A Literature Review of Business Process Reengineering of Manufacturing Systems

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ABSTRACT
Business Process Reengineering is necessary to be flexible to adapt to changing global and competitive environment. Reengineering is a fundamental rethinking and radical redesign of business processes to achieve dramatic improvement in cost, quality, speed, and service. This paper is devoted to a critical review of existing literature on business process reengineering of manufacturing systems, factors and modeling in order to understand the importance of reengineering.

Key words
Business process reengineering, manufacturing system, flexibility

1. INTRODUCTION
The globalization of economy and the liberalization of trade markets have formulated new conditions in the market place which are characterized by instability and intensive competition in the business environment. Competition is continuously increasing with respect to price, quality and selection, service and promptness of delivery. Removal of barriers, international cooperation and technological innovations cause competition to intensify. All these changes impose the need for organizational transformation, where the entire processes, organization climate and organization structure are changed [1]. Reengineering is quite a new research subject and methods for applying it are developed very fast.

Reengineering consists of modifying designs of the manufacturing system's components so that they become integrated into a form such that the managerial characteristics of the products satisfy the values desired by the target market. Reengineering a manufacturing system consists of integrating the productive resources of a current business process so that the products made are focused on the target market and generate the expected profits.

2. BUSINESS PROCESS RE-ENGINEERING
Hales and Savoie [2] and Irani, Sharp, and Race [3], argue that Business Process Reengineering (BPR) is a fascinating concept that has the potential to "save" a "failing" company and lead it to survival and growth, with Farmer [4] and De Bruyn and Gelders [5] reporting empirical evidence to substantiate the "value" of BPR. A variety of definitions of BPR have been proposed in literature [6-9], but the one cited as being normative comes from Michael Hammer and James Champy [10] and was presented in their seminal book *Reengineering the Corporation: A Manifesto for Business Revolution*. Hammer and Champy [10] define BPR as:

Reengineering is the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical contemporary measures of performance such as cost, quality, service and speed.

Process is a structured and measured set of activities designed to produce a specified output for a particular customer or market. It implies a strong emphasis on how work is done within an organization [11].

Reengineering is used to achieve several improvements simultaneously:

- Business Process increases sales effectiveness
- reduces business operating costs
- improves customer service
- improves quality
- exploits new technologies
- copes with mergers and restructures
- becomes 'appropriately' compliant with new regulations

BPR is a vehicle with which to improve performance through radically *redesigning* strategic, tactical, and operational processes, together with the procedures, policies, structures, and infrastructure that support them. Business-process reengineering is cited as offering organizations a whole host of benefits (strategic, tactical, and operational) with differing natures (financial, nonfinancial, and intangible). Such benefits include improved quality of products, processes, flexibility gains, reduced costs, and improved efficiency and effectiveness [3].

One of the main problems is to take the decision if a process needs to be reengineered or not. Although BPR continues to be an important item on the management's agenda, Holland and Kumar [12] report that 60 to 80 percent of reengineering programs have been unsuccessful, with Hammer and Champy [10] claiming that 70 percent of companies fail to achieve any benefits from their reengineering efforts The successful implementation of BPR for a radical change in manufacturing strategy requires a change in attitude and the serious involvement of dedicated individuals and teams [13]. Smith [14] indicates that a major aspect of BPR is the human element. There is need for a more systematic and rigorous assessment of the factors deemed important to project success. In trying to avoid BRP failure, Guimaraes [15] presents critical success factors for BPR, together with those issues that are regarded as factors important in securing BPR project success.

The keywords for Business Process Reengineering are `fundamental', `radical', `dramatic', `change' and `process'. A business process has to undergo fundamental changes to improve productivity and quality. Radical changes, as opposed to incremental changes, are made to create dramatic improvements. BPR focuses on the whole process starting from product conceptual stage to final product design. It provides the opportunity to reengineer the process or to reduce radically the number of activities it takes to carry out a process with the help of advanced Information Technology [16, 10, 17].

3. BUSINESS PROCESS REENGINEERING FACTORS

Reengineering encompasses the envisioning of new work strategies, the actual process design activity, and the implementation of the change in all its complex technological, human, and organizational dimensions [11]. Most of the research reports in literature deal with case studies and conceptual works [18, 19, 15, 20]. According to Elzinga et al. [21] BPR is a structured approach to analyzing and continually improving fundamental activities such as manufacturing, marketing, communications and other major elements of a company's operation. Wright and Yu [22] define the factors to be considered before actual BPR starts and have developed a model for identifying the tools for BPR. Francis and McIntosh [23] have identified causes for the emergence of BPR such as consumers, competition (global), technological development, and IT. Childe et al. [24] have presented frame- works for BPR that focus upon the sequence of activities that form business processes.

In earlier studies, Hall et al. [25] define three critical determinants of successful BPR projects. Maull et al. [26] have conducted a survey of 25 UK companies in order to determine the critical success factors for BPR. Teng [27] has developed a model for strategic perspectives on BPR to enable organizational changes including process changes. Guimaraes et al. [28] test eight Expert Systems (ES) success factors in terms of their importance to BPR. Paper [29] presents a case study conducted in Caterpillar where he adheres to a systematic methodology and insists on creativity training, process simplification and improvement. Elahee and Gupta [30] have discussed six major success factors for BPR. Yoon et al. [31] presented eight success factors for expert systems used in BPR.

4. BPR MODELING

Also discussed is the need for modeling Business Processes and, using various tools, such as simulation, object-oriented programming, queuing theory, and AI techniques [32-34]. The conceptual models have been widely employed to understand the concept of BPR and its major enablers. Broadbent et al. [35] has developed a conceptual model and a framework for highlighting the role of IT in reengineering. This includes how IT can improve the reengineering of a business process in a more generic term.

Yu and Mylopoulos [36] proposes a framework using AI techniques that focus on the modeling of strategic business processes in their organizational settings. Kesler [37] presents a model and a detailed process for redesigning human resources functions by contracting with line executives for new roles and by upgrading the competency of the human resource management staff while reengineering the HR delivery systems. Malhotra et al. [38] propose a conceptual framework that facilitates innovation, flexibility, and an understanding of reengineering of the product development planning process. The framework was then refined and finally presented based on feedback from five experts in the high technology electronics industry. From analyzing the literature on conceptual models, one can observe that most are focused on strategies and methods for reengineering. In addition, conceptual models are much broader in their approach and deal with information flow and human resource management but are less accurate. Moreover, none of the above models have included human perception for gathering data.

Simulation modeling has attracted much attention in literature [39]. The simulation technique is a mainly computerized procedure utilizing numerical techniques [40-42]. The use of AI, such as expert systems, fuzzy logic, and neural networks, to support the decision making in Flexible Manufacturing System FMS design has attracted much attention in recent years [43]. Macedo [44] has presented an intelligent system that uses a new type of neural network that has a fuzzy cognitive map structure that supports reengineering.

Pugh [45] has used a simulation model to evaluate the performance and integrity of a replacement manufacturing database, along with validation tests performed prior to acceptance and implementation. *Kaizen* and *automation* are two different approaches to improve the performance of manufacturers. Lyu [46] proposes a framework to integrate *kaizen* and *automation* in reengineering a manufacturing process. This study concludes that using an animated simulation model is an important step during process redesign. The characteristics of simulation models are that they are more accurate in modelling, but are restricted in their modelling capability. It is also difficult to model the strategic implication of BPR through simulation models.

Al-Mashari et al. [47] attempt to provide a "frame of reference" with which current practices can be re-positioned to identify the level of maturity of BPR concepts within organizations. However, none of these methods have considered uncertainty and human perception to be included in gathering data.

In a recent work, Cioca et al. [48] present fuzzy approach for managerial decision-making regarding business process reengineering. But their approach does not have systemic perspective on observable parameters for each variable. A study by Manley [49] describes how industrial engineers can assist in reengineering worn out, error prone or obsolescent real-time manufacturing systems by helping computer programmers and communication engineers to ensure that critical information control loops are complete and efficient. Hsu and Kleissner [50] examine technology trends, business benefits, and requirements. They described the logical structure of an open workflow system and positions and have designed Object Flow software to illustrate reengineering efforts. However, they have limitations, such as being difficult to understand by the user or model builder. This type of model can only represent part of the total system and does not consider the strategic implications or choices in the reengineering processes.

Chandna et. al [51] used fuzzy logic to take reengineering decision. The main contribution of this work was intended to be the building of a mathematical model in support of reengineering decision based on fuzzy techniques. Because of the great complexity of defining crisp mathematical relationships regarding reengineering, the fuzzy approach is believed as a reliable alternative. Fuzzy logic offers one potential modeling approach that can exploit the inherent vagueness involved in measuring the factors of reengineering. The novelty in the suggested approach stems from the explicit incorporation of the major factors contributing towards reengineering decision together with their respective parameters. A major advantage of the suggested procedure is generic nature of its applicability regardless of the firm setting in which it can be deployed. Furthermore, it accepts inputs in linguistic form, which essentially mimic the way shop managers respond in real-world manufacturing settings. It contributes to coding expertise concerning reengineering decision through multiple antecedent IF-THEN rules.

5. CONCLUSION

In this paper, an attempt has been made to identify and classify the tools/techniques available for modelling and analysis of BPR. Initially, we explained the role of BPR in improving competitiveness manufacturing organizations. Following this, the definition of a business process was presented. The importance of modelling and analysis was discussed. The use of fuzzy logic in taking decision about reengineering is also reviewed.

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