Improvement and digitalization of business processes in small-medium enterprises

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***Abstract* — As small-medium enterprises (SMEs) produce huge amounts of added value in the market, it is important to ensure that their business processes are optimized. Business Process Management (BPM) methodology is popular in large enterprises, however, there is lack of information on how it can be adapted by SMEs considering the financial and informational constraints they face. In this research, a set of qualitative and quantitative analysis methods for improving the quality of business process models are presented and applied to optimize the order management business process of a small Lithuanian optical retail business company. Further, a business process management system (BPMS) is presented to digitalize and support the execution of redesigned process. A brief discussion of applying process quality analysis methods within the selected business domain is presented. It is expected that our research will make BPM initiatives more feasible for businesses of similar type.**

***Keywords*— business process improvement, business process management, business process digitalization, business process management system, small-medium enterprise, BPMS, BPMN, BPM, quality management.**

I. Introduction

Small-medium enterprises are defined as companies with staff count of up to 250 employees or turnover lover than 50 million € or balance sheet total less than 43 million € by the European Commission. Such businesses produce vast majority of added value in the economics of European Union. As stated in the annual report on European SMEs 2017/2018, those kind of businesses accounted for 47% of the increase in the value added and 52% of the cumulative increase in employment in non-financial sector since the global financial crisis [1]. Most of the SMEs are working in the state of very limited resources, accessibility to information and experience in process management and automation. But these fields are of the highest importance when considering that the main goal of business is related to creating value through activity while utilizing resources in the most efficient way. Optimization and documentation of SMEs processes are important as efficient and effective process delivery is a key to a long-term success, business competitiveness, growth and viability [2],[3]. 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 [4], [2]. 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. However, considering the financial and informational environment in which SMEs are working, the effectiveness of this methodology might be unpredictable, and the results might be even detrimental in case of straightforward BPM application in a small-medium sized organization. In order to get positive outcome of BPM initiative in SME, every step in BPM lifecycle should be analyzed in the context of such business.

The main task of this research is to evaluate different types of qualitative process evaluation and optimization methods of small optical retail business order management process. Then test the redesigned processes by using business process simulation tool in order to get the best process optimization result. Such evaluation and example of process optimization might help to apply BPM methodology in SMEs process redesign phase easier for other businesses of the same type.

II. Basic definitions and related work

A. 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. BPM combines the business management, quality control and information technologies traditions. The origin and composition of BPM can be seen in Fig. 1.

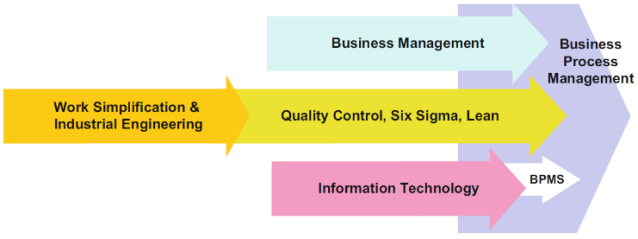


Fig. 1. Approaches of business process change [5]

BPM initiatives are carried out by following a predefined set of stages – a BPM lifecycle (Fig. 2). At first – a business problem is defined and a target process is selected. Then the current state of the process is documented (usually in a form of process model). When a process model is present qualitative and quantitative analysis are carried out so that any improvement could be measured. Then the process is redesigned according to the initially stated issues and a new

process model is created. This process model serves a basis for the next stage – process implementation. The changes are realized and the process is moved to the new state so that performance goals could be achieved. Usually management changes and process automation via development of information systems are implemented. Once changes are completed, process execution data is collected, analyzed, new problems or goals are defined and respective actions are taken.

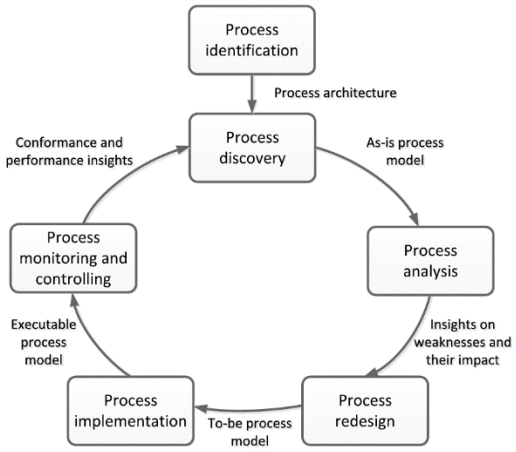


Fig. 2. BPM lifecycle [6]

B. *Quality of the process*

Quality is one of the most important parts through the whole BPM lifecycle. In this case we are talking not about the results of the process – quality of deliverables such as products or services – but about execution properties of the process. Quality models are defined 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 [12]. For this reason, there are numerous qualitative and quantitative process analysis methods which help to find bottlenecks of the process, sources of arising problems, compare different process models and come up with an optimized process model. But there is small amount of information about application of these methods in the scope of small-medium sized business.

C. *Process model optmization methods*

Qualitative process analysis mostly helps to identify redundant or weak parts of the process. In the next section we will summarize some methods of qualitative process analysis.

Value-Added Analysis – 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 one of three categories:

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

By removing the non-value adding tasks we 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]. Though this method might be adapted for thorough problem identification and analysis in business process model with an intention of optimizing it [14]. First step of such analysis is defining perspectives in which stated problems will be explored. 6M model (machine, method, material, man, measurement, milieu), some perspectives from Six Sigma methodology [15] or any other model might be applied. Then each stated problem is analyzed in every perspective while searching for the root cause. This type of analysis does not require a full process model, but the results of it might help redesign ongoing process.

Impact assessment and issue documentation is type of analysis that typically follows up root cause analysis. As mentioned before, root cause analysis defines problems and their cause. But it does not point out their impact to the whole process, so there is no formal way to prioritize them. One suggestion is 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 [6]. If metrics are defined, we can conduct Pareto analysis. In practice Pareto analysis makes an assumption that 20% of problems make 80% of impact [16]. Of course, if there are only few problems stated in the issue register, this type of analysis is unnecessary.

All mentioned types of qualitative analysis help process analytics to identify existing problems and redesign process models. But these methods do not specify any information on how process model redesign could be evaluated, or process models could be compared. In such cases quantitative analysis must be performed to get the required data.

Quantitative analysis may be conducted in three different categories: analysis of process model metrics which are derived from software engineering, theoretical process execution analysis and process simulation.

Software quality quantitative metrics can be applied in business process model evaluation because of huge similarity between processes and software – they both process data, have a structure and are based on a static model [12], [17]. Calculating such metrics 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 [6]. These methods can give valuable data, but they are hardly applicable in real world process models. Flow analysis can be conducted only when process models are simple, have only exclusive or parallel gateways and Queuing theory can only give data for one activity. Also Queuing theory calculations are complicated even for simple situations. For those reasons the most practical solution is process model simulation. The process model simulation can be done by using various tools such as *IBM WebSphere Business Modeler*, *ITP Commerce Process Modeler for Visio*, *ProSim* or an open-source solution – *BIMP* simulator [20]. 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 type of qualitative analysis allows process analysts to easily compare different process

models in different execution environments. Although process analysis is one step in BPM lifecycle and without process digitalization it creates small part of the BPM added value for the business.

Application of BPM is popular among large enterprises, but small-medium sized businesses differ in terms of available resources, process relation, work ethics and the speed of decision making [7]. Thus the application of BPM in SMEs must be investigated.

D. Case studies of BPM application in SMEs

A case study was conducted in three different SMEs in Belgium by C. Bauwens and T. Van Dorpe. They state that the maturity level of an SME must be assessed to understand where the organization is with its BPM development [8]. Hammer's Process and Enterprise Maturity Model [9] and McCormack's Business Process Orientation Maturity Model [10] are used to access SMEs under research. Authors conclude that SMEs have rather low maturity level, they are pointing to weak spots of the small businesses such as lack of documentation and limited inner efforts to process improvements. As the recommendations of improvement goals are provided, no details of how to improve process models is provided.

Another case study conducted within Australian Small Business by I. Dallas and M. T. Wynn goes through steps of BPM initiative and gives implications on what could be improved in the methodology and observations which could help other SMEs [2]. Though process evaluation and optimization get very little attention as the analyzed business was under establishment. Only some advantages of Business Process Management Systems (BPMS) such as automatic work allocation are introduced as main benefits for SMEs. The implementation of BPMS systems in small businesses is also widely discussed in the work of Veldhuizen R., Ravesteijn P. and Versendaal J. They distinguish main differences of SMEs and large enterprises and suggest an adapted BPMS implementation model [11].

As we can see from conducted case studies, despite that BPM is a process improvement methodology, there is almost no research in the area of a process evaluation and optimization for SMEs. Considering that it is one of the early stages of BPM lifecycle and BPMS creation stages, effective process optimization might save both time and financial resources of such companies.

III. Process Optimization in a Small Optical Retail Business

A. Optical retail business order management process

The case organization is an optical retail branch business, which have optical-shops located across Lithuania and is in the market since 1997. It fits all small business parameters defined in section 1. Only process of order management of prescription glasses production will be optimized in the scope of this research. Order management is quite complicated in this type of business. It always must adapt to dynamic market, new technologies and products introduced in the field and finally to always changing systems of suppliers. For this reason, rigid, hard-coded or universal off-the-shelf solutions are usually not suitable or are too expensive to deploy and support an ongoing process. The current (as-is) order management process does not have a supporting information system.

In order to manage the complexity of the process, it was segmented into three sub-sequential sub-processes (Fig. 1.) based on a three level SCOR model [18] – order initiation, order production and order completion (Fig. 1). Each of this subprocess was modeled separately by using BPMN 2.0 modeling language and Camunda Modeler tool [19].

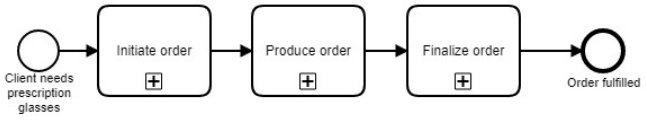


Fig. 3. Top level order management process model

Order initiation subprocess in target business is not documented or formalized, its specific order of execution is defined by optics sales assistant at the order initiation time for each instance separately. Input of this subprocess is client needs and output – a filled order. Order initiation subprocess is explicitly presented in Appendix A, which we think is enough to show the overall complexity of the underlying business logic of the analyzed business domain. Order production subprocess consists of order manufacturing internally or externally. Tasks related to order data sending to manufacturers, ordering lenses, sending order to production sites error management and quality control procedures. Order completion summarizes notifying client, handing finished order to a client, receiving final payment and generating invoices if clients ask. In the scope of order management in optical retail business there were 12 process models created in total.

As this process is executed the target business is facing following problems:

- The states of the orders are not tracked.
- Order fulfillment date often passes due date.
- Late order data retrieval and inaccuracies in it.
- There is no responsible person for each order.
- Delays in notifying clients.
- Sometimes not all required documentation is filled by the sales assistants.
- Long duration of changes implementation.
- Close to no control in order management by managers and other business authorities.

B. Process optimization

Creating an order management information system based on an unoptimized process would be inefficient. Considering the size of the optical retail company process optimization must be done at minimum cost. For these reasons qualitative and quantitative analysis will be performed and there will be a brief discussion about applicability of each method in SME under research. As mentioned in [2], the qualitative analysis in a small business company might be rejected or seen as redundant. Though without it, it is close to impossible to conduct process optimization.

1) Value-Added Analysis

As mention in section 2, the main task of this analysis is elimination of non-value-adding tasks. The presented order management process was broken down to a task list of 71 basic task. Each of the task was then given an assignee and a

category whether it was value-adding, business value-adding or non-value-adding task. The analysis was conducted with a supervision of the company CEO. 11 non-value-adding tasks were identified – most of them related to manual data entry tasks, filling of different forms, work related to a not unified process throughout the company. A plan for each of this task was made – either it was to be automated or eliminated. There were 31 business value-adding tasks which were also revised and if possible planned to automate by introducing business process management system.

2) Root Cause Analysis

During this analysis only problems stated in presentation of current order management process were evaluated using 6M perspective model presented in section 2. CEO of the company was involved in all stages of analysis. From the obtained results we can see that most of the problems in order management were arising from the way the process is executed (method), technical (machine) and human (man) factors. For readability analysis of each problem was depicted with cause-effect (Ishikawa) diagrams. Considering each problem, process model was revised, and a solution was suggested. After the analysis process was remodeled, a business process management system and knowledge system were introduced.

Impact assessment and issue register was not created because as defined in section 2, in the context of SMEs with relatively small amount of problems this method is excessive.

C. To-be model, simultaion results.

The main reason behind qualitative analysis was to find out how effective qualitative analysis is in terms of process execution properties such as execution price, duration and resources utilization. Qualitative analysis was conducted by simulating process models. Process model metrics and theoretical models were not applied because of lack of information and technologies that could be used in SME. As-is and to-be process models were simulated using opensource process model simulator BIMP [20]. Two-year orders historical data was used as input parameters for this analysis. By making the process unified and removing non-value adding tasks we have made the process 12.9% shorter in duration. The remodeled process included more tasks concerning quality control of produced prescription glasses but overall still was 4% shorter in duration and most importantly it reduced resource utilization by 15.9%. On the price point, average execution cost increased by marginal 1.32€, this was probably a result of so called devil's quadrangle [21] – by improving process quality and speed, we have increased its execution price. The optimization results on process flexibility were not tested. Though considering relatively small rate of process initiations in optical retail business flexibility might be more linked to the ability of changing process model than adapting to increased amounts of process instances.

D. Process model digitalization and automation by introducing Business Process Management System

A process quality analysis alone can have little to no impact on the execution of an as-is process in a company. Especially, when a process is remodeled with a supporting information system in mind. In case of analyzed small optical retail business order management process, a business process management system is presented which supports to-be process model. Prototype of this system was developed on an open-source Camunda BPMS platform in order to get highest amount of added-value from BPM initiative and process optimization. Two order management sub-process were completely digitalized. The main advantages of such system identified by the business stakeholders after the presentation of the solution are as follow:

- *Process execution based on an executable process model.* Process model-based execution ensures that all required documentation is present during order management and stored after the order is fulfilled.
- *Business rules automation.* DMN decision tables are integrated in the executable process model and are supported by the platform. Special offers, discounts for product groups are automatically applied during process execution. Most importantly data defining business rules be easily changed by an authorized user with no specific experience in information technologies. Because of this, the implemented solution is considered flexible.
- *Tasks allocation and required data presentation.* Business process management system (Camunda Tasklist component) allocates tasks and provides only relevant task data for the sales assistant at proper time. No excessive data is provided, nor it is required to look up for any data during order management process.
- *Automation of manual tasks*. Most of the manual tasks such as filling order contract, finding order or client data and sending notifications to clients were automated and are performed by the BPMS engine.

Other advantages of BPMS system such as automatic task list creation for each employee by task priorities, process execution data monitoring or the ability to implement changes to process model with little effort and minimal costs are expected to be identified by the business in a long-term testing of the created system. Advantage of information system being built on executable process model is considered an advantage for the developers or administrators of BPMS as it does not create direct value for the target business.

E. Discussion

After conducting qualitative analysis on an order management process of a small optical retail business we have obtained good results for further process reengineering. From the owners and managers of target business it was expected that this type of analysis will not be useful in the scope of small business. Although it pointed out the redundant tasks and weak spots of the process and it was easier to improve the process model. For a fluent qualitative analysis there were not enough information on how to perform it, though a lot of definitions of different methods can be found. It is very unlikely that such analysis could be performed in a SME business without external consultants. Value-Added analysis showed unnecessary tasks, but its results alone lacked information on what parts could be improved. We suggest that this analysis method should always be used with some problem-oriented method. In such method, like Root-Cause analysis, smaller number of perspectives than in 6M model is not advised as it may be difficult to point out which parts of the process require improvement. Finally, the qualitative analysis took more effort to complete than expected. This should be considered and its advantages clarified for the stakeholders as it can be rejected by businesses as not

necessary part of process optimization or automation in an early stage of initiative.

Quantitative analysis, as it stands for, gives specific, comparable results that are understandable for all process stakeholders. For this reason, it is much easier to conduct such analysis in the scope of SME than qualitative analysis. As expected, the qualitative analysis gave strong backup to the results of previously conducted analysis. Although process model simulation requires basic process modeling knowledge. Added the usability of the used simulation tool, it is same as in the case of qualitative analysis – it is unlikely that this type of analysis can be conducted inside SME business with no external help. To achieve this a more stable simulation tool must be developed and more information on how to use it must be provided for the user.

IV. Conclusions and further research

As we can see from an overview of a business process optimization methods and specific optimization case in a small optical retail shop, these methods can be applied in order to optimize small optical retail business order management process. Although for these methods to be applicable widely in small businesses there must be broader amount of information available on this topic. For example, a shared knowledge base with examples for process optimization should be accessible. Further aim of this initiative is to perform a long term BPMS system usability research in a small optical retail business. Employees attitude and effectiveness of BPMS must be investigated in such environment despite initial advantages recognized by the stakeholders of the process like process model based execution, business rules automation, tasks allocation and automation.

Further research on the topic of process optimization could be pointed to improving process simulation and modeling tools by making calculations of process model metrics such as cohesion in real time thus making the evaluation of those models faster and easier.

References

[1] EC. *Annual Report of European SMEs 2017-2018*. 2018. ISBN 9789279968228.

[2] DALLAS, Ian and WYNN, Moe Thandar. Business Process Management in Small Business: A Case Study. *Information Systems for Small and Medium-sized Enterprises* [online]. 2014. No. 2, p. 67–96. DOI 10.1007/978-3-642-38244-4. Retrieved http://link.springer.com/10.1007/978-3-642-38244-4

[3] FREUND, Jakob. *Camunda BPM Compared to Alternatives* [online]. 2015. Retrieved https://network.camunda.org/whitepaper/8

[4] LA ROSA, Marcello. Interview with Michael Rosemann on "The Role of Business Process Management in Modern Organizations." *Business & Information Systems Engineering* [online]. 2016. Vol. 58, no. 1, p. 89–91. DOI 10.1007/s12599-015-0419-8. Retrieved http://link.springer.com/10.1007/s12599-015-0419-8

[5] HARMON, Paul. *The Scope and Evolution of Business Process Management*. 2014. ISBN 9783642451003.

[6] DUMAS, Marlon, LA ROSA, Marcello, MENDLING, Jan and REIJERS, Hajo A. *Fundamentals of Business Process Management*. Heidelberg, New York, Dodrecht, London : Springer, 2013. ISBN 978-3-642-33142-8.

[7] BERNAERT, Maxime, POELS, Geert, SNOECK, Monique and DE BACKER, Manu. Information Systems for Small and Medium-sized Enterprises. *Information Systems for Small and Medium-sized Enterprises* [online]. 2014. No. 2, p. 67–96. DOI 10.1007/978-3-642-38244-4. Retrieved http://link.springer.com/10.1007/978-3-642-38244-4

[8] BAUWENS, Cedric and VAN DORPE, Thomas. *Business Process Management in SMEs*. Universiteit Gent, 2018.

[9] POWER, Brad. Michael Hammer's Process and Enterprise Maturity Model. *Business Process Trends*. 2007. No. July, p. 1–4.

[10] MCCORMACK, K. and JOHNSON, W. Business Process Orientation: Gaining the E-Business Competitive Advantage. . 2001.

[11] VELDHUIZEN, R., VAN RAVESTEIJN, P. and VERSENDAAL, J. BPMS implementations in SMEs: Exploring the creation of a situational method. *25th Bled eConference - eDependability: Reliable and Trustworthy eStructures, eProcesses, eOperations and eServices for the Future, Proceedings*. 2012. Vol. 1949, p. 84–98.

[12] HEINRICH, Robert and PAECH, Barbara. Defining the Quality of Business Processes. *Modellierung 2010 P-161* [online]. 2010. P. 113—148. Retrieved http://subs.emis.de/LNI/Proceedings/Proceedings161/P-161.pdf?origin=publicationDetail#page=134

[13] ROONEY, J J and VAN DEN HEUVEL, L N. Root Cause Analysis for Beginners. *Quality Progress*. 2004. No. July, p. 45–53.

[14] EDITORS, Series, BERNUS, Peter and SHAW, Michael J. *Handbook on Business Process Management 1* [online]. 2010. ISBN 978-3-642-00415-5. Retrieved http://link.springer.com/10.1007/978-3-642-00416-2

[15] DELSANTER, Judith. Six sigma. *Managing Service Quality: An International Journal*. 1992. Vol. 2, no. 4, p. 203–206. DOI 10.1108/09604529210029353.

[16] WILKINSON, Leland. Revising the Pareto Chart. *The American Statistician*. 2006. Vol. 60, no. 4, p. 332–334. DOI http://dx.doi.org/10.1198/000313006X152243.

[17] VANDERFEESTEN, Irene, REIJERS, Hajo A. and VAN DER AALST, Wil M P. Evaluating workflow process designs using cohesion and coupling metrics. *Computers in Industry*. 2008. Vol. 59, no. 5, p. 420–437. DOI 10.1016/j.compind.2007.12.007.

[18] HUAN, Samuel H., SHEORAN, Sunil K. and WANG, Ge. A review and analysis of supply chain operations reference (SCOR) model. *Supply Chain Management: An International Journal* [online]. 2004. Vol. 9, no. 1, p. 23–29. DOI 10.1108/13598540410517557. Retrieved http://www.emeraldinsight.com/doi/10.1108/13598540410517557

[19] CAMUNDA. Modeler. [online]. [Accessed 2019.02.7]. Retrieved https://camunda.com/products/modeler/

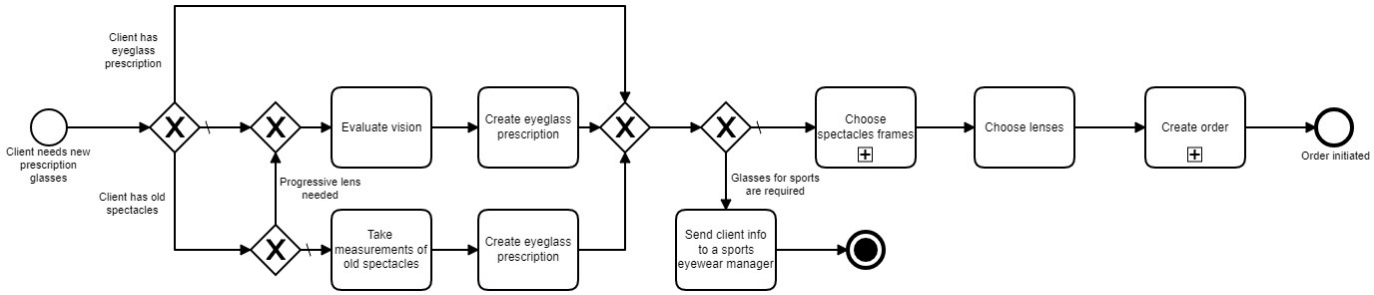
[20] BIMP. BIMP - The Business Process Simulator. [online]. [Accessed 2018.06.13]. Retrieved http://bimp.cs.ut.ee/

[22] REIJERS, H. A. and LIMAN MANSAR, S. Best practices in business process redesign: An overview and qualitative evaluation of successful redesign heuristics. *Omega*. 2005. Vol. 33, no. 4, p. 283–306. DOI 10.1016/j.omega.2004.04.012.

[23] Borowik, G., Woźniak, M., Fornaia, A., Giunta, R., Napoli, C., Pappalardo, G. and Tramontana, E., 2015. A software architecture assisting workflow executions on cloud resources. International Journal of Electronics and Telecommunications, 61(1), pp.17-23.

APPENDIX A. ORDER INITIATION SUB-PROCESS

The following diagram presents the first sub-process of Order management business process, which is Order initiation.



The next two diagrams represent two sub-processes of Order initiation, namely, Choose spectacles frames and Create order.