Towards Business Process Digitalization in SMEs: A Case of a Small Optical Retail Business

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Abstract: As small-medium enterprises (SMEs) produce significant amounts of added value in the market, it is important to ensure that their business processes are optimized. Business Process Management (BPM) is a popular methodology in large enterprises; however, there is a clear lack of explicit information on how it can be adapted by SMEs considering their financial and informational constraints as well as other specific factors. In this research, we concentrated on one of the aspects of BPM, which is a business process improvement, within the scope of a small optical retail business's order management process. Process improvement is crucial when moving towards business process digitalization by the means of business process management systems (BPMSs) or any other IT technology for that matter. In this paper we presented basic aspects of our developed process improvement approach, which contributes to the better understanding of the specificity of process reengineering task in SMEs and could be used as practical means to prepare for process digitalization using BPMS in a more effective manner. The paper also presents process model simulation-based evaluation of a number of qualitative process analysis methods within the scope of a small optical retail business case, which was one of the founding stones of our approach. The acquired process model with the best execution metrics was then used as a base executable model for the developed business order management system in our target business enterprise.

Keywords: Business Process Digitalization, Business Process Analysis and Optimization, Business Process Management System, BPMN, BPM.

1 Introduction

Almost half of added value in European Union is generated by small-medium sized enterprises (SMEs). These are companies that have up to 250 employees or turnover lover than 50 million € or balance sheet total of 43 million € [1]. SMEs make up over 99% of all European Union companies that are not in financial sector [2]. Despite these huge numbers, such companies are working in an environment of limited resources, information and experience in terms of developing and applying information technologies, optimizing and automating its business processes. Because of these reasons various applications of information systems in this type of businesses involve short-term, of-the-shelf or hard coded solutions [3] that are sometimes adopted just to comply with environmental regulations [4]. Though only through documented, efficient and effective process delivery a long-term success, business competitiveness, growth and viability can be achieved [5]. One of the most common ways of improving business processes running in one or across many enterprises is by implementing a Business Process Management (BPM) methodology.

BPM is a widely spread methodology, which concentrates on business processes and aims to improve their quality, efficiency, compliance, customer integration, employee engagement and agility [5], [6]. Arguably, the ultimate goal of BPM is a digitalized enterprise running on optimal business processes throughout its whole life cycle. Even though traditionally most of the successful BPM initiatives are associated with very large organizations, it has no restrictions on being implemented within the working environment of SMEs whatsoever. Application of such technologies has the potential of increasing market capture, cost effectiveness and profitability [7].

However, considering the financial and informational environment in which SMEs are operating, the effectiveness of BPM methodology is unpredictable, and the results might be even detrimental in case of straightforward application of BPM in a small-medium sized organization. In order to get positive outcome of BPM initiative in SME, every step of BPM lifecycle should be analyzed and evaluated in the context of such business.

The main task of this research is to evaluate different types of qualitative process evaluation and optimization techniques applied to small optical retail business order management process with an intention of process digitalization using a selected BPMS.

2 Basic Definitions and Related Work

2.1 Definition of Business Process Management

Business Process Management does not have one specific definition. Generally, it is a methodology, which aims at improving organization performance by concentrating on business processes. In its essence, BPM combines business management, quality control and information technologies paradigms [8].

BPM initiatives are carried out by following a predefined set of stages – a BPM lifecycle. At first, a business problem is defined and a target process is selected. Then the current state of the business process (As-Is) is documented (usually in a form of process model). When a process model is present, carefully selected qualitative and quantitative analysis techniques are carried out so that any improvement could be measured. Then the process is redesigned according to the initially identified issues and objectives, and then a new process model (To-Be) is designed. This process model serves a basis for the next stage – process implementation. When changes are implemented, the process is moved to the new state so that performance goals could be achieved. Once changes are completed, process execution data is collected and analyzed, new goals are defined and respective actions are taken [9].

As we can see, the business process management initiative is iterative and supports continuous change and improvement to organization and its supporting information systems.

2.2 Quality of Business Process

Quality is one of the most important objectives throughout the whole BPM lifecycle. In this case, we are not talking about the results of the process – physical properties of deliverables such as products or services – but rather the execution properties of the process (although properties of the delivered services are closely connected to the quality of the process). Quality models are assumed as easily understandable and changeable models with little to no design errors. A modeled process reveals only activities and decisions, but no information can be retrieved directly about its quality metrics [10]. For this reason, there are numerous qualitative and quantitative process analysis techniques, which help to find various process-related issues, such as bottlenecks of the process, sources of arising problems, compare different process models and come up with an optimized process model. Nonetheless, there is very little information about application of these techniques in the scope of small-medium sized businesses – and that is of critical importance considering the limited resources of such organizations.

Process Model Optimization Techniques. As mentioned before, there is a wide variety of business process model evaluation techniques. In this section, we will briefly describe some of those techniques, which we believe could be used in small-medium sized companies. Most of these techniques are derived from Six Sigma methodology [11].

Value-Added Analysis [12]. The main goal of such analysis is to remove non-value adding tasks from the process model. The process is decomposed to the simplest tasks requiring one action of one process participant. Then those tasks are assigned to one of the three categories:

- Value-adding – a task that contributes to the final product or service,
- Business value-adding – a task that is necessary for business to run,
- Non-Value adding – all the remaining tasks.

By removing the non-value adding tasks one should be utilizing resources in a more efficient way.

Root Cause Analysis. This type of analysis is mostly conducted in manufacturing companies to find out the reason behind various incidents or defects [13]. This method might also be adapted for thorough problem identification and analysis in business process model with intention to optimize it [14]. The first step of such analysis is defining perspectives, in which the identified problems will be explored. Here, the 6M model (machine, method, material, man, measurement, milieu), some perspectives from Six Sigma methodology [15] or any other model may be applied. Then, each identified problem is analyzed in every perspective while searching for the root cause. If the process scope is relatively small, does not expand wide within the organization or the underlying problems are not broad, a different approach, e.g. “5 Whys” [16] might be more effective. The “5 Whys” approach returns more detailed analysis instead of a broader picture. In general, the root-cause analysis does not require a full process model, but the results of that analysis could help in process redesign.

Impact assessment and issue documentation. This is a kind of analysis that typically follows up the root cause analysis [9]. As mentioned before, the root cause-analysis defines problems and their cause. However, it does not point out their impact to the whole process, so there is no formal way to prioritize them. Some suggest to create issue register, in which each problem would have an impact assessment (qualitative or quantitative), such as impact on time, finances or any other metric. If metrics are defined, one can conduct a Pareto analysis. In practice, Pareto analysis makes an assumption that 20% of problems make 80% of impact [17]. Of course, if there are only few problems stated in the issue register, this kind of analysis is unnecessary.

All of the mentioned qualitative analysis techniques help to identify existing problems and redesign process models. However, these techniques do not specify any information on how process model redesign should be evaluated, or process models compared. Therefore, the next sub-sequential step in process model evaluation is conducting a quantitative analysis.

Quantitative Analysis techniques may be divided in three different categories: analysis of process model metrics derived from software engineering, theoretical process execution analysis, and process simulation.

Software quality quantitative metrics can be applied in business process model evaluation due to the similarities between processes and software – they both process data, they have structure, and, finally, they both are based on a static model [10], [18]. Calculating metrics such as model coupling, cohesion, complexity, modularity or size could give good indications about the quality of a process model. Process model metrics are valuable for process analysts, but process stakeholders are usually interested in execution metrics such as execution price, duration, quality of results and model flexibility. All these parameters can be calculated by performing Flow analysis or applying Queuing theory [9]. However, even though these techniques may give valuable data, they are hardly applicable in real world process models. Flow analysis can be conducted only when process models are of the low level of complexity, and hold only exclusive or parallel gateways, while Queuing theory can only provide data for one activity. Also, Queuing theory calculations are become highly complicated even for the simple cases. We argue that the most practical solution for the qualitative analysis of a process model is process model simulation. The process model simulation can be done by using various tools such as IBM WebSphere Business Modeler [19], ITP Commerce Process Modeler for Visio [20], ProSim [21] or an open source BIMP simulator [22]. Process simulation software instantiates huge amount of hypothetic process instances and records properties of each execution. Only process execution data, such as probabilities of various decisions and duration of activities are required as input parameters. This kind of qualitative analysis allows process analysts to compare different process models in different execution environments.

2.2 Process Improvement as Part of BPM Initiative in Small Medium Sized Companies

Some sources state that 60% - 80% of BPM initiatives fail [23]. In the case of SMEs, the success rate of any BPM initiative is influenced by a number of factors, such as variability of available resources, process relation, work ethics, speed of decision making [24]. Therefore, cases of the application of BPM in SMEs must be investigated separately.

The main issue here is that there are very few case studies conducted on the application of BPM as means to process digitalization in SMEs. One case study was conducted in three different SMEs in Belgium by C. Bauwens and T. Van Dorpe [24]. They argued that the BPM maturity level of every SME must be assessed to understand where the organization is with its BPM development. Hammer’s Process and Enterprise Maturity Model [25] and McCormack’s Business Process Orientation Maturity Model [26] were used to access the SMEs. Authors concluded that SMEs were on relatively low BPM maturity levels. Also, they pointed out some weak spots of the small businesses, such as lack of documentation and limited inner efforts to process improvements. However, no explicit details on how to improve the analyzed process models, nor even where to start with this whole initiative was provided.

Another case study was conducted within Australian Small Business by I. Dallas and M. T. Wynn [5]. They went through the whole BPM life cycle and provided implications on what could be improved in the BPM methodology, and also, certain observations which could help other SMEs in their BPM adoption initiatives. However, the process evaluation and optimization stages received very little attention in that research as the analyzed business was under establishment at that time. Only some advantages of business process management systems such as automatic work allocation were introduced highlighting them as benefits for SMEs.

The implementation of BPMS in small businesses was also widely discussed in the work of Veldhuizen R., Ravesteijn P., and Versendaal J. [27]. They distinguished the main differences between SMEs and large enterprises and suggested an adapted BPMS implementation model.

Service-oriented architecture and BPM can be combined to get an agile, scalable solution that fits small scope and budget of SME as stated by I. S. Bajwa et al. [7]. In such BPM-SOA partnership, many third-party services can be combined and managed using internal resources of SME. This paves solid ground for a flexible automation of dynamic business processes. In their work only an architecture of such system was presented, only pointing out the advantages it might provide. No specific information or guidelines, which would help SMEs in adopting these technologies were presented.

The lack of relevant information in scientific literature is also pointed out by N. Imanipour, T. Kambiz and S. Rezazadeh in their study of inhibiting factors for BPM application in SMEs [23]. They found out little to no generalized findings, nor potential differences between different analyzed industries. A systematic approach for BPM initiatives in SMEs is missing. The researchers also pointed out that knowing only benefits of BPM, without having knowledge of how to make process analysis and what to do with its findings, could only provide somewhat confirmation that a company was compliant with one or the other industry standard. Therefore, one of the major issues with the adoption of BPM in SMEs is low level of knowledge and lack of information about the practical BPM applications, process-oriented approaches, and effective process optimization techniques.

Case study on four Scottish SMEs had also highlighted other specificities of SMEs when it comes to adopting BPM, e.g. avoiding to use quantitative information gathered by formal procedures in decision making in traditional family businesses [28]; even though it is acknowledged that the performance measures are an important part of a successful growth for small businesses. One of the advantages of BPM systems is that they provide tools for the implementation and monitoring of performance metrics of an ongoing processes and, therefore, even service level agreements can be easily defined within a single SME or between the collaborating SMEs or other enterprises involved in the process. Such abilities enable SMEs to achieve higher goals of growth and business success.

Considering the overview of conducted scientific case studies in SMEs, one can argue that even though BPM is a process improvement methodology providing opportunities for a controlled and successful growth, there is little to no research on process model evaluation and optimization for SMEs. Various BPM application frameworks and inhibiting factors are presented with no specific procedural details on how to adopt BPM, optimize processes and automate them in the scope of SMEs.

3 Evaluation of Process Model Optimization Techniques

3.1 The Case Organization

The case organization of our research is an optical retail business having its optical shops located all across Lithuania and is in the market since 1997. It is defined as a small business as it fits the definition presented by the European Commission [29]. The ordering of prescription glasses in the target business is a quite complicated process. Moreover, the whole business is in the cycle of continuous evolution due to the dynamic market environment, constant introduction of new technologies and products, etc. For these reasons, rigid, hard-coded or off-the-shelf solutions are hardly suitable, inefficient or too expensive to be adopted by SMEs. The current order management process does not have a supporting information system in the company.

In the scope of this paper only the aspects of order management process analysis will be presented highlighting a roadmap of the practical business process improvement for process digitalization in the scope of SMEs. The analysis of order management process in the case organization will be conducted by applying methods described in Section 2.2 on the current (As-Is) business process model. Each of the methods applied will be evaluated using process model simulation. Changes of the average cycle time of the process as well as its total execution costs after applying each method will be compared.

3.2 Process Under Research

The process of prescription glasses' order management was divided into four sub-processes: Initiation, Manufacturing, Quality check and Finalization. Fig. 1 presents the first sub-process of the As-Is process of order management.

Overall, the business process contains 49 tasks, 21 gateways, and there are 10 participants of 3 different roles involved in the target business order management process. The sales assistant is responsible for creating, administrating, solving various problems related to the order management, checking final quality of the prescription glasses, finalizing the order and communicating with clients on all questions. Optical lab technician is responsible for managing the in-house manufacturing of prescription glasses, edging prescription lenses and fitting them to frames. Finally, a sales manager oversees the whole process, manages the exceptions, complaints, adjusts the process if needed. The sales manager is not directly involved in the steps of an order management process. The As-Is process was not documented in any form and was not conducted strictly across entire organization.

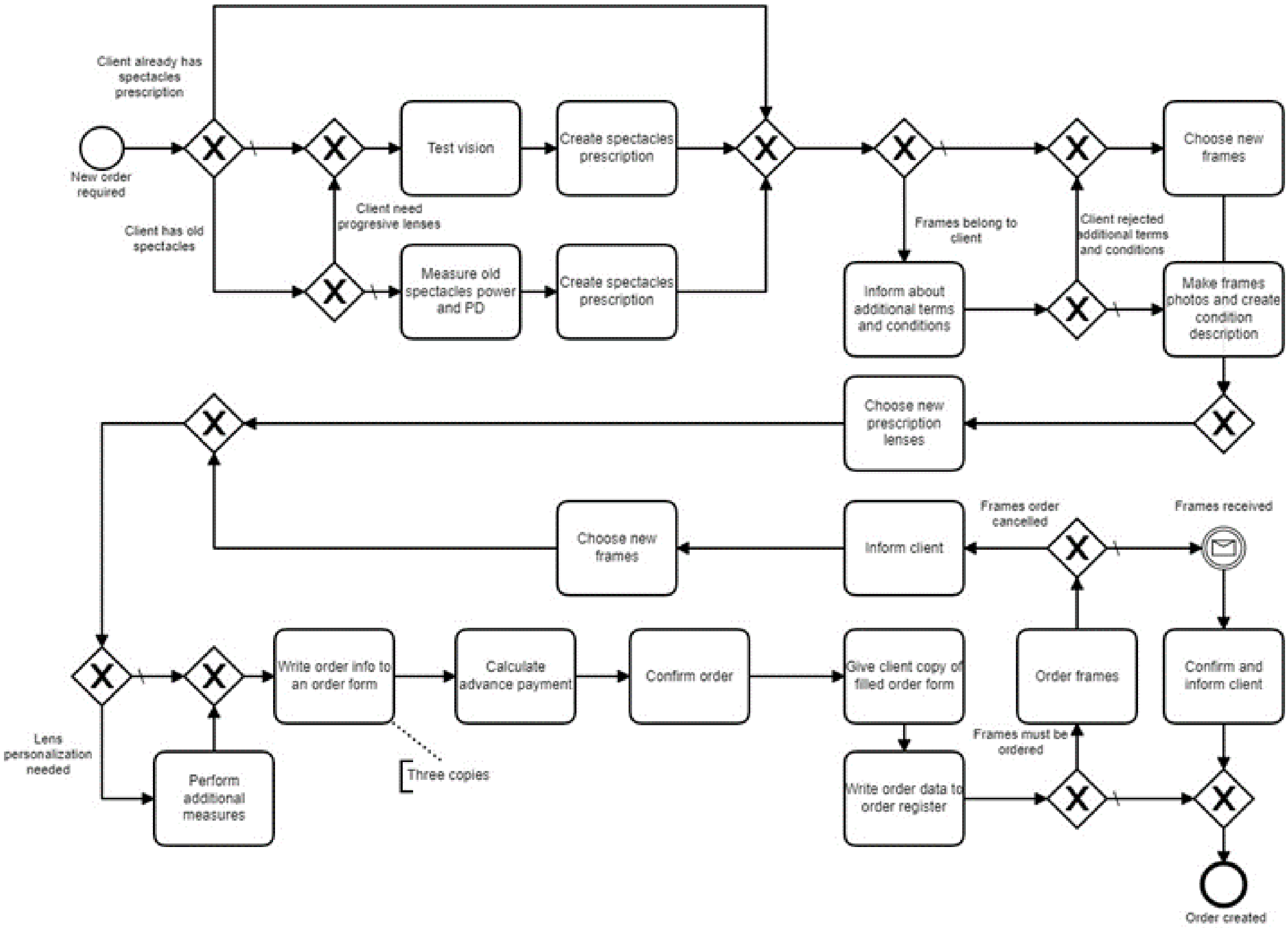

Fig. 1. Order initiation process

3.3 Process Improvement in the Case Business

In this research, the case organization's process of order management is optimized by applying techniques described in Section 2.2 (i.e., value added analysis, root cause analysis with "6M" and "5 Whys" models) separately, and then a combined analysis approach is proposed in Section 3.5. After each optimization technique is applied, the BPMN model of order management process is created with a Camunda BPMN/DMN Process Modeler [30], which is then simulated with an open source process model simulator BIMP [22] feeding sets of different input parameters to test the process execution costs, cycle times, and flexibility. Process flexibility is tested by decreasing time between the initializations of new process instances until the allocated process resources can no longer handle the tasks assigned to them, i.e. tasks start queueing up and the task waiting time increases rapidly. The quality of the process execution and its deliverables must be evaluated in real world testing environment.

Value Added Analysis. This type of analysis is closely related to the methodology of Lean [31]. By revising the order management process with the CEO of the optical retail business non-value adding tasks were removed; those tasks were mostly related to manual data entry and a non-unified process across the business. It was expected that after such analysis the process would become cheaper and faster to execute, but its quality and flexibility should suffer.

Root Cause Analysis. During this analysis in the target business, two different models for problem identification were used: "6M" and "5 Whys". The main difference was that the first model provided a wider view over the process, whereas, the second one – a deeper understanding of the problem cause. It was expected that a deeper understanding would be of more use in the scope of small processes of the SME, though the results of these two analysis techniques were the same. In terms of effect on process execution metrics, it was expected that the outcome of this analysis will present a process model with better flexibility, quality and execution time, though at a higher execution cost.

Combined Process Analysis Technique. After the results of the applied analysis techniques were analyzed, a combined business process analysis technique was proposed. It combines the tasks of a waste and unnecessary tasks removal from the process and solving current problems by introducing new technologies and task automation. Such approach to process analysis is expected to improve the analyzed process quality, execution time and flexibility by increasing its cost related to execution and investments required. Both root-cause technique and the combined analysis technique introduces a business process management system to support the reengineered process.

3.4 Evaluation of Process Optimization Techniques

After the process optimization techniques were applied, 12 process models were prepared for simulation. The process model simulation not only provided one with process execution results, but also generated insightful heat maps (Fig. 2) displaying process parts with the highest load, tasks waiting times and cost. Subsequently, this made it easier to identify bottlenecks within the analyzed process and also highlighted other potential process execution issues that were not known beforehand.

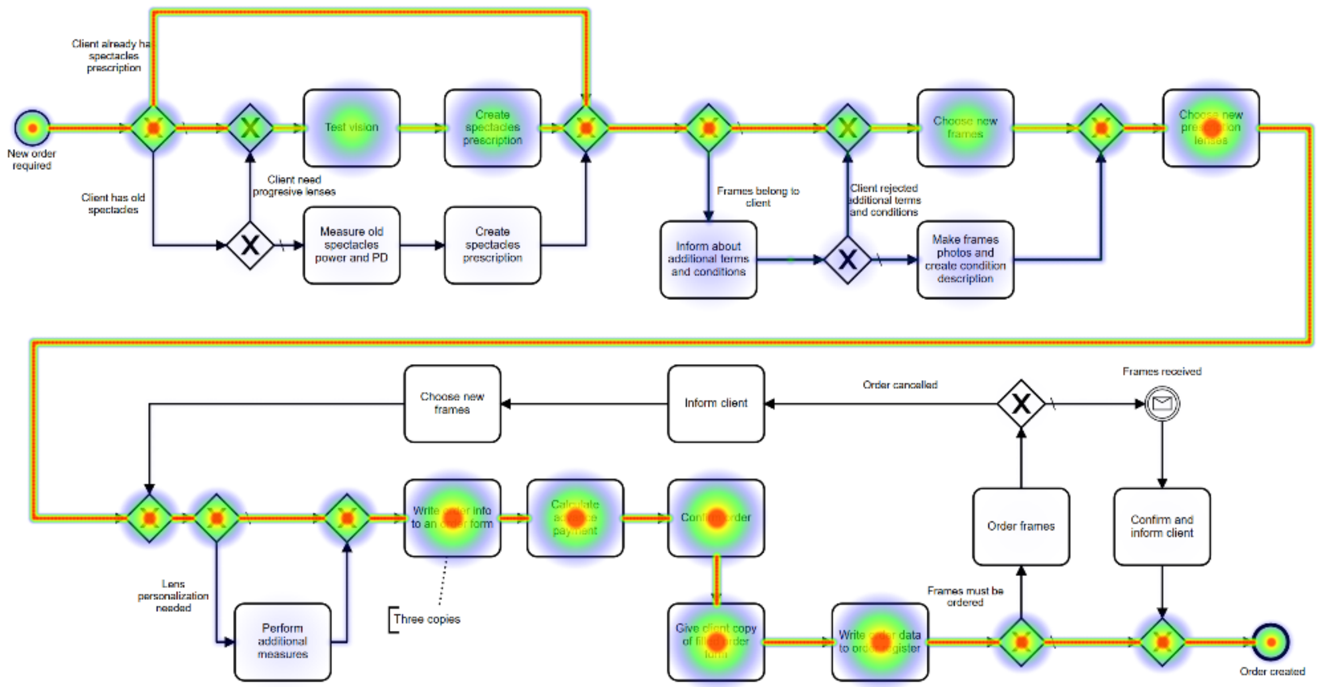

Fig. 2. Simulation heat map of the Order initiation process representing task execution counts

The performed value-added analysis provided expected results. This technique enabled on to cut the average process cycle time from 22.58% to 95.92% in different sub-processes throughout the whole analyzed business process. Also, considerably lower average tasks waiting times were achieved when the process was simulated under "bottleneck" conditions (from 2 up to 40 times) and the process execution costs were decreased by 41.71% on average.

The root-cause analysis with "6M" and "5 Ways" models provided two identical process models as a result. Even though the "6M" allowed one to identify additional issues in the process, those issues could not be directly related to the model of the analyzed business process itself and therefore had virtually no impact of the results of process simulation as well. Compared to the As-Is process model, the average cycle time dropped by avg. 93.52%, and the process execution costs were lowered by avg. 31.13%. The results of the root-cause analysis look better compared to the results of the value-added analysis; however, it must be pointed out that the costs of implementing the new process were not considered. Also, it was observed that the flexibility of the process improved – task waiting time was reduced by 93.52% at the "bottleneck" conditions.

Finally, the combined process analysis technique was conducted. It resulted in a process model with all the unnecessary tasks removed and most of the identified issues solved via the introduction of BPMS as means to the process improvement. The results of the applied approach were as follows: cycle time of the order management process was reduced by avg. 65.58%, execution costs reduced by avg. 48.67% and, similarly, the task waiting time on the increased process start rate was dropped by avg. 97.88%.

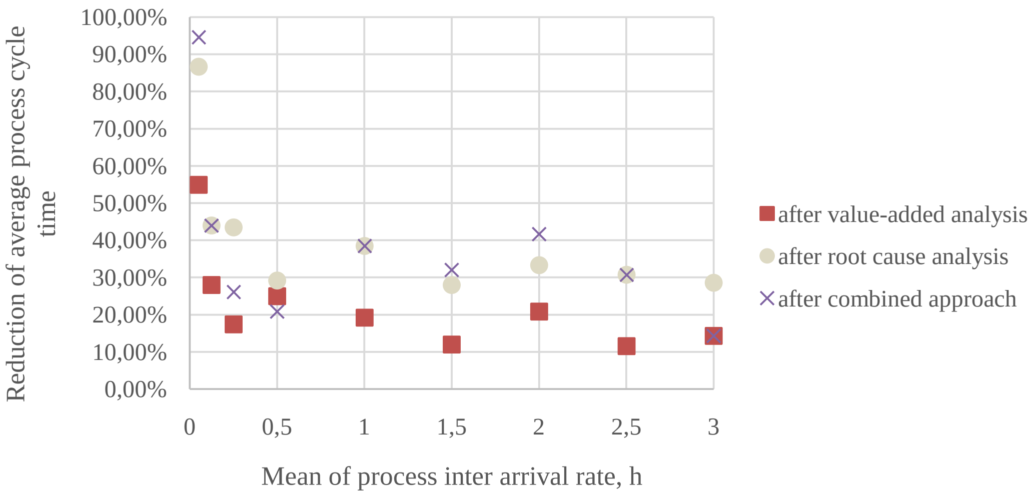

Fig. 3. Order initiation average cycle time reduction compared to an As-Is process after application of each optimization technique

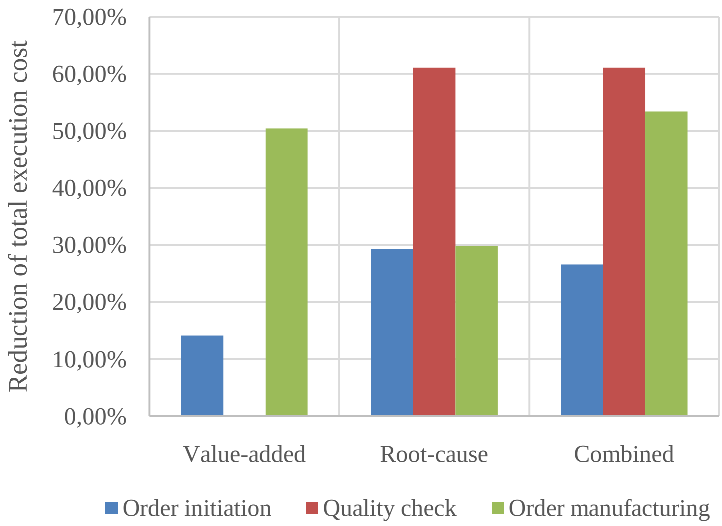

Fig. 4. Execution cost reduction of order management process parts after application of each optimization technique

Average cycle time reduction in order initiation process provided by different techniques is depicted in Fig. 3. One can see that the presented combined analysis technique shows the best results for this part of the process. Equivalent results can be seen in other parts of the order management process as well.

Execution cost reduction of the order management sub-processes after each analysis is shown in Fig. 4.

The presented combined process analysis technique (Section 3.5) shows the highest reductions of process execution costs in most cases, though one should keep in mind that this information represents only the execution costs, and the initial investments of the new process implementation are not considered here.

3.5 Basic Aspects of Process Improvement Approach for SMEs

As the suggested combined process improvement approach showed the best results, when not considering initial investments required, we provide a detailed description of this initiative. This approach is considered to overlap "Process Analysis" and "Process redesign" steps in a BPM lifecycle so we presume that previous steps of the initiative have already been completed and we have an As-Is process model as an input. This approach is derived from the best practices of BPM methodology, our conducted analysis of related work in a field of BPM application in SMEs, and also, deep understanding and long-term experience in the field of optical retail business. This approach is composed of the suggested process analysis technique complemented with the tasks that we argue are necessary for a successful process digitalization initiative introducing BPMS. It is very important to point out that the heavy involvement of the process stakeholders is a crucial success factor on the initiative of this kind. The basic workflow of the proposed approach is summarized in Fig. 5.

In the scope of this paper only the aspects of order management process analysis will be presented highlighting a roadmap of the practical business process improvement for process digitalization in the scope of SMEs.

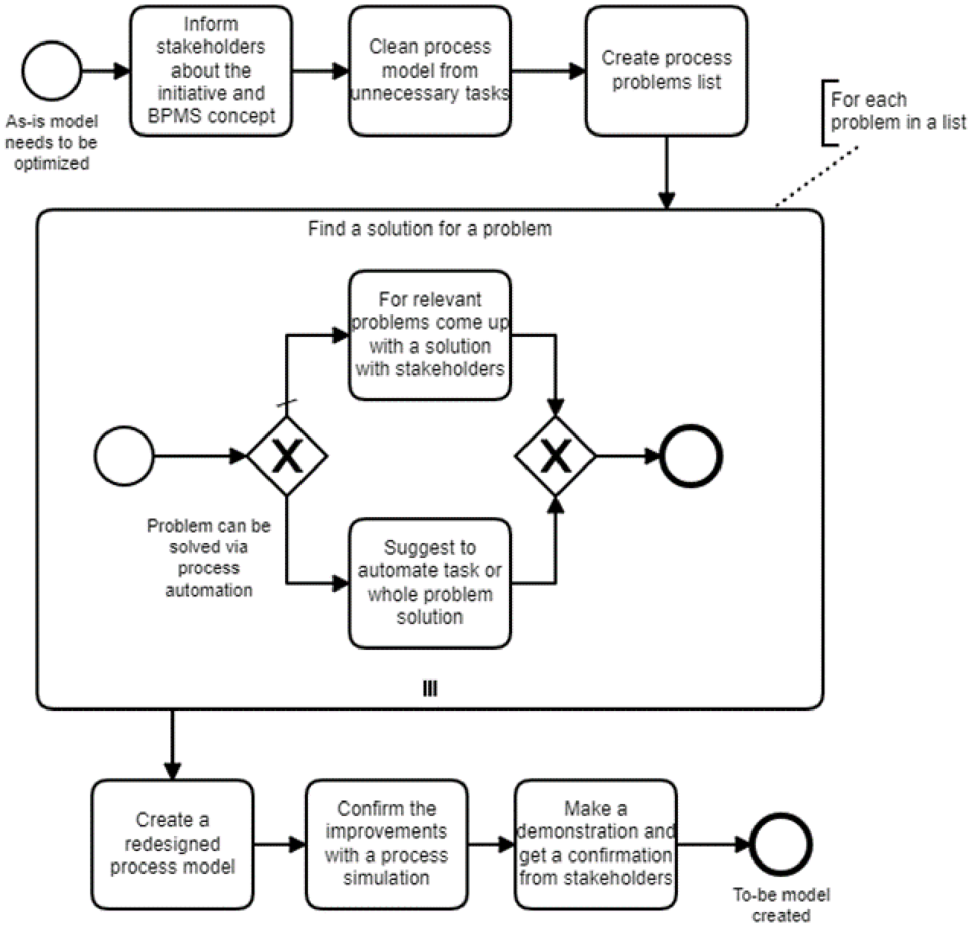

Fig. 5. Basic steps of the process improvement approach

As mentioned before, the input for this process improvement approach is an As-Is process model. This model is at first cleaned from excessive tasks, then its problems are identified, and then solutions for those problems are proposed. Finally, a redesigned process model is created and simulated. The steps of the suggested approach are summarized in Table 1.

Table 1. Steps of the process improvement approach

Step	Description
1. Inform stakeholders about the initiative and BPMS concept	All stakeholders should be informed about the upcoming process of improvement, including the main aspects of BPM accompanied by the main benefits and potential pitfalls of applying BPMS in SMEs. This is to be done as soon as possible so that all stakeholders are aware of the capabilities of such systems and make the next steps of the approach easier.
2. Clean process model from unnecessary tasks	During this step a process model should be cleaned from unnecessary tasks by performing a value-added analysis or other chosen technique.
3. Create process problems list	Next, a process problem list should be created. The problems can be listed as an issue register. To identify problems one can use a root-cause analysis or other appropriate technique.
4. Find a solution to a problem	Each problem should be analysed separately – whether it can be solved by implementing a BPMS, process model redesign or in any other way. It is highly advised that all problems in a problem list are revised. This step requires good cooperation among the stakeholders of the process and the process analyst, so that the information technologies introduced would be used in a most efficient manner.
5. Create a redesigned process model	A redesigned process model should be created with all the results of previous steps in mind.
6. Confirm the improvements with a process model simulation	A redesigned process model should be tested with a business process simulation so that the improvements are quantified.
7. Make a demonstration and get a confirmation from stakeholders	A final demonstration of the redesigned process model with all the benefits it brings must be made. Finally, the redesigned process model must be approved by the process stakeholders. After this step implementation of the new process model and information system can begin.

We argue that the suggested process improvement approach would make the application of BPM methodology easier for small-medium sized enterprises. It should help them to improve their processes with limited financial and informational resources in mind by implementing a BPMS system on an optimized process.

4 Conclusions and Future Research

The conducted process redesign case of a small-medium sized optical retail business showed that the process optimization techniques we experimented with provided certain improvement to the process in terms of process execution cost, cycle time and flexibility. Although, the quality of process deliverables and its execution was not determined via business process simulation. As described in Section 3.3, value-added analysis and other similar optimization techniques aimed at "cleaning" the process from unnecessary tasks require the least of initial investments and provides positive results in terms of process execution metrics. Though, we believe that in more complex business execution cases with critical involvement of IT, a deeper qualitative analysis should take place, such as, a root-cause analysis or the proposed combined approach – this would allow one to anticipate better results when creating or changing the technological and informational environment of the small business and its processes. Also, the improved flexibility of the optical retail business order management process case (e.g., great reduction in process task waiting times on “bottleneck” conditions) promises a more controlled, stable and successful growth of the small business. We believe that calculation of process model metrics could be integrated into business process modeling tools, thus making the evaluation of models faster and easier resulting in processes of higher quality.

The actual benefits of applying process optimization techniques and the adoption of BPMS itself in the case business remain under research as while the developed process-based order management system is being deployed and gets ready to be tested in the real working environment. The real world applicability of such system and the effect on the process quality in the scope of SME processes is yet to be defined and evaluated.

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