem and the need for research the objective is drawn.

To develop, build and implement a comprehensive risk assessment model useful to ERP Projects in Small and Medium Enterprises

1. Identification of risk elements in the five phases of ERP Adoption namely Planning, Acquisition, Implementation, Usage and Percolation and Extension.
2. Develop, Build and Implement a Risk Assessment model and perform Quantitative Risk Analysis using Fuzzy Petri-Nets to evaluate the impact of risk in each of the five phases of ERP adoption.

To accomplish the objectives of this research a theoretical model is presented in order to provide better understanding of the outcome of this research. Accordingly the researcher took inspiration from the Project Risk Management module of the Project Management Body of Knowledge (PMBoK). The fourth section of the Project Risk Management module covers the conduct of quantitative analysis of project risks. The objective of this research is similar because the crux of this research is to identify, define risk elements of
ERP adoption in SMEs in the Auto Component Cluster and then build and implement a risk assessment model using Fuzzy Petri-Nets (Pavliska, 2006). The model is shown in figure 1.1.

![Diagram of ERP Adoption Phases and Project Risk Management](image)

Figure 1.1 Risk Assessment Framework (Self compiled) * Ref.: PMBOK 4th Edition

1.4 Motivation of the Research

There are several motives that have contributed to the conduct of ERP risk assessment in SMEs in the Auto Component Cluster in Pune. First and foremost is the concept based motive. The relevance and quantum of research on addressing the risk factors of ERP adoption in SMEs is limited. This is in comparison to the numerous research studies which have multiple list of success factors that critically impact the ERP systems implementation in general (Al-Mashari et al., 2003; Sun, et.al, 2005; Motwani et al., 2005; Wang et al 2008; Bradley, 2008; Chang et al 2012; Bradford and Florin, 2003; Ehie and Madsen, 2005; Kim et al., 2005; Soja, 2006; Wu and Wang, 2006; Hong and Kim, 2002; Enrique et al., 2005; Osei-Bryson, et al., 2008). Hence, it is really important that research needs to be taken on in the direction of not only to key out the risk factors which bear on the success of these systems in SMEs, but also to research and assess
which risks as perceived by them are significant in each and every phase of ERP adoption.

The second motive is related to the context in which the ERP adoption is studied. The imminent fact is that the awareness and interest in the adoption and usage of ERP systems have increased considerably amongst the SMEs. The SMEs has now started to look at ERP adoption as a strategic business initiative rather than just a piece of software implementation. The formation of industry cluster in India by the Ministry of Micro, Small and Medium Enterprises which comprises of a collection of several homogeneous units has been the centre of attraction for ICT adoption. While the ERP market is saturated for large organizations, it is still sunrise for their smaller counterparts. The result is that a developing number of SMEs are willing to adopt ERP. Here willingness to adopt is twofold, namely the SMEs has accepted the significance of central creation and mutual sharing of operational information for ensuring intra-organizational efficiency and clarity of data flow. The other reason is that the large corporations are now looking at extending the integration of business process with SMEs for which standardization is the key. SMEs will need double-decker integration in the long-run. Double-decker integration comprises at the first deck, the ERP solution to seamlessly incorporate the core business processes in order to ensure timely, precise and transparent information across intra-organisational operations. In the second deck extend such integration to inter-organizational processes with their bigger counterparts. The business relationship between the big corporations and SMEs exhibits one of the highest levels of interdependence between the supplier (SMEs) and the customer (large companies). Currently no research is available for risk assessment of ERP systems in Indian SMEs as it has been observed that a vast majority of the past studies have been in the context of the developed world and also on ERP in general. To the best of the researcher effort and knowledge on a few studies investigated and prescribed certain failure or risk factors during the implementation of ERP systems in developing countries like India, and as such no comprehensive research existed to examine the risk factors that impact the ERP adoption along the five phases of ERP adoption (refer to section 1.3).
The third is the assessment model motive. Though there are quite a lot of models for risk assessment and management relating to finance, marketing, information technology, the researcher found that there is a lot of scope and potential to develop a risk assessment model for ERP adoption in particular. Moreover, the interest is further concretized that such an assessment model should be simple to understand, even robust. The researcher found an opportunity to judiciously blend the managerial/business requirements relating to ERP risks in SMEs with technological enablement relating to certain well proven scientific model, yet unexplored in the field of ERP risk assessment. This is accomplished in this research by the right mix of managerial and technological foundations to develop a risk assessment model using Fuzzy Petri-Nets (Chen et al, 1990) using the synergies of Petri-Nets (Murata, 1989) and Fuzzy Logic (Zadeh, 1965). This will facilitate the conversion of risk perception responses of SMEs on ERP adoption into measurable and quantifiable values of risk so as to enhance the understanding and knowledge about ERP adoption. Currently there is no such a risk assessment model available in both theory and practice.

Finally, this study motivated to extensively refer to the existing research literature, identify the gaps and further contribute to the body of knowledge in theory and practice. The design of this research itself is multi-disciplinary in the sense that the background of the research design is drawn from the works which have already been completed, accepted and proven in the perception of risks in varied subject domains. The learning is applied to the field of information systems, specifically to ERP systems adoptions in SMEs.

1.5 Contributions of the Research

This research will quantitatively analyze the risks in all the five phases of ERP Adoption project, namely Planning, Acquisition, Implementation, Usage and Extension. Fuzzy Petri nets will be used to model, build and develop a risk assessment model.

The main aim of this research task is to establish and develop a risk assessment framework for ERP projects using fuzzy Petri nets, which we think would give
significantly to the quantitative measurement and impact of risks in the ERP adoption phases for the SMEs (Bharathi et al., 2012). This research result will contribute towards producing an assessment framework by way of a Fuzzy Petri net based tool to comprehensively measure the impact of risks in each of the five stages of ERP Adoption for SMEs. This research work will be of support to project managers and decision makers of SMEs in analyzing the risk impacts of ERP projects. This research work will be of support to project managers and decision makers of SMEs in analyzing the risk impacts of ERP projects. Moreover the contribution of this research work can be three-fold, academic, practitioner and research perspectives.

This research will be of use to academics because it will contribute extensively to the existing body of knowledge on Risk Management in ERP projects in SMEs but reinforcing the rules of project risk management from a quantifiable perspective. There has been very limited or almost no research in this area from an emerging market context.

From a practitioner’s perspective the outcome of this research will become an authentic source of reference for predicting and measuring risk associated with ERP adoption in Small and Medium Enterprises for similar SME clusters like ready-made garments, foundry, food processing, power-looms, machine tools, chemicals, electronic goods, agro-products, hosiery, leather etc. in the developing world.

For the researcher, this research will immensely contribute towards enhancing and broadening the scope of knowledge seeking and sharing in the domain of Enterprise Solutions. The experiential learning from the outcome of this research will create visibility of the researcher and can create global opportunities for extending and validating the research into newer industrial and geographic horizons.

1.6 Research Approach and Methodology

A combination of both qualitative and quantitative methods of research is administered by means of semi-structured interviews with experts in ERP implementation and a survey using a structured questionnaire to the SME respondents in the Auto Component Cluster
in Pune. The research was conducted in three stages: First the identification and finalization of risks and the inherent risk factors in each phase of the ERP adoption life cycle. This was enabled through extensive inspection of the past research work into ERP implementation success, failure, risk elements, inputs from ERP experts and advisors. The data collected from experts in the form of an interview were qualitative in nature which facilitated to explore and obtain a deeper understanding about the critical challenges of ERP adoption; the SMEs is currently facing given their nature of operation in the auto component cluster in India and in Pune in particular.

In the second stage, based on the comprehensive list of risks identified from stage 1, a multi-level fuzzy Petri-net based structure involving four components, namely Phase of ERP Adoption, Risks, Risk Factors and Responses (Strongly Agree to Strongly Disagree) from sample SMEs was formed.

In the third and final stage a structured questionnaire was made containing two segments of questions, namely the basic details of the SME units and the second segment involving the questions relating to risk factors in the phases of ERP adoption. The questionnaire was employed to conduct quantitative research with the selected sample of SME units operating in the Auto Component Cluster in Pune.

1.7 Structure of the thesis

There are nine chapters in this thesis the purpose of each one is explained below

Chapter One: Introduction

This chapter introduces the research and covers the rationale and background of the research, and presents the statement of the research problem and research question for investigation. This section also contains the research objectives to be accomplished, the motives behind the conduct of this research, the contributions made by the research outcome, and a brief overview of the research approach and methodology.
Chapter Two: Literature Review

This chapter extensively reviews the research content in the existing body of knowledge relating to certain key concepts like ERP definition and characteristics, evolution and trend in ERP, ERP adoption life cycle; the ERP systems for SMEs, the SME ERP market composition, SME cluster in India and the Pune auto component cluster and the existing stage of ERP research in the cluster; and gives a comparison about the ERP adoption in SMEs with their bigger counterparts. This chapter discusses about the risk perception theories and its relevance to the current study and also relates the earlier works on risk theories to the risk assessment and management in ERP adoption. This chapter includes a detailed discussion on the conceptual understanding on Fuzzy Petri-nets, their relevance, applications in the existing research domains, a study on the tools available for Petri-nets and Fuzzy concepts.

Chapter Three: Methodology of Research

This chapter narrates the methodological approach of this research. This includes a detailed description of the process of the research together with the justification of the methods used such as qualitative study and survey. This chapter includes the sampling method used and the process of arriving at the sample size and also the procedures used for data collection and present the results of the reliability, descriptive statistics and cross-tabulations. This chapter closes by presenting the consideration of ethics and confidentiality in this inquiry.

Chapter Four: FPN based Risk Assessment Model in the ERP Planning Phase

This chapter contains two segments. In segment 1, a detailed description is made about the concept and development of the Risk Assessment Tool in FPN. The various steps followed in establishing the model are narrated here. The general rules for interpreting the risk assessment model in FPN are stated in this chapter.
The segment 2 covers the risk assessment analysis of the beginning stage of ERP adoption namely planning phase. Each of the risk and risk factors are explained in detail and a table containing the codification of risks and risk factors of the planning phase is given based on which the FPN model is drawn. The analysis and quantification of each of the risk through its inherent risk factors are diagrammatically explained. The outcomes of the model are then presented, findings drawn and interpreted based on the FPN rules.

**Chapter Five: FPN based Risk Assessment Model in the ERP Acquisition Phase**

The chapter includes the risk assessment analysis of the second phase of ERP adoption, which is the acquisition phase. The risks and risk factors relevant to the acquisition phase is explained, tabulated and codified and then the FPN model is drawn. The analysis, quantification, findings and interpretation are carried out as per the procedure narrated in segment two of chapter four above.

**Chapter Six: FPN based Risk Assessment Model in the ERP Implementation Phase**

The explanation and analysis pertaining to the risk assessment of the third phase of ERP adoption, namely implementation phase of ERP adoption in SMEs is contained in this chapter. A FPN model is drawn after given a detailed description, tabulation and codification of the risks and risk factors relevant to the implementation phase. The analysis, quantification, findings and interpretation are done applying the process defined in section two of chapter four above.

**Chapter Seven: FPN based Risk Assessment Model in the ERP Usage Phase**

This chapter encompasses the fourth stage of ERP adoption in SMEs namely the Usage Phase. The explanation of the risks and risk factors relating to the usage of ERP in SMEs are given after which these risks are tabulated and codified in building the FPN model.
The procedure for analysis, quantification, and rendering of findings is based on the routine given in section two of chapter four.

Chapter Eight: FPN based Risk Assessment Model in the ERP Extension Phase

The risks and the inherent risk factor relevant to the fifth and final phase of ERP adoption, namely extension phase is taken up in this chapter eight. Here the explanation is about the risks that impact the SME units during the cognitive operation of extending and integrating the ERP functionality with their supply chain partners. The identified risks and risk factors in the extension phase are tabulated and codified based on which the FPN model is arrived. As per the procedure narrated in segment two of chapter four, the analysis, quantification, and interpretation of findings are carried out.

Chapter Nine: Conclusion and Future Direction

The last chapter summaries the whole research in light of its contributions to the existing body of knowledge and its implications to the theory and practice of ERP adoption for SMEs in the Auto Component Cluster in Pune. It clearly brings out the inherent limitations of this research and sets the directions for future research work.