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TOWARDS A CONTEXT-AWARE ANALYSIS OF BUSINESS PROCESS PERFORMANCE

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Abstract

Context-aware business process management is moving into the focus of research interest. Since the environment is changing continuously, these changes influence business processes. Thus, the respective context has to be considered while analysing the performance of business processes. This paper presents a new methodological approach to identify the effect of contextual factors on business process performance in terms of processing time. For this purpose, we look at the level of activities within a business process. In a two-stage approach, process mining techniques are combined with statistical methods. This approach facilitates detecting impacted activities and thus determining which activities within a business process are indeed dependent on the context. The methodology is evaluated based on empirical data of an extensive case study from a bank's loan application process. The results reveal that although some contextual factors have an impact on processing time, the effect is limited to certain activities.

Keywords: Context-aware, business process, process mining, performance analysis.

1 INTRODUCTION

Understanding the reasons for variations in the performance of business processes is critically important for research on business process management (Banker & Natarajan 2008; Rosemann et al. 2008). Trying to identify the root causes for process performance deficiencies and to eliminate them should be the aim of every company. In doing so, it should be considered that the context in which a business process is executed plays an important role for variances of business process performance (Banker & Natarajan 2008).

The influence of the context can be operationalised by contextual factors. These are indicators of the environment surrounding a business process. Contextual factors can be found outside of the external corporate environment or within internal company characteristics (Papadakis et al. 1998). In any case, they are not inherent in the business process under analysis. Examples of contextual factors are weather conditions or holiday seasons (Rosemann et al. 2008).

According to Seethamraju and Marjanovic (2009), there is no single model (in the present case, a measurement model of business process performance) which fits to every business situation, as these are always dependent on the context. The question rather is whether this contextual influence has indeed an impact. Furthermore, the whole business process does not necessarily has to be affected by a contextual factor. This is especially important when looking for improvements in the business process in order to cope with contextual influences.

Ploesser et al. (2009) outline four relevant areas for a context-aware design of processes: (1) Context modelling, (2) context learning, (3) context taxonomies for industries, and (4) context-aware process operations. However, literature focuses mainly on contextual modelling of business processes (e.g. Saidani & Nurcan 2007; Rosemann et al. 2008) or on identifying industry specific contextual factors (e.g. Newman & Sabherwal 1991). Nevertheless, context-aware process operations, i.e., the consideration of contextual factors on business process performance, is of great importance (Banker & Natarajan 2008). Therefore, the following research question arises: How can the impact of contextual factors on business process performance be identified?

To answer this question, this paper presents a methodology which proposes a two-stage approach. In the first stage, process mining techniques are used to identify the relevant data. In the second stage, statistical methods are applied to the data to determine the contextual impact. In this paper, process performance is analysed in terms of time, which is a main factor for the efficiency of a business process besides costs and quality (McLaughlin & Coffey 1990). Analysing each factor in isolation is already a challenging task (e.g. Wynn et al. 2008). Thus, a multi-factor analysis is not performed within this research.

The paper is structured as follows: Section 2 provides information about the research method applied. In section 3, the related work is discussed. This covers the idea of contextual factors as well as existing approaches for the analysis of contextual factors at a process level. Section 4 presents the proposed methodology which is evaluated in section 5 using a case study. Section 6 contains a critical appraisal of the research conducted. Finally, an outlook for further research is provided in section 7.

2 RESEARCH METHOD

The development of the methodology follows the design science framework by Venable (2006) which is based on ideas of Nunamaker et al. (1991), March and Smith (1995), Venable and Travis (1999), and Hevner et al. (2004). According to this framework, the methodology is a new artefact that builds on existing and established concepts of the research streams process mining, context awareness and business process performance analysis. In line with theory building of the framework, the utility theory of this paper is that the application of the presented methodology will help to identify the

impact of contextual factors at a process level. Consequently, the main focus of the paper lies on the development of the proposed methodology (Venable 2006). The evaluation of the methodology's applicability is illustrated by means of a case study. Case studies allow collecting comprehensive process data that is required for the evaluation of the proposed methodology. The case (a loan application process of a mid-sized bank) is a typical example for a business process. Thus, the analytical generalisation of the proposed methodology for the type of problem described will be proved. According to (Yin 2003), a single case study is sufficient for this endeavour.

3 RELATED WORK

3.1 Concept of contextual factors

The idea of being aware of the context in which a company is operating is not new. However, a commonly accepted comprehensive understanding of this idea is still missing (Rosemann et al. 2008). Definitions range from a rather abstract to a very operational level. Early work on context focuses more on an abstract level, namely the strategy of companies. Contextual influence can be divided into environmental and organisational conditions (Youssef 1975). The focus on the influence of contextual factors at a strategic level includes, for example, consideration of the parent company's ownership, the company's age, the company's size, the duration of the company's international involvement, the extent of a company's international involvement, and the degree of host country development (Youssef 1975).

Hambrick and Snow (1977) focus on the strategic level by analysing the influence of environmental conditions, internal power and influence patterns as well as a company's past and present performance. A similar differentiation of contextual factors in the external corporate environment and the company's internal characteristics can be found in Newman and Sabherwal (1991), Papadakis et al. (1998) and Sila (2007).

On a more operational level, Schilit and Theimer (2002) provide a definition with regard to the design of context-aware computer systems. In this case, context is referred to as being aware of the location, the type of users and their interaction with computer systems. As the focus of this view is too narrow, Dey (2001, p. 5) provides an operational but generic definition: "Context is any information that can be used to characterise the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves."

Taking a closer look at the general effect of contextual factors, literature suggests that they have moderating effects on the entity under analysis (Bhatt 2000; Elenkov et al. 2005). Furthermore, contextual factors are themselves dynamic. They exert influence but are also subject to change (Newman & Sabherwal 1991). Thus, a continuous analysis should not only look at the effect of contextual factors but should include the factors themselves.

3.2 Contextual factors and business process performance

Summarising the ideas and definitions described in the previous section and adapting them to a business process level, entities can be the business processes themselves or the respective activities within the processes. Contextual factors that have an influence on performance of business processes are either external or internal conditions of the company.

Within process operations, the consideration of contextual factors could lead to a diversified view of process performance. Instead of analysing the performance of a business process as a whole, it might be favourable to derive different performances based on the major independent contextual factors. Processes should be improved having a multi-performance in mind. One specific characteristic of a

contextual factor might be the reason for a poor overall performance. Figure 1 delivers an example in which the root cause of low performance is the time of day, in this case the evening. Using a call centre as an example, the reason might be a peak of calls caused by customers calling after work, while the number of employees working is the same for all times of day.

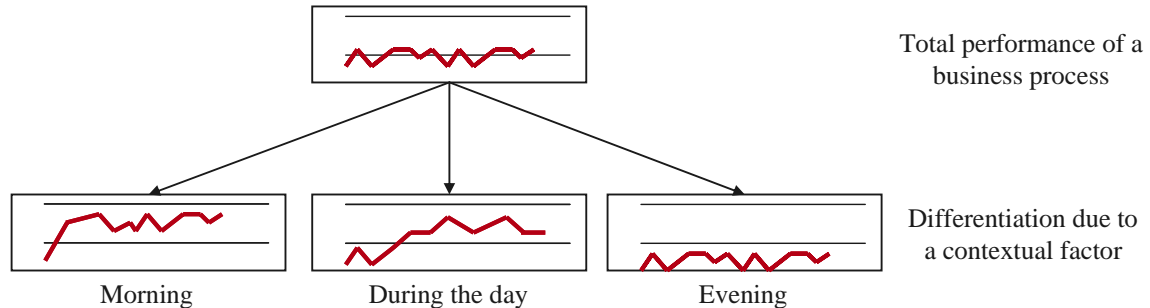


Figure 1. *Differentiation of performance due to contextual factors*

Environmental contextual factors are related to (1) the industry such as industry type, information intensity of the industry (Bhatt 2000) or competitive pressure (Jelinek et al. 2006), (2) customers in terms of their behaviour and expectations (Jelinek et al. 2006), (3) general conditions such as the weather or time (Rosemann et al. 2008), and (4) characteristics of the process instances (Doerr & Arreola-Risa 2000). A process instance is “the ‘thing’ which is being handled, e.g., a customer order, a job application, an insurance claim, a building permit, etc.” (van der Aalst et al. 2007, p. 713 f.). A process instance has to pass the activities necessary within a business process before being finalised (Davenport & Short 1990).

Internal contextual factors can be related to (1) organisational conditions such as the availability of employees, as they often work in several business processes (Davies 1994), and (2) the workload within a business process (Doerr & Arreola-Risa 2000).

3.3 Identifying contextual factors at a process level

To the best knowledge of the author, there are only a few approaches analysing the influence of contextual factors on a process level. Ramos et al. (2010) propose an approach for identifying contextual factors with the aim of process improvement. The impact of possible factors is measured using characteristics of the outcome of process instances, i.e., after the activities within a process took place. Although the authors reference process mining in their approach it is not applied. Thus, the link of contextual factors and process improvements remains vague as the process itself remains a black box.

Burger and Moormann (2010) aim at evaluating the performance of a settlement and clearing process in a bank. For the evaluation of the efficiency of process instances within a process, they apply data envelopment analysis. Here, the focus is put more on benchmarking of process instances. This approach is the first one to apply data envelopment analysis on a process level; approaches before were limited to companies or departments as superior units. The reasons for variances in efficiency remain unanswered. Furthermore, data envelopment analysis exclusively uses an input-output model for efficiency measurement. Therefore, activities within a business process are considered as black boxes (Frei & Harker 1999).

Further research in this field aims at a clustering of inefficiency drivers after performing a data envelopment analysis (Dohmen & Moormann 2010). Inefficiency drivers are certain characteristics that negatively affect the performance of a business process. Similar to the idea of contextual factors, this approach aims at identifying general inefficiency drivers for a business process. Hence, contextual

factors for a business process can be identified, but one cannot analyse which activities are affected. The methodology presented in the following section tries to overcome this weakness.

4 METHODOLOGY FOR IDENTIFYING THE IMPACT OF CONTEXTUAL FACTORS

4.1 Overview

The proposed methodology aims to fill the research gap identified in section 3.3. It focuses on identifying the impact of contextual factors on the activities within a business process. The methodology is separated into two stages: In the first stage, the relevant data for the analysis is identified. Precondition is the definition of the contextual factors which are assumed to have an influence. For these factors, the relevant data can be gathered by using techniques of process mining. Here, the respective characteristics of the contextual factor in combination with the processing time (that is, the time spent on a process instance) are assigned to each process instance. In the second stage, a dependence analysis is performed, i.e., statistical methods test whether there is a difference in processing time depending on each contextual factor. Depending on the type of data (parametric/non-parametric), several statistical methods have to be used. The two stages will be described in detail in the next two sections.

The availability of event logs is a precondition for the proposed methodology. Event logs are automatic timestamps documenting order processing. Table 1 provides a generic example. Event logs can be generated automatically by process-aware information systems such as workflow management systems (van der Aalst & Weijters 2004).

ID (process instance)	Activity	Originator	Begin	End
#203	Documenting complaint	Agent	10:04; 05.03.2010	10:14; 05.03.2010
#204	Handling complaint	Clerk	10:15; 05.03.2010	11:00; 05.03.2010
#203	Documenting complaint	Agent	10:30; 05.03.2010	15:25; 05.03.2010
...

Table 1. Example of event logs

The event logs gathered for a business process have to be pre-processed since real world data usually includes noise. Such noise can be, for example, false timestamps with the same time for beginning and end.

Summarising, the requirements for the proposed methodology are as follows: (1) Event logs containing the minimum information of process instances, activities, begin and end have to be available. (2) Only finished process instances can be included in the analysis due to calculation purposes. (3) The characteristics of contextual factors have to be nominal, i.e., a fixed set of characteristics exists for every contextual factor, to perform the statistical analysis.

4.2 Stage 1: Identification of relevant data using process mining

Firstly, the relevant contextual factors and their characteristics have to be identified. Reasonable categories for business processes are summarised in Table 2 based on the literature presented in section 3.2. Examples are given for each type of contextual factor.

Level	Type	Example	Characteristic 1	Characteristic 2	Characteristic ...
Environmental	Industrial condition	Regulation	Low regulation	High regulation	
	Customer characteristics	Status	Normal client	Special client	

	General conditions	Weather	Rainy day	Sunny day	
	Characteristics of process instances	Weight of parcels	Light (less than 10 kg)	Heavy (more than 10 kg)	
Internal	Organisational conditions	Health situation of employees	Flu season	No flu season	
	Workload within the process	General capacity utilisation	Low (up to 30% capacity utilisation)	Middle (30% - 70% capacity utilisation)	High (more than 70% capacity utilisation)

Table 2. *Types of contextual factors of business processes*

The identification of contextual factors is highly dependent on the concrete business process. There has to be an assumption which factors might have an impact. However, the analysis should take place using the categories above as guidance to either evaluate if existing data fits in these types or if additional data has to be gathered.

Secondly, the relevant processing times have to be extracted from the event logs. Here, the total processing time of process instances as well as the processing time per activity of each process instance (PI) is of interest. The total processing time for each process instance (TWT_i) can be calculated as follows:

$$TWT_i = \sum_{j=1}^{N(A)_i} E_{ij} - B_{ij} \text{ for } i = 1 \text{ to } N(PI)$$

where $N(PI)$ is the number of process instances in the event log, i the consecutive number of process instances, $N(A)_i$ the number of activities documented for a process instance, j the consecutive number of activities per process instance, E_{ij} the end time, and B_{ij} the start time of each activity.

The processing time per activity for each process instance is calculated using the following formula:

$$A_{ki} = E_{ki} - B_{ki} \text{ for } k = 1 \text{ to } N(A) \text{ and } i = 1 \text{ to } N(PI)$$

where $N(A)$ is the number of activities within a business process, k the consecutive number of activities, $N(PI)$ the number of process instances in the event log, i the consecutive number of process instances, E_{ki} the end time, and B_{ki} the start time of a process instance for an activity. The result is a table, as highlighted at the left bottom of Figure 2.

Thirdly, the characteristics of each contextual factor have to be assigned to every process instance within the event log under analysis. There are two generic options:

- The usage of a certain activity of a process instance indicates the respective characteristic of an external contextual factor. This can be, for example, an additional activity like an extensive security check which is only performed for parcels from a politically volatile country. If such an activity is documented in the event logs for a process instance, every timestamp of the process instance has to be assigned with the respective characteristic.
- Date or time of the event logs are used as reference for assigning external data of contextual factors. In this case, the information has to be assigned to a relevant measure for each timestamp independently from the process instances within the event logs.

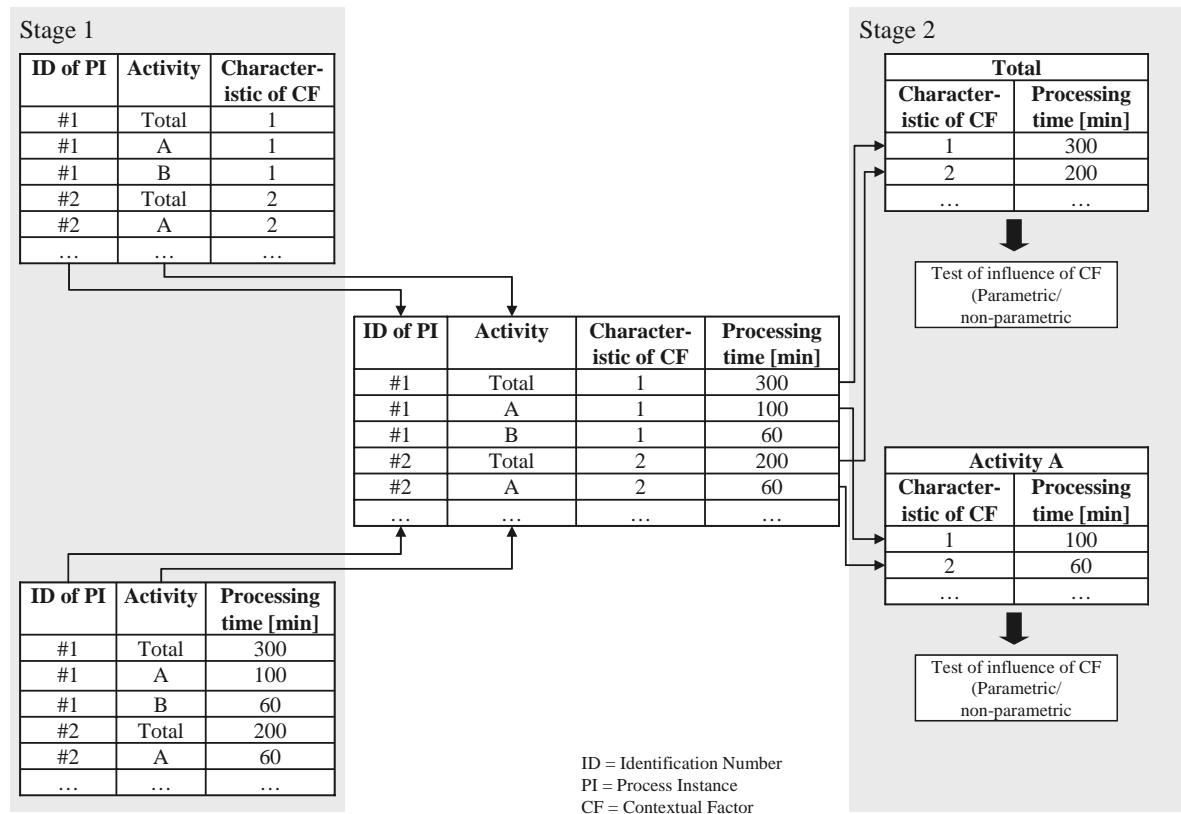


Figure 2. Procedure of the proposed methodology

Having finished the respective procedure, the result will be a table for each contextual factor as indicated at the left top of Figure 2 which gives an overview of the proposed methodology for one contextual factor. The interface between the two stages is a table for each contextual factor in which the respective processing times are assigned to the respective characteristics. The analysis has to be repeated in the same way for each defined contextual factor.

Fourth, the calculated processing times with the assigned characteristics have to be combined. Here, the common elements of both tables are the columns incorporating the ID of the process instances and the activities. Each row that has the same combination can be filled with the respective processing time and the relevant characteristic. The result is a combination of overall processing times as well as for each activity and the corresponding characteristics.

4.3 Stage 2: Analysing contextual influence on processing times with statistical methods

Based on the table developed in stage 1, the first step of this second stage is to test whether the data is normally distributed or not. This precondition, in combination with a test for homoscedasticity, i.e., the variances of the variable analysed are homogeneous, has to be fulfilled. If this is not the case, non-parametric tests have to be applied (Ruxton & Beauchamp 2008). Figure 3 exhibits an overview of the statistical tests which are combined.

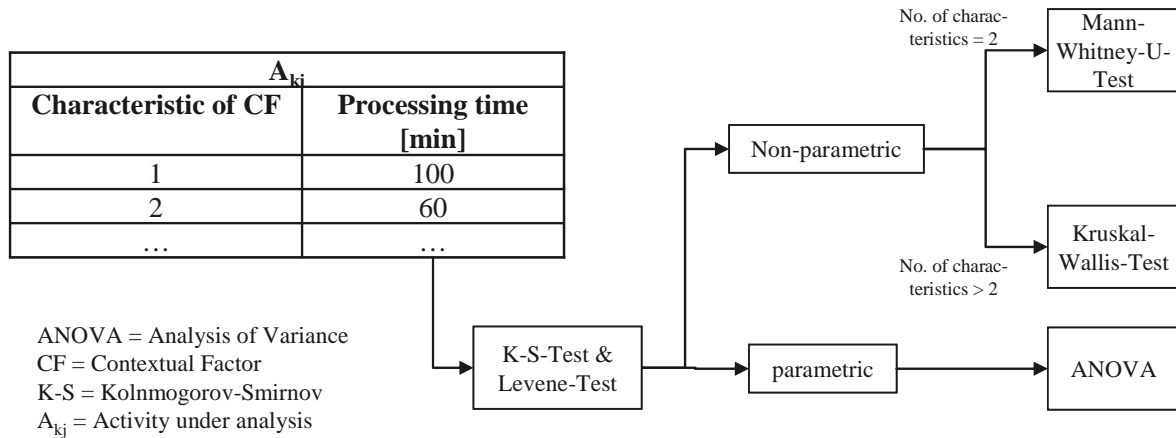


Figure 3. Using statistical methods to test for the influence of contextual factors

More than 40 statistical tests are available to test whether data is normally distributed (Dufour et al. 1998). However, the modified Kolmogorov-Smirnov-Test of goodness of fit is recommended (Yazici & Yolacan 2007). The idea is to test whether the deviation of empirical data from a theoretical statistical function (in this case, the normal distribution) is small enough (Roussas 1973). If the results are statistically significant, the Levene-Test can be applied to test for homoscedasticity (Ruxton & Beauchamp 2008).

If both conditions are fulfilled, a one-way analysis of variance (ANOVA) can be performed. The aim of the ANOVA is to test whether the average value of a metric variable (in this case, processing time) is dependent on a nominal variable (the contextual factor). If the data is non-parametric, the Mann-Whitney-U-Test has to be applied when a contextual factor contains two characteristics and the Kruskal-Wallis-Test for more than two characteristics. These tests focus on the same analysis as the ANOVA but can deal with non-parametric data (Ruxton & Beauchamp 2008). If statistically significant results are detected, descriptive statistics should be applied to measure the percental and the average processing time for each characteristic of a contextual factor in order to determine its impact.

5 APPLICATION OF THE METHODOLOGY WITHIN A CASE STUDY

5.1 Basic information

The case study is based on loan application processing of a bank in Germany. This is a typical process in the financial services industry, as the granting of loans is one of the main tasks of banks. 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 processes, whereby each part can be understood as a separate business process (Chase & Bowen 1991).

In the process shown here, the processing of business customer loans for small and medium-sized enterprises (SME) is conducted without any collateral. "Customers" of loan processing are 22 branches of the bank that sell these loans to SMEs. If information or documents are required from SMEs, the contact happens via the branches.

Data on the loan application process was gathered for six months by the underlying workflow management system. Within this period, 265 loan applications (process instances) were processed completely, meaning they were either rejected or approved. In doing so 3.505 events (activities) were performed by the employees of the process in total and automatically documented while they were

performing their work. The logs contain information of begin, end, originator, process instance and activity for each event. The logs were pre-processed to remove noisy data like event logs from other processes in the workflow management system or activities showing the same time for beginning and end.

The selection of contextual factors for the process is based on available data for the business process. The factors are from three different categories defined. However, the selection is not based on completeness, i.e., to provide an example for every category. The procedure will be the same for every factor of a category.

5.2 Results of applying the methodology

Table 3 shows the contextual factors, including the respective selected characteristics, for the loan application process which could be identified. Thus, “weekdays” belonging to the type “general conditions”, “type of loan” belonging to the type “customer characteristics” and “level of approval” belonging to the type “Characteristics of process instances” are chosen. It is of interest to test whether these have an impact on the respective processing time within the business process. Concerning the first contextual factor, the characteristic “special loans” can be assigned to process instances incorporating timestamps of the activities related to special processing. Concerning the level of approval (this indicates the potential risk of the loan; the higher the risk, for example, due to a high loan amount, the higher the level of approval needed) the same holds true for characteristics 2 to 4. Process instances incorporating a timestamp of the respective activity were assigned to the relevant characteristics. The remaining process instances without a characteristic were marked with characteristic 1. For the contextual factor “weekdays”, each timestamp was labelled with the applicable day based on the date documented in the logs.

Type	Characteristic 1	Characteristic 2	Characteristic 3	Characteristic 4	Characteristic 5
Type of loan	Normal loans	Special loans characterised by non-standard conditions			
Level of approval	Front-Office clerk	Front-Office manager	Back-Office Clerk	Board of management	
Weekdays	Monday	Tuesday	Wednesday	Thursday	Friday

Table 3. Contextual factors of the business process

For the chosen contextual factors, the event-logs were processed as described in sections 4.1 and 4.2. Table 4 provides the final results of the procedure within the stages applied (F indicates that data is parametric; K and U indicate non-parametric data; P is the probability; in case of “-“ N is too small). The results of the Kolmogorov-Smirnov-Test of goodness of fit and the Levene-Test are not listed.

Activities	Type of loan	Level of approval	Weekdays
Overall processing time	U(2113.5), p < .0001	K(3) = 9.58, p < .03	Not applicable
Precheck	U(7695.0), p = .354	K(3) = 11.94; p < .01	K(4) = 2.88; p = .578
Processing incomplete orders	F(1, 51) = 0.62, p = .434	K(3) = 7.07; p = .07	K(4) = 2.00; p = .737
Preparation of special processing	Characteristic 2 only	F(3, 33) = 0.53, p = .665	K(4) = 15.18; p < .01
Execution of special processing	Characteristic 2 only	K(2) = 0.11; p = .948	K(4) = 5.11; p = .276
Scheduling of special processing	Characteristic 2 only	F(3, 44) = 0.56, p = .643	F(4, 42) = 0.61, p = .664
Check of applications	U(3611.5), p = .607	K(3) = 2.09; p = 0.553	K(4) = 4.67; p = .322

Processing of applications	U(1686.5), p = .81	K(3) = 7.81; p < .05	K(4) = 8.44; p = .077
Processing of reply	-	-	-
Scheduling of processing	F(1, 29) = 8.82, p < .01	F(3, 27) = 0.39, p = .759	F(4, 46) = 0.83, p = .515
Get customer signature	U(287.0), p < .05	K(3) = 3.61; p = .307	K(4) = 7.57; p = .109
Check of documents	U(2.50), p = .545	F(3, 7) = 2.76, p = .122	F(4, 6) = 1.49, p = .316
Rework	F(1, 16) = 0.00, p = .966	F(2, 15) = 0.28, p = .758	F(4, 13) = 0.34, p = .847
Check of approvals	Characteristic 1 only	-	F(2, 2) = 0.41, p = .712
Approval	U(7.50), p = .941	K(1) = 0.04; p = 0.85	K(4) = 3.33; p = .504
Processing approvals	Characteristic 1 only	F(2, 8) = 14.97, p < .01	K(4) = 3.43; p = .488
Preparation draft executive	F(1, 8) = 0.68, p = .435	Characteristic 4 only	F(3, 6) = 4.28, p = .062
Approval at executive board	F(1, 6) = 0.03, p = .874	Characteristic 4 only	K(2) = 2.78; p = .249
Archiving	U(3407.0), p = .623	K(3) = 4.44; p = .218	K(4) = 12.21; p < .02

Table 4. Statistical results of testing for contextual factors

The results show that the type of loan and the level of approval have a statistically significant influence on the overall processing time of process instances (the analysis of weekdays on the overall processing time was not applicable as more than one weekday passes during the overall processing time). Yet, a closer look at the single activities within the business process reveals a different picture. A total of seven activities exhibit a statistically significant influence from the contextual factors. Furthermore, few activities deal with one characteristic of contextual factors only. To determine the effect on the average processing time per activity, descriptive statistics are provided in Table 5.

Activity	Characteristic 1	Characteristic 2	Characteristic 3	Characteristic 4	Characteristic 5
Precheck	Front-office clerk (70.6%; avg. 24.5 min)	Front-office manager (18.9%; avg. 12.4 min)	Back-office clerk (6.7%; avg. 11.2 min)	Board of management (3.8%; avg. 7.8 min)	
Preparation of special processing	Monday (13.9%; avg. 2.7 min)	Tuesday (16.7%; avg. 23.6 min)	Wednesday (27.8%; avg. 7.7 min)	Thursday (22.2%; avg. 10.0 min)	Friday (19.4%; avg. 6.6 min)
Processing of applications	Front-office clerk (76.8%; avg. 40.3 min)	Front-office manager (14.6%; avg. 82.0 min)	Back-office clerk (6.7%; avg. 57.7 min)	Board of management (1.8%; avg. 18.7 min)	
Scheduling of processing	Normal loans (77.4%; avg. 52.0 min)	Special loans (22.6%; avg. 77.1 min)			
Get customer signature	Normal loans (88.3%; avg. 43.9 min)	Special loans (11.7%; avg. 112.3 min)			
Processing approvals	Front-office clerk (0.0%; avg. - min)	Front-office manager (18.2%; avg. 7.5 min)	Back-office clerk (72.7%; avg. 32.6 min)	Board of management (9.1%; avg. 265.5 min)	
Archiving	Monday (21.0%; avg. 58.3 min)	Tuesday (17.9%; avg. 66.6 min)	Wednesday (19.8%; avg. 42.6 min)	Thursday (20.6%; avg. 67.0 min)	Friday (20.6%; avg. 47.4 min)

Table 5. Descriptive statistics of activities with contextual influence

The results indicate that the majority of process instances of the activities “Scheduling of processing” and “Get customer signature” are normal loans. These are characterised by a shorter processing time than special loans. Concerning the level of approval “Precheck,” the majority of loans are approved in the front-office and have the longest processing time. “Processing of applications” has a similar distribution of characteristics, but the majority (Characteristic 1) has the second shortest processing

time. For “Processing approvals” this is different. The majority of loans processed are approved by back-office clerks; loans that are approved by front-office clerks are never processed. Concerning weekdays, the processing of the activities “Preparation of special processing” and “Archiving” takes place on all weekdays with the almost the same percental share. However, the processing time is extremely low on Mondays for the activity “Preparation of special processing.”

6 POSSIBLE LIMITATIONS

The methodology presented is helpful in identifying the impact of contextual factors at a process level. Nevertheless, some limitations should be taken into account:

- Event logs gathered using process mining techniques enable a relatively fast analysis of service processes over a large time span. Nevertheless, event logs are limited to documented activities monitored by a workflow management system. Activities of employees, like informal phone calls if certain information is missing, will not be documented.
- Since the data for the evaluation consists of approved loans only, some activities associated with loan applications, for example activities that started prior to or ended after the observation period, were not considered. This could lead to a bias in analysing contextual factors. The bias is expected to be negligible if a long time period is used as in the case presented.
- Costs or quality of processing as further common indicators for process performance were not considered either. They could deliver a different result of the impact of contextual factors as fixed costs per activity and different levels of employee costs might occur. Quality might also influence performance, but is hard to be measured. One possibility could be the number of back-loops while working on a process instance. These aspects are going to be integrated in further research.
- The evaluation has been conducted with one case study only. This might be a problem with regard to a generalisation of the applicability of the methodology. Therefore, different degrees of generalisation exist limiting that the designed artefacts works at any time (Gregor & Jones 2007). The evaluation conducted has shown that the methodology works with the data fulfilling the defined requirements. Therefore, it is assumed that the methodology works with any business process having more than one activity and fulfilling the requirements.

7 CONCLUSION

The presented methodology enables the identification of the impact of contextual factors on business process performance in terms of processing time. The case study shows that two contextual factors have an impact on the overall processing time of the process. Nevertheless, the detailed analysis reveals that this impact is limited to certain activities. Most activities are not affected, and a few even do not handle process instances with different characteristics of contextual factors at all. However, the affected activities can be identified and the percental share of each characteristic and its average processing time calculated.

Overall, the contribution of the methodology is on the identification of the impact of contextual factors on a process level. As the results show this is necessary. The methodology allows for a clear depiction at which stages of a business process contextual factors have indeed an impact. Thus, a well-directed analysis of the root causes for a low performance due to contextual influence can be conducted.

The method so far highlights business processes incorporating mainly activities performed by employees. Nevertheless, the method can also be applied for business processes consisting of automated activities. The added value for manually performed activities within a business process is higher, but even highly automated business processes, for example the process of settlement and

clearing in banks incorporate many variations concerning processing time (Burger & Moormann 2010).

The results are the basis for precise improvements of the business process. Control can be improved as the variance of processing time can be traced back to certain characteristics of process instances or external circumstances. If the process manager knows, for example, that the amount of special loans will rise significantly due to marketing activities he can estimate the consequences. For activities that involve a high percentage of processing special loans combined with a long processing time, he can plan to staff additional employees to ensure a reasonable overall processing time. Furthermore, improvements should focus on activities with a long processing time. This requires looking more closely for the underlying root causes due to a certain characteristic. This may be, for example, the question why particularly special loans need such a long processing time and how this can be improved.

The evaluation of reasonable process improvements identified can take place using business process simulation. The historic data can be used to build a simulation model of the business process. Expected future scenarios can then be combined with planned changes to analyse whether the performance increases with regard to the impacting contextual factors.

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