Monitoring **B**usiness **P**rocess **R**edesign in **ERP** **I**mplementation **P**roje**cts**

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Abstract

ERP implementation success is influenced by a large number of factors, which most of the times are difficult to measure objectively. Adequate Business Process Redesign (BPR) is one of the most cited critical success factors in ERP implementation projects, and one of the most critical ones for the their satisfactory outcome. This study attempts to define a set of metrics for monitoring BPR within ERP implementation projects by using the Goals/Questions/Metrics method. The results of this work are twofold. First, a literature review on the BPR topic as related with ERP implementation projects is presented. And second, a Goals/Questions/Metrics preliminary plan to monitor and control BPR within ERP implementation projects is proposed.

Keywords: Enterprise Resource Planning, business process redesign, critical success factors, metrics, GQM, ERP implementations.

1. Introduction

In order to study ERP implementation projects, some researchers are using a critical success factors (CSFs) approach (Esteves and Pastor 2001). However, little has been done in relation to the management and the operationalization of these CSFs. Project evaluation is critical to the understanding, control and monitoring of the CSFs of an ERP implementation project. ERP project success is influenced by a large number of factors, and most of the times it is difficult to measure them objectively. Adequate Business Process Redesign (BPR) is one of the most cited CSFs in ERP implementation projects (e.g. Bancroft et al. 1998, Bingi et al. 1999, Holland et al. 1999, Nah et al. 2001). Comprehensive BPR is related with the alignment between business processes and the ERP business model and associated best practices (Esteves and Pastor 2000). As Valiris and Glykas (1999) mention, in the literature there has been some confusion regarding the use of terms like reengineering, process improvement and redesign. They suggest that reengineering is synonymous to radical change and process improvement to incremental change and that both, reengineering and process improvement are included in the definition of redesign. In this paper we adopt the same view. Therefore, we will use as topic 'business process redesign' since it is the term that has the broadest scope.

This study attempts to provide a set of metrics to control and monitor BPR in ERP implementation projects in order to help managers to achieve success in their projects. According to Jurison (1999, p. 28) the purpose of project control is: "to keep the project on course and as close to the plan as possible, to identify problems before they happen and to implement recovery plans before unrecoverable damage is done". Al-Mashari and Zairi (2000, p. 308) pointed out that "having a comprehensive measurement system provides a feedback mechanism to track implementation efforts, identify gaps and deficiencies in

performance, and recommend the necessary actions to fine-tune the situation in hand in order to achieve the desired business-centered outcomes". Kale (2000, p. 142) says that measures for innovative process reengineering should be: visible, meaningful, small in number, applied consistently and regularly, quantitative and involving personnel closest to the process.

Although there is the recognition of the needs to control and monitor a redesigned process and link it to continuous improvement programs, many methods studied did not reflect the recognition of these needs (Kettinger et al. 1997). Usually, the metrics proposed in the ERP implementation methodologies are related with time milestones and costs aspects. This is particularly due to the fact that these methodologies follow the common definition of project success: on time and on budget. We used the Goals/Question/Metric (GQM) method to develop our set of metrics. The result of the application of this method is a GQM plan. The GQM plan is a document that contains the goals, questions, and metrics for a measurement program (Solingen and Berghout 1999), in this case an ERP implementation project.

This paper is organized as follows. First, we present the research approach used. Next, we present background in BPR. Then, we present a brief description of GQM method and the GQM plan propose. Finally, we present some conclusions and plans for further work.

2. Research Approach

The purpose of this study is to develop a set of metrics help to control and monitor BPR issues in ERP implementation projects. We used the GQM method to develop a measurement plan. The steps were:

- Literature review on BPR and its relation to ERP implementation projects
- Definition of the preliminary GQM plan: definition of goals, definition of questions associated for each goal, definition of metrics associated to each question, metrics interpretation.

A literature review on the BPR topic and ERP implementations was made in order to acquire knowledge related with this CSF. The information provided by the literature survey was the main source of knowledge for the task presented in this paper. We used the concept of preliminary GQM plan due to the fact that the project team that is going to use it must validate it before it becomes the final GQM plan. Here, we only provide a proposal for this plan.

3. Business Process Redesign Overview

BPR has been popularized in recent years as the most important technique for restructuring business operations to achieve improvements. However, the technique is not new. BPR originated in the 1950s as large enterprises began to explore the potential impact of computers on the efficiency and effectiveness of their business processes. In the early 1990s, BPR had an explosive dissemination, especially after the publication of the book by Hammer and Champy (1993) entitled "Reengineering the Corporation: A Manifesto for Business Revolution". Another reason is the fact that during the 1990s an increasingly competitive world was driving the use of BPR (Hammer and Champy 1993) and business restructuring to improve profitability and return on capital employed (Martin and Cheung 2000). According to Hammer and Champy (1993, p. 32) BPR 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".

A process is "a lateral or horizontal organizational form, that encapsulates the interdependence of tasks, roles, people, departments and functions required to provide a customer with a product or service" (Earl 1994, p. 13). A business process is "comprised of the people who conduct it, the tools they use to assist them, the procedures they follow and the flows of material and information between the various people, groups and sub-activities" (Tjaden et al. 1996). Whitman and Gibson (1997) developed a study for discovering why enterprises use BPR. In order of importance, the reasons are: to improve inefficient business processes, to be industrial leader, to reorganize business functions, and to improve current industry position.

Jih and Owings (1995) suggested that management is taking a more holistic approach to the redesign and packaging of business processes and their relation with information technology. The benefits from reengineering arise from combinations of organizational changes with information and information technology (Hammer and Champy 1993, Davenport 1993, Lillrank and Holopainen 1998, Jarrar and Aspinwall 1999). Therefore, there is a strong relationship between BPR and organizational change management procedures during a BPR project with the support of top management. This evidences the need to integrate techniques for organizational design and change into BPR projects (Kettinger et al. 1997).

3.1 BPR and ERP

According to Kraemmergaard and Moller (2000), ERP systems pave the way for BPR since the implementation of ERP systems requires examination of many business processes (Boudreau and Robey 1999, Taylor 1998). The frontiers of which comes first, BPR and then ERP, or ERP and then BPR, are not quite well defined in most of the cases. Some organizations use ERP systems to promote a BPR (e.g. Martin and Cheung 2000), while others are driven into BPR during the implementation of an ERP system. A survey made to 220 European companies implementing SAP showed that simultaneous implementation of BPR and SAP has proved to be the most effective and powerful method for business improvement (Chemical Marketing Reporter 1996). Another important issue in BPR/ERP projects is the cycle time expended for redesigning the processes and obtaining the expected results.

3.1.1. BPR Methodologies

Bancroft et al. (1998) defined a four-basic-steps approach for a BPR method: choose a process, understand it to the extent needed, redesign it, and implement the change. Kale (2000, p. 136) proposes an eight-steps BRP methodology. Usually authors identify two dimensions in a BPR initiative, magnitude of change and scale of the change effort involved:

- Magnitude of change - although the initial concept of BPR was associated with a radical change, nowadays these changes are on a continuum from streamlining to reinvention (Bancroft et al. 1998). “Streamlining a business process implies making incremental changes to the current process to increase quality, decrease cycle time, or reduce cost. Reinventing a business process means scrapping the current one and creating a process that truly meets the needs of the company” (Bancroft et al. 1998, p. 116).
- Scale of the change effort involved – this dimension refers to the portion of business involved in the BPR project. Bancroft et al. (1998) quoted that the more departments and people involved in the change, the greater the scale and therefore the higher complexity of effort. Some organizations adopt the approach of starting with a small portion in a pilot project and the extend the experience to the whole organization, to an approach with major sections.

3.1.2. BPR Concerns in the ERP Context

Based on a survey, Jarrar and Aspinwall (1999) defined a set of CSFs for a successful BPR project categorised in four main aspects: culture, structure, process and information technology. Although the analysis of Jarrar and Aspinwall (1999) was not related with ERP projects, we think these factors should be taken into account in future research. Some of those CSFs in BPR projects (such as employee involvement, top commitment, training, assign the ‘best’ people, involve outside consultants) are very similar to some of the CSFs in ERP projects (Esteves and Pastor 2000). On both cases the organizational perspective is more important than the technological perspective. Based on field interviews of BPR experts, Kettinger et al. (1997) consider four major project characteristics in BPR planning: project radicalness, process structuredness, the potential for IT enablement and customer focus. Figure 1 represents a summary of the main concerns in a BPR approach during ERP implementation projects. These concerns were based on the articles referenced in this work and the literature inside them.

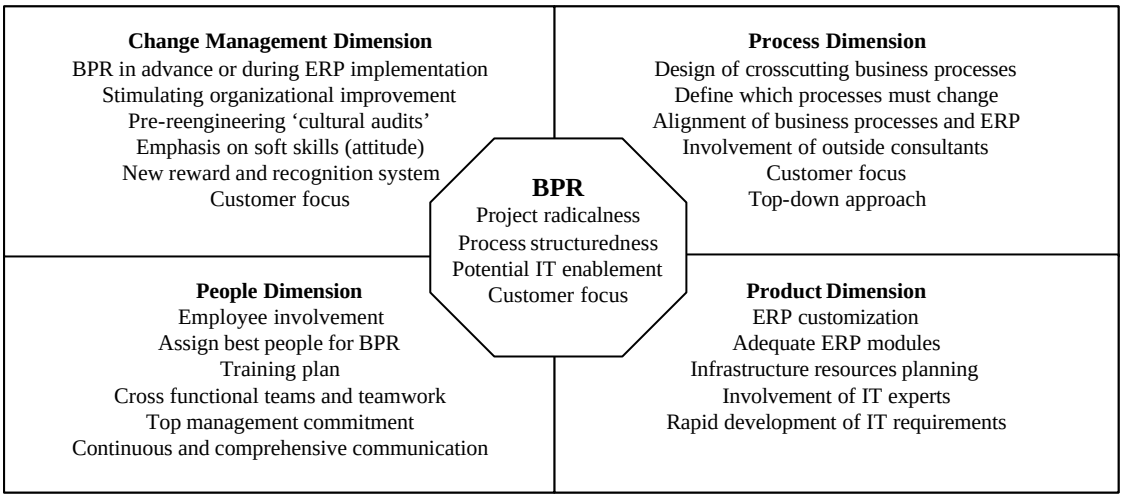

Figure 1 – BPR Concerns in the ERP Context.

3.2 Towards a BPR Strategic View for ERP Implementations

Based on the literature review that we made on the BPR topic, we propose that managers must develop a strategic view of BPR instead of a tactical one. In most ERP implementation projects, BPR is seen as a consequence of an ERP implementation and hence its importance is dismissed. At the tactical level managers are worried in redesigning their business in order to align the ERP system and the current business processes. However, a BPR effort in strategic terms is an intervention, and probably the most important intervention associated with the adoption of the ERP system.

A BPR intervention is not merely the adaptation of an ERP system or the business processes of an organization, it implies changes in the way of doing business as well as on the structure and culture of an organization; it is changing the way of working of an organization and the process-oriented vision that organization needs to integrate. As Kale (2000, p. 132) refers, "the most important outcome of BPR has been viewing business activities as more than a collection of individual or even functional tasks; it has engendered the process-oriented view of business". Thus, the BPR effort must be seen as an enabler of organizational and business improvement. The BPR intervention may have deep effects not only on the short term of organizational behavior, but also on its long term behavior and strategy. Two main reasons arise in order to develop this strategic view: current changes in the business world and the rising knowledge organization.

The concepts of ERP and BPR are unique and to understand better how they are related to each other one has to follow the path of process study of the problem. In essence, understanding the existing business processes is one of the key elements in ERP implementations. Implementing an ERP system involves reengineering the existing business processes to the best business process standard (Bingi et al. 1999). ERP systems are built on best practices that are followed in the industry domain. Therefore, in practice, BPR is aimed at only when the customer's requirements are not met within the scope of customization allowed by the ERP system. The organization business strategy outlines 'what' you want to do. BPR outlines 'how' you want to do it - reengineering (human and system) behaviours in your business to achieve those goals. ERP answers the question 'with what'.

As a system, the ERP is a tool to help change behaviours. As a philosophy, ERP is a strategy for changing that behaviour. Soliman and Youssef (1998) note that information technology, in general, and ERP systems in particular, are central to the success of the BPR method. The main consulting organizations have their own BPR methodologies and are based on the use of specific tools, such as Coopers&Lybrand (currently PriceWaterhouseCoopers) that used a proprietary process modelling and simulation tool called SPARKs. Kettinger et al. (1997) made an extensive review of BPR methods and techniques available. In sum, ERP becomes a philosophy (with technical tool overtones) that supports a BPR effort. These changes should support the business strategy. Project team members and managers must identify the core business processes in order

to prioritise the BPR approach. Techniques such as Process Quality Management (PQM) could be applied. Figure 2 represents a summary of the main issues that arise in a BPR approach during an ERP implementation project.

Aspects of BPR	
Positive aspects	Negative aspects
-Stimulates business improvement -Alignment of business processes and ERP system -Design of crosscutting business processes	-Causes project delays -Requires additional effort from employees -Most of the times is too technological oriented -Adoption of certain ERP functionality implies the adoption of several modules

Figure 2 – Main issues in a BPR approach during an ERP implementation project.

We summarised the main issues of measuring BPR: define which business processes must change, define who collects the BPR metrics, define which ERP processes must change, and analyse when BPR monitoring must be done, Organizational/business implications of BPR. Some authors propose some metrics to define and measure the effectiveness of business processes. For instance, Tjaden et al. (1996) proposed a set of metrics, name ly: simplicity, flexibility, integration and efficiency, which are based in what they call the business process structural characteristics. We recommend that these metrics be incorporated in a BPR approach within an ERP implementation project. The goal of this study is not to define these metrics or core business processes identification. Instead, we want to help monitoring the BPR actions along the ERP implementation project.

4. A GQM Preliminary Plan for BPR in ERP Implementations

We present below an overview of GQM approach and then, we describe each of the components of the GQM preliminary plan: measurement goals, questions and metrics. For the measurement goal defined, the following aspects are described: measurement goal description, its refinement into questions, and finally, refinement from questions to metrics.

4.1 GQM Method Overview

The GQM approach is a mechanism that provides a framework for developing a metrics program. It was developed at the University of Maryland as a mechanism for formalizing the tasks of characterization, planning, construction, analysis, learning and feedback. GQM does not provide specific goals but rather a framework for stating measurement goals and refining them into questions to provide a specification for the data needed to help achieve the goals (Basili et al. 1994). The GQM method was originally developed by V. Basili and D. Weiss, and expanded with many other concepts by D. Rombach. The GQM method contains four phases: planning phase, definition phase, data collection phase and interpretation phase (for more details see Solingen and Berghout 1999). The GQM top-down approach assists managers and developers not only in knowing what data to collect but also in understanding the type of analysis needed when the data is in hand (Pfleeger et al. 1997).

The definition phase is the second phase of the GQM process and concerns all activities that should be performed to formally define a measurement program. One of the most important outcomes of this phase is the GQM plan. A GQM plan or GQM model documents the refinement of a precisely specified measurement goal via a set of questions into a set of metrics. Thus, a GQM plan documents which metrics are used to achieve a measurement goal and why these are used - the questions provide the rationale underlying the selection of the metrics. Definition phase has three important steps:

- Define measurement goals - Measurement goals should be defined in an understandable way and should be clearly structure. These measurement goals should be relevant to the business, represent strategic goals from management, and support high priority processes of the organization (Solingen and Berghout 1999).

- Define questions - Questions should be defined to support the interpretation of measurement goals. Questions are a refinement of measurement goals from an abstract level to an operational level, which is more suitable for interpretation. By answering questions, one should be able to conclude whether a measurement goal is reached. As Solingen and Berghout (1999) refers, the questions should be defined at an intermediate level of abstraction between the metrics and the measurement goals. The list of questions is developed through interviews.
- Define metrics - Once measurement goals are refine into a list of questions, metrics should be defined that provide all the quantitative information to answer the questions in a satisfactory way. The metrics defined must ensure that sufficient information should be available to answer the questions.

4.2 Measurement Goal of the GQM Preliminary Plan

In our case of BPR, the definition of the measurement goal associated with BPR is made using the template provided by Basili et al. (1994). We defined one measurement goal based in our CSF:

Measurement Goal

Analyse:	The actual redesign of business processes
For the purpose of	Understanding BPR
With respect to	ERP implementation projects
From the viewpoint of	Project managers and their project teams
In the context of	Organizations under BPR/ERP initiatives

4.3 Questions

For the above measurement goal we defined a set of questions (see table 1) based in the BPR dimensions (see figure 1). The questions for our measurement goal focus on identifying objective and quantifiable aspects that were related to the baseline characteristics of the business processes that need change.

Table 1 – The definition of questions related with our measurement goal.

Dimensions	Questions
Change management	1. What is the magnitude of redesign for each business process? 2. What jobs are affected by the changes? 3. How many departments are affected?
People	4. How many users are involved? 5. Are key-users for each business process involved?
Process	6. How many business processes need to be redesigned? 7. Which other business processes are affected with the business process redesign? 8. What is the complexity associated with these business processes? 9. What is the effort of redesigning these business processes? 10. How long is the redesign going to take?
Product	11. How many ERP processes need to change?

4.4 Description of Metrics

In this section we show the definition of each metric and the relationship between the questions defined above and the metrics (see table 2). We also represented graphically the relationships (see figure 3). The graphic represents the three levels: measurement goals, questions, and metrics. Metrics can help answer more than one question. For instance, in this case with the metric users involved (metric four) we can know how many users were involved and how many key-users were involved.

Table 2 – The Definition of Metrics and their Relationship with Questions.

1	Magnitude of redesign	Magnitude of redesign that is necessary for each business process.	Q1
2	Number of jobs affected	Number of jobs that are affected for each business process redesigned.	Q2
3	Number of departments affected	Number of departments that are related with each business process redesigned.	Q3
4	Users involved	Users involved in the BPR process	Q4
5	Number of business processes redesigned	Number of business processes that need to be redesigned.	Q6
6	Number of business processes affected	Number of business processes that need changes due to the redesign of another business process.	Q7
7	Complexity of business processes	"Sum of the number of activities, the number of people in each activity, the number of material flows into and out of the process, and the number of material flows between the activities of the process" (Tjaden et al. 1996).	Q8
8	BPR effort	This metric is related with the portions of business involved in the BPR redesign. It is composed of the total number of departments, the number of business processes redesigned and the people involved in each phase.	Q9
9	Duration of business process redesign	Estimated time necessary to redesign each business process.	Q10
10	Number of ERP processes affected	Number of ERP processes that need changes due to the BRP process	Q11

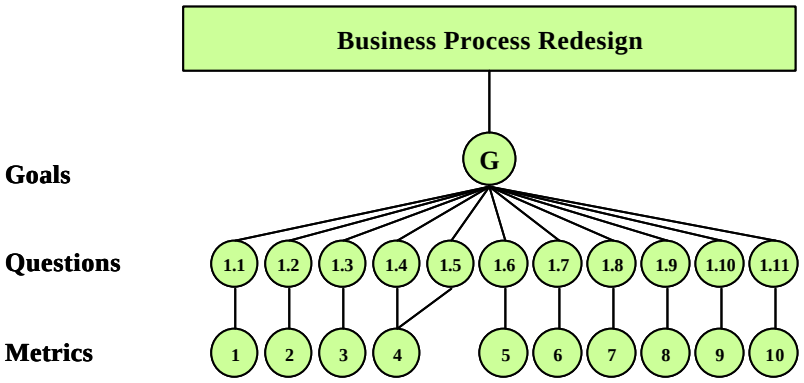

Figure 3 - Graphical representation of the GQM preliminary Plan.

The metrics description was done by using a special form that we created for the task. For each metric we defined the following aspects: what they measure, when they must be measured, what possible values they could have, the metric scale, who will measure it, what medium is used for data collection. Most of the metrics proposed are direct measurements except the metrics related with percentages.

4.5 Interpretation of Metrics

In relation to the magnitude of redesign metric, Kettinger et al. (1997) developed a "project radicalness planning worksheet" in order to assess the BPR project radicalness. This worksheet includes eleven factors related with BPR project planning: strategic centrality, feasibility of IT to change process, process breadth, senior management commitment, performance measurement criteria, process functionality, project functionality, project resource availability, structural flexibility, cultural capacity for change, management's willingness to impact people and value chain target. Each factor is measured in a Likert

scale (1-5 scores). However, their view is not for each business process but for the project as a whole. We think that this worksheet is very useful at the beginning of the BPR project to define the BPR plan and allocate the adequate resources. This also is important to establish management commitment and support (other CSF in ERP implementation projects). Higher radicalness implies more commitment and lower radicalness implies more analysis of existing processes in order to improve them (Kettinger et al. 1997).

Based on the magnitude and the scale of effort involved in a BPR approach, Bancroft et al. (1998) proposed a matrix of magnitude versus scale of effort. BPR effort is quite similar to the complexity of each business process. The more departments and people involved in the change, the greater the scale and therefore complexity of the BPR effort. As Bancroft et al. (1998, p. 118) pointed out, "identifying the correct quadrant helps the project team and the executive sponsor to choose the appropriate project process and appreciate the amount of change required. This knowledge will positively influence their success rate". Therefore, it will be useful for each business process to locate its correct quadrant in order to define the best project processes to redesign it. According to Esteves and Pastor (2001), the BPR CFS is more relevant in the three initial phases of an ERP implementation project. Therefore, the effort to monitor and control this CSF should be put in these three initial phases.

5. Conclusions

This study attempts to define a first set of metrics for BPR in ERP implementation projects. The results of this work are twofold. First, a GQM plan to monitor and control ERP implementation projects is presented and second, a literature review on BPR topic related with ERP implementation projects. BPR is cited as one of the most relevant CSFs in ERP implementation projects. We think these metrics have two important proactive characteristics: they help to detect deviations from the project plan and to act before damage is made, and second, these metrics can have the effect of motivating and encouraging top managers in their involvement and commitment with the ERP project. Therefore, the purpose of this study is not to describe an exhaustive list of metrics. Instead we intend to present a form to develop these metrics in future ERP implementation projects and provided the first set of metrics that should be extended and adapted according to the specific needs of ERP implementation projects.

One of the most important benefits on evaluating BPR is that it can help as a diagnostic technique to permit the revision of BPR plan to meet the goals and objectives of the ERP project. Other benefits gained by evaluating BPR affect decision making particularly because evaluations can help decide between alternative BPR methods and to decide who should participate in the BPR plan. Some of the main arguments for better evaluation of BPR: to validate BPR as a business tool, to justify changes incurred in a BPR effort, to help improve the BPR plan and, to help in selecting BPR methods.

This study only provides the first step to propose a set of metrics for BPR, i.e., the definition of the metrics. Next steps will be the validation and interpretation of these metrics. Two possible kinds of validation methods can be applied: case study or control experiments (Calero et al. 2001). We would like to remark that we are conscientious that this GQM preliminary plan will be subject to changes during the next steps of the research due to new information gathered and experience gained in the feedback sessions. Another aspect is the importance of knowing the relevance of the BPR CSF along the stages of an implementation project (Esteves and Pastor 2001) due to the fact that this information can help managers know when they should put more attention to specific metrics in each stage. Currently, we are developing a software application for the management of the metrics defined here. Additional research will attempt to define metrics to other CSFs defined in the literature of ERP implementation projects.

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