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Introduction of electronic documents: how business process simulation can help

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Abstract
Purpose – Many companies still use paper documents within their service processes, which is supposed to be inefficient, and a digitalisation of documents is a promising alternative. However, such a change is expensive and the process typically has to be adapted. Thus, the purpose of this paper is to show how business process simulation (BPS) can be used to forecast the effects of the introduction of electronic documents.

Design/methodology/approach – This paper presents a case study of a German bank, and shows how BPS can be used to evaluate the introduction of electronic documents in financial service processes.

Findings – The case study shows how BPS can be applied to evaluate the implications of introducing IT systems using the example of e-files. The results reveal that not only cycle time, but also costs and administrative workload, can be reduced, while the number of processed orders increases.

Practical implications – On the one hand the data generated in the simulation results can form the basis for feasibility studies regarding IT investments, e.g. for the migration of historical data from the old document management system system. On the other hand, further actions can be deduced for sales staff and other processes, which can use employees’ additional free time.

Originality/value – Real case examples are rare, as many companies do not apply simulations. This paper is the first to analyse the impact of introducing electronic documents in service processes using BPS. The paper provides an approach how to conceptualise such settings.

Keywords Banking, Automation, Management, Services, Process improvement, Business process simulation

Paper type Case study

1. Introduction
The financial services industry is characterised by intense competitive pressure. Banks and insurance companies are faced with a change from a supplier-dominated to a demand-oriented market. This trend goes in line with the increasing usage of internet-based financial services. As a result, customers expect lower prices and fast and transparent service processing, and this includes financial and insurance products. However, a major drawback is the dependence of most banks on paper documents. These documents are essential for service delivery, either for processing the documents themselves, e.g. for ordering, or for recording information due to legal restrictions. Thus, a lot of paper is used in financial service companies, and is passed on between employees. To enable increases in efficiency, a major opportunity is seen in the digitalisation of these documents (Sprague, 1995; Hwang et al., 2013).

A precondition for the equal treatment of digital documents is audit-proofed document management systems (DMS) that allow archiving in accordance with the principles of data access and the verifiability of digital documents. In the case of Germany, these principles are defined by the digital audit rules from the Federal Ministry of Finance. Currently, the over-reliance on paper documents has been holistically resolved only in a few banks. Often, a central approach to creating and
managing documents is missing. There should be a weighting between the advantages of more efficient document handling, and the investment in such a DMS (Leikums, 2012).

However, before investing a high amount of money, the question should be addressed of how such an introduction of electronic documents can be evaluated in advance. The aim of this paper is to show how business process simulation (BPS) can be used to forecast the effects of the introduction of electronic documents in the context of a loan application process. Thus, a conceptual model is derived showing how such an introduction can be described (Robinson, 2008). As such conceptual modelling is domain specific, the paper shows not only the possible impact of DMSs on existing processes but how such settings can be modelled from a conceptual point of view.

Therefore, a case study from a German bank is presented. The paper is organised as follows: first, a description of the applied method and the theoretical background of managing documents in information-processing services is provided. Based on the theoretical foundations, the case study is presented, along with the simulation model and the simulation results. This is followed by a discussion of the findings and the limitations. The paper concludes with a summary of the study’s contributions to research and practice.

2. Method

In general, there is agreement in the academic field that dynamic model descriptions and analyses have to be integral parts of studies, and be related to superior systems (Sharda and Bury, 2011). Dynamic modelling, specifically simulation, can be regarded as an essential element of process modelling. BPS in particular entails developing dynamic models for the purpose of analysing and evaluating business processes. Within this context, a number of attempts to integrate static and dynamic process models have been undertaken – with varying levels of success (Barber et al., 2003).

All in all, BPS seems to be a preferable instrument to evaluate different measures for increasing process efficiency, especially since mutual dependencies and effects can be analysed based on their chronological sequence.

Although BPS is stated to be the most widely used approach for operational research, it is rarely used in companies (Melao and Pidd, 2003). This holds especially true for the daily use of simulation models for operational control. This situation is no different within the service sector. Overall, there exists common agreement on the fact that BPS is very helpful to manage complex service processes (Robinson, 2004; Doomun and Jungum, 2008). A variety of applications for BPS can be found in the literature as described in literature reviews (Banks et al., 2005; Jahangirian et al., 2010). However, reviewing the studies contained in these reviews, to the best of our knowledge there does not currently exist any systematic approach which analyses the structure of service processes, considering the heterogeneous degrees of integration.

3. Theoretical background

3.1 Characteristics of financial service processes

Financial services are delivered by processes in which a customer order is fulfilled. The starting point for service delivery is the respective customer order. During processing, the activities needed to deliver the service are performed. This work is performed for process instances (also referred to as customer orders) that contain information about the required activities (da Silva et al., 2012). Essential for a characterisation of such services is the chosen perspective (Corrêa et al., 2007). Within the scope of this paper’s
focus on processing, services can be distinguished according to three generic types of services (Lovelock and Yip, 1996):

- processing of possessions: tangible actions to physical objects and transport of objects (e.g. car repairs);
- processing of people: tangible actions to people and transport of people (e.g. haircuts, flights); and
- processing of information: collection, production and transfer of information (e.g. granting of a loan)

Information, possessions and people are included in almost every service delivery. Nevertheless, the focus of differentiation is on the main subject or object on which the service is performed.

Using this classification, financial services can be characterised as information-processing services. The major objective of financial services is to transact orders (e.g. payments and shares) and to sell financial products such as loans, insurance and savings deposits. To deliver these services, all kinds of information have to be processed. Therefore, the delivery of financial services has no local dependence on the service object – that is, the information. In contrast to physical objects or persons, information can be duplicated and easily processed at different places. In addition, the physical presence of customers, when their input is required for service delivery, is not mandatory. The degree of customer integration is low to medium, as financial services require information from customers which can be processed mainly without the customer being physically involved (Leyer and Moormann, 2012).

3.2 Managing documents in financial services
As financial services are mainly focused on information, a carrier is required. Traditionally, paper documents are used to fulfil this function. Information related to customer orders is provided in the form of documents, e.g. the income information from a customer is provided in tax assessments, or the information on the collateral value of a property is shown in the form of an expert opinion. Consequently, a bank has to focus on managing the documents to ensure an efficient service delivery (Climent et al., 2009).

Document management is the acquisition, processing, management and storage of documents, ensuring accuracy, performance, safety and reliability, regardless of a specific format (Leikums, 2012). The intensive usage of specific forms by banks, and the rule-based specification of financial services, provide a foundation for the use of DMSs. A DMS is a software system that allows files to be managed in such a way that the employees in a company have electronic access to the documents (Hwang et al., 2013).

Organisational aspects, such as the synchronous processing of documents or integration in the financial service process, cannot be managed using these DMS. Thus, the term “DMS” has to be used in the broad sense to encompass process-oriented IT systems in which the document management function is embedded. Examples are groupware systems, workflow systems, electronic filing systems with digital optical memory and e-forms. The functionality of many systems goes far beyond the basic functions of DMSs. Such systems integrate the functionality of document management directly into the respective business application, for example the workflow management system of a bank (Iverson and Burkart, 2007).

However, the terms “document management” and “workflow management” cannot be used interchangeably, despite a certain overlap. While a DMS organises filing,
searching and restocking of documents for further processing, a workflow management system allows the modelling of work-sharing processes, which take place according to defined rules within the company (Bae and Kim, 2002).

Despite immense progress in computerisation, the majority of banks in Germany are still relying on paper documents in many business fields. Transactions of money or shares are highly automated, while the levels of paper-based information exchange are still high in areas like loan processing and claim settlement. The following case study shows the benefits of introducing electronic documents into a loan process.

4. Set-up of the case study

4.1 Basic information

The case study describes a transaction process for construction financing and business banking loans of a commercial German bank. Due to legal requirements, the sale of loans is separated from the processing of loans. This leads to a division into front- and back-office activities (Zomerdijk and de Vries, 2007). The focus of this case study is on the whole loan process.

In the initial situation in this particular bank, information related to customer orders is mainly paper-based. The back-office departments have access to an electronic filing system; however, the branches are working with private and business customers on paper-based documents. The project aims to introduce centralised e-files, which allow easy access for all departments participating in the process.

It is assumed that the introduction of e-files contributes to improving performance. However, the project not only aims to digitalise the documents, but also to use the new possibilities to improve the process in terms of cycle time and costs. Additionally, the branches are especially interested in using the additional time to handle more customer orders, i.e. to distribute more loans.

The following two questions are of interest for the project:

• Are the performance metrics (average cycle time and costs per loan application) improved by using e-files?

• Which potentials for improvement are possible from a branch point of view? For example, can copying and administrative activities for the paper-based reference file be reduced, in cooperation with other process resources? How many additional customer orders could be handled in the same time?

However, a test regarding the introduction of such e-files in reality, and an objective assessment of the introduction a priori, is hard to perform. The ongoing business cannot be paused to test a system, which also costs a large amount of money to develop. Furthermore, future situations like an increased number of loan applications can hardly be accounted for in terms of the inherent complexity of such a high number of objects (Chevalier and Van den Schriec, 2008). Therefore, a scientific support project was set up to build a simulation model for evaluating the introduction of e-files in the loan process.

4.2 Modelling the as-is situation

To gather the necessary data regarding the process, a description based on available documentation and process staff’s existing knowledge was prepared. Afterwards, in a joint workshop with representatives of the units, the process was described in detail. Refinements were carried out in several interactive interviews, after clarification of outstanding issues via e-mail with every employee involved.
The necessary data were gathered with this procedure and the simulation model was implemented using the simulation software package iGrafx 2011. Figure 1 gives an overview on the activities within the process. The depiction of this as-is model focuses on the loan process for the branches and the Credit Risk Management (CRM) Unit as this part will be changed for the to-be simulation. Thus, the processes in the loan factory, the support units and the external scanning and archiving services are not mapped in detail. The model is reduced to what is considered to be relevant process paths and resources. Conversely, several process steps need to be broken down to a more detailed presentation level to analyse the relief the process will provide to the branches, and the effects in CRM.

The macro process begins with a customer requesting a new loan or a loan extension, which includes the generator for the introduction of loan requests as customer orders in the process. Before the loan application is registered, it is checked whether the required documents are available. If not, customers have to provide additional documents or if the content of the document is insufficient in this pre-check the loan application is discarded at this stage. Once the loan application is registered, documents are copied and stored. Within this activity it can happen, that a failure is detected and the documents are directly sent to the deletion activity. In the normal case, the documents are forwarded to CRM, internally to compile every document in sales regarding the customer and to prepare a potential loan offer. This loan offering is dependent on the decision of CRM. These employees check the documents again, request additional documents and either agree to prepare a loan offer or reject the request. In any case the documents are scanned by the service provider.

If the customer agrees to the loan offering, a loan contract is demanded by sales and provided by the service provider. Afterwards, finalisation of the loan documents takes place in sales, customer signs and the relevant documents are stored and scanned. If a customer refuses to sign or the loan application is rejected, the relevant documents are archived due to legal restrictions. This process can be split into 24 activities on the first level of the macro-process. Of these, four are modelled in more detail with sub-processes, within which a total of 29 activities are carried out. In addition, within the macro- and sub-processes together, a total of eight decision points exist, from which different paths are initiated. Figure 2 provides the information on the sub-processes.

There are two possible final events in the macro process, “Scanning loan documents” and “Archiving loan documents”, because new incoming documents are scanned and archived after the loan decision and processing. All activities for the modelling of problem-related tasks have been completed at this time. Loan requests that are rejected before detection in the operational systems of the bank end in an early stage of the process (activity: “Discard of loan application”).

The process instances are paper-based documents that are submitted by the customer as part of the loan request. The model does not depend on individual pages, but on bundles of documents that represent a customer request for a loan commitment. It is assumed that this bundle of documents contains the basic customer information, which is enhanced by documents (e.g. loan contracts) from the bank later in the process. While introducing documents in the process, it is irrelevant whether the request is for a new loan or an extension of the customer’s credit exposure. During the process, the differences are modelled by the probabilities of the branches.
Figure 1. As-is simulation model of the loan process.

Introduction of electronic documents.
Figure 2. Sub-processes of the as-is model
The simulation model is filled with the following parameters:

- **Number of processed customer orders**: data is required on the number of transactions processed. From the operating process system, the number of processed customer orders can be extracted. This results in a total of approximately 100,000 credit commitments per year – or per 250 working days, at around 400 commitments per working day. A survey of the project team regarding the entire volume of documents, including a projection of future quantity structures, resulted in approximately 61,000 scanned pages per day.

- **Working time within the activities**: in reality, varying working times arise because activities are not always constant in length. In data collected via interviews and expert estimates, there are usually intervals listed, depending on the workload or previous processing times of information. Based on the experiences of the employees, an activity might take, for example, about five to 10 minutes. This condition is addressed in the model by stochastically distributing the values of attributes.

The assumption of normal distribution will be set for every working time within the specified interval as the involved representative experts indicated that this distribution describes the reality as best as possible. The actual working time is calculated for each loan application during the simulation run, using a random number generator. Only sporadic tasks are deposited with a constant working time, if they do not vary significantly in reality. The times were determined based on process documentation, direct measurements and interviews with experts:

- **Probabilities of events at the decision points**: loan applications can take different paths, depending on the attributes throughout the process. The paths are modelled by stochastic distributions, which have been drawn from reports from the bank's systems and expert estimates of the participating departments. Such probabilities of events include, for instance, the proportion of new commitments, the rejection rates, the acceptance rates of offers by customers, etc.

- **Number and availability of staff resources per business unit**: the number of users of e-files is estimated at 3,500 sales representatives with appropriate expertise in the credit business, and 55 employees in CRM who process lending decisions. The effective number of employees who are present in the simulation period equates to 2,940 sales representatives, as well as 46 to employees in CRM. These numbers are taking 30 vacation days and ten days for other absences, e.g. for seminars or illness, into account. The daily working hours are set by calculating the relevant divisions of 39 working hours per week. Overtime is not possible for reasons of simplicity. A typical schedule (for Germany) of 7.8 hours per working day is used, starting at 8:12 a.m. and ending at 5 pm including a lunch break from 12 am to 1 pm. This schedule is set for all employees as the opening hours of the branches and thus the working hours are standardised. The fact that sales staff, in addition to pursuing the administrative tasks of the credit decision process shown in the model, complete numerous other tasks, is modelled by a limited availability. Thus, sales staff are only available for 12 per cent of their working time to complete the tasks depicted in the present simulation model. The absence is usually 0.74 hours to 2.21 hours for each absence.
Cost of staff resources in hourly rates (staff costs): the cost of resources is an important input factor in order to assess the process to simulate alternative design options. For employees, an hourly fee of €61 at full cost is assumed, which was calculated at 210 actual working days and 7.8 hours per day.

At this point, the process model is enriched by the data so far so that a test run can be started for verification purposes. The required working time and resource utilisation of activities, and the probabilities of decision points, are already included in the simulation model. For a test run, a simple generator is used for the simulation period of four weeks, in which 100 funding requests are created each week. Using the graphical animation, the individual process objects can be monitored and, in this manner, a first verification of the model is made regarding the process logic (Hoad et al., 2010). All activities are addressed in the animation. Regarding the business process, the model is at this point already adequate. Thus, through the transformation step of the process documentation of the simulation model in terms of proper programming, the flow diagrams can be verified.

4.4 Validation of the simulation model

The validation of the model is results-oriented on the one hand, and functional in terms of plausibility on the other. The comparison is based on the existing data collected from the as-is process. Thus, a weighted cycle time of 4.96 hours (297.60 minutes) can be observed. After subtracting from a total of 88.06 minutes all steps that the process within the simulation model did not consider, namely customer selection, appointment and advisory, the result is an average cycle time of 3.49 hours. Furthermore, the empirical observed amount of processed loan applications (400 per day) is considered. The average cost for processed loan applications is not calculated by the bank, and thus cannot be considered.

To determine the effect of a concept in a certain situation, the simulation model has to start with the parameters reflecting the respective situation (van der Aalst et al., 2008). To ensure this, a warm-up period is suggested (Hoad et al., 2010) which is set to four weeks for a total simulation time of eight weeks. The observed maximum delay time of customer orders adds up to 23 days. Thus, an initial phase of four weeks seems adequate to produce a normal system state. The stochastic nature of the simulation model leads to different results every time the simulation model is executed. Thus, the simulation model has to be run several times to determine a stable average value of the relevant variables. The results can then be compared with the historical data using a double-sided t-test (Sargent, 2010).

To conduct statistical tests for a comparison of the cycle time the statistical software package SPSS 19 was applied. The simulation model leads to a cycle time of 3.8 hours for 200 iterations. This result is statistically significant ($T(199) = 718.56; p < 0.001$). A further check for the number of processed loans reveals similar results ($T(199) = -763.12; p < 0.001$). Thus, there is no necessity to increase the number of simulation runs due to validation criteria.

A function-based validation of the simulation model for the as-is process is conducted using extreme value tests. Tests with extreme values for individual input parameters can help to identify whether the model reacts in the expected way, like the real system. For example, when the loan requests are doubled, the average cycle time increases markedly. Similarly, the model responds to a halving of the full-time
equivalent FTE values with long cycle times. In contrast, if one puts unlimited FTE resources into the model, no idle times occur and the cycle time is reduced accordingly. The model thus behaves in a plausible manner.

4.5 Modelling the to-be situation (e-files)
The pre-defined as-is process forms the basis of the to-be process. The following paragraphs focus on the changes and their implementation in the simulation model. These changes relate to the elimination or modification of particular activities, as well as to a reduction of selected working times.

In the to-be process, the existing DMS is replaced by an e-file with additional functionalities. After eliminating the paper-based manual records of sales, the sales people get first access to digitised documents in the e-file. Thereby, copying the file manually is eliminated, and sales staff is relieved of these administrative activities. In the as-is process, the sales staff mirror documents in paper-based files, which are no longer required in the to-be process. Therefore, the activity “copy documents and store physical documents”, and, following the customer’s signing of the loan documents, the activity of “sort in physical documents” are no longer applicable (See Figure 3; changes are highlighted in grey).

The originals or certified copies are forwarded only after the completion of processing for the scanning service in which the digital archiving is performed.

In addition, changes are made to individual activities in the sub-process “Check of documents”. The activity of “acquire existing physical documents” is replaced by opening the e-file, because documents on existing customers are stored in digital form and are already present. The usage of the e-file on a computer takes less time than finding a single source file in a filing cabinet. Also, the working time for the activity “Comparison of existing and required documents” is reduced in contrast to the as-is process. A reduction of working time by 20 per cent was a consensus among the involved representative experts and validated by experimental sample tests in the existing process. Thus, the reduction valued at 20 per cent from five to 10 minutes in the as-is process to four to eight minutes in the to-be process. Finding digital documents with a keyword search is faster than retrieving them from assorted paper records. A filter option in the to-be process facilitates the document search. Up to five documents can be opened and viewed in parallel. The filing rules determine under which registers and classifications certain types of documents are stored by the scanning service. Furthermore, the elimination of coordinating with the branch office location or specialty mortgage advice unit to locate distributed documents has to be considered in the reduction of the cycle time.

In the sub-process “loan approval decision” for existing customers, the activity “open existing documents” is replaced with “open e-file”.

Although the back office, as opposed to the sales unit, already had access to digitised content in the old DMS, changes in the to-be process lead to additional functionality and improved stability and speed of application. Within the activities “Check of documents” (CRM) and “Loan approval decision” (CRM), working times are reduced, due to the improved search and filter function and an optimal indexing scheme. In addition to this, improvements in user friendliness shorten access and retrieval times of the e-file, in contrast to the old DMS, resulting in shorter cycle times. The activity “Comparison of existing and required documents” is characterised by a reduction of 20 per cent in working time, leading to eight to 24 minutes instead of 10 to 30 minutes. Due to the increased complexity of
Figure 3.
To-Be simulation model of the loan process
the loan exposures analysed in CRM, these activities will take longer in CRM than in sales. Figure 4 highlights the activities which are affected by the described changes.

4.6 Scenarios
For reasons of allowing a later comparison of the performance between the as-is process and to-be process, the same scenarios are defined for both process alternatives. The basic scenario is the initial situation observed in reality, which has been validated. A change in the simulation environment for process execution in the model allows a scenario analysis. In this way it is possible to determine what effects changes in input parameters have on the performance indicators of the business process. Central to this is the number of funding requests in the real system, which can vary depending on the competitive situation.

A realistic scenario is the increase of this number by 25 per cent (Scenario 1), as well as a possible decrease by the same number (Scenario 2). Thus, both variants are simulated as well.

5. Results of the simulation
In the 200 simulation runs of the as-is process, 14,930 transactions are completed during the measurement period of 28 days, i.e. this number of loan requests is simulated by running the entire process model in the form of bundles of documents for each case. These can be either completed and accepted loans, as well as rejected funding requests, or approved loans that are not accepted by the customer due to a competing offer. Funding requests that are rejected before the approval process starts do not count as completed (activity “funding request rejected”). The completion is decisive in the sense that it runs through the entire business process to one of the two defined endpoints for the documents during the scan service provider (existing customers) or the archive service provider (non-customers). Not every object that is induced by the generator at the beginning of the process is completed during the measurement period. The reason for this is that some objects enter the process at the end of the simulation time, and are not yet finished when the simulation period ends.

Within the to-be process, the number of process objects, which run through the entire business process to one of the two endpoints, increases from 14,930 to 15,018. It is remarkable that an increase in funding requests of 25 per cent leads to a reduction of 909 completed transactions in the as-is process. This is due to the utilisation of the sales staff in the as-is process, which, in the basic scenario, is already at 98.09 per cent. This usage may be reduced, with the introduction of the e-file in the to-be process, to 88.84 per cent. Therefore in the to-be process more transactions can be completed, even if the funding requests increase (plus 2,214 transactions compared to the as-is-situation). Figure 5 gives an overview.

The cycle time is measured from the start event to one of the two endpoints, and can be found in the following transaction statistics. The average cycle time of 186.14 hours (7.76 days) is made up of a working time of 3.80 hours, and the majority of 182.34 hours’ idle time. Within the idle time, the blocked time dominates with 112.84 hours, followed by the inactive time (58.47 hours) and the idle time (11.03 hours), due to shortages of resources. The reduction to 179.56 hours of the average cycle time from the as-is situation to the to-be situation arises for two reasons: working hours are a reduced by 18.6 minutes to 3.49 hours, and a lower
Figure 4.
Sub-processes of the to-be model
resource waiting time of 8.92 hours and lower inactive periods of 53.84 hours can be observed. However, the blocked time of resources is slightly increased (113.30 hours).

Having a look on the administrative workload from sales staff, the number of 77 per cent drops down to 69 per cent. Figure 6 gives an overview on the overall cycle time in every scenario.

From a transaction perspective it can be observed that the waiting time of transactions in the process decreases from 182.34 hours to 176.07 hours.

The transaction costs are the second dimension of process performance in this study. The costs considered here are composed of the labour costs of the as-is process used for staff resources, and IT costs for the DMS, which is divided into the categories infrastructure (€15,384.62) and software (€53,846.15) during the simulation period of 28 days. Thus, the average costs per funding request of €236.68 consist primarily of labour costs, which total approximately €3.46 million, and result in €232.04, on average, per transaction. For the increased number of 15,018 transactions in the to-be scenario, average costs per funding request are €215.05 (€212.89 for resources). This is due to the increasing number of transactions and the reduced cycle time, as well as lower IT costs. The average labour costs per transaction in the to-be process are lower in each scenario. Especially with an increase in the instantiated process objects, there is a reduction to €207.96. However, the different number of completed transactions must be borne in mind as a reference for these average costs (Figure 7).

How do the performance metrics change in the transition between the as-is process and the to-be process? The problem requires less accurate measurement of the absolute performance of a single business process, but rather entails a comparison between the process alternatives in terms of relative performance. The relative change in the
previously presented results individually in terms of times and costs can be found in the following table. It contains the results regarding a comparison of the as-is situation and the to-be model using the empirical observed number of incoming orders. The table provides an evaluation at an aggregate level of the business process in the sense of mean measures of completed transactions.

In addition to the initial situation, the three scenarios described above were simulated. The cycle time in the as-is process almost doubled with an increase of loan applications by 25 per cent. This result is also triggered by the enormous increase in the waiting time for resources to 47.87 hours.

This effect can be reduced with the introduction of the e-file in the to-be process. Here, the cycle time increases by approximately 54 per cent, and the average resource wait time increases to 27.92 hours. The pressure on capacity is diminished in the to-be process. The working time in the to-be process is decreased in each scenario by about 0.3 hours, compared to the as-is process. The effects on cycle time thus arise mainly due to changing idle times (Figure 8).

6. Discussion
The simulation results show – except for the slight increase in blocked time – an improvement in all measures, compared to the as-is process; this underlines the positive impact of the introduction of the e-file on the performance of the business process. Using the simulation results, the questions outlined earlier in the paper can now be answered.

Are the performance metrics (average cycle time and costs per loan application) improved by using the e-file?
Introduction of electronic documents

Figure 7.
Average working time

Figure 8.
Average costs per loan
When comparing the resulting output measures, it becomes clear that the introduction of the e-file has a particularly beneficial effect on cycle time in an environment of increasing funding requests. Compared to the as-is process, the cycle time in the to-be process is even about 25 per cent lower in the situation with an increasing number of incoming loans. The e-file can therefore support a strategy of growth in lending, in which more funding requests are generated.

The relative analysis revealed that the resource-wait time decreases significantly, by 19.13 per cent. The hypothesis set out above is confirmed: the reduction of working hours results in a disproportionately large reduction in wait times by itself. As shown in Table I, working hours are reduced by 0.32 hours. This will result, with reference to the interdependencies in resources in the model, to a roughly 19-times greater reduction in non-value-adding delays (6.27 hours).

Administrative relief for the sales staff, which is one of the intended benefits of the e-file introduction, is reached via the target process, and the simulation results show that the administrative workload drops by 10.39 per cent. The average cost per transaction decreases by 9.14 per cent due to the reduction in working time resources (8.16 per cent), and also decreasing IT costs.

Which potentials for improvement are possible from a branch point of view? For example, can copying and administrative activities for the paper-based reference file be reduced, in cooperation with other process resources? How many additional customer orders could be handled in the same time?

The potential reduced processing and idle times are reflected in an increase in completed transactions. Within the to-be process in the simulation period of 28 days, an increase of 88 units in completed funding requests was achieved. However 31 of these funding requests were rejected by customers or the bank. When this is extrapolated to a year, the remaining 57 units lead to 741 additional financing contracts. With an average loan amount of €150,000, the introduction of the e-file potentially offers around €111 million of additional funding volume per year. In addition, the time saved per funding request for sales staff is 0.32 hours, which can be used, for example, for cross-selling activities.

Using BPS to model a process is time-consuming, and therefore costly. However, the costs of risking a non-profitable business case are supposed to be higher (Doomun and Jungum, 2008). In the present case, no obvious information is available about the effects for sales staff, number of processed orders or cycle time. Regarding the research question as to how the introduction of electronic documents can be evaluated in advance, the conducted BPS delivers the necessary data for

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<th>Object for analysis (measurement unit)</th>
<th>Change (%)</th>
<th>$T$-test result</th>
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<td>Finished transactions (unit)</td>
<td>+0.59</td>
<td>$T(397) = -46.704; p &lt; 0.001$</td>
</tr>
<tr>
<td>Cycle time (hours)</td>
<td>−3.53</td>
<td>$T(397) = 113.77; p &lt; 0.001$</td>
</tr>
<tr>
<td>Working time (hours)</td>
<td>−8.16</td>
<td>$T(388.2) = 542.67; p &lt; 0.001$</td>
</tr>
<tr>
<td>Waiting time of transactions (hours)</td>
<td>−3.44</td>
<td>$T(397) = 108.95; p &lt; 0.001$</td>
</tr>
<tr>
<td>Waiting time of resources (hours)</td>
<td>−19.13</td>
<td>$T(397) = 220.44; p &lt; 0.001$</td>
</tr>
<tr>
<td>Blocked time of resources (hours)</td>
<td>−0.41</td>
<td>$T(397) = -13.04; p &lt; 0.001$</td>
</tr>
<tr>
<td>Inactive time of resources (per cent)</td>
<td>−7.92</td>
<td>$T(397) = 136.23; p &lt; 0.001$</td>
</tr>
<tr>
<td>Administrative workload of Sales (per cent)</td>
<td>−10.39</td>
<td>$T(389) = 144.26; p &lt; 0.001$</td>
</tr>
<tr>
<td>Costs of resources per transaction (Euro)</td>
<td>−8.25</td>
<td>$T(398) = 630.46; p &lt; 0.001$</td>
</tr>
<tr>
<td>Costs per transaction (Euro)</td>
<td>−9.14</td>
<td>$T(398) = 192.78; p &lt; 0.001$</td>
</tr>
</tbody>
</table>

**Table I.** Process performance – as-is situation vs to-be model based on the empirical observed numbers of incoming orders.
a decision. This makes it possible to model the assumed changes and to indicate the implications for processing times, costs and workload. Thus, it can be indicated that there is a positive business case for implementing such a system. However, it can also be planned for the future which accompanying actions have to be conducted to cope with variations in workload. There has to be a coordinated action plan in place for sales staff, so that they can use their additional time properly. Furthermore, the bank can rely on data regarding the ability to process all loan requests for customers in a reasonable time. In addition, it has been shown that these improvements lead to a cost reduction, which is a major factor influencing success in today’s competitive market.

7. Limitations
For the simulation model, the number of exposures and the percentage of new customers from the operational systems are used. However, there is no workflow management system from which all the input data can be generated, and the missing values are estimated by experts who are familiar with the process. Thus, the working times for each activity are modelled largely on the basis of this expert information, with distributions. In particular, working times for activities in sales are mainly based on surveys that were conducted as part of process cost accounting for mortgage loans. It has to be noted that the expert estimates for input parameters are naturally associated with the uncertainty, since they are subjective.

A simulation model is never a complete representation of the real system, and thus some shortcomings have to be taken into account. The model accounts solely for the document flow, and neglects other activities such as customer service, as these run similarly in the as-is process and the to-be process. Furthermore, there are some feedback loops in the model, e.g. in the request for further information through CRM. Additionally, sales staff is busy with numerous other activities in addition to the processing of funding requests, which are not mapped in detail in the model, but are only represented by the limitation of available time.

Regarding the simulated cost savings, it has to be noted that these can be realised only with a full implementation of the to-be process. However, at the time of the study, the new system could not display the historical information of a loan. As a result, in addition to the e-file, it is necessary to conduct a parallel operation of the old system with cost burdens for both. IT costs are reduced only at a cut-off of the old system. One-time costs regarding the migration of existing data, as well as the implementation costs of the new system, are not represented in the above calculations.

8. Conclusion
This paper has shown how business process simulation can be used to evaluate the introduction of e-files in a process. Especially the modelling shows how a conceptualisation for simulation purposes of such settings can be performed. Beside the typically used factor time, we also highlight implications for additional business based on workload analysis, and for resulting costs. The e-file enables efficiency gains through the elimination of copying and administrative duties for paper-based manual filing, and is the basis for industrialisation steps such as automation, workflow control, centralisation and outsourcing of processing steps. The average cycle time, as well as the costs, could be reduced. Additionally, it is shown that the reduction of working hours by introducing the e-file disproportionately affects a reduction in wait times.
Thus, the resource wait times can be identified as bottlenecks in the process. Furthermore, sales staff have a reduced administrative workload, which also leads to a reduction in costs for processing a loan request. The introduction of the e-file has a positive effect on the relevant performance indicators, and opens the potential for additional business. These aspects could only be identified using the simulation model described. Thus, a company can ensure a coordinated action plan to effectively use the resulting business opportunities, and only focus on the technical implementation of such a system.

The case study shows how business process simulation can be applied to evaluate the implications of introducing IT systems using the example of e-files. The results go beyond a simple assessment of the technical perspective, which means that the business implications are also covered. Thus, on the one hand the data generated in the simulation results can form the basis for feasibility studies regarding IT investments, e.g. for the migration of historical data from the old DMS system. On the other hand, further actions can be deduced for sales staff and other processes, which can use employees’ additional free time.

A further extension of the results can be made to outsourcing attempts of an e-file management system. Internal effects like the one presented can be compared to the situation if the IT system is outsourced and e-files are provided by an external supplier. In such a case further effects of an e-file introduction on cost would be in the focus of the analysis. The simulation model used in this paper already includes an external service provider. Here, the parameters for fixed costs would have to be changed as cost per transaction by a service provider would be more feasible. Also further effects on internal staff could be studied to determine the additional free time for other tasks within the organisation. Overall, the described procedure in this paper would remain similar but the parameters would have to change.

The results could also be transferred to service providers in other domains (e.g. airlines and health care provider) which have information-processing services. Such processes typically cover activities in which customer data is stored which is used by various groups of employees during the service delivery. To ensure that the data is available independent from place and time, DMS can be helpful but the impact weighting benefits and costs has to be weighted for individual settings. In such settings the presented approach to set up a conceptual model in these domains could be beneficial.

References


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