Process Evaluation and Improvement: A Case Study of The Loan Approval Process

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Quality assurance in software development is one of the key processes in any organization, where Information Technology systems impact the realization of business processes significantly. For digitalization and informatization of business processes, organizations need to have a clear notion of their processes, which can be achieved by focusing on the evaluation, optimization, and continuous improvement of business processes, in addition to supporting software quality. The research addresses the problems of the financial business sector. More specifically, the frequently performed loan approval process and its existing information solution support. Reports have been made about existing risks, unexpected fallouts, resources wasted in the loan approval process and lack of quality information support. Therefore, the research focuses primarily on the possibilities to optimize the business process by analyzing and evaluating the process activities (measuring the quality of existing software, introducing new information system support and risk management solutions, as well as identification of optimization potentials, where possible). The current state is modeled, simulated, and evaluated(according to a literature review and interview results). Finally, the possibilities of optimization are proposed, and the potential effect on the quality of the loan approval process.

1. INTRODUCTION

Measuring the quality of processes and their supporting software, as well as the constant process of optimization, are important elements of every business organization`s success, keeping its processes free of waste, optimizing time and cost, as well as achieving optimal values of different Key Performance parameters or Indicators (known as KPIs). Since businesses rely on Information Solution (IS) support, it is important to provide qualitative solutions that fit the user's expectations, are well accepted and provide a positive user experience. In addition, management and quality assurance of processes is a growing issue in companies that rely on several (often unconnected) IS, and the modeling approach affects the understanding of the IS role and supports quality assessment of IS based process. In addition to the growth of users and their demands, there is also an escalation of providers producing several challengers among Information Technology (IT) companies and their processes. Growing numbers (of devices, solutions as well as users), result in several unconnected solutions, causing complex integration of products, introducing chaos, uncertainty and risk in users' (digital) lives.

Due to the importance and actuality of the subject, even more so in the past years since the economy suffered, efforts are dedicated to managing and anticipating risks. The importance of measuring several quality aspects (quality of business processes, based on IS), is also increasing. Reportedly, expected risks can be detected in a timely manner, and managed only by a systematic approach. Even more so in the present day, banks carry out various risk management activities and processes before decisions are being made (loans are issued, for example) performed manually, or

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supported by software solutions. As part of risk management, banking institutions reportedly use several approaches, some of them automated, however, not all, and there is potential for improvements. Information support includes different methods, most of them from the field of Operational Research, such as stochastic processes for determining risks, prices, guarantees, and delays` evaluation (Duffie 2005). Among the used methods (as reported in academic research and interviews) are also linear discriminant analysis, logit analysis, logistic regression, classification, and regression trees (Vojtek and Kocenda 2006).

With the increase of Information Technology (hereinafter, IT) support and possibilities electronic banking provides, the majority of business processes are being redesigned and re-planned, with the inclusion of greater informatization and automation (Dias et al. 2019). However, those efforts vary among banks, as well as countries. Therefore, the aim of our research is an analysis of the quality of processes focused on (general) existing IT support (through literature review and interviews), resulting in a process optimization proposal. As part of the research, the business process is suggested to be transformed from the AS-IS model to the renewed TO-BE model. Therefore, due to lack of access to software solutions, the quality of listed information support will be evaluated on the process level.

The paper is organized into five sections. Definitions of business process optimization and different optimization approaches are presented in Section 2, while the preliminary research is described in Section 3. Section 4 presents the case study of the optimization of the loan approval process, including a general description of the process, as well as the simulation of the loan approval process with different optimization approaches. The last, Section 5, includes a summary of results and the conclusion, followed by listed literature.

2. BUSINESS PROCESS OPTIMIZATION

2.1 Definitions

A business process is defined as a collective set of tasks that, when connected and sequenced properly, perform a business operation (Vergidis, Dhish, and Tiwari 2012). The aim of a business process is to perform a business operation, i.e., any service-related operation that produces value to the organization. The design and management of business processes is a key factor for the operation of the organization. By focusing on the optimization and continuous improvement of business processes, organizations can improve their efficiency and quality, reduce cost, and enable adaptations to change requirements (Vergidis, Dhish, and Tiwari 2012). Therefore, business process optimization is a technique to help organizations improve their efficiency by improving their processes.

2.2 Process optimization approaches

Primarily, there are several known approaches to process optimization, respectively, transformation of a process (Pušnik et al. 2018), including Modeling, Simulation, KPI identification, the 5 why method, revision, Waste identification, the root cause analysis, Voice of a customer, process success measuring, value flow mapping, IS/IS-NOT method, critical path method, risk analysis method, a 5S work environment organization, and others. A preliminary survey, (Pušnik, Welzer Družovec, and Šumak 2019) conducted in 2019, ranked the mentioned methods from most to least useful. As shown in Fig.1., Modeling was recognized as the best possible approach, followed by Simulation and KPI identification. Voice of customer, Ishikawa diagram, and process success measuring were identified as the least useful optimization approaches.

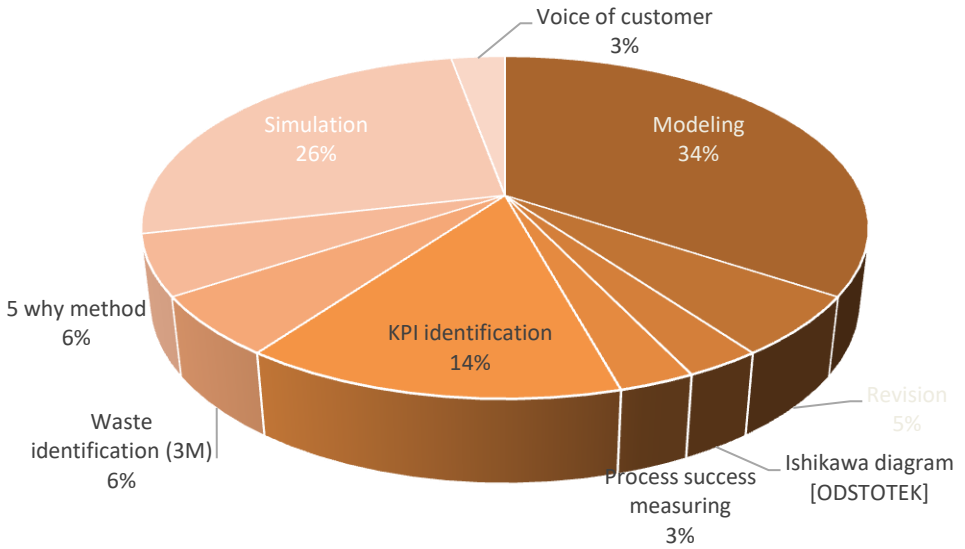

Fig. 1. Favorites among optimization approaches (Pušnik, Welzer Družovec, and Šumak 2019).

Similar findings are also presented in an extended research (Čuček 2018), where a supplementary survey about optimization methods use was performed among IT companies, and coincides with similar research results in (Pušnik, Welzer Družovec, and Šumak 2019). The results in Table 1 show that Modeling, Simulation, and KPI identification were identified as the most useful approach/method for process optimization, followed by other approaches. All listed approaches/methods are described in the following subsection and used in the case study presented in Section 4.

Table 1: The list of methods and approaches, ordered according to the evaluation of their usefulness (Pušnik, Welzer Družovec, and Šumak 2019)

Method/approach	1 – very useless	2 – useless	3 – neutral	4 – useful	5 – very useful
Modeling	0%	0%	0%	42%	58%
KPI identification	0%	0%	4%	50%	46%
Simulation	4%	8%	21%	33%	33%
Ishikawa diagram	0%	17%	38%	29%	17%

Process Modeling

Process modeling is a method for representation of processes in a process model. This is usually done through different graphing techniques, such as the flowchart, IDEF, Unified Modeling Language (UML), Petri nets, Business process models based on mathematical or algorithmic models, etc.(Kostas, Tiwari, and Majeed 2008). The de-facto Standard for business processes diagrams is the Business Process Modeling and Notation (BPMN) developed by the Object Management Group. BPMN is a graphical representation for specifying business processes in a business process model based on a flowcharting technique. The primary goal of BPMN is to provide a notation that is readily understandable by different business roles (Object Management Group 2019). Therefore, from the business analysts that create the initial drafts of the processes to the technical developers

responsible for implementing the technology that will perform those processes, and also, to the business people who will manage and monitor those processes (Object Management Group 2019).

Process Simulation

Simulation is the process of creating and analyzing a digital prototype of a physical model to predict its performance in the real world. Simulation modeling is used to help designers and engineers understand whether and under what conditions a process could fail and what loads it can withstand. The act of simulating a complex system needs the support of an IT solution, such as Signavio, Enterprise Architect, or others. (Pušnik, Welzer Družovec, and Šumak 2019)

KPI identification

KPI identification is the most known method in measuring business process quality (Pušnik, Welzer Družovec, and Šumak 2019). KPIs are performance metrics that measure specific goals for businesses` processes. Based on the identified risks and possible problems in the process, indicators are defined to help measure the success or effectiveness of the process (usually numerical values, such as time, cost, profit, number of complaints, number of rejections, etc.). Each KPI includes a definition, how is it measured, and when is it successful. KPIs express how to increase efficiency, representing a multitude of measurements that focus on the aspect of organizational performance that is most critical to the current and continued success of the business process (Pušnik, Welzer Družovec, and Šumak 2019).

Ishikawa diagram

Ishikawa diagrams were popularized in the 1960s by Kaoru Ishikawa, who pioneered quality management processes in the Kawasaki shipyards, and, in the process, became one of the founding fathers of modern management. The Ishikawa diagram (also known as fishbone diagrams, herringbone diagrams, cause-and-effect diagrams, or Fishikawa) is a tool used for identifying and presenting all possible causes of a particular problem in graphical format systematically. Usually, it can be made using the following steps:

(1) Identify the problem
(2) Work out the major factors involved (8M):
   - *People or Man power – causes, caused by people*
   - *Methods - causes caused by rules, regulation, legislation or standards*
   - *Machines – causes, caused by equipment such as machinery, computers, tolls*
   - *Materials – causes, caused by a defect or material properties*
   - *Measurements – causes, caused by improper or poorly chosen measurement*
   - *Environment (Mother nature) – causes, caused by the environment - temperature, humidity or the culture*
   - *Management – causes, caused by improper management*
   - *Maintenance – causes, caused by improper maintenance*
(3) Identify possible causes, and
(4) Analyse the diagram.

Despite the lower grade of the technique when performing the survey in Table 1, the Ishikawa diagram was, nevertheless, chosen due to its graphical presentation and clarity of potential problems. Fig. 2 illustrates the general structure of the Ishikawa diagram.

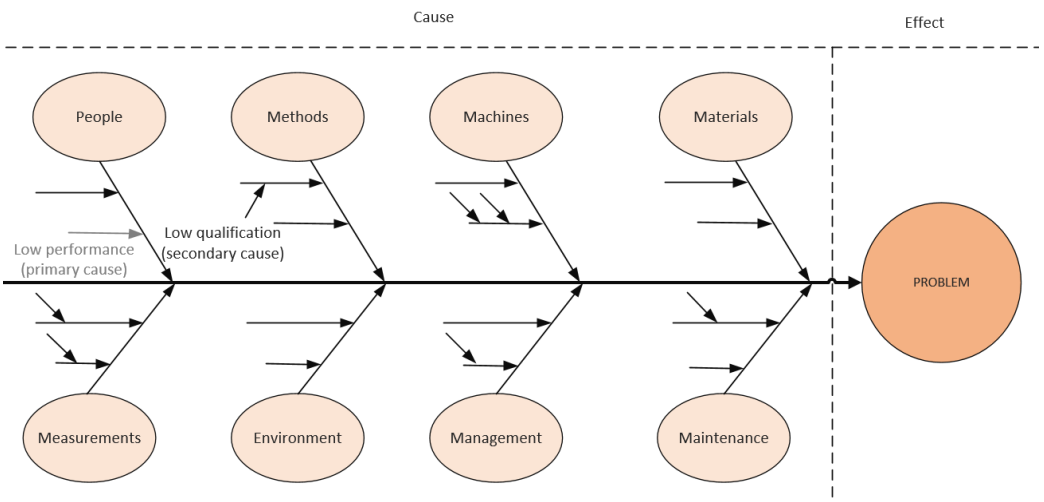

Fig. 2. General Ishikawa diagram

3. PRELIMINARY RESEARCH: INTERVIEW

The preliminary research was carried out with an interview and survey targeting banks and financial institutions. Most banks declined the received collaboration request. Therefore, the difficulty of gaining data was evident. Due to the very poor responsiveness, the interview was conducted with two employees from one bank (one in person, one through e-mails).

The summary of questions and answers is presented in Table 2 (both interviewees` answers were the same). To point out question 3 (Q3), the inquiry was focused on which activities are computerized in the bank (e.g., informative calculation of loan, calculation of the interest rate and repayment period, financial verification of the client, deciding on the suitability of the loan applicant, digital signature of the contract and other). The results indicated that, despite some computerized activities, not all are completely automated, and there is a lot of human effort necessary. The results show that the loan approval process is partly automated; however, no optimization methods are used for evaluating or approving loans.

Based on the received information, the problem of non-optimized activities was recognized in the loan approval process. To investigate potential possibilities to create change, general examples of the loan approval process are presented in the following sections, in addition to a conducted case study.

Based on the identified setbacks of banks' loan approval processes, a case study investigating the process' possibilities was performed in the following Section.

Table 2: Interview structured questions.

ID	Question	Answer
Q1	Does most of your work require the use of personal computers?	YES
Q2	Do you expect increased use of computers in the future?	YES
Q3	Are most of your activities computerized (loan approval process among them)?	SEVERAL, but not ALL and never COMPLETLY
Q4	How many loan applications are received via e-bank daily?	0-20
Q5	Are there more physical or electronic credit claims?	PHYSICAL
Q6	Does your bank offer customers mobile banking services?	YES
Q7	Can a customer apply for a loan on a mobile application?	NO
Q8	Does your bank have a business process for granting loans?	YES
Q9	Is there room to improve the existing business process of granting loans?	YES
Q10	Is the loan approval process automated?	PARTLY
Q11	What optimization methods do you use when approving loans?	NONE
Q12	Do analysts solve problems related to operating or optimization methods without IT support?	YES

4. CASE STUDY: OPTIMIZATION OF THE LOAN APPROVAL PROCESS

4.1 The business process of loan approval

The business process of loan approval is an integral part of a bank or institution. Each business process also includes a certain level of risk associated with credit scoring. Based on a literature review, the bank distinguishes between two groups of credit: Approval and rejection of a loan, which involves a risk assessment process. Before the loan granting, banks verify the individual user who would like to take out a loan (verification in Slovenia is carried out using the SISBON information system (Banka Slovenije 2019)). SISBON aims to exchange and process clients' personal data between banks. The SISBON information system collects and processes data that relate to the actual and potential indebtedness and the fulfillment of contractual obligations of customers. Its mission is to manage the credit risk of banks, savings banks, and other creditors, to ensure responsible lending and avoid excessive indebtedness of individuals (Banka Slovenije 2019).

Once a loan is approved by a bank, an agreement between the bank and a customer is set, under terms which vary among banks, as well as countries. Credit risk is the possibility that money will not be returned, resulting in a financial loss. Credit risk from the point of view of a banking institution is the risk that the claim will not be settled within the specified time limits or under certain conditions by the debtor. There are several different types of credit risk, which are presented below (Anson et al. 2004):

(1) Default risk (PD): The primary type of risk based on the probability that the borrower will not be able to repay his claims. The risk of default by the borrower is determined primarily by its creditworthiness and the duration of the credit relationship. In order to calculate this risk, the bank needs an appropriate system for obtaining information and regular monitoring of the client. By extending the credit period, the probability of PD by the borrower increases.
(2) Loss Given Default (LGD): The bank will not be able to recover the debt, or that it will not be possible to repay losses from the sale of insurance instruments. In order to approve the loan, the bank requires adequate insurance with redemption, which is secured against possible default of the loan. Recovery of debt, or repayment in the case of the unpaid loan, depends on the quality of the insurance, which requires adequate monitoring of its liquidity.
(3) Exposure risk (EAD): Is caused by uncertainty in repayment. The Bank's exposure is divided into two types: Maximum and expected. The expected exposure is the expected loss of the bank in the event that the debtor fails to settle its obligations, while the maximum exposure is the maximum amount lost by the bank in the event of default by the debtor.

Different KPI's were identified based on the risks (Table 3). The listed risks are a part of the "Evaluation of the credit loaner" activity in Fig. 3. In addition to risk evaluation, there are also KPIs, that are critical to the current and future success of the loan approval business process.

In our case study, most of the KPI's cannot be simulated, nor did we receive sufficient information from the banks. However, basic time and cost constraints can, nevertheless, be included. Regarding the time constraint, we overviewed some possible wastes as well, connected mainly to excessive waiting (for documentation, approval or other non-optimized respectively non-automated activities).

Table 3. KPI's.

KPI	Name/Sim. appropriate	Description
KPI1	Level of difficulty to approve a loan/NO	Included in all activities, performed by the bank. KPI is focused on the speed of how quickly the bank succeeds in checking the conditions for granting a loan.
KPI2	Number of creditworthy clients/NO	Set to the "Evaluation of the credit loaner" activity. KPI represents the number of clients classified according to their creditworthiness. An indicator connected to the creditworthiness of a client is the actual percentage of clients who paid their credits successfully.
KPI3	Number of contracts/NO	An indicator of success representing how many contracts were set, which enables measuring the quality of the services to the process.
KPI4	Costs/YES	Process costs are built into the Signavio online environment to measure the costs within the process of granting credits.
KPI5	Time consumed/YES	Built into the Signavio web environment, enabling measuring of the time spent from loan request to loan approval. The tool allows you to measure the time in the credit approval process.

4.2 AS-IS model

In Fig. 3, a generalized credit approval model is presented, modeled using the BPMN notation in the Signavio web tool. The process contains two main roles: The bank and the customer/potential loaner. The process begins with the activity of selecting a client's bank, then the bank presents its information on loans, on the basis of which the customer decides to apply for a loan. When the bank accepts the application, it begins checking the data based on the documentation provided by the customer, and through the SISBON information system. After verifying the results and credit assessment, the bank prepares a Contract. The client signs the Contract. The signed Contract becomes valid, and the bank transfers funds to the client's account. The transfer of funds ends the process. The model and simulation of the process are presented in Fig. 3.

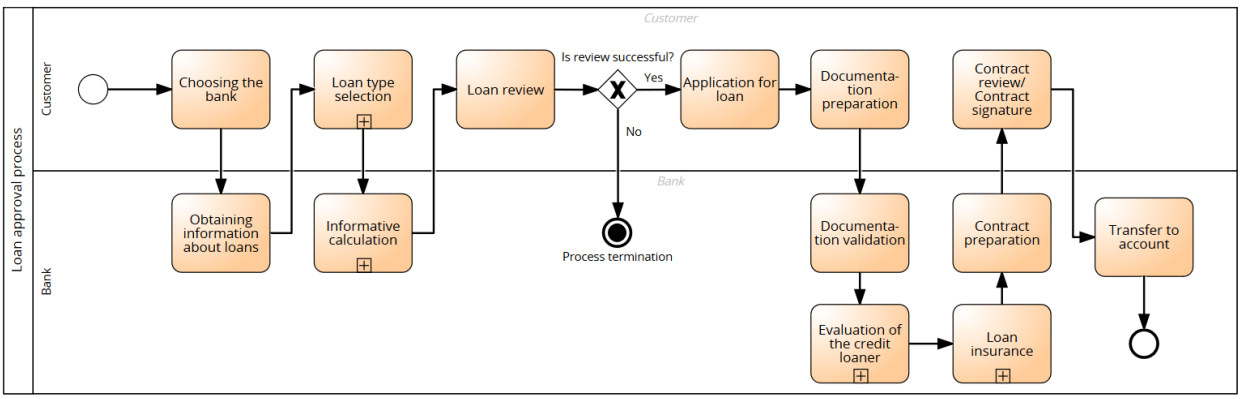

Fig. 3. Simplified BPMN credit approval process.

The process analysis was carried out using the Signavio online tool. Through the web tool, we entered the information costs on the activities, or the number of costs that a given activity has. Information was obtained with the help of literature (Dermine 2014; Smartbizloans 2017) and the answers of interviews. Based on the interviews, some possible delays are presented on the Ishikawa diagram in Fig. 4. Although the mentioned diagram was not chosen as the most appropriate approach when optimizing a process, we nevertheless, included an example focusing on weak points of the process and possible sources of problems that need to be addressed in order to optimize (in our case simulate) the correct process activities.

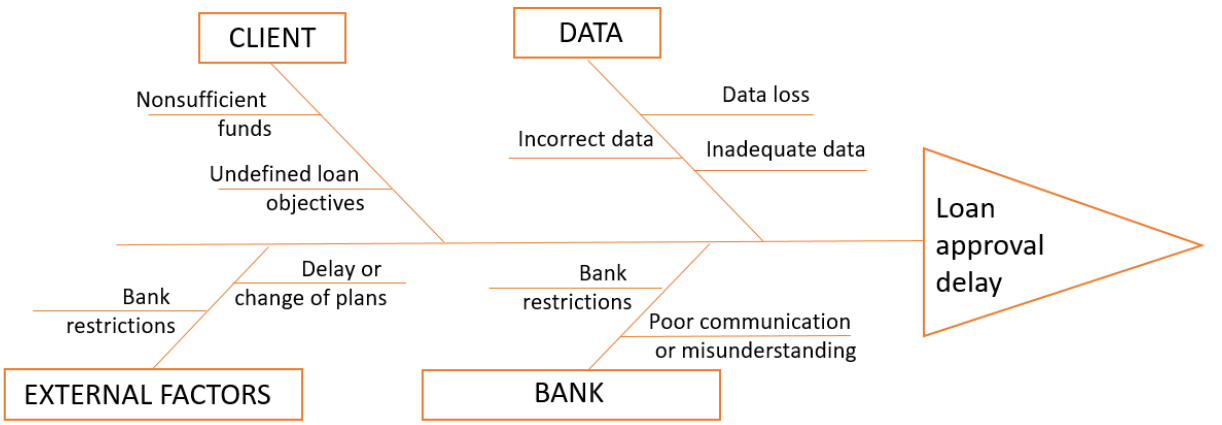

Fig. 4. Root cause analysis.

To simulate the process with several instances, we observed the queue theory, a study of waiting lines in order to predict the length and waiting time (Howl 1966). The queueing theory is a mathematical study of waiting lines, or queues (Duffie 2005). A queueing model is constructed so that queue lengths and waiting time can be predicted (Duffie 2005). The queueing theory is generally considered a branch of operations research, because the results are often used when making business decisions about the resources needed to provide a service. The analysis of the theory has shown that an increase in the number of employees from a cost point of view is impractical, which led to an assessment of the reduction of process times in order to achieve the goal within the limits of satisfactory intervals. Therefore, one of the primary aims of the TO-BE model is time reduction.

4.3 TO-BE model

The TO-BE model is a proposition of the AS-IS model optimization, indicating the activities that need additional support (through automation or human interaction) to improve KPIs (especially time-related indicators). A business process transformation can be carried out in several ways. Some simple solutions (digitalization, for example), are already implemented within most banks; the renovation can also be carried out using methods based on the design of the product. The key factors are influenced by the restructuring of the business process: Time, quality, costs, flexibility. Only time and cost were evaluated through simulation,.

The TO-BE model has to improve at least one of the factors (Schoenberg 2013). Using the heuristics of the implementation of the process, we can renew the process by removing tasks (deleting unnecessary activities), job scheduling (task aggregation), and parallelism. In order to redesign the business process, key variables of business process renewal must be considered, since an acceptable relationship between maintaining the integrity of the process and functionality should be balanced.

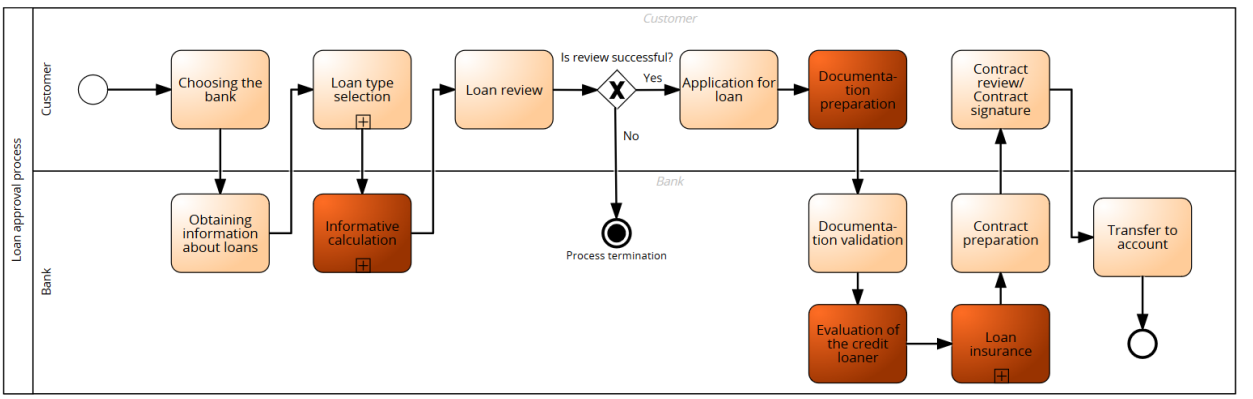

Fig. 5. The TO-BE model

The activities that were proposed during the renovation are presented in Fig. 5. Activities with no added value, such as printing a credit agreement or handwritten signature, are replaced with informatization where possible. The changes in the model are shown with a different color of activities. Due to several non-automated activities, the simulation of the AS-IS process produced several bottlenecks, omitted in the TO-BE process. The comparison of the bottlenecks is presented in Table 4.

Table 4. The ratio of resource consumption during indicating bottlenecks

	AS-IS	TO-BE
Choosing the bank	39	6
Obtaining information about loans	0	28
Loan type selection	4	40
Informative calculation	9	1
Loan review	0	5
Application for loan	48	3
Documentation preparation	0	2
Documentation validation	0	1
Evaluation of the credit loaner	0	1
Loan insurance	0	3
Contract preparation	0	2
Contract review/ Contract signature	0	7
Transfer to account	0	1

Not all bottlenecks were solved, and some new ones accumulated due to the rearrangement. However, the sum of all bottlenecks has, nevertheless, decreased (Table 4). Table 5 presents the improvements of the process renewal; the costs have not changed significantly, however, the time aspect is significantly improved due to the informatization in activities such as Information calculation, Evaluation of the credit loaner and Loan insurance decision.

Table 5. AS-IS to TO-BE improvement.

	Costs	Total cycle time	Resource consumption
AS-IS	4000 €	4d 15 h	1d 16 h
TO-BE	3950 €	3d 15 h	1d 16 h

The optimization technology has enabled modeling, partial integration of success indicators, simulation of the business process, and business process comparison between AS-IS and TO-BE conditions. The TO-BE process is less time-consuming and more efficient. After the analysis, we concluded that IT solutions could improve the business process characteristics. It is sensible to include additional risk management in the process of approval, as well as evaluate the quality of software solutions.

Despite relatively affirmative results, there are several risks to the validity of the research. An interview was conducted at one bank with two people, and the survey of optimization approaches and simulation was run within IT companies and not banks. Therefore, the results are challenging to be generalized, with its answers, to other banks in Slovenia.

5. CONCLUSION

The loan approval process is one of the more sensitive areas of banking and the Finance sector. Due to the pursuit to create efficient processes and achieve an optimized resource consumption regardless of a domain, the search for a qualitative product application is becoming vital. Measuring quality of software can, additionally, be extended to measuring the quality of processes, assuming that the process model is a prerequisite for the real process and the process execution relies on IS. In addition to economic and mathematical knowledge, appropriate IT solution support needs to be applied, including information security, transfer of business processes into digital form with the purpose of measuring and evaluating with the help of computer programs, application of mathematical methods to activities in the process, replacement of manual operations with new ways of electronic business, and introduction of e-banking among the widest possible target audience.

As a proposal for optimization, using advanced IT support can optimize the credit approval process to some extent. However, traditional systems like banks are less prone to change, and use few of the available possibilities. Within the research, some potentially replaceable activities were highlighted where IT could be included. To support defined ideas, a survey was made among employees from IT companies evaluating different optimization approaches (Čuček 2018)(Pušnik, Welzer Družovec, and Šumak 2019). The survey included an evaluation of several optimization methods. However, modeling, simulation, KPI definition, and Ishikawa were chosen as the most favorable ones. They were later used within the case study.

Within the paper, we evaluated the high level loan approval process, and presented some possible methods and approaches to optimization. Supporting IT solutions, as well as additional methods, can play an important part in improving every business process, as long as it is acknowledged that improvements can be made and would benefit end-users, as well as employees. Since the paper presents an initial acquaintance with one of many processes (from the Information Solution support point of view), the future work will expand the analysis and comparison of a further set of processes. Future work will include an expansion of the survey, respectively, interviews, covering other non-IT-domains in smart cities, comparing the optimization level of different business processes, and evaluating motivation to change and improve processes within different domains, supported by digitalization and informatization. Among the process optimization approaches presented in Section 2, the use of operational research for smart(er) decision-making within IT solutions was often

mentioned, which will be the subject of future research and, therefore, included among the opportunities for process optimization and process quality growth.

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