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How suitable is the RePro technique for rethinking care processes?

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ABSTRACT

Improving the performance of care processes requires a well thought-out technique that supports healthcare practitioners in generating process improvement ideas. In this paper, we evaluate a new, systematic technique for rethinking care processes: the RePro (Rethinking of Processes) technique. The backbone of this technique is a set of process improvement principles that has its roots in two different groups of principles: Business Process Redesign (BPR) best practices, which primarily support redesigning administrative processes, and TRIZ innovation principles, which in their original form provide support for innovating products. To analyze and fine-tune the suitability of the different groups of principles and its associated application procedure, a cross-case survey and an applicability check were conducted. These evaluations reveal that the two groups of principles provide complementary insights into how care processes can be improved, and indicate that the RePro technique provides comprehensive, parsimonious and well-structured support for rethinking care processes.

Keywords: Business Process Redesign, TRIZ, Healthcare, Cross-case survey, Applicability check.

1. INTRODUCTION

Healthcare organizations are challenged to cure more people with fewer resources while satisfying strict quality and safety regulations. The redesign of care processes has become one of the key mechanisms to cope with this challenge (Locock, 2003; Vanhaecht, Bollmann, Bower et al., 2006; Van Lent, Sanders and Van Harten, 2012). Care processes often include several consultations, diagnostic tests and treatments, as well as supporting steps, such as scheduling. A typical process redesign initiative that targets these processes consists of describing the as-is process, conducting an analysis of the as-is to identify process weaknesses, and generating process improvement ideas. Whereas a lot of time is typically spent on describing and analyzing the as-is situation, process improvement ideas are often generated in one or a few workshops using traditional creativity techniques such as brainstorming (Netjes, Vanderfeesten and Reijers, 2006; Limam Mansar, Reijers and Ounnar, 2009; Griesberger, Leist and Zellner, 2011). Unfortunately, such techniques lack any guidance with regard to the kind of process alternatives that need to be considered and do not provide a solution for the personal inertia to search for process alternatives that are different from familiar directions (Chain, Zhang and Tan, 2005). These limitations restrict the systematic exploration of the full range of redesign possibilities, which increases the risk on biased choices and neglecting

interesting process alternatives (Chain, Zhang and Tan, 2005; Limam Mansar, Reijers and Ounnar, 2009).

In this paper, we evaluate a new, systematic technique for generating improvement ideas for care processes: the RePro (Rethinking of Processes) technique. This technique relies on a set of process improvement principles that has its roots in two groups of comprehensive principles: *Business Process Redesign (BPR) best practices*, which primarily support redesigning administrative processes (Reijers and Limam Mansar, 2005), and *TRIZ innovation principles*, which in their original form provide support for innovating products (Chain, Zhang and Tan, 2005). All RePro principles are based on solutions that have been applied previously and seem worthwhile to reproduce in another situation or setting. Examples of these principles are *parallelism*, "consider whether tasks can be executed in parallel", and *reconstruction*, "consider reconstructing the physical lay-out". The RePro technique includes an application procedure, which allows practitioners to go through the list of process improvement principles systematically. As such, the RePro technique aims to support practitioners in generating a rich set of improvement ideas for care processes.

The evaluation of the RePro technique in this paper contains a cross-case survey (Larsson, 1993; Lewis, 1998) and an applicability check with potential end-users of the technique (Rosemann and Vessey, 2008). As part of the cross-case survey, the suitability of the different groups of RePro principles is investigated and potential enhancements are identified by investigating process improvement proposals in healthcare case studies. The applicability check is used to further investigate and improve the potential for an explicit application of the set of RePro principles.

This paper is structured as follows. In Section 2, we provide background information with regard to the main building blocks of the RePro technique. Section 3 provides a summary of the RePro technique and in Section 4 we discuss related work. In Section 5, we explain the research methodology that was used to evaluate the RePro technique. Section 6 presents the results of this evaluation and in Section 7 we determine the implications of the results for research and practice. Section 8 concludes this paper.

2. BACKGROUND

The backbone of the RePro technique is the set of RePro principles. This set is based on a systematic integration of two comprehensive and often-cited groups of process improvement principles: *Business Process Redesign (BPR) best practices* (Reijers and Limam Mansar, 2005) and *TRIZ innovation principles* (Chain, Zhang and Tan, 2005).

The set of *BPR best practices* contains 29 process improvement principles that were derived from a literature review (Reijers and Limam Mansar, 2005). The BPR best practices were gathered with the administrative domain as application domain in mind. Among others, these principles aim at improving the contacts with customers, and the way information is used and created in a business process. Although the set of BPR best practices has been successfully applied in healthcare (Jansen-Vullers and Reijers, 2005), the administrative bias raises the question to what extent the set of best practices is complete for care processes. For example, many care processes require the active involvement of patients throughout the process, whereas digital information objects are mainly processed in administrative processes. Due to this difference, other process alternatives related to the involvement of patients might become of interest.

As part of the development of the RePro technique, we investigated the *TRIZ innovation principles* as a potential source for enhancing the *BPR best practices*. TRIZ is the Russian acronym for "Theory of

Inventive Problem Solving" and was developed by Genrich Altshuller and his colleagues in the USSR in 1946 (Chain, Zhang and Tan, 2005). By analyzing thousands of product patents, product innovation patterns were identified. These patterns were translated into 40 TRIZ innovation principles that provide concrete guidance regarding product innovation options. Although *product* innovation principles do not seem to be directly relevant for rethinking care *processes*, care processes share several characteristics with products. Firstly, care processes face numerous synchronization challenges due to the existence of autonomous medical disciplines and specialized departments that require interdisciplinary cooperation and coordination. To some extent, products face similar synchronization challenges due to highly interacting product components. Secondly, care processes typically require the physical presence of patients, whereas products frequently process physical objects (e.g. luggage conveyor systems). Third and finally, care processes as well as products typically have to fulfill strict safety regulations. Due to these three similarities, we expect that the TRIZ innovation principles have potential to provide new and complementary insights into how care processes can be improved. As far as we know, the set of TRIZ innovation principles has not been used to improve care processes so far. However, some preliminary attempts can be found in literature that use the set of 40 TRIZ innovation principles to improve services or processes in other domains (Chain, Zhang and Tan, 2005; Wang and Chen, 2010).

Based on the reasoning above, a Delphi procedure was used to compare and integrate the BPR best practices and TRIZ innovation principles. More details with regard to this procedure can be found in Vanwersch, Pufahl, Vanderfeesten et al. (2014). This procedure resulted in a list of 45 RePro principles, which will be discussed in more detail in the next section.

3. THE REPRO TECHNIQUE

The RePro technique consists of the set of 45 categorized RePro principles and an application procedure. All RePro principles are categorized into 9 categories that address aspects of a process that can be improved. These categories extend the BPR practices framework (Reijers and Limam Mansar, 2005) with two TRIZ-related categories, i.e. "facilities, equipment and material" and "physical lay-out". Table 1 provides a description of each RePro category, the number of RePro principles per category and an example of a RePro principle. In the third column of this table, we show between brackets the number of RePro principles that are part of the original group of BPR best practices (first number) and the number of principles that we added based on the integration with TRIZ innovation principles (second number). For example, Table 1 shows that the "tasks" category contains six principles that are related to the kind of tasks that are part of the process. This set of six principles contains four BPR best practices and two TRIZ-related principles. One of the TRIZ-related principles in this category is *prior counteraction*. This principle states: "add tasks to prevent happening of an undesirable situation or to reduce its impact". A description of all 45 principles can be found in Appendix 1 at the end of this paper.

RePro category	RePro category description	No of principles	Example of RePro principle (source)
Customers	Contacts with customers	3 (3 + 0)	Control relocation: move controls towards customers (BPR)
External environment	Collaboration and communication with third parties	3 (3 + 0)	Outsourcing: consider outsourcing a business process in whole or parts of it (BPR)
Tasks	The kind of tasks that are part of the process	6 (4 + 2)	Prior counteraction: add tasks to prevent the occurrence of an undesirable situation or to reduce its impact (TRIZ)
Task order and timing	The order in which tasks are executed and the more detailed timing of task execution	7 (5 + 2)	Parallelism: consider whether tasks may be executed in parallel (BPR)
Human resources	The number and types of available human resources, and the way they are allocated to tasks	11 (10 + 1)	Empower: give workers most of the decision-making authority and reduce middle management (BPR)
Facilities, equipment and material	The number and types of available facilities, equipment and material, and the way these non-human resources are allocated to tasks	7 (0 + 7)	Resource adjustment: consider changing the number of involved non-human resources (TRIZ)
Information	The way information is used or created in the process	3 (2 + 1)	Buffering: instead of requesting information from an external source, buffer it by subscribing to updates (BPR)
Information and Communication Technology	How information and communication technology is used	2 (2 + 0)	Task automation: consider automating tasks (BPR)
Physical lay-out	The physical arrangement of the process	3 (0 + 3)	Reconstruction: consider reconstructing the physical lay-out (TRIZ)

Table 1. RePro categories.

In order to support the application of the RePro principles, we developed an application procedure based on the nominal group technique (Van de Ven and Delbecq, 1974) and the multi-level design approach (Patrício, Fisk and Cunha, 2011). As shown in Figure 1, the RePro application procedure contains five steps:

1. Introduction and explanation of procedure: The facilitator explains to the participants the objective and procedure of the meeting(s).
2. Individual idea generation: Each participant individually generates process improvement ideas based on RePro principles and an analysis of the as-is process.
3. Sharing ideas: The facilitator invites the participants to share their process improvement ideas, and records each idea.
4. Discussing ideas: The facilitator encourages participants to seek verbal or further details about any ideas of other participants that are not clear to them.
5. Voting and ranking ideas: The participants prioritize the ideas by voting and ranking the ideas.

During the second step of the application procedure, the RePro principles are explicitly considered by each participant while following the multi-level design approach as outlined in the lower part of Figure 1.

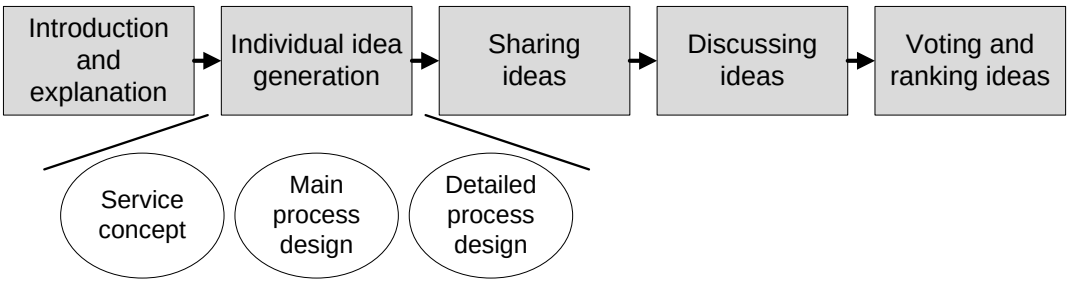

Figure 1. RePro application procedure.

This multi-level design approach implies that all RePro categories and related principles are assigned to three levels that can be considered successively:

1. Service concept: Includes principles that are related to the service concept, i.e. the positioning of the process in relation to its customers and third parties. The principles of the "customers" and "external environment" category are assigned to this level.
2. Main process design: Includes principles that are related to the tasks that have to be executed in order to fulfill customer needs. The principles of the "tasks" category are assigned to this level.
3. Detailed process design: Includes principles that are related to the details of task execution, i.e. the "when, who, with what, where" aspects of task execution. Principles belonging to the "task order and timing", "human resources", "facilities, equipment and material", "information", "ICT", and "physical lay-out" category are considered at this level.

More detailed information about the design choices and exact procedure can be found in Vanwersch, Pufahl, Vanderfeesten et al. (2014).

4. RELATED WORK

Besides the RePro technique, several other alternatives are available for traditional creativity techniques (Vanwersch, Shahzad, Vanhaecht et al., 2011; Vanwersch, Shahzad, Vanderfeesten et al., 2013). In particular, two other groups of techniques are available that, in contrast to traditional creativity techniques, offer guidance regarding the kind of process alternatives that need to be considered: *repository-based* and *case-based* techniques.

A *repository-based* technique assumes the existence of a repository that includes specifications of numerous existing processes (e.g. Malone, Crowston, Lee et al., 1999; Bernstein, Klein and Malone, 1999; Klein and Petti, 2006; Margherita, Klein and Elia, 2007). As a first step, practitioners are asked to determine the core activities of the process under study. Subsequently, they are able to explore the process variants available in the repository in a systematic way. As a final step, practitioners select the most suitable process design.

A *case-based technique* makes use of a library of well-documented previous business process redesign projects, i.e. BPR cases (e.g. Limam Mansar, Marir and Reijers, 2003). This technique enables an efficient identification of relevant earlier BPR cases based on a description of several characteristics of the ongoing BPR case. These earlier BPR cases offer process improvement proposals that can be worthwhile to consider for the process under study.

When comparing the RePro principles with concrete variants offered by the repository-based technique and concrete process improvement proposals provided by the case-based technique, it can be concluded that the RePro technique offers more abstract redesign guidance. Although this might

be considered a weakness, the higher level of abstraction is likely to enable practitioners to generate more diverse and more original process solutions. In addition, the RePro technique does not require the availability and maintenance of a database with either process descriptions or descriptions of process improvement projects. Based on the reasoning above, we expect the RePro technique to have the most potential to replace traditional creativity techniques.

5. RESEARCH METHODOLOGY

To evaluate the application potential of the RePro technique, two complementary research methods were used: a cross-case survey and an applicability check. For both methods we employed a detailed research protocol, which is available as an online report[1]. Both protocols are briefly summarized below.

5.1 Cross-case survey

By analyzing existing case studies as part of a cross-case survey, an abundant source of rich field-based information is used while conserving many resources that would have been needed to conduct multiple, original case studies (Larsson, 1993; Lewis, 1998). The main objective of this cross-case survey is to investigate the suitability of the different groups of RePro principles and identify potential enhancements. None of the case studies considered for this purpose explicitly considered a set of principles to generate process improvement proposals. However, the process improvement proposals described in these case studies allowed us to determine retrospectively which RePro principles were considered. In other words, we were able to investigate the implicit usage of these principles.

A systematic search and selection procedure was independently executed by two reviewers to identify case studies that included detailed descriptions of process improvement proposals. We decided to focus on case studies that aimed at improving perioperative processes, which consist of steps that are performed just before, during and after surgery. Besides the fact that these high-volume and high-cost processes are often the object of redesign in healthcare, perioperative processes are also characterized by many synchronization challenges, intensive patient involvement throughout the process, and a large amount of safety requirements (Cardoen, Demeulemeester and Beliën, 2010). As such, perioperative processes seem a suitable basis for investigating the set of RePro principles and identifying missing principles.

After identification of the set of case studies, two reviewers extracted independently process improvement proposals from these studies. After reaching consensus on data extraction, the reviewers coded the process improvement proposals independently. More precisely, each reviewer assigned to each proposal one or more RePro principles that were implicitly applied to generate the improvement proposal. For example, the *feedback* and *integral technology* principle were assigned to the extracted improvement proposal “implement an OR dashboard tool for continuous performance measurement and efficiency monitoring” (Schubnell, Meuer and Bengtson, 2008). In case no clear assignment to an existing RePro principle was possible, a new principle was considered to be formed and assigned to the improvement proposal. Data extraction as well as coding discrepancies were discussed by the two reviewers and resolved by consensus.

[1] Cross-case survey: https://robvanwersch.files.wordpress.com/2014/11/research-protocol-ccs1.pdf; Applicability check: https://robvanwersch.files.wordpress.com/2014/11/research-protocol-applicability-check1.pdf

More detailed information about the search and selection procedures (e.g. used search engines and search terms, and relevance and quality screen criteria) and data extraction, coding and synthesis can be found in the online cross-case survey protocol.

5.2 Applicability check

In order to gain more in-depth insights into the potential of explicitly applying the set of RePro principles and improve its application potential, we decided to conduct an applicability check. Rosemann and Vessey (2008) define applicability checks as "evaluations by practice of theories, models, frameworks, processes, technical artifacts, or other theoretically based IS artifacts that the academic community either uses or produces in its research". In our applicability check, the categorized set of RePro principles and related application procedure was the subject of investigation.

Exercise sessions and focus group discussion sessions with a pilot group and two different end-user groups of the technique were conducted: 7 external consultants and 7 nurses involved in improving care processes. These sessions made it possible to gain more in-depth insights into the suitability of the RePro principles and identify enhancement possibilities. In addition, we were able to discuss with potential end-users the procedure supporting the application of the RePro principles and identify improvement directions.

During the 2-hours exercise sessions, every individual participant was asked to rank the RePro principles regarding their understandability and their expected impact. This was done in order to ensure that participants were familiar with the set of RePro principles before examining issues in a face-to-face focus group discussion. Moreover, both ranking procedures included several follow-up questions (e.g. providing examples and reasoning for low and high ranked items), which provided input for the focus group discussion sessions. During the 1.5 hours follow-up focus group discussion sessions, we identified concrete possibilities to improve the suitability of the RePro principles and the associated application procedure.

More detailed information about the participants and the set-up of the exercise and focus group discussion sessions can be found in the online applicability check protocol.

6. RESULTS

In this section, the results of the cross-case survey and the applicability check are presented.

6.1 Results cross-case survey

For the investigation of the implicit usage of the RePro principles and the identification of new principles, 28 case studies including 134 (perioperative) process improvement proposals were selected. The coding of the 134 process improvement proposals in these case studies led to 168 assignments to implicitly used principles. 129 out of 134 (96%) process improvement proposals were linked to the implicit usage of at least one RePro principle (i.e. 99 one-principle assignments, 26 two-principles assignments and 4 three-principles assignments were the result of the coding procedure). The remaining 5 process improvement proposals were assigned to a newly identified principle. In the remainder of this section, we investigate the implicit usage of the different groups of RePro principles, and discuss the newly identified principle.

Implicit usage of RePro principles

Figure 2 displays the implicit usage of RePro principles. In this figure, we distinguish between the two groups of principles: the BPR best practices (*BPR*) and the principles that we added as part of the TRIZ-related integration procedure (*TRIZ*). Furthermore, we show the implicit usage of RePro principles per category.

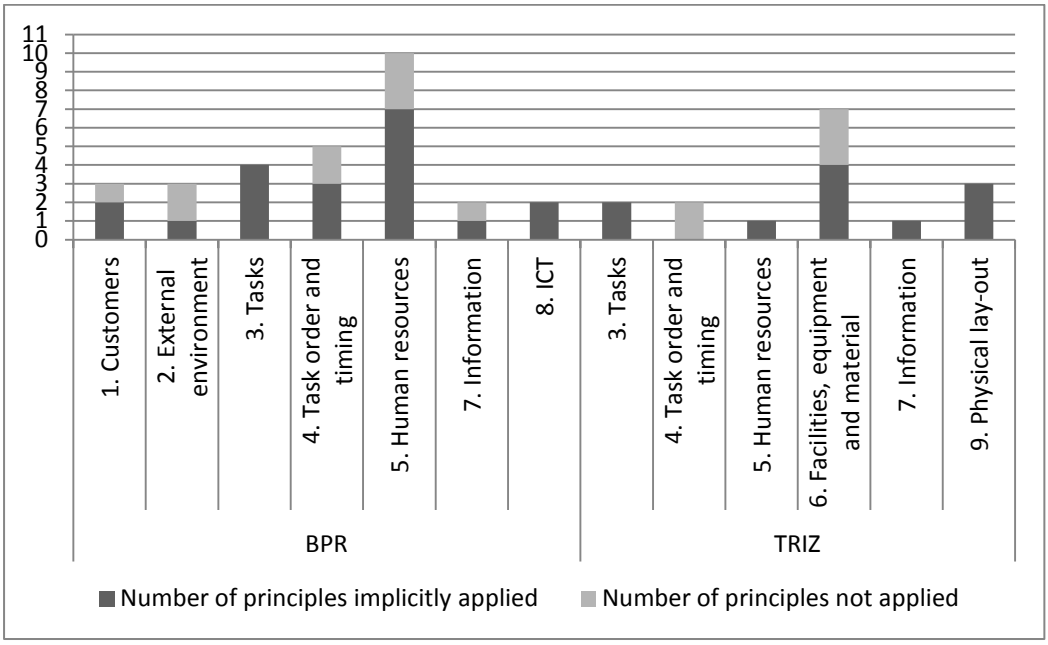

Figure 2. Implicit usage of RePro principles: number of RePro principles that are implicitly applied per group and category.

Figure 2 shows that the large majority of both groups of principles are implicitly applied in at least one case study. More specifically, the sample of case studies covers 20 out of 29 principles (69%) of the set of BPR best practices. Similarly, 11 out of 16 (69%) of the principles that we added as part of the TRIZ-related integration procedure are covered by the sample of case studies. The results per RePro category in Figure 2 also indicate that the two categories that we added as part of the TRIZ-related integration procedure, i.e. “facilities, equipment and material” (FEM) and “physical lay-out” (PL), are relevant enhancements. 4 out of 7 (57%) FEM principles and 3 out of 3 (100%) PL principles are applied in at least one case study.

Table 2 zooms in on the implicit usage of individual RePro principles, and displays the five most often applied principles. This table reveals that the TRIZ-related principle *prior action*, which belongs to the tasks category, is applied in the highest number of case studies. This principle states: “perform tasks, before they need to be executed, or add tasks to smooth the execution of remaining tasks in the process”. In total, 13 case studies applied this principle. An example of an implicit application of the *prior action* principle is completing nonsurgical tasks that are normally performed in the operation room earlier (Cima, Brown, Hebl et al., 2011). In this way, a more effective utilization of operation rooms is achieved.

Other TRIZ-related RePro principles with a high implicit usage are *specialist / generalist* (category facilities, equipment and material) and *reconstruction* (category physical lay-out). Together with the

BPR best practices *specialist / generalist* (category human resources) and *integral technology* (category ICT), these principles complete the "top 5".

Overall, the implicit usage results indicate that the two groups of principles provide complementary insights into how care processes can be improved. Furthermore, the results indicate that the total set of RePro principles provides almost complete coverage of frequently, yet implicitly applied principles and is parsimonious at the same time (i.e. the number of principles without any implicit applications is limited). These findings suggest that there is potential for an explicit consideration of RePro principles in process redesign projects in healthcare.

RePro principle *(BPR / TRIZ)*	**Definition principle**	**RePro category**	**Application example principle**	**No. of case studies applying principle**
1. Prior action *(TRIZ)*	Perform tasks, before they need to be executed, or add tasks to smooth the execution of remaining tasks in the process	Tasks	For subsequent surgical cases, nonsurgical tasks normally performed in the OR are completed concurrent with the ongoing case (Cima et al., 2011).	13
2. Specialist-generalist HR *(BPR)*	Consider to make human resources more specialized or more generalist	Human resources	The reception nurse is cross-trained to support nurses involved in transfers of patients during idle time (Barkoui et al,, 2005).	10
3. Specialist-generalist NHR *(TRIZ)*	Consider to replace non-human resources with more specialized or more general-purpose non-human resources	Facilities, equipment and material	Make use of a standard instrument setup for cardiac cases (Krasner et al., 1999).	10
4. Reconstruction *(TRIZ)*	Consider reconstructing the physical lay-out	Physical lay-out	Create a separate preparation room adjacent to the OR theatre for anaesthesia (Meredith et al., 2011).	9
5. Integral technology *(BPR)*	Try to elevate physical constraints in a business process by applying new technology	Information and Communication Technology	Provide physicians with online access to the surgery schedule (Schubnell et al., 2008).	8

Table 2. Five most often implicitly applied RePro principles.

Identification of new principles

As stated, only 5 out of 134 coded improvement proposals are not captured by one of the 45 RePro principles. These improvement proposals led to identification of one new principle:

Information provision (category "information"): This principle states that one should consider providing additional information to customers. Particularly, it is recommended to inform patients about diagnostic and treatment activities that are going to happen, as well as the reason for executing them. This principle aims to improve the quality of the process as perceived by customers. An example of

an application of this principle is giving patients access to a video that introduces them to the peri-operative experience (Heyrman, Hopkins, Stiene et al., 1995).

6.2 Results applicability check

The cross-case survey focused on the implicit usage of different groups of RePro principles. The applicability check was conducted in order to gain more in-depth insights into and improve the explicit application potential of the RePro technique. In this subsection, we present the results of this applicability check. With regard to the RePro principles, we outline several adjustments that enable an effective uptake of these principles in practice. Moreover, we discuss several improvement directions for the RePro application procedure.

Adjustments with regard to RePro principles

The exercise sessions and follow-up focus group discussion sessions made clear that none of the principles is considered to be irrelevant or without value. However, some fine-tuning regarding the description of several RePro principles seemed desirable to enable an effective uptake in process redesign projects in healthcare. Small textual adjustments were made with regard to ten RePro principles (six BPR best practices and four TRIZ-related principles). For example, we changed the name and definition of the *centralization* principle (treat geographically dispersed human resources as if they are centralized) into *geographic centralization* (arrange technological support to enable effective collaboration of geographically dispersed human resources). This adjustment was made to prevent confusion with the frequently applied centralization that aims at keeping all decision-making powers within the head office or the centre of the organization.

Besides ten textual adjustments, we also introduced two changes that were related to the content of the principles:

Substitution (categories “human resources” and “facilities, equipment and material”): The original definitions of the TRIZ-related *substitution* principles state that one should consider replacing expensive (non-) human resources with less expensive ones. The premise of these principles is that resources are often over-qualified or over-equipped for the tasks to be executed. Consequently, cost savings are possible by hiring / procuring less expensive resources that are less qualified or less equipped. During the focus group discussion sessions, we concluded that an exclusive focus on substituting expensive resources by less expensive ones can result in a situation of being “penny wise, pound foolish”. Moreover, the opposite variant of the substitution principle is worthwhile to consider in many situations. The extra labor costs of more qualified employees might be easily recouped by faster task execution or less rework. Furthermore, recruiting more qualified employees might lead to additional efficiency gains (e.g. set-up time reductions) due to increasing possibilities for combining small tasks into larger composite tasks that are executed by the same, more qualified employee. Based on this reasoning, the *substitution (HR)* principle was changed into “consider replacing expensive human resources with less expensive ones when human resources are over-qualified for tasks to be executed; consider replacing inexpensive and poorly-performing human resources with more expensive and more qualified ones in order to improve process performance”. Similarly, the *substitution (NHR)* principle was changed into “consider replacing expensive non-human resources with less expensive ones when non-human resources are more than capable to perform the tasks to be executed; consider replacing inexpensive and poorly-performing non-human resources with more expensive and more capable ones in order to improve process performance”.

Interfacing (category “external environment”): The original definition of the BPR best practice *interfacing* states: consider a standardized interface with customers and partners. The idea behind this principle is that a standardized interface with customers and partners will diminish the probability of mistakes, incomplete applications and unintelligible communications. Consequently, a standardized interface may result in fewer errors, faster processing and less rework. During the focus group discussion sessions, we agreed that these advantages do not only apply to information transfers with customers and partners, but also to internal information transfers between employees. Consequently, we decided to change the definition of this principle into: consider a standardized interface for information transfers. This change was complemented with moving the principle from the “external environment” to the “information” category and rephrasing the explanation of the principle.
Beyond these adjustments, the group of nurses and the group of external consultants agreed that the set of RePro principles provides adequate coverage of frequently, yet implicitly applied principles in healthcare.

Evaluation of RePro application procedure

Next to the set of RePro principles, the RePro application procedure was evaluated during the focus group discussion sessions with nurses and external consultants. In all groups, the participants reached consensus about the positive influence of using the multi-level design approach to facilitate the explicit consideration of RePro principles. One of the external consultants stated the key advantage of the multi-level design approach as follows: “Splitting up the principles in different levels is certainly valuable. In this way, manageable subsets of principles are created”. Similarly, one of the nurses noted: “It seems to be a lot of work for an individual to go through to all the principles. Splitting up the principles in different chunks makes application feasible.” Also, both groups reached consensus about the appropriateness of following the different steps of the nominal group technique. Three external consultants highlighted the similarities with the approach they were using for rethinking processes: “It resembles the standard workshop approach we are using”. In line with this observation, one of the nurses noted: “In fact, it is a more formalized and systematic version of the brainstorming approach we are typically using to generate improvement ideas.”

In addition to these remarks, which confirm the potential of the RePro technique, the group of external consultants argued that it is worthwhile to consider several variants on the standard nominal group technique:

Variant 1: Instead of inviting individual participants, install teams of two persons to generate process improvement ideas. According to the consultants, this variant offers more possibilities for social interaction and might have a positive influence on task motivation.

Variant 2: Split the level “detailed process redesign” (see Figure 1) into two or more chunks of related categories, which can be considered by different groups of individuals. This variant separates concerns even more and might prevent individuals from being overwhelmed by a wide variety of process improvement principles.

7. IMPLICATIONS

Our study reveals that *BPR best practices* and *TRIZ innovation* principles provide complementary insights into how care processes can be improved. As such, process improvement initiatives in the healthcare domain are able to profit from insights from the administrative domain as well as the product innovation domain. This observation underlines the value of cross-domain research, and

encourages advocates of a single management philosophy (e.g. Business Process Re-engineering adepts) to broaden their field of interest to related philosophies.

Our study also indicates that the RePro technique provides comprehensive, parsimonious, and well-structured support for rethinking care processes. Based on this finding, we contend that the RePro technique is a suitable alternative for traditional creativity (e.g. brainstorming), case-based, and repository-based techniques. In this way, our work informs research into the efficiency and effectiveness of process redesign techniques (e.g. Kettinger, Teng and Guha, 1997; Griesberger, Leist and Zellner, 2011; Vanwersch, Shahzad, Vanderfeesten et al., 2013).

As a closure of this section, we discuss two limitations of our study, which offer directions for further research. Firstly, the cross-case survey includes only improvement initiatives targeting perioperative processes. Also, the nurses who participated in the applicability check are mainly involved in executing activities that are part of these processes. Although perioperative processes are, given their characteristics, a suitable basis for evaluating the RePro technique, we invite other researchers to evaluate the technique by means of investigating other types of care processes, e.g. diagnostic pathways in an outpatient setting. In this way, adequate support for improving different kinds of care processes can be further established.

Secondly, more research is needed to investigate the benefits of (different application procedure variants of) the RePro technique. Our premise is that an explicit consideration of RePro principles leads to a higher amount and diversity of ideas generated, and outperforms traditional creativity techniques. Moreover, we expect that the RePro technique outperforms the repository-based and case-based techniques in terms of the diversity and originality of the ideas generated. These premises are open to be challenged, for instance using an experimental research design.

8. CONCLUSION

In this paper, we evaluated the the RePro (Rethinking of Processes) technique by means of a cross case survey and an applicability check with potential end-users of the technique. The backbone of the RePro technique is a set of process improvement principles that has its roots in two groups of principles: *Business Process Redesign (BPR) best practices*, which primarily support redesigning administrative processes, and *TRIZ innovation principles*, which in their original form provide support for innovating products. The evaluations reveal that the two groups of principles provide complementary insights into how care processes can be improved. Furthermore, the evaluation results indicate that the RePro technique provides comprehensive, parsimonious and well-structured support for rethinking care processes. Hence, we contend that the RePro technique is a suitable alternative for traditional creativity (e.g. brainstorming), case-based, and repository-based techniques. Further research will be needed to fine-tune the RePro technique, and investigate and compare the performance of different application procedure variants of the technique.

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* = Studies cross-case survey

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APPENDIX 1

* = TRIZ-related principle

Level 1: Service concept

Category: Customers
1. Control relocation: *'Move controls towards the customer'*
2. Contact reduction: *'Reduce the number of contacts with customers and third parties'*
3. Integration: *'Consider the integration with a process of the customer or a supplier'*

Category: External environment
4. Trusted party: *'Instead of determining information oneself, use results of a trusted party'*
5. Outsourcing: *'Consider outsourcing a process in whole or parts of it'*
6. Interfacing: *'Consider a standardized interface with customers and partners'*

Level 2: Main process design

Category: Tasks
7. Order types: *'Determine whether tasks are related to the same type of order (patient group) and, if necessary, distinguish new processes'*
8. Task elimination: *'Eliminate unnecessary tasks from the process'*
9. Prior counteraction*: *'Add tasks to prevent happening of an undesirable situation or to reduce its impact'*
10. Prior action*: *'Perform tasks, before they need to be executed, or add tasks to smooth the execution of remaining tasks in the process'*
11. Triage: *'Consider the division of a general task into two or more alternative tasks'* or *'consider the integration of two or more alternative tasks into one general task'*
12. Task composition: *'Combine small tasks into composite tasks and divide large tasks into workable smaller tasks'*

Level 3: Detailed process design

Category: Task order and timing
13. Order-based work: *'Consider removing batch-processing and periodic activities from the process'*
14. Periodic action*: *'Consider making an action periodic or changing the periodicity of an already recurrent action'*
15. Shortcut*: *'Introduce process shortcut possibilities'*
16. Resequencing: *'Move tasks to more appropriate places'*
17. Knock-out: *'Order knock-outs in an increasing order of effort and in a decreasing order of termination probability'*
18. Parallelism: *'Consider whether tasks may be executed in parallel'*
19. Exception handling: *'Design processes for typical orders (patients) and isolate exceptional orders (patients) from normal flow'*

Category: Human resources
20. Order assignment: *'Let workers perform as many steps as possible for single orders (patients)'*
21. Customer teams: *'Consider assigning teams out of different departmental workers that will take care of the complete handling of specific sorts of orders (patients)'*

22. Case manager: *'Appoint one person as responsible for handling of an order (patient), the case manager'*
23. Flexible assignment (HR): *'Assign human resources in such a way that maximal flexibility is preserved for the near future'*
24. Centralization: *'Treat geographically dispersed human resources as if they are centralized'*
25. Split responsibilities: *'Avoid assignment of task responsibilities to people from different functional units'*
26. Numerical involvement: *'Minimize the number of departments, groups and persons involved in the process'*
27. Resource adjustment (HR): *'Consider changing the number of human resources'*
28. Specialist / generalist (HR): *'Consider to make human resources more specialized or more generalist'*
29. Empower: *'Give workers most of the decision-making authority and reduce middle management'*
30. Substitution (HR)*: *'Replace expensive human resources with less expensive ones'*

Category: Facilities, equipment and material
31. Flexible assignment (NHR)*: *'Assign non-human resources in such a way that maximal flexibility is preserved for the near future'*
32. Buffering (NHR)*: *'Consider to buffer equipment and material'*
33. Resource adjustment (NHR)*: *'Consider changing the number of non-human resources'*
34. Specialist / generalist (NHR)*: *'Consider to replace non-human resources with more specialized or more general-purpose non-human resources'*
35. Substitution (NHR)*: *'Replace expensive non-human resources with less expensive ones'*
36. Copying*: *'Consider to use inexpensive copies of non-human resources instead of expensive original ones'*
37. Sustainable use*: *'Consider to make use of material with reusable, dissolving or evaporating characteristics'*

Category: Information
38. Control addition: *'Check the completeness and correctness of incoming materials and check the output before it is send to customers'*
39. Buffering (I): *'Instead of requesting information from an external source, buffer it by subscribing to updates'*
40. Feedback*: '*Consider introducing feedback'*

Category: Information and communication technology
41. Task automation: *'Consider automating tasks'*
42. Integral technology: *'Try to elevate physical constraints in a process by applying new technology'*

Category: Physical lay-out
43. Reconstruction*: *'Consider reconstructing the physical lay-out'*
44. Flexible lay-out*: *'Make the physical lay-out flexible'*
45. Physical shortcut*: *'Introduce physical shortcut possibilities'*

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