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ANALYSIS OF TECHNIQUES FOR BUSINESS PROCESS IMPROVEMENT

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Abstract

This paper is about identifying and analyzing techniques that can be used in a business process improvement (BPI) situation. To determine suitable techniques, the term BPI is defined and criteria are derived to analyze the usability of the selected techniques. Over 300 techniques from various improvement methods were reduced to those techniques which can be applied to help improve business processes and, in particular, to support the act of improvement. Identifying these techniques is helpful, because in most cases the act of improvement is a black box that lacks guidelines or structured procedures. In our research we developed an evaluation scheme to analyze the usability of BPI techniques and give hints about how to select a suitable technique for a certain improvement situation.

Keywords: Business Process Improvement, Techniques

1 Introduction

The demand for improving business processes increased after the business process reengineering (BPR) wave in the early 1990s (Davenport 1993); (Hammer/Champy 1993) and methodologies, techniques, and tools were developed for conducting BPR projects (see (Shin/Jemella 2002); (Doomun/Jungum 2008)). In contrast to BPR, which focuses on revolutionary changes in business processes, the concept of business process improvement (BPI; see e.g. (Harrington 1991)) focuses on continuous improvement and evolutionary change (like e.g. the Six Sigma method). A Gartner survey in 2009 covering more than 1,526 CIOs by whom BPI was stated to be the number one priority among the top ten business priorities (Auringer 2009) thus points out that BPI still is an important issue for top management. Thus it is not amazing that BPI issues “are within the most important and common titles in both literature and applications” (Coskun et al. 2008) and that process improvement has become an everyday task and a part of the processes’ lifecycle (Doomun/Jungum 2008).

But even though many attempts were made to establish a business process redesign framework, less emphasis was placed on optimizing business processes with given objectives (Vergidis et al. 2006). Furthermore, many methods respectively techniques were developed in the field of BPI most of which offer scope for creativity. Hence, in literature it is widely agreed that the most value-adding phase in a business process management (BPM) project, namely the *act of improving*, is lacking specific guidelines (see e.g. (Valiris/Glykas 1999); (Vergidis et al. 2006)).

Thus the challenge is to analyze how the act of improving a business process can be supported in a structured, methodological way which, for instance, techniques may ensure thus enabling to understand the transformation from the as-is- to the desired to-be-state of a business process.

The aim of this paper is to analyze existing techniques in the field of BPI as to their ability to support the act of improving a business process. The object of investigation is not to find out how good the application of BPI techniques may work on a business process. It is rather more interesting to see if techniques provide a structured procedure or if creativity is the key to success.

The remainder of this paper is organized as follows: in chapter two terms and definitions (e.g. business process improvement) are explained. Chapter three concentrates on related work. In chapter four, the research design as well as the selection of techniques are described. The selected techniques are analyzed by means of an evaluation scheme in chapter five. Chapter six gives a summary and highlights the implications for further research.

2 Conceptual Basis

2.1 Business Process

The term business process is defined differently in literature, but similarities can be perceived. A process can be seen as a cohesive sequence of *activities* which add value to *input* and transform it to *output* (Harmon 2007); (Harrington/Lomax 2000). Similarly, a *business* process also is a sequence of activities, but focuses on fulfilling an *organizational* task (Davenport/Short 1990); (Harrington 1991). As a business process is performed by *human beings* and *machines*, it can be seen as a socio-technical system (Shaw et al. 2007).

2.2 Improvement

To be able to analyze whether a technique does support the improvement of a business process or not, it is necessary to know the general meaning of ‘improvement’. The Oxford English Dictionary de-

scribes improvement as „the turning of a thing to profit or good account” or “realization of the profits of anything”. Improvement ends in an advanced stage or a developed form (of something); it is “a process, change or addition, by which the value of excellence of a thing is increased”. (Oxford 1961) The Standard Dictionary of the English Language defines improvement as “a beneficial change or addition; an advance” (Funk&Wagnalls 1965). According to Chambers Dictionary improvement is “a better thing substituted for, or following, one not so good” (Chambers 1993). The Heritage Dictionary of the English Language describes “improve” as “to advance to a better state or quality” (Heritage 1969) whereas the Merriam-Webster’s Collegiate Dictionary defines it as „to enhance in value or quality“, „to advance or make progress in what is desirable”, “to make useful additions or amendments” or “to make more acceptable or bring nearer a standard” (Merriam-Webster 1998).

In the context of business processes, improvement often results in an advancement of effectiveness and efficiency (e.g. (Harrington 1991)) mostly depending on the perspectives *time*, *quality*, *cost* and *flexibility* (e.g. (Pourshahid et al. 2009)). Other goals of improving business processes are change (e.g. (Adesola/Baines 2005); (Davenport 1993); (Harrington 1991)) or gaining competitive advantages through better processes (e.g. (Shahzad/Zdravkovic 2009); (Vergidis et al. 2006)).

Hence, our understanding of the term improvement follows the Heritage Dictionary of the English Language and focuses on the advancement to a better state (or quality) from an as-is situation to a to-be situation.

2.3 Business Process Improvement

According to the above definitions improving a business process means changing its state in order to be faster, cheaper, more flexible, or to achieve a better quality. Even though several possibilities exist, for example to reduce process cycle time or to cut costs, they are generally based on a change of the sequence of activities, the extent of the activities or the involved resources. Hence, changes on a process can only be made by modifying its elements. Therefore we define business process improvement as follows:

Business process improvement is achieved by changing the state of elements of a business process. Thereby the state after the change exceeds the state before the change in such a way that the degree of accomplishing organizational goals is increased, which improves the performance of the business process.

For the identification of elements of a business process we initially regarded standard business process definitions as stated in section 2.1 and subsequently took a closer look at mandatory elements of a business process as applied in widely-used business process modeling languages such as BPMN (OMG, 2010a), EPC (Scheer and Schneider, 2006) and UML Activity Diagram (OMG, 2010b). According to these sources the following elements of a business process can be identified: activity, people and organizational unit, (IT-) resource, input, output, control flow, information flow, material flow and organizational assignment. Triggered by an external event (e.g. a customer request), the process starts. During the process input is transformed into output by executing activities. The order of the activities is scheduled by the control flow. Organizational units, including people or departments, execute the activities and give an overview of the responsibilities which is represented by the organizational assignment. The transformation of the input during the flow of activities is supported by resources such as work equipment, information, machines or technology. The information flow represents the flow of the information (e.g. immaterial resources) needed during the processing whereas the material flow represents the flow of physical resources. The organizational assignment depicts the relation of an organizational unit or person with an activity and represents the responsibilities within a process model.

Several definitions of business processes include external triggers as elements of a business process. But due to the fact that external triggers are events, it is not reasonable to regard them in our investigation, because techniques are not capable of impacting on events.

In order to evaluate the change after an improvement activity, it is necessary to measure the change. This can be done with the help of success factors and performance indicators. Common success factors often applied to measure change are cost, quality, time, flexibility, staff or customer satisfaction (e.g. (Kettinger et al. 1997); (Lee/Chuah 2001)) (see section 5.1). The success factor cost denotes the monetary quantification caused by the consumption of resources. Quality implies to what extent the output of a business process with regard to the output's condition conforms to customer needs. The success factor time stands for the duration of a business process from the starting event to the completion of the output. Flexibility represents the ability to adapt a process with regard to different customer needs. The success factor staff relates to the people responsible for the execution of a business process. At last, customer satisfaction indicates whether the customer's expectations are fulfilled by the output of a process. The term "act of improvement" denotes the activity which performs the improvement of a business process. It is an active operation that is executed on an element of a business process with the help of a certain procedure. After executing this procedure the business process is transformed from an as-is to a to-be state.

2.4 Techniques

Techniques can be seen as detailed guidelines to create results (e.g. (Pacicco et al. 2010)). A technique is „(...) a set of precisely described procedures for achieving a standard task.“ (Kettinger et al. 1997) Moreover, a technique can be part of a method (which is used to solve a more individualized problem) and can be supported by tools (especially by IT). In literature the terms method, technique and tool are often used inconsistently or synonymously (see (Grünberg 2003)), even though they have different meanings. In order to avoid the problem of term misinterpretations we concentrate on techniques according to our definition regardless of the terms used in literature. The criteria for selecting techniques for our analysis are, on the one hand, the aim of the technique (to improve business processes or elements of it) and, on the other hand, the existence of a procedure to create the desired result(s).

3 Related Work

There is a range of literature concerning BPI and BPR, which reviews techniques, methods and tools in this field and even give classification schemes for them. However, even though such overviews exist, they are not examining the actual mechanisms of techniques by analyzing how to support the act of improving a business process. Table 1 is based on (Zellner 2011) and shows that related work, even if it provides an overview of BPI and BPR techniques, does not indicate how the techniques actually support the improvement of business processes or parts of it.

Author(s)	Goal of paper	Context	Overview of BPI/BPR techniques	Indications how to support the act of improvement
(Adesola/ Baines 2005)	“(...) this paper describes research that has formed and tested a generic and practical methodology termed model-based and integrated process improvement to support the implementation of BPI.”	Reviewing and analysing methodologies	Yes	No
(Bunney/Dale 1997)	“Outlines the main findings of a longitudinal study into the use and application of quality management tools and techniques in a speciality chemicals manufacturer.”	Use and application of QM-tools and -techniques	Yes	No
(Hagemeyer et al. 2006)	“A proposed classification scheme for problem-solving tools allows the user to identify the correct tool at the proper time in the problem-solving process.”	Problem-solving quality tools	Yes	No
(Kettinger et al. 1997)	“This article investigates BPR Methods, Techniques, and Tools and places them within an empirically derived reference framework.”	BPR methodologies, techniques and tools	Yes	No

Author(s)	Goal of paper	Context	Overview of BPI/BPR techniques	Indications how to support the act of improvement
(McQuater et al. 1995)	“Outlines the key factors in the successful use of quality management tools and techniques in a process of continuous improvement.”	Use and application of common tools and techniques	Yes	No
(Siha/Saad 2008)	“The purpose of this paper is to survey and analyze current process improvement approaches, their empirical results reported in the literature and develop accordingly a conceptual framework and implementation guidelines.”	Current process improvement approaches	Yes	No
(Zellner 2011)	„The purpose of this paper is to provide a structured overview of so called business process improvement (BPI) approaches and their contribution to the actual act of improving.”	Literature review of BPI methods	Yes	No

Table 1. Related work

As illustrated in Table 1, none of the literature addresses how techniques support the act of improvement or even provides advice as to how to provoke improvement. Our research tries to bridge at least part of this gap by providing a structured and evaluated overview of techniques in the field of BPI and BPR which all have in common that they are used to improve business processes.

4 Research Design

The following analysis covers techniques that are well-known and approved in the field of BPM/BPI: these two requirements seem to be fulfilled, if a technique appears or is mentioned in several sources the context of which address BPM/BPI (e.g. (Andersen 1999); (Pande et al. 2000); (Rath&Strong 2002)). Equally, if such techniques are contained in a reference book that deals with a comprehensive overview of techniques in BPM/BPI, this would serve as proof of their general awareness (for corresponding reference books see e.g. (Harrington/Lomax 2000); (John et al. 2008); (Kanji/Asher 1996); (Kettinger et al. 1997)). Besides, most of the selected techniques have been applied in several cases which are documented.

Our research for business process improvement techniques led to a plurality of results. In particular, 487 techniques, methods (like e.g. Six Sigma, Kaizen), tools and management approaches (like e.g. “Just in Time”) were identified. As not all of the results can be associated with the act of improvement (e.g. some techniques are used for controlling a process (e.g. control charts) or analyzing cause and effect relations (e.g. fishbone diagram) etc.), the techniques had to be filtered in four steps:

- In a first step, all duplicates named by the different references had to be eliminated.
- In a second step, all methods, tools and management approaches which did not fulfill our definition of a technique had to be sorted out. This definition underlines the requirement that a technique has to include detailed guidelines for achieving a standard task in a structured way. Even though methods (like e.g. Six Sigma) were excluded because they are used to solve individual problems, the techniques of those methods (like FMEA, Pareto Charts, SIPOC etc.) were considered in our research. The second step resulted in 248 different techniques that are used in the BPI context.
- In step three of our filtering, only those techniques were selected that focused explicitly on the improvement stage during an improvement project. For this selection, techniques were focused that either supported the generation of new solutions or the generation of problem solving like for example in the improve phase of the Six Sigma cycle (John et al. 2008); (Rath&Strong 2002). Both criteria were derived from approaches to categorize techniques for BPI (see (Harrington/Lomax 2000); (Kanji/Asher 1996); (Andersen 1999)).

- The last step was used to eliminate so called supporting techniques which do not directly support the act of improvement but help to support techniques used in an improvement situation. For example, the technique “consensus reaching” helps to select a solution from a list of derived solutions using consensus (Rath&Strong 2002). So this technique does not directly help to improve a process (by providing an actual measure to improve a process), but it helps to select an appropriate improvement solution (Harrington/Lomax 2000).

In summary, Figure 1 shows the procedure of filtering suitable techniques for improving business processes.

Step	Description	Number of techniques
	Methods, techniques, tools and management approaches in BPI	487
1	↓ Elimination of duplicates	↓
	↳ Methods, techniques, tools and management approaches in BPI (no duplicates)	304
2	↓ Elimination of methods, tools and management approaches	↓
	↳ Techniques in BPI	248
3	↓ Focus on improvement	↓
	↳ BPI techniques with focus on improvement	56
4	↓ Elimination of supporting techniques	↓
	↳ Techniques that support the „act of improvement“	36

Figure 1: Filtering of BPI techniques

An overview of the 36 remaining techniques is given in section 5, where the extent to which these techniques really help to support the act of improving a business process will be analyzed.

5 Structured comparison of BPI techniques

5.1 Criteria for comparison

In this chapter, the ability of the 36 techniques to support the act of improving business processes will be examined. The analysis was conducted by one researcher and was performed as follows. First, the goal and the procedure of a technique as well as the target of its implementation (e.g. reduce costs) were investigated. Next, the elements of a business process were determined that are affected by the application of a technique. The examined elements were: activity (A), organizational unit (OU), resource (RE), input (IP), output (OP), control flow (CF), information flow (IF), organizational assignment (OA), and material flow (MF) (see section 2.3). Thereupon, the success factors were determined by means of which the success of a technique’s application can be measured. The success factors under examination were cost, quality, time, flexibility, customer and staff (see section 2.3). This procedure was applied for all of the 36 techniques and the results were recorded in an evaluation scheme consisting of the above-mentioned parts. In Figure 2, we give an example of the evaluation scheme for technique [22], „Process Cycle Time Reduction“. The last section of the evaluation scheme (“Notes”) explains how and why the researcher allocated the elements of a business process or success factors to a certain technique so that the selection process can be comprehended.

Criteria	Content										References
Goal	„An approach to reduce the time that it takes to move an item through a process.“										(Harrington/Lomax 2000, p. 250)
Procedure	<ol style="list-style-type: none"> 1. Flowchart the process that is being studied. 2. Conduct process walkthrough to understand process and verify flowchart. 3. Collect cycle-time data related to each activity and task (minimum, maximum and average). 4. Collect data that define the quantity flow through each leg of the flow diagram. 5. Construct a simulation model that includes all of the data that have been collected. 6. Perform replication analysis, using the simulation model that includes all of the data that have been collected. 7. Classify each activity or task as real-value added, business-value added or no-value added (eliminate business-value und no-value added activities). 8. Define the average cycle time's critical path through the process, using the simulation model. 9. Using the cycle-time reduction principles, eliminate the critical path. 10. Repeat activities 8 and 9 until the minimum cycle time is obtained. 11. Define worst-case critical path through the process using the simulation model. 12. Using cycle-time reduction principles eliminate the critical path. 13. Repeat steps 11 and 12 until the minimum worst-case cycle time is obtained. 14. Develop a plan to change the process to be in line with the modified simulation model. 15. Pilot the modifications as appropriate. 16. Implement the new process. 										(Harrington/Lomax 2000, pp. 254/255)
Result	Reduction of cycle time.										(Pande et al. 2000, p. 312)
Mandatory elements of business process	A	OU	RE	IP	OP	CF	IF	OA	MF		
	✓	✗	✗	✗	✗	✓	✗	✗	✗		
Success Factors	Cost		Quality		Time		Flexibility		Customer		Staff
	✓		✗		✓		✗		✓		✗
Notes	<p>In step 7 of the procedure each activity or task needs to be classified as real-value added, business-value added or no-value added. Business-value und no-value added activities should be eliminated.</p> <p>Changing the control flow depends on a potential rearrangement of real-value added tasks (Harrington/Lomax 2000, p. 252).</p> <p>„To date, most of our focus has been on reducing processing time because we see it as added labor cost. (...) Long cycle times delay product delivery to our customers and increase storage costs.“ (Harrington/Lomax 2000, p. 251)</p> <p>The customer (satisfaction) is affected with this technique, as the cycle time determines how fast the process output can be supplied to the customer. The costs of the new solution are determinant for the evaluation of the solution (Harrington/Lomax 2000, p. 251).</p>										

Figure 2: Evaluation scheme for technique [22] “Process Cycle Time Reduction”

The goal of the technique is to reduce the time it takes to move an item through a process. To reduce this time a 16-step-procedure is suggested. The desired result of the technique is the reduction of the cycle time. Concerning the elements of a business process, this technique focuses on both activities and control-flow (see check marks at elements “A” and “CF”). This is because the purpose of the technique is to analyze the activities of a process as well as their order (control flow). Regarding the success factors, this technique helps to improve cost, quality and customer satisfaction (see check marks at success factors “Cost”, “Time” and “Customer”). As the name of the technique suggests, time is a success factor that has to be measured when applying the technique. Furthermore, long cycle times are, on the one hand, seen as additional labor cost, while, on the other hand, it is suggested that they have negative effects on customer satisfaction (see field Notes in Figure 2).

5.2 Comparison of BPI techniques

The filtering of BPI techniques in section 4 resulted in 36 techniques which support the act of improving a business process according to our selection process. Table 2 gives an overview of these techniques (with their corresponding references in parentheses). All 36 techniques were evaluated according to the evaluation scheme illustrated in Figure 2. The result of this evaluation is presented in Table 3. Table 3 allocates each BPI technique to the business process elements it focuses and to the success factors it supports. For example, in the crossing cell of activity and cost four different techniques ([5] Bureaucracy Elimination, [22] Process Cycle Time Reduction, [24] Process Simplification and [26] Redundancy Elimination) are listed that focus on improving activities of a business process with respect to cost reduction. In addition to the crossing cells of elements of a business process and success factors, there are some techniques that only refer to a success factor without describing which element of a business process has to be changed (last column “no element of a business process affected” in

Table 3). On the contrary, there is no technique that helps to improve an element of a business process without having at least one success factor in mind, so the last line (“no success factor affected”) in Table 3 is empty.

No.	Technique	No.	Technique
[1]	Anti-Solution Brainstorming (3)	[19]	Other Points of View (OPV) (2)
[2]	Best-Value Future-State Solution (BVFS) (2)	[20]	Potential problem analysis (PPA) (4; 6)
[3]	Brainstorming (1; 2; 3; 4; 5; 6; 7)	[21]	Problem prevention plan (4; 6)
[4]	Brainwriting (1; 3; 4)	[22]	Process Cycle Time Reduction (1; 2)
[5]	Bureaucracy Elimination (1; 2)	[23]	Process decision program chart (1; 2; 4)
[6]	Cause and effect analysis (1; 2; 3; 4; 5; 6; 7)	[24]	Process Simplification (2)
[7]	Error proofing (pokayoke) (2; 3; 4; 6)	[25]	Quality function deployment (QFD) (1; 2; 4; 5; 6)
[8]	Evolutionary operation (EVOP) (4)	[26]	Redundancy Elimination (1)
[9]	Failure mode and effect analysis (FMEA) (2; 3; 4; 6; 7)	[27]	Replenishment Pull System (3)
[10]	Fast Action Solution Technique (FAST) (2)	[28]	Robust design (off-line quality control) (4)
[11]	Generic Pull System (3)	[29]	Setup Time Reduction (3)
[12]	Idealizing (1)	[30]	Should-be Process Map (6)
[13]	Mind mapping (2; 4)	[31]	Snowballing (4)
[14]	Morphological forced connections (4)	[32]	Taguchi methods (4)
[15]	Negative Analysis (2)	[33]	The Importance of Speed (3)
[16]	Nominal group technique (1; 2; 3; 4; 5)	[34]	Theory of Constraint (TOC) (3)
[17]	Objective ranking (4)	[35]	Total productive maintenance (3; 4)
[18]	Opportunity cycle (2)	[36]	Visioning / Imagineering (2; 4; 5; 6)

References: (1)= (Andersen 1999); (2)= (Harrington/Lomax 2000); (3)= (John et al. 2008); (4)= (Kanji/Asher 1996); (5)= (Kettinger et al. 1997); (6)= (Pande et al. 2000); (7)= (Rath &Strong 2002)

Table 2: Overview of BPI techniques

		Elements of a business process									
		Activity (A)	Organizational Unit (OU)	(IS-)Resource (RE)	Input (IF)	Output (OP)	Control-Flow (CF)	Information-Flow (IF)	Organizational Assignment (OA)	Material-Flow (MF)	No elements affected
Success Factor	Cost	[5]; [22]; [24]; [26]	[26]	[24]; [26]; [27]	[27]	[27]	[22]; [24]	[5]; [26]	[24]; [26]		[2]; [10]; [15]; [18]; [23]; [34]
	Quality	[29]		[29]; [35]			[29]				[11]; [18]; [23]
	Time	[5]; [22]; [24]; [29]; [30]		[24]; [29]; [35]			[22]; [24]; [29]; [30]	[5]	[24]		[2]; [10]; [11]; [23]; [33]
	Flexibility	[29]		[27]; [29]	[27]	[27]	[29]				[11]
	Customer	[22]; [24]; [29]; [30]		[24]; [27]; [29]	[27]	[25]; [27]	[22]; [24]; [29]; [30]		[24]		[9]; [17]; [33]
	Staff			[6]	[6]						
	No success factor affected										

Techniques not included in the matrix : [1], [3], [4], [7], [8], [12], [13], [14], [16], [19], [20], [21], [28], [31], [32], [36]

Table 3: Evaluation of BPI techniques (the numbers correspond to those in Table 2)

As Table 3 shows there are 16 out of 36 so-called BPI techniques (over 44% of the evaluated techniques) that are not included in the matrix, which means that they neither affect elements of a business process nor help to improve any of the success factors even though they are mentioned as BPI techniques. These techniques do not offer support by referring to an element of a business process or describing how to measure their application. Nevertheless these techniques can be used to create solutions for improving a business process in general, whereby it has to be determined individually which element of a business process needs to be changed. The 16 techniques are, in most of the cases (e.g. Brainstorming, pokayoke, idealizing), means to support creative thinking and can be used in every improvement or solution creating situation.

So the benefit of most of these techniques is to support the general act of idea generation, but not to improve elements of a business process. In contrast to the supporting techniques (that were eliminated in step four of the filtering process in section 4) which help to prioritize improvement solutions, these techniques are aiming at the creation of actual measures to improve a business process.

Only the remaining 20 techniques provide hints as to which elements of a business process are affected and/or with the aid of which success factors improvement could be measured when applying these techniques. A first look on the table also shows that a comprehensive technique which completely supports the improvement of all elements of a business process does not exist.

Most of the techniques address activities (16.7%) or resources (16.7%) as the basis of their improvement procedure. The sequence of the activities is determined by the control flow. This element of a process is named four times as the target of different improvement techniques (11.1%). Input, output, information-flow and organizational assignment are only twice the subject of techniques (5.6%), the organizational unit only once (2.8%). The material-flow is not improved by any of the 36 techniques at all. Likewise, it is notable that there is no technique that focuses on an element of a business process without considering a success factor.

Concerning the dimension success factor of Table 3, 30.6% of the techniques focus on costs and also 30.6% focus on time as a success factor. 25.0% of the techniques aim to improve parts of the business process in order to enhance customer satisfaction. Quality is only an important factor for 13.9% of the techniques. Finally, 8.3% of the techniques refer to the flexibility of a process and 2.8% consider staff.

5.3 Discussion of the results of the comparison

When regarding the matrix in Table 3 it can be observed that some techniques, as opposed to others, appear quite often. For example, technique [24] (Process Simplification) is included in 12 cells (elements activity, resource, control flow and organizational assignment crossed with success factors cost, time and customer), whereas technique [9] (FMEA) is contained in just one cell (success factor customer). This does, however, not automatically mean that Process Simplification is, by all means, better than FMEA. Depending on a particular context, both techniques can make contributions within an improvement project. For our approach, it can be suggested that Process Simplification is more structured regarding the description of how to accomplish the act of improving a business process.

One benefit from the matrix in Table 3 is that it becomes possible to determine a suitable technique, when a problem and/or a weak point in a business process can be attributed to a certain element of the business process and/or can be expressed in terms of a success factor. For example, if a customer complains about the long delivery time of a product, the performers of the business process can assume that this can be measured with the aid of the success factor time. With this knowledge in mind, the techniques [2], [10], [11], [23] and [33] (crossing cell: “time” and “no element of a business process affected”) may be helpful to solve this problem/weak point. If further analysis results in the finding that the problem is caused by activities having to wait too long for their required resources, the element resource can be put in focus. In doing so, the techniques [24], [29] and [35] (crossing cell: “time” and “resource”) should be considered for taking counter-measures.

The techniques offer several mechanisms for the improvement of business processes' elements. As already noted most of the techniques address activities as well as the control flow (see section 5.2). Regarding the control flow, the procedure models of some techniques (e.g. [22], [29]) support a structured search for bottlenecks, constraints, interfaces, loops or media disruptions and can highlight potential for improvement. Therefore, single activities can be eliminated, the sequence of activities can be changed, or the activities can be arranged in parallel instead of serially. Furthermore, technique [26] e.g. suggests the integration of interdependent activities to reduce cost, errors or cycle time. Moreover, activities should be concentrated the efficiency of which add value to a remarkable extent (see technique [30]). Another possibility that is mentioned by technique [24] is to automate the execution of an activity e.g. with the aid of IT instead of someone having to perform this activity manually. (Andersen 1999); (Harrington/Lomax 2000); (John et al. 2008).

Summarizing, there are more techniques that refer to an element of a business process and/or a convenient success factor than those which offer scope for creativity. The 16 techniques which are not included in the matrix, because they neither reference an element of a business process nor a success factor, can nevertheless make contributions when a business process is meant to be improved. As these techniques predominantly represent creativity techniques (all of them except EVOP, Robust design and Taguchi methods), their objectives lie exclusively in the generation of innovative ideas (e.g. Brainstorming, Mind mapping etc.). Under certain circumstances such innovative ideas can, at any time, turn a business process into a progressive state when implementing these ideas.

6 Summary and Conclusion

The aim of the paper was to analyze to which degree techniques in the field of BPI provoke improvement of a business process in a structured way. A structured categorization of more than 300 different techniques was performed and as a result 36 techniques could be identified and analyzed in accordance with a derived evaluation scheme. Although a lot of techniques exist in the field of BPM, BPI and TQM, they only moderately support the act of improving business processes considering the elements of a business process and the success factors. 16 out of 36 techniques do neither affect any element of a business process nor any success factor at all, but predominantly represent creativity techniques which help to generate innovative ideas in order to improve a business process. Most of the remaining 20 techniques either focus on enhancing the success factors cost and time or on improving the elements activities and control flow of a business process.

The derived matrix in section 5.2 is the result of our analysis and can be used as an instrument in a business process improvement project. The matrix associates the elements of a business process with the success factors. Hence, if a problem or a weak point in a business process can be expressed in terms of an element and/or a success factor, the matrix possibly provides suitable techniques which might lead to improvement.

The paper also provides a contribution to this area of research. Based on the definition of business process improvement, a structured approach (the matrix of the BPI techniques) for the improvement is defined. In addition, a classification of existing BPI techniques regarding the two dimensions of the matrix is derived, which distinguishes the BPI techniques to the extent they can improve a business process. Since many cells of the matrix do not contain a BPI technique, the investigation also identifies great potential for further BPI techniques. The investigation is therefore a starting point for further research which may include the following topics:

- Since in some cells more than one technique is listed, the characteristics and special capabilities of the techniques should be identified. If the techniques in one cell differ considerably, guidelines should be provided as to which technique should preferably be used under which circumstances.
- The development of a method that combines the different techniques of the matrix as a best of breed procedure.

- The evaluated techniques could be examined in regard to common patterns that could ease the improvement of business processes (business process improvement patterns).
- Further research needs to investigate the interdependencies between the success factors (e.g. increasing quality could mean increasing costs) and the elements of a business process (e.g. how does the change of an activity affect other process elements?).

This research also has some limitations which need to be mentioned:

- Even though the research comprises 300 BPI techniques which, in fact, is a high number, it may still be that some techniques are missing.
- It could be assumed that modifications or changes of several elements have different effects on both the state of a process and the degree of improvement achieved, which does, however, depend on the particular element (e.g. activity or resource). The different influences of the elements regarding the improvement should be considered in further research.
- The underlying assumption that a structured procedure to improve business processes leads to better results than only relying on creativity has not been evaluated.

As BPI seems to be rather art than science (Davenport 2005); (Hall/Johnson 2009) the research concerning the act of improving a business process is still at its beginning. Creativity is a major part during the improvement process, but the more structured the support of the act of improvement, the better the goal oriented and transparent results. Our research is one step in this direction and shows in a first approach the capabilities of the existing techniques. The derived matrix helps to identify the adequate technique to improve a business process in order to achieve a predefined target.

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