Competence and impact of tools for BPR

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Accepted 21 March 1999

Abstract

Software tools for Business Process Reengineering (BPR) promise to reduce cost and improve quality of projects. This paper discusses the contribution of BPR tools in BPR projects and identifies critical factors for their success. A model was built based on previous research on tool success. The analysis of empirical data shows that BPR tools are related to effectiveness rather than efficiency of the projects. Process visualization and process analysis features are key to BPR tool competence. Also success factors for BPR tools are different from those for CASE tools.

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Keywords: Business process reengineering (BPR); BPR tool competence; BPR success; Computer aided software engineering (CASE); CASE tools

1. Introduction

Since the emergence of Business process reengineering (BPR), a large number of software tools have emerged to help BPR efforts. However, studies show that the lack of user-friendly, yet flexible, software to support BPR is seen as a major problem [3,13]. It is surprising that despite the discrepancy between user needs and available tools, there have been only a few studies about BPR tools. In order to provide a basis for evaluation and proper selection of BPR tools, research is needed to examine their features and their contribution to BPR success.

Since BPR tools have many similarities with Computer-aided software engineering (CASE) tools, the failures of CASE tool have led to concern about similar failures of BPR tools. This research, therefore, focuses on the following questions.

1. Which features are important in BPR tools?
2. How important are BPR tools in BPR success?
3. Does the failure of CASE tools also portend similar failure for BPR tools?

To answer these questions, important features of BPR tools and CASE tools experiences were identified through a literature survey. A model was built to explain the relationship between BPR tools’ success and determinants of success such as features, costs, and organizational conditions.

2. BPR perspectives

Hammer and Champy [9] defined BPR as “the fundamental rethinking and radical redesign of busi-
ness processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service, and speed”. Thereafter, various BPR approaches and methodologies have been proposed [1].

In addition to BPR, some efforts to automate workflow have emerged. Workflow automation aims to improve work processes through developing applications for managing, measuring, and revising processes that span the efforts of multiple workers, applications, and organizations. Workflow automation is closely linked to BPR because sometimes it is used as a step towards workflow automation.

Different perspectives of prior studies about BPR were mapped according to their range as illustrated in Fig. 1. In its narrowest view, BPR is considered as a redesign of process that can be carried out through predetermined steps, such as those proposed by Furey [5] and Kim and Kim [14]. Some designers focus on the project management side of BPR, which requires organizational and social considerations for successful planning and implementation. McPartlin [16] deals with BPR in this context. He includes process redesign as a part of the BPR project. If its purpose is workflow automation, effort consists of two parts—workflow design and workflow automation. The Workflow view in the figure reflects this perspective.

The project management view was selected for analyzing BPR tools features in this research, because it clearly identifies three separate areas that can be supported by BPR tools: (1) planning; (2) design and implementing and (3) project management. The process redesign view was also used to break down the design and implementation phase of BPR project into three sub-categories: (1) visualization and mapping; (2) modeling and measuring and (3) modifying.

3. BPR tools success model

Here we attempted to determine those success factors for a BPR project that are linked to tools. These success factors were used to build a testable model that covers key variables. Grover et al. [8] have identified important problems that people generally encounter when they try to implement BPR. They found that those more directly related to the conduct of a project, such as process delineation and project management, were perceived to be highly related to project success. Since BPR tools can support process delineation and project management, a close relationship between the use of BPR tools and BPR success was expected.
An initial BPR success model for our purpose contains two sets of factors. One consists of the factors that can be supported by BPR tools, and the other consists of the factors that are outside the scope of BPR tools. The factors related to BPR tools can be represented as ‘BPR tool competence’. Here we refined the set of factors that can be supported by BPR tools, but to keep the scope of our study manageable, we did not examine the factors not related to BPR tools.

3.1. BPR tool competence

BPR tool competence is defined as ‘the degree of success or effectiveness of a BPR tool’ that results from the factors related to the tool. The competence is similar to ‘IS success’, because a BPR tool can be considered as a specific type of information system. We distinguish BPR tool competence and IS success because of the following two reasons. First, competence is success of IS in a specific context, i.e., success of software tool that supports specific type of project, while the IS success is a more general term. Second, in most IS research, IS success has been the de-facto final dependent variable. Although there is an implicit and ultimate dependent variable that IS research may consider, corporate performance, the link between IS success and success of the company has not been examined in many studies. Here BPR tool competence is both a dependent variable in the model and an independent variable for explaining BPR project success. If an organization has a competent BPR tool there is a potential for BPR project success, however, it does not necessarily lead to a successful BPR project, because there are many other factors influencing BPR project success. Thus, BPR tool competence differs from IS success in that BPR tool competence creates a potential for success, while IS success is usually a final dependent variable.

3.2. Critical factors for BPR tool competence

A subset of the factors determining IS success from earlier research may be a good basis for identifying critical factors for BPR tool competence. Among the studies to identify success factors of IS, two main research streams are found: one has tried to identify success factors at the individual user level while another has focused on the organizational level.

An example of the first stream is the study by Goodhue and Thompson [7], which examined the link between task-technology fit and individual performance. In their technology-to-performance chain (TPC) model they argue that the fit between task and technology affects an individual’s perception and utilization of the IS and performance. This model implies that an IS can improve an individual’s performance only if it has good technology or features that fit into the characteristics of the task it supports. Although this model provides a good understanding of the causal relationship between individual performance and related variables, it does not explain group or organizational performance. If the purpose of research is to compare IS rather than to explain individual performance, organizational factors need to be considered.

A good example of the second stream is the study by Montazemi [17], which investigated the factors affecting IS satisfaction: one of the surrogates of IS success. The factors identified include organizational factors, such as top management involvement, relationship with EDP staff, and degree of decentralization. This also provides another perspective on the factors for IS success.

In addition, there might be other factors that are specific to BPR tools. CASE tools share many commonalities with BPR tools. The tasks that both tools support are designing tasks considered to be professional work. Both require substantial learning to be fully utilized. Adopting either means that the users have, to some extent, to discard their old working habits and realign their work processes and task sequences.

However, there are some differences. For instance, CASE tools can support almost all aspects of software development, while BPR tools support relatively small part of BPR projects, mainly the design of processes. BPR tools can support process visualization and analysis, but cannot support process modification while most software implementation phases are well supported by CASE tools with such features as automatic code generation.

Therefore, BPR tool competence is likely to be affected by the factors that have had effects on CASE tool success.
3.3. Lessons from CASE tools

CASE tools have been expected to improve productivity of software developers and of software by reducing the problems associated with the manual development of documentation, as well as the requirements definition, backlog, and maintenance problems. Users state that the productivity and quality improvements are achieved primarily through improved communications and documentation [18]. Finlay and Mitchell [4] examined the introduction of a CASE tool into a company, and observed considerable benefits, including improved productivity and higher level of job interests both to the organization and the individual developers. Subramanian and Zarnich [22] also found a significant productivity improvement through the use of CASE tools.

However, Norman et al. [19] investigated CASE implementation in a large organization and observed its failure to achieve the desired acceptance by developers. They found that system analysts and programmers resisted the implementation of CASE, because it encompassed a methodology and philosophy that fundamentally changed the work process of systems development personnel. They also observed that lack of training was one of the main reasons for failure. Gifford [6] claims that CASE tools encounter organizational resistance from system developers because they require changes in their way of working from an artist to an engineer. Kwok and Arnett [15] argue that introduction of CASE tool in an organization will result in the redistribution of responsibility according to a developer’s experience and knowledge about the CASE tool. This change will cause resistance from traditional personnel who perceive more job instability. Similarly, Sumner and Ryan [23] argue that most organizations have found it difficult to implement CASE because of costs, resistance by systems developers, and unacceptable learning curves.

There are contingency perspectives that take conditional factors into account. Orlikowski [20] argued that the contradictory results in the CASE literature reflect the difference in intentions, processes, and contexts around the adoption and use of CASE tools. Vessey et al. [25] argue that adoption of a CASE tool has to be considered as a new methodology rather than a simple tool and suggest a categorization of philosophies for methodology support.

Though there exist both success and failure stories in CASE tools, it is obvious that many factors other than features such as learning curve effect, organizational resistance, and cost are critical.

3.4. BPR success model

Fig. 2 represents our BPR success model, reflecting the other factors. Having too many variables is not always beneficial, but we needed to cover most of the important variables in the model. If BPR tools support various activities in various phases of BPR effort well,
then the BPR tool competence would be improved. Cost, learning effect, and organizational factors are included because they were identified to be important success factors for CASE tools.

4. Empirical test

In order to test our model, a questionnaire was designed and sent to practitioners who had participated in BPR projects and used BPR tools in those projects.

4.1. Survey design

The questionnaire was designed to measure each construct in the model. It was, therefore, necessary to cover all tools used in a BPR project. Respondents were asked to think of all BPR tools they used in a BPR project as one tool. Care was taken to measure the learning curve effect accurately. When people have obtained experience on BPR projects, the learning time of the tool, which is the operational variable of the learning curve, will be shortened. Therefore, people who had worked in multiple projects were asked to answer in the context of the first project for which they utilized BPR tools in order to eliminate this learning curve effect.

4.2. Operational variables

4.2.1. BPR tool competence

Measures for IS success can be used in measuring BPR tool competence. DeLone and McLean [2] point out that there are numerous IS success measures that are categorized according to the sequence of the IS effect:

- System quality.
- Information quality.
- Use.
- User satisfaction.
- Individual impact.
- Organizational impact.

System quality was integrated into information quality, because it has many overlaps with information quality in case of software tool like BPR tool. Individual impact was also merged with organizational impact, because it was thought to have overlaps with organizational factors in case of individual tools like BPR tool. As a result, four out of the above six measures, information quality, use, user satisfaction, and organizational impact, were chosen as the measures of BPR tool competence.

4.2.2. BPR project success

To measure BPR project success, two constructs were selected: efficiency and effectiveness of the project. Efficiency of the project was elicited by two operational variables: time and budget. Effectiveness was elicited by another two variables: result of project and organizational impact.

4.2.3. Features

The first step to investigate BPR tools’ functionality is to develop a proper framework of BPR tools functionality. There have been some research efforts related to BPR tools’ functionality. Klein [12] categorized BPR tools into six groups, and Thé [24] suggested a shopping list of BPR tool functions. The results of these studies can be integrated into our framework. In Table 1, we re-classified the proposed features according to the BPR framework. The framework in Table 1 can be used to derive operational measures for BPR tools.

Henderson and Cooprider [10] developed a functional model of CASE tools. They started from open-ended interviews with leading CASE designers to develop a list of possible CASE functionality and ended up with 98 clarified functionalities. We used a similar approach to refine our framework. Three commercial BPR tools were selected and the authors explored their features, which were categorized into one of the four categories. Then, this list was refined by integrating similar features and clarifying the wording.

As a result of exploring commercial tools three main categories were identified. The main component of BPR project–design and implementing–retained two categories: process visualization and mapping (four operational variables) and process modeling and analysis (three operational variables). No measures were defined for modifying because the analysis of commercial BPR tools shows that currently there is very little support for this step. The planning and
Components were integrated into one measure that was broken down into three operational variables. An additional technical feature also seemed critical: data compatibility. This feature is related to the ability to import/export and share data with other tools such as CASE and workflow. Three operational variables were defined to measure this.

Table 2 shows the final list of the operational variables for each category.

- **Process visualization and mapping** for supporting the representation of current business processes: usually, visualization features, such as flow-charts.
- **Process modeling and analysis** related to measurement of business processes and production of basic indices for judgment and comparison of alternative processes: time and resource calculation for each task is a typical function.
- **Data compatibility** related to the ability to import/export and share data with other tools such as CASE and workflow tools.
- **Project management** refers to the functionality for managing BPR projects.

The respondents were asked to answer, for each item in Table 2, the importance and quality of the tools.
they used. For example, respondents were asked to answer (1) how important was ‘Ease of modeling’ of a BPR tool, and (2) what was the ‘Ease of modeling’. They were asked to answer the next item, ‘Completeness of models’, in the same way, etc. Five-point Likert scales were used in the questionnaire.

4.2.4. Costs
In order to measure the cost, total purchase price of each BPR tool was elicited, and the total costs in purchasing, training, and maintenance were also determined. From the literature on CASE tools, cost is expected to have a negative relationship with BPR tool competence, because a BPR tool with strong features is normally considered unsuccessful if its relative cost is too high.

4.2.5. Learning effects
In measuring learning effects and requirements of a tool, relative time (spent in learning divided by total project time) is just as important as absolute time: both were elicited. Additional questions were asked concerning the gap between expected and actual ease of use, and the threshold for effective use of tools.

4.2.6. Organizational factors
The tendency towards organizational resistance can be measured by asking about the factors that potentially change their way of working. Four items were measured.
- Perceived change of the work.
- Perceived sufficiency of training.
- Perceived loss of expertise.
- Perceived productivity gains.

4.3. Pilot test
The questionnaire was refined through an interview with an expert who has participated in several BPR projects and used multiple BPR tools. He checked to see if the questions were valid to elicit corresponding constructs and any important items were missing. The questionnaire was further refined by a pilot test conducted with three people who had used BPR tools.

4.4. Data collection
The questionnaires were sent to subscribers of a list server specializing in BPR. Respondents could answer through e-mail, authors’ web page, mail, or fax. To motivate respondents, they were told that a copy of the results would be sent to them if they responded. A total of 102 questionnaires were collected and the number of responses used in the final analysis was 83 after dropping 19 invalid responses. The demographics of respondents is shown in Table 3.

4.5. Data analysis results and discussion
In our model, 13 representative features of BPR tools were categorized into four groups. To validate that classification, a factor analysis was performed. The variables used in the analysis were respondent’ evaluations of features of the tools they used, weighted by the importance of each feature. In the factor analysis of this research, principal component extraction method and VARIMAX rotation method were used.

As shown in Table 4, four factors which have eigen values greater than 1 were extracted for BPR tool feature. The factor analysis confirms that the features of each group have strong relationship, which implies that the classification of features can be justified.

Another factor analysis was performed for the construct of BPR tool competence. Four operational variables for BPR tool competence were factored into one.

The variables related to ‘organizational factors’ were grouped into two factors. The variables in the first factor are related to user support, since the items
are about training and how users perceive the tool. ‘Change of work’ was separated as an independent factor. The fact that ‘perceived loss of expertise’ was separated from ‘change of work’ implies that change of work caused by BPR tools does not necessarily bring about the perception of ‘loss of expertise’.

The variables that measure BPR success were factored into two groups – effectiveness and efficiency. As expected, output and organizational impact are grouped into effectiveness, while time and budget are grouped into efficiency.

### 4.5.1. Factors determining BPR tool competence

A regression analysis was used to examine the relationship between BPR tool competence and their features, cost, learning, and organizational factors. Stepwise regression retained four variables, two features and two organizational factors.

Table 5 shows that two features (process visualization and mapping and process modeling and analysis) and two organizational factors (user support and change of work) have high positive relation with BPR tool competence. The high $R^2$ implies that these four variables explain most of the variance in BPR tool competence. Signs of coefficients are as expected, except for ‘change of work’. The positive coefficient means that the more changes a BPR tool causes, the more competent the tool is viewed. Maybe most of the users of BPR tools are new to BPR, while most of CASE tools user are experienced workers in system development. Since most BPR tools are based on theoretical process models, novice users often learn from the tool by simply following the methodology, which leads to a positive effect on the project.

User support is also an important factor for BPR tool competence. It consists of three operational vari-
ables – perceived sufficiency of training, perceived loss of expertise, and perceived productivity gains. The significant positive relationship between it and BPR tool competence implies that managers should provide appropriate user support, such as sufficient training and communication with users for the prevention of the perceptions of expertise loss.

It is interesting that costs and learning time do not play an important role in a BPR project. Probably, this is because BPR tools are relatively inexpensive and easy to learn. The cost of CASE tools in a software development company with 75–150 developers are estimated to be $1.1 million to $2.7 million [11,21]. Average total purchase cost of BPR tools reported by the respondents was approximately $23,840 – visualization tool $10,210; measuring tool $11,426; project management tool $2204. Although the training cost was not elicited in the survey, there is a remarkable difference in costs.

4.5.2. How important is BPR tool competence for BPR success?

In order to examine the relationship between BPR tool competence and BPR success, two regression analyses were performed.

There is a significant relationship between BPR tool competence and the success of BPR project as in Table 6. One interesting result is that BPR tools are related to the effectiveness side of BPR project but not related to efficiency. One possible reason is that usually BPR projects spend more time on implementing (modifying), which is not influenced by BPR tools. In our survey, average time spent on designing was 169 days while average time for implementing was 374 days. The effectiveness of the project, however, is directly linked to how well the new process is designed, which can be improved by BPR tools.

Fig. 3 is a graphical summary of the test results of our model.

5. Limitations of the study

We see some limitations in this research. First, the questionnaire required both BPR tools experience and BPR project experience. Although a list server specializing in BPR offers a good sample through which we can access the people with such experience there is a possibility of a sampling bias. However, list servers usually have a variety of subscribers, which mitigates the possible bias caused by the sampling. The demographics of respondents that is balanced in their background confirms this.

Secondly, most of the variables were measured using subjective five-point scales. For some variables, such as BPR success, objective measures, such as cycle time, number of jobs processed, and profits, can be good measures. But such objective measures also have measurement problems. For example, use of profit as a measure has the problem of how to separate profit increase due to BPR from profit increase due to other factors. If we choose indices like cycle time and

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Variable (extracted factors)</th>
<th>Coefficient</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Features</td>
<td>Process visualization and mapping</td>
<td>0.521</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>Process modeling and analysis</td>
<td>0.259</td>
<td>0.01</td>
</tr>
<tr>
<td>Organizational</td>
<td>User support</td>
<td>0.312</td>
<td>0.00</td>
</tr>
<tr>
<td>factors</td>
<td>Change of work</td>
<td>0.196</td>
<td>0.07</td>
</tr>
</tbody>
</table>

*a Adjusted $R^2 = 0.522; F = 16.8; significance of $F = 0.00.

Table 6

Regression result (BPR tool competence and BPR success)

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Independent variable</th>
<th>Coefficient</th>
<th>Adjusted $R^2$</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effectiveness side of BPR project</td>
<td>BPR tool competence</td>
<td>0.297</td>
<td>0.075</td>
<td>0.01</td>
</tr>
<tr>
<td>Efficiency side of BPR project</td>
<td>BPR tool competence</td>
<td>0.032</td>
<td>-0.013</td>
<td>0.79</td>
</tr>
</tbody>
</table>
number of jobs reduced, it is difficult to combine those measures, and they do not completely reflect the quality of a new process.

Thirdly, the quantitative relationship between BPR tool competence and the factors affecting it were investigated in this research. Qualitative studies would be needed to analyze the procedure through which these factors affect the BPR project.

6. Conclusions

This research examined the important determinants of BPR tools success and the relationship between BPR tools and BPR success. The result shows that BPR tools are different from CASE tools in various aspects. Costs, long learning time, and organizational resistance in BPR tools do not seem to be as critical as for CASE tools. BPR tools are linked to effectiveness of BPR projects rather than efficiency of BPR projects. Interestingly, unlike CASE tools, change of work has a positive impact on BPR tool competence.

Our model confirmed that process visualization and process analysis are key features for the success of BPR tools. On the organizational side, one important finding is that sufficient training of users, informing them about productivity gains, and persuading them that tools would not deprive them of their expertise are necessary for the success of a BPR project in which BPR tools are utilized.

In a BPR project, managers should pay attention to the selection and usage of BPR tools. In addition to careful selection of tool, managers will also have to be thoughtful in managing usage of the tool and supporting users. Different tools and different usage would result in difference in design and, in turn, difference in the success of the project. The survey shows that BPR tools can contribute to the effectiveness of BPR projects by providing better visualization and measurement of processes.

References


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