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Framework of a Process Laboratory for the Operational Control of Service Processes

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Abstract

Service processes such as financial advice, booking a business trip or conducting a consulting project have emerged as units of analysis of high interest for the business process and service management communities in practice and academia. While the transactional nature of production processes is relatively well understood and deployed, the less predictable and highly interactive nature of service processes still lacks in many areas appropriate methodological grounding. This paper proposes a framework of a process laboratory as a new IT artefact in order to facilitate the holistic analysis and simulation of such service processes. Using financial services as an example, it will be shown how such a process laboratory can be used to reduce the complexity of service process analysis and facilitate operational service process control.

Keywords

Operational Control, Process Model Design, Modularisation, Business Process Simulation, Process Laboratory.

1. INTRODUCTION

Service companies like travel agencies, accountants, carriers, and banks have to deal with intense competition in their respective markets. Therefore these companies are forced to reduce their costs significantly. In order to achieve this goal, a strict management of business processes is essential. Effective and efficient Business Process Management demands an integrated concept of leadership, organisation and control (Davenport and Short 1990). This leads among others to a goal-oriented control system of business processes that consists of normative, strategic, and operational process control. As the environmental conditions are continuously changing, ongoing operational control of service processes is a decisive factor for the agile organisation.

Within operational process control the process manager continuously observes the process routing of orders in a production system, which consists of all processes necessary for the service delivery (Gregory et al. 2005). In case of a deviation from defined goals he/she takes action to influence the process routing immediately (Kawalek and Kueng 1997). Within the manufacturing industry a number of concepts for operational control are available. Especially car producers have optimised their control by creating not only a simple assembly line being able to produce a wide range of individualised cars (economies of scale) but also different models (mass customisation). However, those concepts cannot be transferred one-to-one to the service industry (Davies 1994).

This paper proposes to use a process laboratory to analyse and enhance operational management of service processes in order to close this gap. A process laboratory is characterised by a goal-oriented, experimental, computer-aided execution of process models. A process laboratory facilitates anticipating the behaviour of a process in an artificial environment and without direct disturbance of the running processes. The *aim of this paper* is to provide a framework of such a process laboratory for the operational control of service processes. As such, this paper reports on a major part of a Design Science process, i.e. the development of an important new IT artefact.

The necessity of controlling service processes has been shown e.g. in an empirical study by Heckl (2007) focusing on service processes in the German financial services sector. The study reveals that service providers like banks consider process control as important to raise effectiveness and efficiency (>75% of the respondents). Despite this result, most banks (80%) have not documented their sub-processes and therefore report major problems in measuring their service processes. Finally, the answers related to the control of service processes show that banks miss a structured proceeding and even advanced banks rarely use operational control for their service processes. Based on the results three critical factors for the development of a framework of a process laboratory have been identified: At the beginning the specific characteristics of service processes have to be taken into account (Section 2). The framework of a simulation-based process laboratory is developed to analyse and evaluate options for operational control of service processes (Section 3). As the modularisation technique for structuring service processes is a major part of the framework, it is presented in more detail (Section 4). Finally, the authors draw conclusions and give an outlook on further research.

2. CHARACTERISTICS OF SERVICE PROCESSES

Prior to thinking about operational control of service processes, it is necessary to characterise the unit of analysis "service process" to understand the specific requirements for operational control. Basically one can find three major influences determining services:

- Firstly, service processes are mostly characterised by a direct involvement of the customer into the production process (Zeithaml et al. 1985). A patient, for instance, has to be physically present at the physician's office in order to receive an immunisation shot. Similarly, business consultants rely heavily on information their customers provide. Customers' involvement entails providing external production factors, also referred to as external factors. Very often customers provide more than one external production factor (e.g. information and physical goods) and shape the actual delivery of the service (so-called co-creation). But, the co-creation does not take place in the sense of a collaborative process. Throughout a service process, it is clearly defined where a customer can be integrated and what the possible actions of this integration are. Therefore, the interaction between customers and employees is clearly defined.
- Secondly, the way the service customers are integrated, differs between customer groups and service offers (Silvestro et al. 1992). For example, mail delivery services require integration of the external factor merely at the beginning and at the end of the service process, whereas tax consulting services require on-going and repeated contact with the external factor. Differences in service processes emerge by the individual choice of customers concerning possible actions leading to individual courses of service processes per customer. Consequently, the integration of the customer in the service delivery process has to be further differentiated by contact frequency or intensity, the degree of customisation, or the types of external factors that have to be integrated (van Helsdingen et al. 1999).
- Thirdly, in contrast to physical goods services cannot be stored (Zeithaml et al. 1985). They can only happen when a customer demands the delivery of a service. But the external production factors are available to the service provider during a limited time only. The combination of external production factors with the internal production factors into the service delivery process is restricted to this period.

Thus a service in general is – in contrast to a physical good – characterised by the involvement of the customer into the actual output process ("integration of the external factor"). Certainly, there are services without customer integration e.g. transactional services like money transfer. But these are not in the focus of this paper. To specify this, the term "service process with heterogeneous customer integration" will be used in this paper to refer to service processes with customer involvement

These characteristics limit the options of service providers in controlling the service production process (Davies 1994). This holds especially true for information provided by the customer during the service delivery process. The customer provides such information (e.g. requirements), also referred to as external process information to obtain a service output (e.g. a customised financial product). Two types of information have to be distinguished:

- External non-impacting process information is processed, changed, and utilised during the service delivery process. Such information, however, does not impact the process flow, but is merely used to provide the final service offer itself (e.g. demographic data of the customer for a standard service). Often such information is also needed to tailor the service offer to the customer's desired service attributes (e.g. information about payment options).
- External process-impacting information includes customer information that have a direct influence on service production, including the service provider's activities and processes. For example, if a customer applies for a home financing loan, other service processes and process flows will be required than for a personal loan. The

request for a home loan necessitates activities related to the assessment of the collateral and agreements on the encumbrance of the property, whereas these activities are not required for a personal loan.

Consequently the organisation of a service company and the design of service processes depend on a thorough understanding of the extent of customer involvement. Service processes exhibiting little integration can thus be developed autonomously by the company and can be autonomously re-arranged. This is not possible for service processes with a high degree of integration because they are highly dependent on customer requirements. In addition, there are service delivery processes (e.g. application for a home mortgage) that exhibit different degrees of integration in their individual sub-processes. Thus, the question is how to handle this complexity and variety of service processes to enable operational control. To solve this problem, “service processes with heterogeneous customer integration” have to be structured and their inherent complexity needs be understood and managed. For this purpose we suggest the development of a process laboratory that facilitates operational service process control.

3. FRAMEWORK OF A PROCESS LABORATORY

3.1 Conceptual Foundation

The first task when developing a process laboratory for operational control is to analyse, what constitutes operational management of service processes with heterogeneous customer integration. Doing this, a widely accepted operational management cycle can be identified based on the PDCA cycle (Plan, Do, Check, Act) proposed by Deming (1993) which consists of three phases (Figure 1): (a) Process measurement: Starting point is the determination of the level of goal attainment that key process metrics have to achieve. (b) Process analysis and control: Based on the measurement, comparisons between actual and planned performance can be conducted within process controlling. If the planned targets have not been achieved, specific actions have to be identified to improve process performance levels. This requires an analysis of the activity parameters, i.e. the possible courses of action and their potential influence on the target achievement. (c) Process implementation: Having identified appropriate specific actions, the process manager has to select and implement these in order to increase process efficiency.

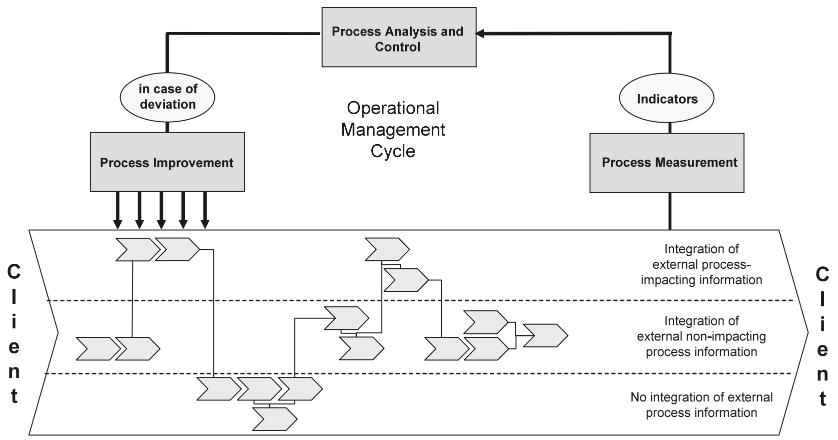


Figure 9: Operational Management Cycle for Service Processes with Heterogeneous Customer Integration

For the proceeding of decision-making within operational management, an analysis of the interdependencies between different courses of action and attainable performance is required. However, the limited rational capacities of human beings make it impossible to fully comprehend a “service process“ with all its cause-and-effect relationships. In order to reduce this complexity, the reductionist approach suggests dividing the entire system into sub-systems. Meanwhile, the holistic approach postulates that systems have to be analysed in a comprehensive fashion because they have to be understood in their entirety (Cilliers and Simon 2005). Regardless of the approach, it is typically impossible to experiment with the real-world system in order to analyse the cause-and-effect relationships of the process. This can only be done through the development of models, which combine a process view and a large variety of performance measures. Looking for a type modelling of the system “service process” that adequately describes the system behaviour under different circumstances (e.g. different levels of service requests over time), only a dynamic model provides an appropriate approach. Such a model allows analysing the dynamic interdependencies between alternative courses of action and process performance (Barber et al. 2003).

In general, there is agreement in the academic field that dynamic model description and analysis have to be integral elements of studies related to systems (Barber et al. 2003). Dynamic modelling, specifically simulation, can be regarded as an essential element of process modelling. Particularly Business Process Simulation (BPS) entails developing dynamic models for the purpose of analysing and evaluating business processes. Within this context, a number of different attempts to integrate static and dynamic process models have been undertaken – with different success (Barber et al. 2003). All in all, BPS seems to be a preferable instrument to evaluate different measures for increasing process efficiency, particularly since mutual dependencies and effects can be analysed based on their chronological sequence.

Concerning the services industry most approaches described in literature are case-studies concentrating on specific problems (Robinson 2005). There are a few attempts like Davies (1994) that take customer integration into account. However, most of these approaches are rather generic and lack a sound methodology in terms of systematic analysis and structuring techniques. Furthermore, BPS-studies are mostly focussed on the aspect of reducing the cycle time. Additionally, authors often do not build their simulation models on existing processes, but populate their models with fictive data.

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 a daily use of simulation models for operational control. This situation is not different within the service sector. However, there exists common agreement on the fact that BPS is very helpful to manage complex service processes (Laughery et al. 1998). In conclusion, it can be stated that up to now there does not exist any systematic approach which analyses the structure of service processes considering heterogeneous degrees of integration.

In this context the idea is to develop and implement a process laboratory based on simulation. A process laboratory is characterised by a goal-oriented, experimental, computer-aided execution of process models. Such a process laboratory facilitates anticipation of the characteristics of processes while they are running and provides insights into planned processes without having to actually run the process in practice. Consequently, the idea is to set up a model based on real process data and to conduct simulation experiments. The results can be compared with the process performance (e.g. time, cost and quality) observed in reality (van der Aalst et al. 2008).

The process laboratory should be applicable for all kinds of service processes with customer integration. To ensure this with regard to the heterogeneous degree of customer integration a framework for a general design of the process laboratory is necessary. The idea of a framework is to define major components that are necessary to implement a process laboratory for any service process with customer integration. Fleury and Fleury (2007, p. 951) stated that "a [conceptual] framework provides a technical language system, a set of interpretative principles and important benchmarks for guiding thought. […] A researcher's [conceptual] framework is likely to have been developed within a particular professional culture and internalised in such a way that the members of that culture can easily communicate with each other, share a common evaluative structure and routinely frame research questions and possible ways of finding answers".

The core of such a framework is the operational management cycle. Its parts, process measurement, process control and analysis, and process improvement, have already been discussed and examined by multiple researchers (e.g. Neely et al. 2005). The unique aspect of the framework presented here lies in the interaction of these three aspects from an operational perspective. Doing this, the framework aims to enable process managers to measure, analyse and manage processes in day-to-day business to improve process performance. In order to do this effectively, the process manager must have access to instruments that allow him to continuously measure the existing process, to compare different process alternatives, and to implement the selected course of action within the process flow. As a result, the following critical issues have to be addressed when designing the framework:

(a) *Management of the service process:* The system "service process with heterogeneous customer integration" has to be identified and structured. A key approach to handle its inherent complexity is the modularisation of the whole process. Therefore, the service process should be cut into phases isolating the customer influence.

(b) *Process performance measurement:* Since the objective of operational control is to improve the performance of service processes, the process manager needs instruments to evaluate the service process. This includes performance indicators, detailed measurements and process indicators for the defined process goals. Consequently, a service process performance measurement system needs to be set up.

(c) *Management of options:* Based on the defined and structured service process, the possible options of actions of the process manager have to be evaluated. Examples for Options are the allocation of jobs to staff or the number of staff working on a specific task. Therefore, the basic conditions for the process manager to what extent he is allowed to change input, throughput, and output of the process through corrective courses of action have to be defined.

3.2 Components of the Framework

Based on the previous considerations the framework should define general components being necessary for the implementation of a process laboratory for service processes with heterogeneous customer integration. Figure 2 shows the components of the proposed framework.

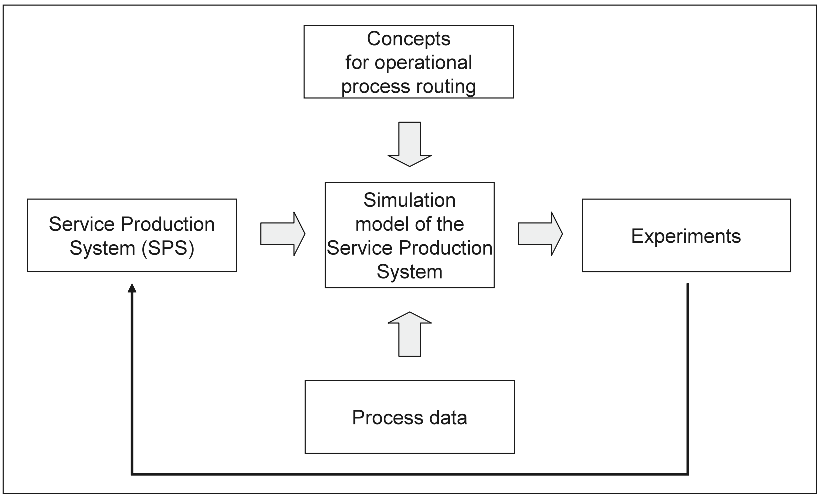


Figure 10: Components of the Process Laboratory

The components work together as follows:

(a) *Service Production System (SPS):* The first step is the implementation of a Service Production System (dynamic model). Within this context a SPS consists of all processes, agents and applications which are necessary to produce services. In the case of a loan, input is information delivered by customers (loan applicants) like personal income, financial situation, collaterals, duration of a loan, payback characteristics, and signatures. This information is used in the production line by the relevant agents in a bank to generate outputs for the customers (e.g. loan agreement and money transfer).

Based on the characteristics of services, there are major challenges for implementing such a production system. Different products (e.g. mortgage loans, trade loans) should be producible on a single production line and the integration of customers has to be taken into account. Opportunities of technical support for automated processes like workflow technology have to be considered as well. Additionally, operational managers must be empowered to influence key performance indicators such as cycle time, cost, staff capacity and quality. Also related information concerning existing business services contracts or other related business processes have to be considered (Dietrich 2006).

To address these challenges, service processes have to be flexible covering the different degree of customer integration. Consequently, processes should be decomposed in modules. Within a system of modules it should be possible to (1) identify the needed modules clearly, (2) have easy and comprehensible modules, (3) have general interfaces that have to be changed seldom, (3) change the content of modules independently (Parnas & Clements & Weiss 1985). A modularisation technique, covering these aspects, for structuring service processes will be presented in Section 4. Applying the modularisation technique to isolate customer influence, reduce complexity and improve flexibility of the processes the result will be a structured process enabling operational control. Based on this, concepts for operational process routing from the manufacturing industry can be adopted.

(b) *Concepts for operational process routing:* Within operational control the number of options for action is restricted. The basic structure of the process, for example, can not be changed in the short-term. Therefore, the focus of operational control is mostly on scheduling, capacity planning, and job release. These influence the process routing of service orders through the production system. Examples from manufacturing industry are "Work In Process Control", "Work In Process To Bottleneck Control", "Workload Control", and "First in, First Out" (e.g. Yan & Lou & Sethi 1999).

(c) *Simulation model of the Service Production System:* Additional to the Service Production System, aspects of BPS theory are needed. Using this knowledge the SPS can be implemented as simulation model. Simulation enables understanding the foundations of business systems, generating opportunities for change, and assessing the effect of those changes (Doomun and Jungum 2008). This is necessary to conduct simulation and experiments to evaluate the usefulness and effectiveness of the service production system. Since the objective is the development of a process laboratory for operational control the following aspects have to be considered: (1) The simulation model has to continuously reflect the status quo of reality in order to generate a business value (Davies 1994). This includes both the structure and the process data of a production system. (2) The model has to be as generic and flexible as possible, so that it can be used for any service product. (3) The software used has to enable the previous two aspects.

(d) *Process data:* To get an applicable simulation model the idea is to use real process data of the financial industry. Therefore, real process data has to be added to the simulation model. The starting point for gathering the data needed could be event logs in which the data of executed processes is automatically stored by workflow systems (Rozinat and van der Aalst 2006).

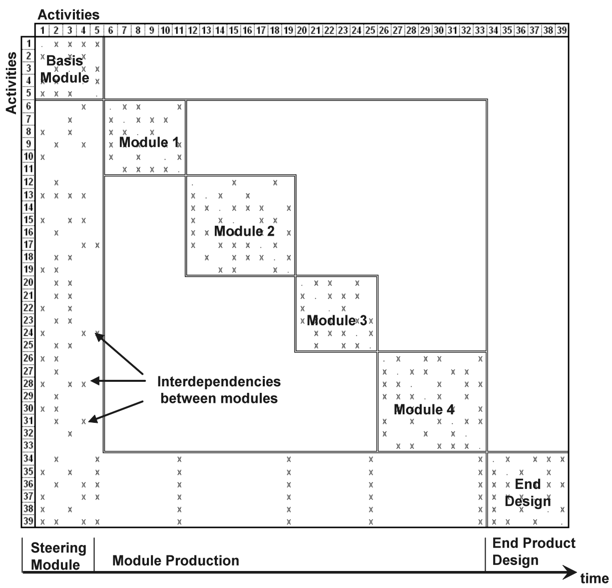
(e) *Experiments:* Having completed this step experiments can be conducted. Therefore several concepts for operational process routing will be simulated in different scenarios. The results should be documented in terms of key performance indicators (e.g. cost, time, and quality) for each scenario. An evaluation of these results can be conducted in two ways. Firstly the results for each scenario can be compared within the same SPS in the process laboratory. Secondly a scenario could be checked against other SPSs using the same concept for operational process routing. Based on the results the SPS can be enhanced and further experiments can be carried out..

The result of the process laboratory will be the knowledge about the appropriate application of options for operational control for service processes with heterogeneous customer integration. This includes the question which concepts are applicable in general and how they can increase the performance.

4. MODULARISATION TECHNIQUE AS THE BASIS FOR OPERATIONAL CONTROL OF SERVICE PROCESSES

4.1 Basic idea

A complex system, such as a service process, is characterised by a multitude of elements that interact with one another (Cilliers and Simon 2005). In case of the delivery of a service such elements can be for example the necessary activities, the customers with their requirements, and the employees. These elements have multiple interdependencies and it is not obvious how they work together. To reduce this complexity, the elements are combined in clusters (also referred to as modules), resulting in a decrease in the number of system elements that interact with each other. To achieve an ideal modular system the interdependencies between the modules within a system have to be minimised (loose coupling) while the components within a module interact strongly with each other (high cohesion). To separate between both kinds of dependencies, Baldwin and Clark (2000) distinguish between visible and hidden construction parameters for the system. The hidden construction parameters represent module-inherent information which does not influence the overall system. The visible construction parameters describe the configuration of the system and thus the interaction of the modules.



1 to 39 = Required activities for service production
X = Indicates dependency between two activities

Figure 11: Structure for Modularisation

The result of this modularisation approach for an optimal situation concerning a service process is shown in Figure 3 matching the recommended structure by Baldwin and Clark (2000). Firstly, a basic process module consisting of interdependent activities of the service process is created. This module serves as a basis by providing impacting information (inputs) for subsequent process modules like property definitions of the service that has to be produced. Secondly, the module execution takes place through the production of individual module outputs (process modules) on the basis of the impacting information. The individual process modules consist of interdependent activities. Except the visible dependencies between the basis module and the individual process modules there are no dependencies between the individual process modules. At the end the information of the basis modules serves to combine the individual module outputs in the last part of the process, the end design.

This modularisation approach can be used to develop a service process model to enable operational control as done by Heckl and Moormann (2009). Doing this, process modules are configured and designed while considering the interdependencies between the process modules at the same time. Individual activities within a process module and their inherent dependencies are not considered. The result is a limited number of clearly delineated process modules which can be controlled by a process manager from the operational perspective.

But service processes with heterogeneous customer integration are characterised by more dependencies than the inherent dependencies between their sub-processes and activities. As shown in Section 2, such a service process is also dependent on the external factor "customer" and the information provided by customers. The external non-impacting process information and the external process-impacting information have to be considered, too.

At the very beginning the customers' external process-impacting information should be gathered (e.g. information about the collateral for a loan provided by the customer). This enables the process manager to understand the dependencies on such impacting information from the outset. To eliminate any potential unknown factors such impacting information could be integrated in the basic process module as recommended in the Baldwin and Clark model. This step is not obligatory for external non-impacting information. While these can still be added during the actual process flow, it should be considered that not all modules should include non-impacting information. To reduce complexity the bundling of non-impacting information within a small number of clearly defined process modules is recommended. Figure 4 illustrates this concept at the example of a three-phase loan process model developed by Heckl and Moormann (2009).

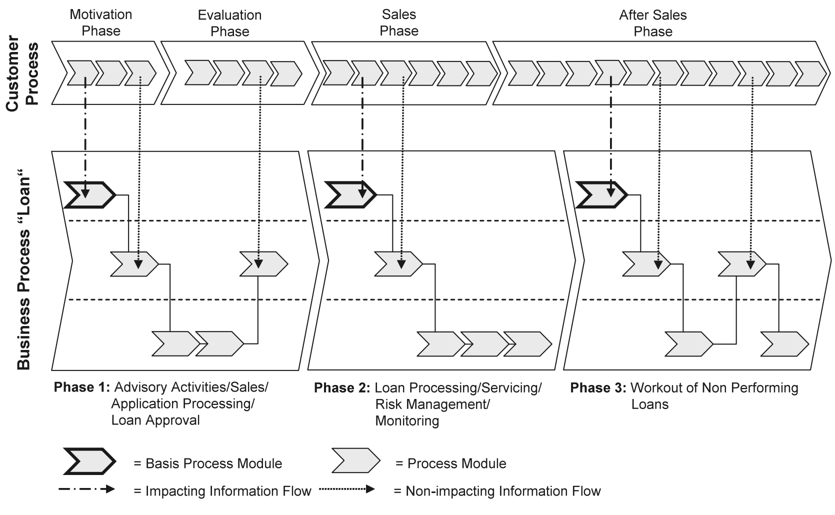


Figure 12: Schematic Modularisation of a Service Process

Each phase of the loan process model starts with a basic process module including the customer's external impacting information. This information is necessary input factor to perform the subsequent activities during this phase by determining the selection of the required process modules within the basic process module as well as the sequence of the modules within that phase. Beside the external impacting information all other activities should be combined in process modules on the basis of their degree of interdependence and external non-impacting information. Such information does not influence process module selection or process module sequence but impacts the service attributes (e.g. loan decision, interest conditions, payment terms). At the end the process modules should be as independent from each other as possible, while the activities within a module should exhibit a degree of interdependence that is as high as possible. All available modules of a bank or of its business network (i.e. the bank and its cooperation partners) are considered for this procedure.

A disadvantage of this methodology is the dependence on a substantial amount of information that is needed to evaluate the dependency criteria for the design of the modular architecture. For some companies it might be difficult to create the necessary information. But to use the approach, access to sufficient information that meets certain quality standards is unavoidable. Additionally, this methodology carries the risk of introducing bias, particularly in the evaluation of the dependency criteria (Gershenson et al. 2004).

But there are also major advantages. If the module architecture is designed adequately and has been implemented successfully it can provide a significant reduction of the complexity of the process model. In such an environment potential modules can be aligned in parallel, modules can be exchanged, or eliminated and new modules can be added easily (Feitzinger and Lee 1997). Thus, new opportunities for the management of service processes as well as for sourcing and cooperation models are possible.

4.2 Example: A Modularised Loan Process

Based on the described modularisation methodology an exemplary loan process will be used to demonstrate the modularisation approach. Figure 5 shows the result of the modularisation of Phase 1 of the loan process "Advisory Activities/Sales/Application Processing/Loan Approval". This phase can be represented by "Definition of Module-Routing", "Execution of Modules", and "End Product Design."

The "Definition of Module-Routing" phase starts with the first contact with the customer. Based on his/her requirements the process of generating an initial offer for a loan that is tailored to the customer's requirements including the loan itself and additional required products is started. This leads to the determination of the modules required for the provisioning of the loan during the last sub-process of the "Definition of Module-Routing." During the module processing all customer requirements and pieces of information are gathered which at this point exert a steering impact on the process flow. As the process moves into the "Execution of Modules", impacting influence by the customer is no longer permitted.

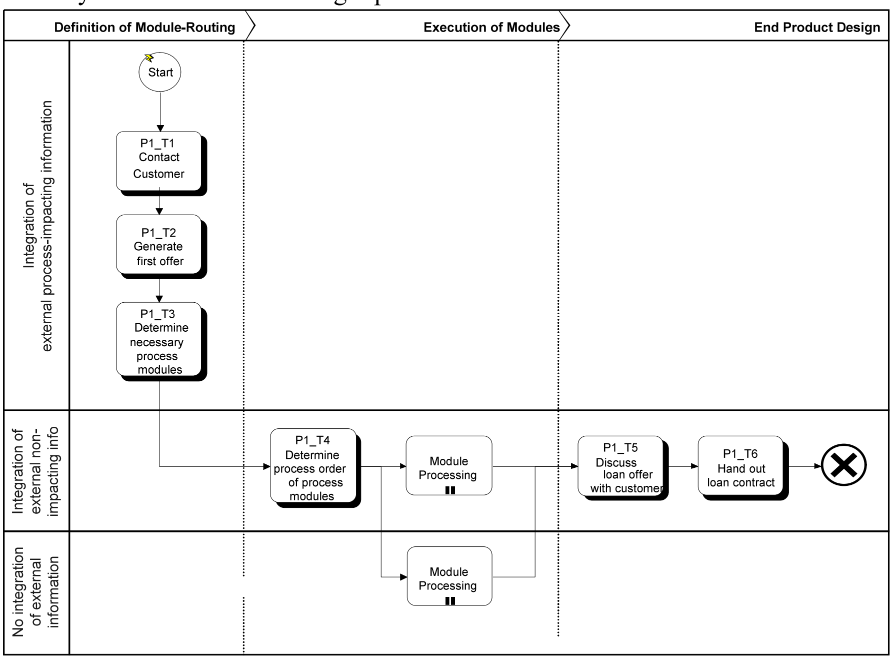


Figure 13: Sub-processes of Phase 1 "Advisory Activities/Sales/Application Processing/Loan Approval"

During the "Execution of Modules" part the identified modules that are required to deliver the requested service (e.g. liquidity analysis, credit-rating report, loan approval, and collateral evaluation) are executed. Some modules require customer information, but this kind of customer information does not have an impact on the process flow. Furthermore, the chronological sequence of the modules has to be defined in more detail, although there is an opportunity for operational intervention at this point.

In the "End Product Design" part of the process the outputs of the modules are combined. By doing this it is possible to make a decision whether the loan service can be offered to the customer or not. If the decision is negative, the customer will receive a rejection notification. In the other case, a final loan offer with terms and conditions will be prepared and discussed with the customer. Finally, the loan contract will be handed to the customer with the request for signature. At this point Phase 1 of the loan process, "Advisory Activities/Sales/Application Processing/Loan Approval", ends. If the customer decides to accept the loan offer and signs the loan contract, the process moves to Phase 2 of the loan process "Loan Processing/Servicing/Risk Management/Monitoring".

4.3 Summary

Overall, the proposed modularisation technique serves as an instrument for structuring service processes with heterogeneous customer integration and defines the necessary steps to enable operational control. It is precisely defined when process-impacting information is permitted to enter the process flow and at which time the permission ends. Additionally, it allows flexibility for changes of the module sequence during service production. Applying the proposed modularisation technique a Service Production System can be modelled.

5. CONCLUSION

In contrast to physical goods, services are mostly characterised by the involvement of the customer in the production process (co-creation). This paper has pointed out that the degree of integration has to be considered particularly in the field of operational control of service processes. The main question is how operational control for service processes can be analysed and enhanced. As there does not exist any satisfying solution so far, the framework for a process laboratory was laid out. The framework uses a dynamic service process model reflecting the reality. Based on the framework it is possible to cover and evaluate the relevant aspects for operational control of service processes. The main components of this framework which have been drafted in this contribution are the first step in this direction. Furthermore, the modularisation technique as a major part within the framework was presented. The modularisation technique describes how service process with heterogeneous customer integration can be structured and how operational control is enabled Using the framework to implement a process laboratory it should be possible to analyse and evaluate concepts for operational process-routing and enable process managers to measure, analyse and control processes in day-to-day business.

Next steps of research will concentrate on the empirical evaluation of the applicability of the framework of the process laboratory. Further conceptual challenges are related to the design of corporate objectives, the technical implementation of the simulation model, the integration of real process data, the modelling of the cooperation of customer and company, and the scalability of the approach. Doing this, the process laboratory can be helpful to evaluate and enhance operational control of service processes towards an "industrialised" production of services.

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