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ScienceDirect

Expert Systems with Applications xxx (2008) xxx–xxx

Expert Systems with Applications

www.elsevier.com/locate/eswa

Development of a decision-making strategy to improve the efficiency of BPR

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Abstract

To support the efficient appraisal of and selection from a list of generic business process improvement principles, this paper proposes a strategy for the implementation of business process redesign (BPR). Its backbone is formed by the analytic hierarchy process (AHP) multicriteria method and our earlier research into the popularity and impact of a set of redesign "best practices". Using AHP, we derive a classification of most suitable directions for a particular process to be redesigned. Criteria such as the popularity, the impact, the goals and the risks of BPR implementation are taken into account. A case study is included to demonstrate the method's feasibility and effectiveness.

Keywords: Business process redesign; AHP; Multi-criteria; Decision-making; Best practices

1. Introduction

One of the highlights in a large survey among senior business managers is that business process redesign (BPR) is almost as popular again as it was in the beginning of the 1990s (Rigby & Bilodeau, 2005). Despite the continued interest in this approach to rethink existing process structures considering the opportunities that IT provides, few analytical tools exist to support the actual redesign of a business process (Nissen, 1988). The aim of the work as presented in this paper is to develop a tool that supports the decision-making process practitioners apply to come up with a new, improved plan for a business process.

This aim links up with a more general observation that BPR often does not lead to the desired results, because it is a time-consuming and costly affair with unpredictable results. It has been argued that there is a clear need to improve the redesign process itself (Hofacker & Vetschera, 2001; Nissen, 1988; Reijers, 2003). The goal of the decision-making tool that is described in this paper is to:

(i) increase *the efficiency* of the redesign process itself, and
(ii) to lead to a *more systematic evaluation* of improvement opportunities.

In earlier work (Limam Mansar & Reijers, 2005, 2007; Reijers & Limam Mansar, 2005), we published on our efforts to attain the second goal through the identification, validation, and practical use of a set of so-called "best practices". In this context, a best practice is a general heuristic derived from earlier successful encounters to improve process performance, which may need skilful adaptation to be applied in a concrete setting. For example, instead of using a paper file which favors processing in a sequential way (i.e. the physical document is passed from one executor to the other), the use of an electronic file may be con-

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doi:10.1016/j.eswa.2008.01.008

sidered to speed up the work, as people can work *concurrently* on their own electronic copies.

The proposed set of best practices may be used to structure the redesign sessions with business professionals, as we did, for example, for the redesign of an intake procedure in a mental health-care setting (Jansen-Vullers & Reijers, 2006). Each best practice was considered by all participants on its applicability and subsequently subjected to a more thorough performance evaluation by simulating the process models. But even though this structured approach improves upon the often intuitive way that BPR is carried out, it remains problematic in the sense that such an approach requires considerable time and efforts from all participants to carry out the project.

The described tool in this paper still fosters the *systematic* breadth of considering a set of redesign best practices, but it also addresses the efficiency of the BPR process by *efficiently* classifying a set of most appropriate best practices for a specific case. Such a result may serve as a "kick-start" for the redesign team involved, speeding up the redesign process.

There have been other contributions in this field where mainly artificial intelligence algorithms have been used. Case-based reasoning and inference rules are examples of such approaches (see e.g. Min, Kim, Kim, Min, & Ku, 1996). However, the majority of these contributions require the gathering of a large set of successful cases or address only specific processes for a given industrial or service sector. An exception is the work of Nissen (Nissen, 1988) that aims to detect weaknesses in a given process design by using various metrics and dedicated algorithms. Although the aim of this work is comparable to ours, the approach is completely different, as will be discussed in our related work section (see Section 7).

In the remainder of this paper, Section 2 will give the necessary background for this paper in the form of an overview of our earlier work. Section 3 gives a high-level description and contribution of our tool and specifically how it may help to improve upon common design practice. Section 4 deals with introducing the different aspects or criteria that should be taken into account when deciding which best practice should be implemented in a concrete situation. Section 5 introduces AHP as the multicriteria decision-making method chosen for this study and builds up the strategy for the implementation of BPR using AHP. Section 6 applies our findings to the case study of a Dutch municipality. Section 7 is a review of related work. Finally, Section 8 provides our conclusions and future work.

2. Background

In total, we earlier identified 29 best practices (Refer to Table 2) that are widely applied by practitioners and found (partial) support in the literature to improve the performance of existing processes (Reijers & Limam Mansar, 2005). To search for improvement opportunities in an *existing* process and to *locally* apply one or more best practices is clearly different from the original reengineering idea, which is to get rid of current work practice and start thinking out the business process all over again (Hammer & Champy, 1993). However, the latter "clean slate" approach has repeatedly proven to be impractical in reality (Al-Mashari, Irani, & Zairi, 2001; Davenport & Stoddard, 1994; Sockalingam & Doswell, 1996), which explains the focus of our work. In the same paper in which we published our set of best practices (Reijers & Limam Mansar, 2005), we also discussed the qualitative impact of each best practice on four important performance indicators of the redesigned processes: its time, quality, cost and flexibility.

If a process were to be redesigned using this set of best practices, all 29 of them would need to be carefully scrutinized to assess their applicability to the process at hand. It is clearly a lengthy procedure that will require many meetings involving various stakeholders. We already aimed to limit this effort by listing and classifying the best practices into a framework (Limam Mansar & Reijers, 2005). The idea behind a framework is to help practitioners by identifying the components that should be considered and how these components are related. Our framework included eight components, namely, the customer's perspective of the process, the information handled, the product delivered by the process, the operation, behavior and organization views of the process, the technology that supports the process and finally the external environment.

In the same paper (Limam Mansar & Reijers, 2005), we published on the exposure of the best practices and the framework to experienced BPR practitioners in both the Netherlands and the United Kingdom. To establish their practical use and impact, a survey was undertaken in the years 2003–2004. In that survey, we asked the experts' help to validate our framework and to classify the ten most popular best practices; this in an effort to highlight the most relevant ones.

In Limam Mansar and Reijers (2007) we continued our survey analysis discussing the feedback received from the experts on the practical impact of the various best practices in terms of cost, time, quality, and flexibility improvement. It is important to note that the latter discussion was conducted on the top ten best practices only (as it would have been too long to include them all in the survey).

So far, we applied the set of best practices to improve existing business processes in various settings, such as a mental health-care institute, a medium-sized mortgage lender, a Dutch ministry, and a large multi-national bank (Jansen-Vullers & Reijers, 2006; Limam Mansar & Reijers, 2005; Reijers, 2003). This paper includes the case of a local municipality where the set of best practices was applied to redesign their invoice handling process (see Section 6).

These accumulated experiences, stressed even further the importance of making the BPR process itself more efficient. They also delivered many of the insights that were required to develop the tool, of which the specifics will be given in the following sections.

3. The redesign process

To position the contribution of our work in this paper, we will describe in this section a general context of the redesign process and how it is thought to be improved by the decision-making strategy we propose. In Fig. 1, we show three different approaches, all of which lead to an improved design for a certain business process in a more or less systematic way.

At the left-hand side of the figure, the so-called "creative approach" is depicted. Starting from a set of goals, brainstorming sessions and constructive discussions are held to finally arrive at an improved process design. This is an intuitive and highly iterative approach, often carried out within the setting of a workshop facilitated by management consultants (Reijers, 2003). Its advantages are obviously that users as well as practitioners have a broad playing field for creativity and innovation. Its drawbacks are that discussions can lead to biased choices or even to neglecting some alternatives that might be worth testing. As we argued before (Reijers & Limam Mansar, 2005), this approach is probably the most applied way to reach an improved design and is described as such in practitioner guides and management text books (see e.g. Davenport, 1993; Hammer & Champy, 1993; Sharp & McDermott, 2001).

An alternative is the so-called "structured approach", which can be seen in the middle of Fig. 1. As detailed extensively in Limam Mansar and Reijers (2005) and industrially applied in the settings of a municipality (see Section 5) and mental healthcare (Jansen-Vullers & Reijers, 2006), this approach builds on an extensive list of potentially effective techniques to change and improve an existing process that we called best practices. We explained that our earlier research has identified (Reijers & Limam Mansar, 2005) and validated (Limam Mansar & Reijers, 2005; Limam Mansar & Reijers, 2007) a set of 29 recurring best practices in process redesign projects. In the structured approach, each best practice from the extensive list is evaluated together with a representation of stakeholders, after which simulation is used to evaluate the performance improvement. The (sub)set of best practices that leads to the most desirable performance is then presented to the users for final discussion, choice and augmentation. The advantages of this approach are the drawbacks of the creative approach: less bias and a systematic evaluation of opportunities. However, the drawbacks are the lack of creativity and innovation (advantages of the creative approach),

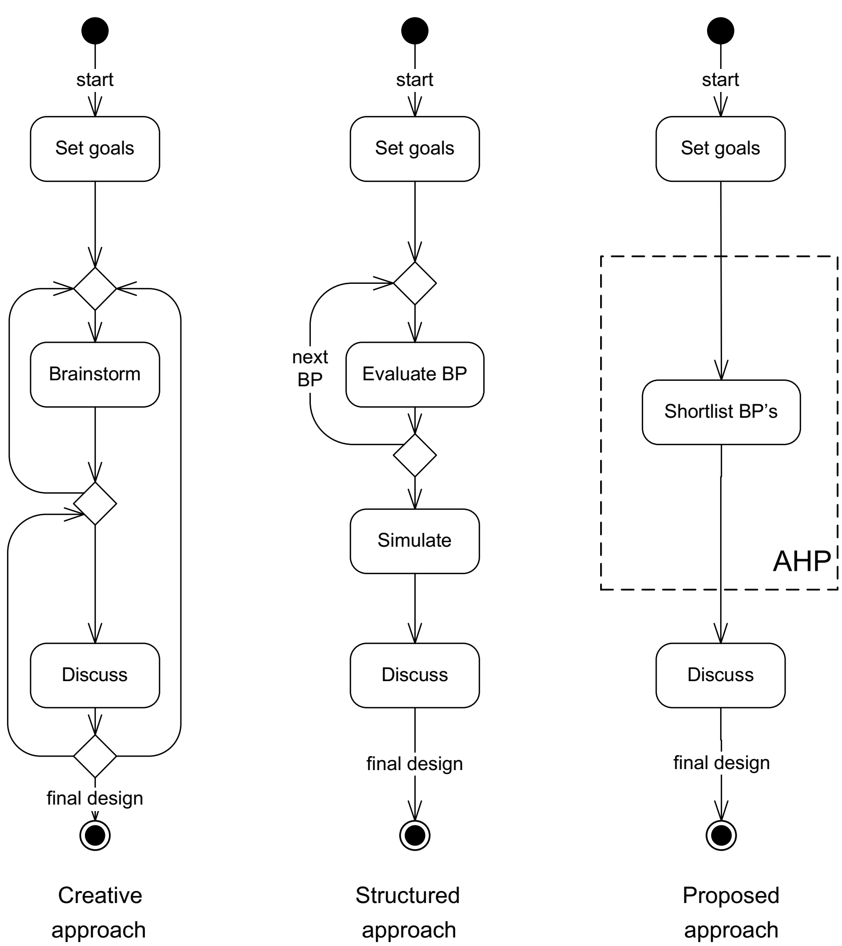

Fig. 1. Transformation of the redesign process.

but also the fact that a model is an imperfect representation of reality and the output of the simulation needs always to be interpreted cautiously. Furthermore, simulation is a cumbersome process and simply takes time to be set up.

In this paper we propose an improved approach to redesigning processes as shown at the right-hand side of Fig. 1. It attempts to counter the drawbacks of the creative as well as of the structured approaches we have discussed so far. After discussing with the users the goals of the redesign and the risks that need to be faced, a decision-making tool (based on AHP, presented in Sections 4 and 5 and illustrated in Section 6) is used to generate a list of preferred best practices for redesign. It gives a *focus* to a set of best practices that could potentially be applied to improve the performance of the existing process. By providing such a shortlist, it cuts out a number of best practices and narrows the scope for the discussions with the users. The users remain the final decision makers and can choose the best practices to implement or revert to simulating the short listed best practices for further insights. Compared to the use of discrete event simulation, the presented approach is more efficient, although it still relies on approximations and on modeling the decision-making process. At the same time, it focuses more on a qualitative, user-involved evaluation of best practices performances rather than a quantitative, simulation approach from behind a desk.

The proposed approach implies building a decision-making tool that will allow the redesign team to express preferences and hence derive a shortlist of best practices. To do so, we define in this paper appropriate selection criteria. We set up their importance and build the decision-making process using the AHP algorithm. The output of the tool is a generated short list of best practices within the proposed approach. In the next section, we discuss the selected criteria.

4. Criteria for a decision-making strategy

Based on the analysis of practitioner guidebooks (e.g. Sharp & McDermott, 2001) and on our practical redesign experience (e.g. Reijers, 2003), we developed our insights on how process redesign takes place in practice. As argued in the introduction, practitioners tend to start with first observing the process and the organization. They identify with (top) managers the issues within the process and the *risks* the implementation may face and set up one or several *goals* (performance) for the redesign. They may decide not to look back at existing processes and produce a completely new design or they may decide to improve the current processes. In the latter case, they would use their experience to spot areas of improvement and come up with alternative designs. Redesign *rules* are used for this purpose and practitioners choose amongst the rules for one or several reasons: they 'always' use some *popular* rules, they choose a rule because they expect it to have some sort of *impact* on the process (reduce cost, improve the quality, etc.) or because it improves on some *components* of the redesign such as the use of technology or relationships with the customers.

This implies that the decision on which rules to use is implicitly based on a set of *criteria*:

– The popularity of the redesign rules.
– The component of the redesign, i.e. which perspective are we looking at?
– The impact of the redesign rules on the processes.
– The redesign goals.
– The redesign risks.

These criteria are our starting point for the decision-making tool to support and improve the efficiency of BPR. In what follows, we explore ways to qualitatively or quantitatively express the criteria and relate them to the BPR best practices. For qualitative evaluation, we will use the original AHP scale as introduced in Saaty (1980). It sets preference statements defined to be selected from a set of integers between 1 and 9. In Table 1 we show the scale measurement we use for the preference statements in-line with the AHP algorithm.

4.1. Exploring the 'popularity' criterion

We have explained in our introduction that in previous research, we have collected and discussed best practices used by practitioners for BPR implementation. We gathered and classified these rules (cf. Reijers & Limam Mansar, 2005), identifying a list of 29 widely used best practices. For instance, one very popular rule is 'task elimination': It advocates the elimination of redundant or unnecessary tasks. In Limam Mansar and Reijers (2005) we have derived a list of top ten best practices in the field. We initially selected them because of their frequent use in the literature review and case studies. The experts consulted for our survey further classified them into a "top ten" list. We have restricted the classification of the best practices to ten only because the survey would have been cumbersome for the participants should they have to examine 29 best practices. Table 2 displays the top ten best practices followed by the remaining 19 best practices not being classified. For the purpose of this present study, we leave

Table 1
Scale measurement for AHP (Saaty, 1980)

Numerical Values	Definition
1	Equally important
3	Slightly more important
5	Strongly more important
7	Very strongly more important
9	Extremely more important
Reciprocals	Used to reflect dominance of the second alternative as compared with the first.

Table 2
Best practices in BPR

Best practice
1. Task elimination
2. Task composition
3. Integral technology
4. Empower
5. Order assignment
6. Resequencing
7. Specialist-generalist
8. Integration
9. Parallelism
10. Numerical involvement
– Control relocation
– Contact reduction
– Order types
– Order-based work
– Triage
– Knock-out
– Exception
– Flexible assignment
– Centralization
– Split responsibilities
– Customer teams
– Case manager
– Extra resources
– Control addition
– Buffering
– Task automation
– Interfacing
– Outsourcing
– Trusted party

out the external environment best practices (Interfacing, Outsourcing, Trusted party) as we feel that there are too many factors, typically outside the discrepancy of the redesign project itself, to take into account to determine their applicability in specific settings. Nevertheless, the latter best practices may still be examined or used by the redesign team if they deem it appropriate. We recall that our proposed approach includes discussions after applying the decision-making process (refer to Section 3 and Fig. 1). This brings the number of best practices we do study to 26.

In order to prepare for our decision-making tool, we need to quantify the popularity of a best practice. To do so, we differentiated the top ten best practices for which we do have a classification from the remaining 16 best practices. For the top ten group, the top four received a value of 4, the three next popular best practices were assigned a value of 3 and the last three popular best practices a value of 2. The remaining 16 best practices were all allocated a value of 1. We do not have sufficient information to differentiate between them.

Note that despite the variability of the popularity criteria over time (while popular today, a best practice might become unpopular in the future) we still believe that it is relevant as another criteria 'impact', assesses the performance impact of the best practice on the redesigned process thus dissociating how a best practice is currently ''perceived'' (popularity) and its real performance (impact).

4.2. Exploring the 'component' criterion

In earlier work (Reijers & Limam Mansar, 2005) we established a framework for BPR implementation. The framework identifies eight *components* which need to be addressed during a redesign implementation: the customer, the information, the product, the operation view, the behavior view, the organization, the technology and the external environment. For the same reasons for which we took out the three best practices Interfacing, Outsourcing and Trusted party (refer to Section 4.1), we take out the external environment component as its impact is difficult to assess on parts of processes.

In Limam Mansar and Reijers (2005), we provided some indications to the relative importance of the different components of the framework. In other words, while redesigning a process which aspect should the redesigning teams focus on most? Is it the way the process deals with customers? Or is it the way the information is processed or any other component of our framework?

To determine the importance of the various elements of our framework we conducted a survey amongst experienced BPR practitioners in both the Netherlands and the UK. We asked the practitioners to indicate how often they focused on each framework component when undertaking a BPR project. Extensive details and discussion of this work can be found in Limam Mansar and Reijers (2005). Most importantly, the results showed that the customer component was the most frequently cited, followed equally by the information and product components, then the operation and behavior views components and finally the organization and technology. For the purposes of this present study, we translated the latter classification into preferences using the AHP scale. We use it to quantify the relative importance of the various components (cf. Table 3). For example, the customers' component becomes 'extremely important' in a redesign context (which is worth a value of 9 on the AHP scale) since it was the most frequently cited.

In Limam Mansar, Reijers, and Ounnar (2006) we organized the best practices according to the framework's components. We can use this organisation to quantify the relationship between a best practice and a framework's component. For example, we established in our earlier work that the task elimination best practice impacts the operation behavior of the process. In Table 3 the reader

Table 3
Assigning component indicator's values

Components' classification	AHP scale	Interpretation
1. Customer	9	Extremely important
2. Information	7	Very important
3. Product	7	Very important
4. Operation view	5	Important
5. Behavior view	5	Important
6. Organization	3	Slightly important
7. Technology	3	Slightly important

may note that the latter is assessed as 'important' for the redesign and allocated a value of 5. The best practice 'task elimination' is thus allocated the same value '5'.

4.3. Exploring the 'Impact' criterion

We introduced in Reijers (2003) the 'devil's quadrangle (cf. Fig. 2). We use it to graphically display the qualitative *impact* of a best practice on four different dimensions: quality, time, cost and flexibility. This impact may be positive, resulting in a desirable improvement, neutral or negative, resulting in a less performing process. In Limam Mansar and Reijers (2007) the survey we conducted with practitioners in the Netherlands and the United Kingdom quantified this impact. Practitioners were presented with our top ten best practices and asked to rank the impact of a best practice on a business process between 0 and 10. If less than five, this ranking meant a negative impact. If more than five, this ranking meant a positive impact. We gathered and estimated the average rankings. Fig. 2 for example displays the impact of the order assignment best practice. The grey diamond delimitates a neutral area (value 5). Within the area, a negative impact is expressed. Outside the area is the positive impact. It shows that improvements are expected on all four dimensions when this rule is applied. It can be noticed in Fig. 2 that we display the theoretical result (literature review) as well as the survey result.

For the top ten best practices, we used the values of the survey results to quantify the impact of a best practice on quality, time, flexibility and cost. In this paper, we translate the survey values into the AHP scale: for a negative impact we use the values 1, 3 (1: highly significant decrease in performance; 3: significant decrease in performance), for no impact we use the value 5 (neutral) and for a positive impact we use the values 7, 9 (7: significant increase in performance, 9: highly significant increase in performance).

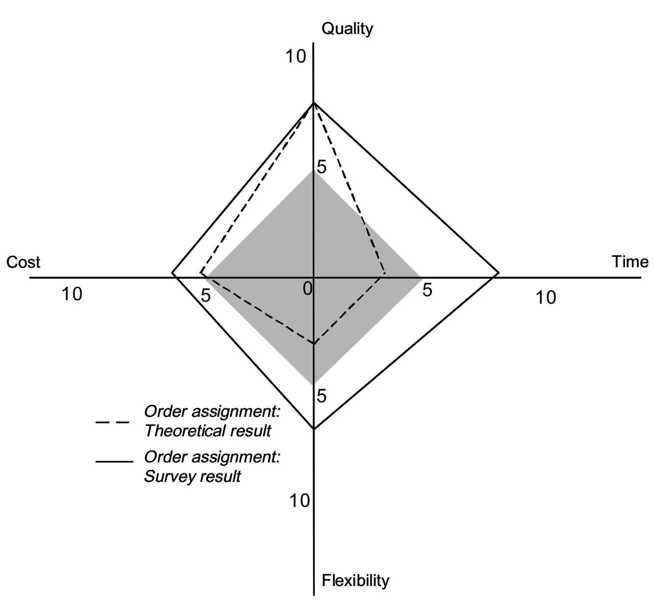

Fig. 2. Devil's quadrangle for the Order assignment best practice.

For example, for the order assignment best practice, based on its corresponding devil's quadrangle (cf. Fig. 2) we assign the values 9 for the impact on time, 9 for its impact on quality, 7 for its impact on flexibility and 7 for the cost impact. This translates into the order assignment best practice has a strong positive impact on the redesigned process's quality and time and only a limited one on its cost and flexibility.

For the remaining 16 best practices not tested by the survey's experts we used results from the literature review (discussed in Reijers & Limam Mansar, 2005) as well as our own experience to define appropriate values. At this stage of the research, we trust that these values are sensible enough to provide a clear understanding of what the tool can achieve. Future research may include a validation of the values with an additional survey.

So far, we exploited our previous research to come up with three important criteria in the decision-making process of selecting best practices for a redesign: 'component', 'popularity' and 'impact'. The main results are

- There are a number of *popular best practices* that can be used for redesign: *These are general, and context-independent* (manufacturing/service, small/large organization, etc.). To quantify the popularity of the best practices we emphasized the importance of a top ten list derived in Limam Mansar and Reijers (2005) and assigned the remaining best practices a lesser value to express that they may not be chosen by practitioners.
- There are a number of *components* to address during a BPR implementation: The different components are not all equally vital for the redesign. In this paper, we used the AHP scale to quantify this difference and assign them to best practices.
- We know the qualitative *impact* of each best practice (rule) on four different dimensions: quality, time, cost and flexibility (positive/negative) and we explained in this paper how we can quantify this impact using the AHP scale.

We now introduce and discuss two additional criteria which should be considered when choosing best practices: redesign projects' goals and risks.

4.4. Exploring the 'Goal' criterion

Any redesign effort targets a need for improvement to some specific areas. We studied earlier contributions that identify the goals usually targeted in redesign projects. According to (Guimaraes & Bond, 1996; Hammer & Champy, 1993; Malone, Crowston, Lee, & Pentland, 1999), goals usually fall into the following categories:

- improve quality,
- reduce costs,

– reduce service time or production time,
– improve productivity,
– increase revenue,
– improve customer service,
– use IT capabilities,
– and improve competitiveness.

It remains the responsibility of the redesign team to discuss the relative importance of the goals for their project. To do so, the redesign team will need to use the AHP scale (refer to Table 1).

Our role is only to assess how each best practice can support each goal (or not). To do so we used the AHP scale to quantify goals related to best practices. If we continue on the example of the task elimination and examine the goal 'use IT capabilities' then one may argue that applying this best practice (eliminating tasks) would neither help nor obstruct this goal (use IT capabilities) from being achieved. We could then give it a neutral value of 5. At this stage of the research, we derived the different values informally, using our best judgment and experience. Future research may look into the impact of varying such values on the final result.

4.5. Exploring the 'Risk' criterion

Before starting the redesign, practitioners identify the factors that will challenge the redesign of the process. Some best practices might then become inappropriate because they would increase the identified risk. Research indicates, for example, that for BPR projects, top management commitment and managerial support are the most important factors. Throughout the literature review, the following risk factors are often considered (Al-Mashari et al., 2001; Crowe, Fong, Bauman, & Zayas-Castro, 2002; Guimaraes & Bond, 1996):

– limited implementation time (Davidson, 1993; Grover, Jeong, Kettinger, & Teng, 1995),
– poor information system architecture (Davenport, 1993; Davidson, 1993; Grover et al., 1995),
– limited funds (Bashein, Markus, & Riley, 1994; Davenport, 1993),
– lack of managerial support (Alter, 1990; Davenport & Short, 1990; Grover et al., 1995),
– lack of top management commitment (Alter, 1990; Davenport & Short, 1990; Grover et al., 1995),
– employee resistance (Grover et al., 1995).

As for the 'goal' criteria, it remains up to the redesign team to discuss the relative importance of the risks for their project. For example, does the redesign team consider that the redesign might be put at risk because they expect a strong resistance from the current employees? And how important is this risk versus a perceived lack of top management commitment? To express the latter, the redesign team will need to use the AHP scale (refer to Table 1) assigning relative preferences for risks.

Our role here is only to assess how each best practice can increase or decrease each risk. We use the AHP scale to do so in the same way that we did with the goal criterion. If we continue on the example of the task elimination and look at the risk 'employee resistance', then one may argue that applying this best practice would increase this risk as eliminating tasks may reduce some employees' responsibilities and this might be perceived as a threat. We could then give it a value of 3 to emphasize a negative impact.

As was explained for the goal criterion, at this stage of the research, we derived the different values informally, using our best judgment and experience.

To summarize this section, deciding which best practice to apply is a complex process that involves looking at several criteria: the *component* the best practice belongs to, the best practice's *popularity*, its *impact* on a redesigned process, the initial redesign *goal* and the identified *risks*. We explored ways to quantify each criterion and link it to best practices. In what follows, we investigate the usefulness of *a multicriteria decision-making method* for the choice of best practices and describe it hereafter.

5. Using AHP as a multicriteria method

Classifying the best practices is based on a set of qualitative and quantitative criteria (cost, time, etc.), we thus use a multicriteria method. Our choice for a particular multicriteria method is mainly based on earlier work and experience (Ounnar et al., 1999; Mekaouche, 2007). We can distinguish three classes of multicriteria methods: multicriteria decision aid methods, elementary methods and optimization mathematical methods. The choice of one of the three classes methods depends either on the set of data, or on the way in which the decision maker models preferences. The multicriteria decision aid methods support the decision maker refining his decision-making process to choose an action among a set of potential actions, or to classify a set of actions by examining the logic and the coherence of its preferences. These methods are based on the aggregation of the preferences. This aggregation can be done according to three approaches: Complete, Partial or Local Aggregation.

In order to classify the set of best practices, complete aggregation was exploited. There are several methods that deal with complete aggregation: the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), the Multiple Attribute Value Theory (MAVT), the Multiple Attribute Utility Theory (MAUT), the Simple Multiple-Attribute Rating Technique (SMART), the Utility Theory Additive (UTA), the EVAluation of MIXed criteria (EVAMIX) and the Analytic Hierarchy Process (AHP).

Unlike the other quoted multicriteria decision aid methods, the AHP method is the only one that allows on the one hand, the measure of the coherence of the decision maker preferences and on the other hand, taking into account at the same time the independence and the interdependence of the considered criteria. Moreover the AHP method allows to take into account qualitative and quantitative criteria.

The Analytic Hierarchy Process (AHP) is a method developed by Saaty (Saaty, 1980) for complex multicriteria problems for which quantitative and qualitative aspects could be taken into account. AHP is widely used to classify alternatives based on a range of criteria. It is a more descriptive and less normative analytic approach than the existing alternatives. In Ounnar, Pujo, Mekaouche, and Giambiasi (2007) an application is given for the supplier evaluation problem. A more detailed description of the AHP decision mechanism is provided in Ounnar and Pujo (2005). The AHP process is performed in four phases:

– Phase 1: Building a hierarchical process for the decision problem.
– Phases 2 and 3: Pair-wise comparison of each built hierarchical level's elements and Relative weight appraisal between the elements of each two adjacent levels which develops priorities for the alternatives.
– Phase 4: Relative weights aggregation of the different hierarchical levels to provide alternatives' classification of the decision.

In what follows, it is explained how the AHP method evolves in the setting of our paper.

5.1. Phase 1: building a hierarchical process for the decision's problem

As stated, the AHP method helps the decision makers to structure the significant components of a problem in a hierarchical structure. This is based on the assumption that the identified entities can be grouped into disjoint sets. The elements in each group (also called level) of the hierarchy are assumed to be independent. The hierarchy of the decision-making process is defined by a quadruplet ⟨L1, L2, L3, L4⟩ (cf. Fig. 3) where

– Level 1 (L1) = Global Objective.
– Level 2 (L2) = Criteria Level.
– Level 3 (L3) = Indicators Level.
– Level 4 (L4) = Alternatives Level.

This is a key phase as it determines the purpose of the decision-making process. In Fig. 3 we graphically display the hierarchical process. As explained in Section 3, our objective is to find appropriate best practices for BPR projects. This defines the global objective (L1). In other words, AHP will classify the set of best practices according to a best compromise between all the criteria we consider as important for the redesign process.

Practitioners base their decisions on a set of five criteria (refer to Section 4): component, popularity, impact, goal and risk. This defines the second level of the AHP method (L2). We also explained that some criteria involve many indicators. For example, the criteria impact needs to further be broken down into impact on Time (T), Quality (Q), Flexibility (F) and Cost (C). These define the third level of the AHP method (L3). Finally, the level 4 (L4) of the method represents the alternatives to be classified – here being the 26 best practices.

After completing this phase, the results are synthesized by decomposing complex decisions into a series of simple comparisons and arrangements (cf. Fig. 3).

The following notations are used Ci = Criterion i ($i = 1{:}4$); Iik = Indicator k of Ci ($k = 1$ for $i = 1{:}2$, $k = 1{:}4$ for $i = 3$, $k = 1{:}8$ for $i = 4$, $k = 1{:}6$ for $i = 4$); Aj = Alternative j [practices $N°j$ ($j = 1{:}26$)].

5.2. Phases 2 and 3: pair-wise comparison of each built hierarchical level's elements and relative weight appraisal between the elements of each two adjacent levels

5.2.1. Evaluation of the relative importance of the criteria to the global objective

We assess the importance of criteria against each other (pair-wise comparison). That means quantifying what is perceived as really important when choosing a best practice for the redesign. Note that this assessment is *independent* of the project under study and is explained here for the sake of clarity. It is incorporated in our AHP algorithm but hidden from the users. We summarized the assessment in Fig. 4. In this figure, for example, 'Popularity' is indicated as strongly more important than 'Component' (value 5) and 'Impact' is indicated as strongly more important than Risk (1/5).

In order to describe the remainder of the method, let us note that AHP is based on determining a classification for the alternatives. The central 'ingredient' of the AHP method is comparisons. The pair-wise comparison evaluates the relative importance of two elements for the decision maker. It contributes to the achievement of the adjacent higher level's objective. The classification by priority of the elements of the hierarchy level contributing to reaching an objective of the adjacent higher level is called 'relative weight' or 'order of priority'. The AHP method scale of value is used (Saaty, 1980). It defines numerical values (1–9) corresponding to the importance of a factor against another factor. Note that it is used here for comparing qualitative data (refer to Table 1).

5.2.2. Evaluation of the relative importance of the indicators to the criteria

We assess for each criterion the importance of the indicators against each other (pair-wise comparison). That means quantifying which indicators are really important when it comes down to the level of each criterion separately. There are five criteria: component, popularity, impact, goal and risk. Component and popularity criteria are described by one indicator only and thus do not need any assessment in this phase. The goal and the risk criterion are closely dependent on the process to be redesigned.

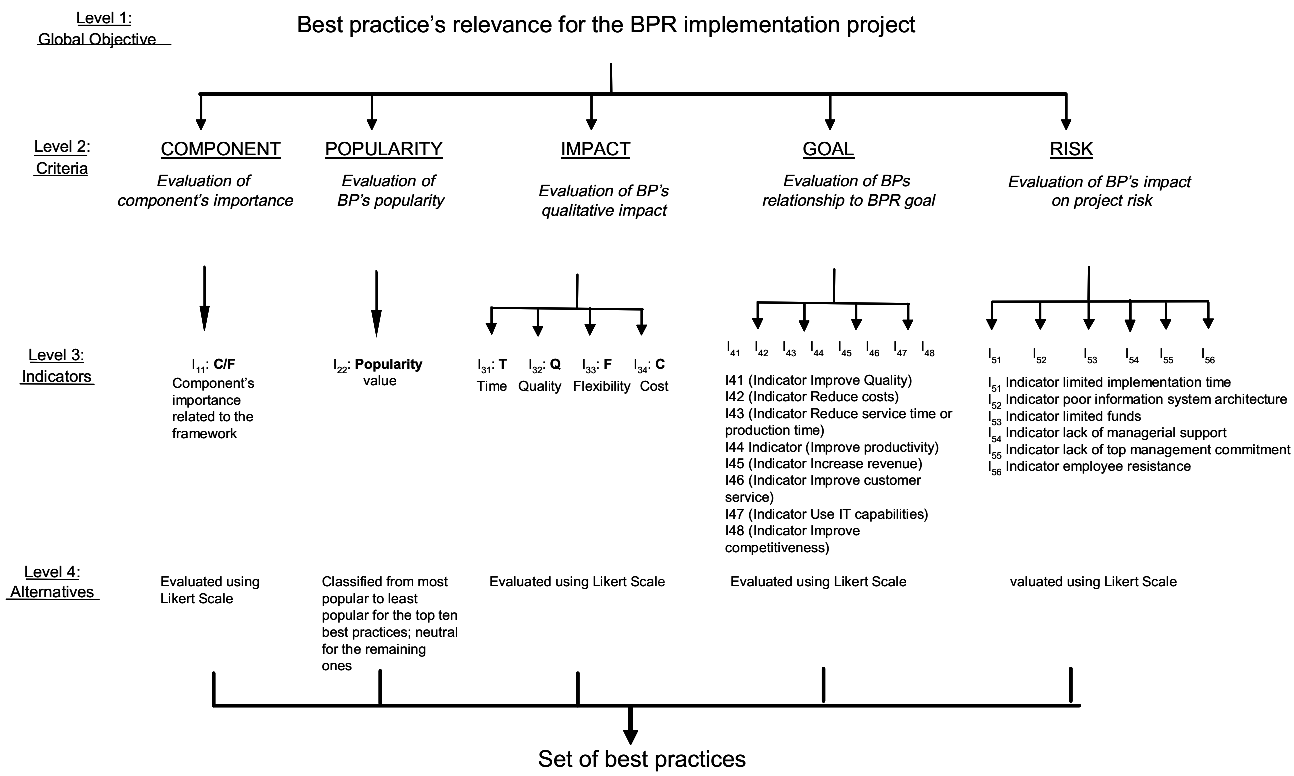

Fig. 3. Hierarchical classification for best practices evaluation.

	Component	Popularity	Impact	Goal	risk
Component	1				
Popularity	5	1			
Impact	5	1	1		
Goal	9	7	7	1	
Risk	3	1	1/5	1/9	1

Fig. 4. Pair-wise comparison of the criteria.

	$I_{31}(T)$	$I_{32}(Q)$	$I_{33}(F)$	$I_{34}(C)$
$I_{31}(T)$	1			
$I_{32}(Q)$	1/5	1		
$I_{33}(F)$	1/7	1/3	1	
$I_{34}(C)$	1	5	5	1

Fig. 5. Pair-wise comparison of Impact's indicators.

It is thus not possible to assess them in this phase. In the next section, we will evaluate and illustrate the importance of the goals and risks for a case study. The only criterion that is left to be assessed is the impact criterion. Table 1 is used as an assessment scale (1–9) as required by the AHP method and results are described in Fig. 5.

In this figure, for example, 'Time' is indicated as strongly more important than 'Quality' (value 1/5). The values were determined by the authors based on their judgment and experience.

5.2.3. *Evaluation of the relative importance of the alternatives to the indicators of each criterion*

We assess for each alternative (best practice) the appropriate values for the different indicators. The good news is that this assessment is *totally independent* from the specific BPR project under consideration. The values are presented in Table 4 and will not have to be changed by the users of the method. They are incorporated in the AHP algorithm but completely hidden from the user of the method. They are displayed here for the sake of completeness only. In the sequel we describe how the values in Table 4 are assessed for the best practices.

5.2.3.1. Popularity. Let us recall that in Section 4.1 we defined the popularity as values that reflect the best practice's frequent use by practitioners. We explained in Section 4.1 that we quantify the evaluation of this criterion (popularity) in the following way: we assign a high value of 4 to the four first most popular best practices, a value of 3 to the next three popular best practices, a value of 2 to the next three best practices and a neutral value of 1 to all the other best practices. This assignment was based on the results of the survey we conducted. Table 4 displays the values for all best practices: consider the column 'popularity'.

5.2.3.2. Components. In Section 4.2 we explored how the 'components' criterion can be quantified. It was a result of the survey we conducted before. Let us recall the example: the task elimination best practice impacts the 'operation behavior' of the process. In Table 3 the reader may

Table 4
Indicator's values for selected best practices

Best practice	Component	Popularity	Impact				Goal								Risk					
	C/F		T	Q	F	C	I_{41}	I_{42}	I_{43}	I_{44}	I_{45}	I_{46}	I_{47}	I_{48}	I_{51}	I_{52}	I_{53}	I_{54}	I_{55}	I_{56}
Task elimination	5	4	9	7	5	9	7	9	9	9	5	5	5	5	7	5	5	5	5	3
Task composition	5	4	9	7	7	7	7	7	9	9	5	5	5	5	5	5	5	5	5	3
Integral technology	3	4	9	9	9	9	9	9	9	9	7	9	9	7	1	1	3	5	5	3
Empower	3	4	9	7	9	7	7	7	9	7	5	5	5	5	3	5	7	5	5	9
Order assignment	3	3	9	9	7	7	9	7	9	9	5	9	5	7	5	5	5	5	5	3
Resequencing	5	3	9	9	5	7	9	7	9	5	5	5	5	5	5	5	5	5	5	3
Specialist-generalist	3	3	9	9	9	9	9	9	9	7	7	5	5	5	1	5	3	5	5	1
Integration	9	2	9	9	7	7	9	7	9	7	7	9	5	7	1	1	5	5	5	5
Parallelism	5	2	9	5	5	7	5	7	9	9	7	5	7	5	3	5	5	5	5	5
Numerical involvement	3	2	9	7	7	7	7	7	9	7	7	5	5	5	3	5	7	5	5	3
Control relocation	9	1	5	9	5	3	9	3	5	5	5	9	5	7	5	5	7	3	3	3
Contact reduction	9	1	7	7	5	3	7	3	7	5	5	1	5	3	5	5	1	3	5	7
Order types	5	1	7	3	5	9	3	9	7	9	5	5	5	5	5	5	1	7	5	1
Order-based work	5	1	9	5	5	1	5	1	9	9	5	7	5	5	5	1	1	5	5	1
Triage	5	1	7	9	3	7	9	7	7	5	5	5	5	5	5	5	1	7	5	1
Knock-out	5	1	3	5	5	9	5	9	3	3	5	5	5	5	5	5	1	5	5	1
Exception	5	1	7	9	3	5	9	5	7	9	5	5	5	5	5	3	1	5	5	1
Flexible assignment	3	1	7	7	5	5	7	5	7	5	5	5	5	5	3	5	9	9	5	9
Centralization	3	1	9	5	9	5	5	5	9	9	5	5	7	5	5	1	1	1	1	5
Split responsibilities	3	1	7	7	3	5	7	5	7	3	5	5	5	5	7	3	1	1	1	1
Customer teams	3	1	3	7	3	5	7	5	3	7	5	9	5	7	3	3	5	5	5	5
Case manager	3	1	5	9	5	1	9	1	5	9	5	9	5	7	5	5	5	5	5	7
Extra resources	3	1	9	5	7	3	5	3	9	9	5	9	5	7	1	5	1	1	1	9
Control addition	3	1	3	9	5	9	9	9	3	3	7	9	5	7	1	5	1	7	5	1
Buffering	7	1	9	5	5	3	5	3	9	7	5	5	5	5	5	5	7	5	5	7
Task automation	3	1	7	7	3	3	7	3	7	9	9	5	9	5	1	9	1	3	5	3

note that the latter component of our framework is assessed as important for the redesign and allocated a value of 5. The best practice 'task elimination' is thus allocated the same value '5'.

Here is another example: Table 3 shows that the *customer* component is extremely important. The "integration" best practice has been identified as a *customer* best practice and will thus be assigned a value of 9 to reflect the importance of this component. (For both examples, 'integration' and 'task elimination', refer to Table 4 and look at the column 'Component' and rows 'integration' and 'task elimination').

5.2.3.3. Impact. Let us recall that in Section 4.3 we explained that the Impact values are derived from the devil's quadrangles for each best practice which was defined on the basis of the survey that we conducted. The values are reflected in Table 4. Look at the example of task elimination: based on its corresponding devil's quadrangle the impact values are as follows: I_{31} (T) = 9; I_{32} (Q) = 7; I_{33} (F) = 5 and I_{34} (C) = 9. This translates into: the task elimination best practice has a strong positive impact on the redesigned process's cost and time, only a limited one on its quality and is neutral in terms of flexibility.

5.2.3.4. Goal. We explained in Section 4.4 that the relationship between the goal's indicators values and the best practices has been valued by ourselves. The AHP scale was used in the same way as it was used for the impact and risk criteria. Refer to Table 4.

5.2.3.5. Risk. We explained in Section 4.5 that the relationship between the risk's indicators values and the best practices was determined using our discretion. The AHP scale was used in the same way as it was used for the impact criterion. Please refer to Table 4.

We aim to establish a classification of the alternatives (best practices) with respect to the indicators of each criterion. To do so it is necessary to compare, for each $I_{i,k}$ indicator of the L3 level belonging to the I_i set, the $I_{i,k,j}$ values between the Best Practices BP_j of the set of the considered best practices.

5.3. Phase 4: relative weights aggregation of the different hierarchical levels to provide alternatives' classification of the decision

Having carried out the pair-wise comparison, AHP calculates a vector of priority that classifies the alternatives in an ascending or descending order. In this fourth phase the different criteria, indicators, alternatives and their associated values derived in the previous phases are entered into the AHP algorithm to derive a classification of the alternatives (i.e. a classification of the most suitable best practices to use to redesign the studied process).

To summarize, Fig. 3 describes the criteria and the indicators that are important when deciding which best prac-

	I_{41}	I_{42}	I_{43}	I_{44}	I_{45}	I_{46}	I_{47}	I_{48}
I_{41}	1							
I_{42}	7	1						
I_{43}	9	5	1					
I_{44}	1	1/7	1/9	1				
I_{45}	1	1/7	1/9	1	1			
I_{46}	1	1/7	1/9	1	1	1		
I_{47}	1	1/7	1/9	1	1	1	1	
I_{48}	1	1/7	1/9	1	1	1	1	1

Fig. 6. Pair-wise comparison of Goal's indicators.

	I_{51}	I_{52}	I_{53}	I_{54}	I_{55}	I_{56}
I_{51}	1					
I_{52}	1	1				
I_{53}	7	7	1			
I_{54}	1	1	1/7	1		
I_{55}	1	1	1/7	1	1	
I_{56}	1	1	1/7	1	1	1

Fig. 7. Pair-wise comparison of Risk's indicators.

tices should be considered to redesign processes. As far as the users of the methods are concerned, the *only* input they need to make to run the method is an assessment of the goals and risks of their *specific* BPR project. i.e. build up figures similar to Figs. 6 and 7. This assessment will make it possible to derive values for the risk and goal matrices and thus run the method.

It is worthwhile to end this section with a reflection on the use of AHP. AHP has some disadvantages, such as the potentially big effort to parameterize the various tables and mainly the possibility of Rank Reversal (Belton & Gear, 1983; Bouyssou et al., 2000; Dyer, Saaty, Harker, & Vargas, 1990). Even so, the method is still attractive for our purpose. In the first place, the modeling effort can be restricted to a specific subset of the data, as we just explained (only goals and risks have to be entered). Also, the aim is not really to find *the* best practice, but to get an idea about the most suitable ones for the redesign to consider in more detail. In the next section, a case study is used to illustrate and discuss this.

6. Case study

This case study relates to a local municipality of 90,000 citizens in the northern part of the Netherlands, more specifically its Urban Management Service. This service takes care of the sanitation, parking facilities, green spaces, and city districts, and it employs over 300 civil servants. In 2002, we undertook a study to identify the redesign potential for its *invoice processing* workflow. On a yearly basis, the municipality handles about 10,000 invoices with this process. In Limam Mansar and Reijers (2005) we described this case in more detail. In particular, we described how a simulation-based methodology was used to assess which of the 26 best practices to implement in this case. For each best practice it was determined (through workshops) whether it would be applicable in the context of the process under consideration.

To study the effects of an applicable best practice, we constructed a simulation model of the business process *assuming* that just this single best practice would be applied. Finally, two workshops that involved end users, managers, and IT professionals from the municipality were organized during which it was determined whether a best practice should be included in the final design. A simulation model was built that incorporated all applicable best practices. This subset seemed the best combination in terms of performance improvement.

It will be interesting now to compare the results from this earlier project with those provided by the decision-making algorithm as proposed in this paper. In the sequel, we describe the different values we assign in relation to this case study and needed by the algorithm to make suggestions. As explained in phase 4, the only input the user needs to make is an assessment of goals and risks related to redesigning the invoice processing workflow. The remaining values are as defined before.

6.1. Goal(s) of this project

We identified eight goals that might be considered for redesign. We recall that they are I_{41} (Indicator Improve Quality), I_{42} (Indicator Reduce costs), I_{43} (Indicator Reduce service time or production time), I_{44} Indicator (Improve productivity), I_{45} (Indicator Increase revenue), I_{46} (Indicator Improve customer service), I_{47} (Indicator Use IT capabilities), I_{48} (Indicator Improve competitiveness). We have to evaluate in a pair-wise way the goals' importance for this current project, i.e. some goals are not relevant while others are the focus of the redesign. Time and cost have been identified by management as key indicators for the criteria goal, resulting in the values in Fig. 6.

For example, reducing service time I_{43} was perceived as extremely more important than improving the quality I_{41} for this case study (value 9).

6.2. Risk(s) of this project

We identified six risks that might be considered for redesign. We recall that they are I_{51} (Indicator limited implementation time), I_{52} (Indicator poor information system architecture), I_{53} (Indicator limited funds), I_{54} (Indicator lack of managerial support), I_{55} (Indicator lack of top management commitment) I_{56} (Indicator employee resistance). The risk 'Limited funds' was identified as the most threatening risk for this case study, resulting in the values in Fig. 7.

For example, the limited funds risk I_{53} was perceived as very strongly more important than the limited implementation time risk I_{51} for this case study (value 7).

Please cite this article in press as: Limam Mansar, S. et al., Development of a decision-making strategy to improve ..., *Expert Systems with Applications* (2008), doi:10.1016/j.eswa.2008.01.008

Table 5
Best practices classified by AHP for our case study

3	Integral technology
1	Task elimination
2	Task composition
7	Specialist-generalist
5	Order assignment
4	Empower
8	Integration
6	Resequencing
10	Numerical involvement
9	Parallelism
13	Order types
25	Buffering
19	Centralization
18	Flexible assignment
23	Extra resources
17	Exception
15	Triage
24	Control addition
20	Split responsibilities
26	Task automation
11	Control relocation
14	Order-based work
16	Knock-out
12	Contact reduction
21	Customer teams
22	Case manager

6.3. Results

The application of the AHP algorithm delivered a ranking of best practices as shown in Table 5. It advises the implementation of the (1) integral technology, (2) task elimination, (3) task composition, (4) specialist-generalist, (5) order assignment and (6) empower, as the six first choices. The best practices that were finally integrated in the redesigned process (out of simulation and workshops' discussions) were (1) integral technology, (2) task elimination, (3) task composition, (4) specialist-generalist, (5) resequencing and (6) numerical involvement (Limam Mansar & Reijers, 2005). Note that both methods came up with four similar best practices out of sets of six. An explanation for the differences could be that the simulation did not take all the components of level 2 into account, such as e.g. the risk and goal factors. Another explanation is that the method we present was not confronted with the users whose input might have changed the final choices made. Nonetheless, it seems highly conceivable to us that the application of our method could have led the redesign team to come up with a redesign based on very similar ingredients *without* the use of simulation, as was actually the case.

7. Related work

In their seminal work (Hammer & Champy, 1993), Hammer and Champy identified IT as a key enabler for redesigning business processes. This new role of IT "represents a fundamental departure from conventional wisdom on the way an enterprise or business process is viewed, examined, and organized" (Irani, Hlupic, & Giaglis, 2000) and triggered many articles on the role of IT in the context of BPR. However, as pointed out in Gunasekaran and Kobu (2002), most of the studies deal with conceptual frameworks and strategies – not with modeling and analysis of business processes with the objective of improving the performance of reengineering efforts.

The use of IT to actually support a redesign effort can take on various forms and a variety of tools are available in the market place. Kettinger, Teng and Guha compiled a list of 102 different tools to support redesign projects (Kettinger, Teng, & Guha, 1997). Building on this study, Al-Mashari, Irani and Zairi classified BPR-related tools and techniques in 11 major groups (Al-Mashari et al., 2001). These groups cover activities such as project management, process modeling, problem diagnosis, business planning, and process prototyping. Gunasekaran and Kobu reviewed the literature from 1993–2000 and came to the following classification of modeling tools and techniques for BPR: (i) conceptual models, (ii) simulation models, (iii) object-oriented models, (iv) IDEF models, (v) network models, and (vi) knowledge-based models (Gunasekaran & Kobu, 2002). More recently, Attaran linked the various available tools to three different phases in a BPR program: before a process is designed, while the process is being designed, and after the design is complete (Attaran, 2004). In these phases, a tool can respectively act as a facilitator (e.g. as an inspiration for a new strategic vision), as an enabler (e.g. for mapping the process, gathering performance data, and simulation), and as an implementer (e.g. for project planning and evaluation). Using the classifications of these authors, our interest in this paper lies with the role of IT as an enabler during the design phase.

Considering the state of the art on tools for process redesign, Cypress found the existing first-generation computer-based tools of the early 90s inadequate for process design (Cypress, 2004). The more recent analysis by Kettinger et al. found few tools for conducting front-end BPR activities such as process planning, competitive analysis, and creative thinking (Kettinger et al., 1997). Only techniques – in contrast to tools – are mentioned as suitable for actual redesign, such as brainstorming, nominal group techniques, and "visioning". More recently, Irani et al. commented on the continuous releases of new tools for process modeling, which, however, are unable to conduct what-if analyses or show the dynamic change of business processes (Irani et al., 2000). Although simulation tools can meet these requirements, Al-Mashari et al. found in their survey that of all available categories of BPR tools "organizations made least use of prototyping and simulation techniques" (Al-Mashari et al., 2001). The authors conjecture that this is due to the complexity frequently associated with them and the conditions that need to be met to ensure feasible use of such techniques.

Nissen states that despite the plethora of tools for modeling and simulation of business processes, "such tools fail to support the deep reengineering knowledge and specialized expertise required for effective redesign" (Nissen, 2000). Similarly, Bernstein, Klein and Malone observe that "today's business process design tools provide little or no support for generating innovative business process ideas" (Bernstein, Klein, & Malone, 2003). Gunasekaran and Kobu indicate that only a few knowledge-based models for BPR have been developed (Gunasekaran & Kobu, 2002). It is interesting to note here that although the absence of this kind of BPR support by automated tools is regretted, this functionality was not yet considered in early studies on BPR tools and languages (see e.g. Janssen, Jonkers, & Verhoosel, 1997; Gunasekaran & Kobu, 2002).

The most important reasons to work towards IT support for the design phase would be that new design alternatives can be developed more easily (Gunasekaran & Kobu, 2002), more cost-effectively (Nissen, 1988), quicker (Malone et al., 1999; Nissen, 2000) and more systematically (Malone et al., 1999; Pentland, 2003). At this point in time, few tools qualify with respect to these requirements. The ProcessWise methodology, although promoted as "advanced" and supported by an integrated tool, does not offer any guidance for the design itself (Calvert, 1994). Case-based reasoning (CBR) systems are presented in Ku and Suh (1996), Min et al. (1996). They enable an efficient search and retrieval of earlier redesign solutions that may fit the aims of a new BPR effort. However, the gathering of successful solutions is problematic. Another drawback is that the cases are typically restricted to a certain business domain, e.g. banking.

More promising seems the approach on the basis of the MIT Process Handbook as presented in Malone et al. (1999). The process recombinator tool is implementing this approach (Bernstein et al., 2003). Through the notions of (i) process specialization and (ii) coordination mechanisms, new designs can be systematically generated on the basis of an identified list of core activities. It is the end user who then can select the most satisfactory process. In contrast to the earlier CBR approaches, the existing design knowledge extends over multiple business domains and the end user is supported in a meaningful way to generate alternatives. The Open Process Handbook Initiative[1] aims at involving practitioners and researchers in the described approach.

In research that is associated to the MIT Process Handbook, a quite different yet promising approach is presented in Lee and Pentland (2000), Pentland (2003). It attempts to capture the *grammar* underlying a business process. Just like natural language consists of words and rules to combine these words, business processes are seen as consisting of activities that can be combined using rewrite rules. A clear advantage of this approach would be that different process variants can be systematically generated and explored. However, it seems difficult to identify the rules and constraints that apply for certain categories of processes and to represent these in a grammatical framework.

The last approach particularly worth mentioning here is the KOPer tool described in Nissen (1988), Nissen (2000). The idea is that a limited set of process measures (e.g. process length, process handoffs, etc.) can be used to identify process pathologies in a given process (e.g. a problematic process structure, fragmented process flows, etc.). These process pathologies can then be matched to redesign transformations known to effectively deal with these pathologies. Although the tool does not generate new designs itself, e.g. by visualizing the effect of a suggested transformation on an existing design, experiments suggest that the tool "performs redesign activities at an overall level of effectiveness exceeding that of the reengineering novice" (Nissen, 2001). It is an open issue, however, how the various redesign transformations must be prioritized.

In summary, although the existence and importance is acknowledged of tools to support redesigners with the technical task of generating new process designs, few tools exist that can match this task. The approach that is described in this paper (cf. Sections 3–5) is similar to the CBR-based approach and the KOPer tool with respect to the type of support that is offered to increase the efficiency of BPR. A main advantage over these approaches is that through the link with the redesign best practices the empirical knowledge becomes available to the process designer to determine the *historic link* with earlier, successful redesign solutions (i.e. without the need to codify/gather this knowledge in earlier cases) with a clear idea on *the priorities* of applying these earlier solutions (i.e. which is missing in the KOPer tool).

8. Conclusion

This paper presented a decision-making method based on AHP to support practitioners in the field of BPR to choose appropriate best practices to enhance processes. It is important to emphasize that this work supports business process redesign where *process improvement* is the goal as opposed to a clean slate approach to redesign. In that context, the main contribution of this paper is twofold. Firstly, it presents a new approach to business process redesign (refer to Section 3 and Fig. 1). This approach aims at shortening the time practitioners will spend discussing the usefulness of best practices and at providing them with a much clearer appreciation of best practices importance and impact. Secondly, it synthesizes all important criteria for selecting best practices, introducing the goal and risks of the examined projects. This forces the redesign team to reflect on the conditions in which the redesign is conducted.

Secondly, the presented parameterization and application of the AHP algorithm to select best practices for a specific redesign project is a further step towards the development of a decision-making strategy for BPR. Based on earlier work of ourselves and others, we came up with substantiated comparisons and weights of the tables that

[1] http://ccs.mit.edu/ophi/index.htm, last consulted July 31, 2007.

are used in the appraisal of AHP. Although some values were derived in previous papers (Limam Mansar & Reijers, 2005; Limam Mansar & Reijers, 2007; Mansar et al., 2006; Reijers & Limam Mansar, 2005), they were not presented or organized in such a way that it would clearly indicate how they can be used by practitioners.

Despite the well-known disadvantage of AHP in terms of effort required to rate criteria and options, the rating is really restricted to defining the relative weights for the indicators of the goal and the risk criteria only (equivalent to filling the values of Figs. 6 and 7). Also, the use of AHP in the presented method should be seen in the light of a more rational approach towards BPR, attaining the advantages of a more systematic search for redesign opportunities but more efficiently than by using simulation.

Our method has been implemented in Java 2 (JBuilder), compatible with the JDK standard 4.0 and higher. For now, data in the form of different tables is entered in text files and used by the algorithm. The results are then generated and displayed visually on a computer screen. The algorithm takes virtually no time to make the computations for the size of data that we considered here. Clearly, our implementation is still a prototype and needs enhancement of its user interface to be fully used in a business environment. Currently, contacts with a Dutch investment bank are exploited to enhance the tool with respect to this issue. Using a case study in this paper, we showed the feasibility and potential of the approach. We compared and discussed its outcome to the real application, where simulation was used.

The presented method allows the user to identify potentially interesting best practices. Although AHP's output is a ranking of best practices, we do not think the exact ranking is important. What should be considered is merely a preferred set of best practices as opposed to *all* best practices or *the* best practice. Indeed, in none of the redesign initiatives the authors have been involved in merely one best practice was singled out. Discussions always resulted in indicating a preferred *set* that later was tested or applied.

With the presented method, the best practices' relevance is addressed through a "high-level" assessment. It considers factors such as the redesign project's risks and goals and the characteristics of the best practices, for example their impact on the processes' performance indicators. In this respect, it is different from the work of Nissen (Nissen, 1988) that takes a "low-level" approach. This work considers the structure of a given process in much detail (e.g. length of the paths, number of steps, etc.) to identify improvement opportunities. It would be interesting to see whether these approaches could actually be used together or even merged and by doing so, take another step in moving redesign from art to science.

Future research should also focus on further validating the values assigned informally in this paper, namely the relative importance of the criteria and of the impact indicators as well as the relationship between the risk's and goal's indicators values and the best practices

Acknowledgements

The authors would like to thank Dr. Patrick Pujo from the *Laboratoire des Sciences de l'Information et des Systèmes*(LSIS), Marseille, France, for his valuable contribution in implementing the AHP algorithm. Part of this work was done by Hajo Reijers while visiting Zayed University.

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