|Analysis of a Digital Business Processes Transformation: A Case Study on Digitizing Absence Management

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Abstract. Companies transform their analog processes into new digital solutions to save costs and reduce administrative effort. However, processes in (German) higher education institutions (HEIs) are still predominant in an analog manner. We conduct an in-depth case study based on the absence management process of a HEI with a five-step approach: (1) state-of-the-art and formalizing the analog process, (2) analyzing the variables collecting data, (3) evaluating the analog process with seven criteria of [1], (4) deriving a digital process, and (5) comparing the analog and digital process. We derive an operationalized methodology transforming a process from analog to digital. Research can use the results for investigation of the multi-role business administration processes within or outside the environment of HEIs. Practitioners can use the defined operationalization to define the requirements for a transformation from analog to a digital process.

Keywords: Process analysis of digitalization, business process reengineering, higher education institution

1 Introduction

Digitizing business processes is a common approach within companies. These digital solutions make the process more attractive for the employees and simultaneously enables the companies to save costs and time by reducing the administrative effort for the roles involved. However, in terms of administration in (German) higher education institutions (HEIs), numerous business processes are still analog. Curiously, companies with similar processes often use digital solutions already. This difference raises several questions: Why are business processes, such as absence management, not digitized in HEIs? Which requirements does a digital approach have to meet? Which are the critical success factors?

We analyzed these questions literature-based to identify the differences between companies and educational institutions. Besides, when designing the digitization of processes, a variety of factors require attention such as data protection (GDPR), economic efficiency, hierarchical levels (e.g., subsidiarity principle within HEIs), collective agreements and working time models, legal requirements (federal/state), lack of autonomy, substitution rules, or different groups of people - with or without teaching responsibility.

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This work aims to model an end-to-end business process for the digital-enabled university for absence management. This management includes e.g., vacation requests and special leave. We are working on a new methodology. We concentrates our study, in this work, on the analysis of a unique case at the Technical University of Munich (TUM) [1]. Within the analysis of the related work, we present the highlights of a conducted literature research [2] on the current methods for digitalizing business processes. Thorough research of current literature and information technology (IT) forms the foundation for further action.

This article contributes to the research on information systems in several respects: (1) to the best of our knowledge, we illustrate the first utilization a methodology to transform an analog business process to a digital process; (2) we comprehensively identified additional phases in the business process on this topic; (3) we identify and address research gaps to guide future research on this topic. We do so because we want to know: *What is a suitable operationalization to get from an analog process to a digitized process?*

Thereby, we guide our research with the following expected results: (1) The current state of research on the transformation of processes, (2) identification of individual actors, events, and activities in the process of absence management, and (3) a suitable concept for modeling the digitized business process of absence management.

The remainder of this study is structured as follows. First, in the section Related Word, we shed light on our significant findings in the literature. We describe the procedure of our analysis and the case in the Method section. In the section Results, we present our findings of the case and analyze according to the identified measures of the theory to come up with a methodology to transform a business process from an analog to a digital one. Therefore, we formalize and analyze the current process using the example of a paper-based absence card with the extended business process model and notation (eBPMN) 2.0 to transform the business process from analog to digital. Subsequently, we identify unique roles, events, and activities using expert interviews to validate and enable the digitalization of the process [3].

Additionally, we evaluate the findings of the research and expert interviews [3]. By interpretative examination, we address and point out possible limitations. In addition, we define a process for the absence administration and present further considerations for a generalized concept for the digital process transformation. We discuss our findings in the Discussion section, before we conclude our article and discuss the implications for future research in the section Conclusion, Limitations, and Future Research.

2 Related Work

Various researchers already approached the topic of process digitalization theoretically, focusing on the business perspective. The theory has identified what properties a digitalized process needs to comply with [1]. The seven attributes (1) programmability, (2) addressability, (3) sensibility, (4) communicability, (5)

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memorability, (6) traceability, and (7) associability define attributes which a digital process needs to fulfill in order to comply with the paradigm [1]. Also, other contributions are applying this approach for their argumentation in this field [5, 6]. Another contribution that follows a very close-to-practice approach applies these criteria to validate a newly developed digital process [1, 6]. This study analyzes the digitalization of processes in HEIs with the example of the onboarding process for employees [6]. The scope presented is very comparable to the topic of our work [6]. They conclude that the process of digitalization in HEIs is comparable with the V-Model XT [6]. Thus, we decided to test the analog process at the current state against these criteria like kind of pre-test. Afterwards, we design a digital process and rerun these criteria as a post-test to evaluate our new digital process.

Another related work argues that advanced digital technologies can reduce communication costs while increasing the scope and resulting in better network connectivity within digital information systems (IS). Additionally, advanced digital technologies also influence the speed of digital convergence [5]. This finding helps the contributors to identify different implications for future innovation research. This work is well-known and frequently cited in the literature of this field [5].

Furthermore, there are several literature reviews and case studies on the topic of process digitalization and its impact on businesses. Others describe the literature dealing with the impact on process digitalization in Small and Medium-Sized Enterprises [7]. Within his contribution, Imgrund [7] defines a maturity model for processes in a digitalized organization, naming it Process and Enterprise Maturity Model for Digitalized Organizations.

Another approach divides the process into (1) data recording, (2) processes, and (3) cross-linking [8]. According to this and another similar approach [9], we separate the overall approach on how to digitalize a process into three main phases: (1) exploratory, (2) building, and (3) extending.

Four theorizing logics (solution design pairing, socio-cognitive sense-making, technology affordances and constraints, and orchestration) are defined to explain innovation processes and outcomes and give researchers new fields and research questions to contribute [10]. It is meant to be a broader foundation for the digital world to reinvent innovation management.

As the process of absence management is not only standard in HEIs but as well in other industries, there are plenty of standardized software solutions on the market [11]. The company offers an end-to-end solution for absence request management, including frontend, backend, and processes, as well as other human resources (HR) tasks in one. Customers, such as Dell, Lindt, and even HEIs such as the University of Toronto, are using this solution for their absence management.

Another software, used by Apple, Uber, Cisco, and various other well-known enterprises, is ResourceGuru [12, 13]. The London based company also offers a variety of HR processes, including absence management. Both solutions are at a similar price range at about 6 US Dollars per employee per month [14, 15].

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3 Method

We applied an inductive approach to derive a methodology concept at the example of modeling the digitized business process of absence management. Contributions to the research question are gathered based on a literature review using the keywords as well as forward and backward search [2, 4]. This conceptional framework provides aims to support the understanding, executing, and evaluating IS research.

3.1 Case Description

We gained access to the case through the Senior Vice President and Chief Information Officer of the HEI Technical University of Munich (TUM) [5]. This institute is a top-ranked university with more than 550 professors, about 10,500 employees educating approximately 41,500 students in over 400 buildings with 15 departments [5]. The annual budget is more than 1.5 billion Euros, including clinics. We chose the case as it is an exquisite example within a HEI of a highly analog standard process that is applicable for almost every institution or company [5]. The process includes various standard procedures of business processes such as validation, submission of documents, or notifications for actions. These standard procedures are a matter of particular interest. Using longitudinal coding, we derived a group of measures to analyze and assess the literature. Two persons coded together and discuss each codeword to find a common understanding. However, a common understanding of the codewords was in general given by definition and clear by the naming of the applied part of the process such as ‘name’, or ‘address’.

3.2 Case Analysis

We conducted a five-step approach for our case study:

First, we consolidated the current, analog, and paper-based process in a formal way using Event Process Chain (EPC) and Business Process Model and Notation (BPMN). Analyzing all variables involved in the vacation process and their origin builds the core fundament of this model. TUM uses two different documents for the analog vacation process. These two documents need a separate analysis and comparison to find a standardized set of variables. Besides, we gather further information concerning the flow of the university’s vacation process by conducting expert interviews in the period from 1st to 31st of July 2019 with the head of the HR Department of Informatics, the head of the HR Department of Mathematics, the head of IT administration and a staff member (vacation taking person). The interview is semi-structured and followed the use case of the applied analog vacation card in the Department of Mathematics and the Department of Informatics. To ensure getting all the needed information, we decided to use a report from memory.

Second, we developed a common denominator for the variables used to reduce the redundancy within the vacation administration process. This unique set helps to design the digital process that needs to address all variables individually to ensure the

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compatibility with both processes. To map the process to a standardized model, we used the unique variables and the requirements from the different inputs.

Third, we assess the process with the definition of Yoo for the digitalization of artifacts [6]. Therefore, the analog process examines on programmability, addressability, sensibility, communicability, memorizability, traceability, and associability [6]. This analysis derives approaches for each criterion for transforming the process from paper to a digital-basis. In this context, an artifact is a non-computer interface with which we interact with [6].

Fourth, we derive a digital process that is addressing all identified unique variables in the process and complies with the criteria defined in the third step [6].

Fifth, we compare the analog and digital processes. To do so, we identify phases in the process describing the activity performed during that phase. Afterward, we compare the phases of the analog and digital processes to identify the impact of digitalization. Consequently, we derive an operationalized methodology for the transformation from analog to digital.

4 Results

We divided our results into two steps describing the overall outcome. *First,* we present our findings in the documents and variables in the absence validation process. *Second,* we illustrate the process with an in-depth analysis of the current process.

4.1 Documents

When analyzing the vacation process of the HEI, we found two different documents used for the vacation administration process, depending on the origin of the file. One department creates and processes one of the documents, referred to as process A. Another document created by the second department referred to as process B. However, both types of the process have the same output and fulfill the criteria and regulations according to the absence administration. They follow the same process steps, but they differ in manual and system-supported actions. In the process A, the TUM wide HR unit has to calculate ‘manually’ the remaining vacation days of the requestor.

In contrast, in process B the absence management HR unit of a specific department only types in an IT-system the requestor's data. In addition to that, the process slightly differentiates depending on the used documents. Further analyzing the variables, we found a total number of 48 variables in both documents. The number of variables of process A is 20; process B counts 28. Nonetheless, 17 of these variables are overlapping between the two processes, where 14 are unique. Unique means that a variable is either appearing in one or the other document, but never in both documents. We can conclude that there are 31 differentiable variables within the two processes. Thus about one-third of the variables are doubled. Table 1 shows the results from the coding of the variables.

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Table 1. Variable Analysis of all Involved Documents, HR = Human Resources, * Variables are separated with '/'

*Variable**	*Assigned to*	*Doc A*	*Doc B*	***SUM***
First Name / Last Name / Institute / Service Designation / Holiday Year / Recovery Vacation in days (current year) / Additional Vacation in days (current year) / Total Vacation in days (current year)/ Start Date / End Date / Validation Requestor / Vacation duration in days / Proof of absence / Validation HR	Requestor	1 / 1 / 1 / 1 / 1 / 1 / 1 / 1 / 1 / 1 / 1 / 1 / 1 / 1	1 / 1 / 1 / 1 / 1 / 1 / 1 / 1 / 1 / 1 / 1 / 1 / 1 / 1	**2 / 2 / 2 / 2 / 2 / 2 / 2 / 2 / 2 / 2 / 2 / 2 / 2 / 2**
Validation Delegate	Delegate	1	1	**2**
Validation Manager	Manager	1	1	**2**
Left holidays from current year	Administrator	1	1	**2**
Distribution of working time over days / 'Nebenstelle'	Requestor	1 / 1	0 / 0	**1 / 1**
Entered into card file	Administration	1	0	**1**
Phone Number / Recovery Vacation in days (previous year) / Additional Vacation in days (previous year) / Total Vacation in days (previous year)	Requestor	0 / 0 / 0	1 / 1 / 1	**1 / 1 / 1**
Entrance notification in HR office / Phone Number / Recovery Vacation in days (previous year) / Additional Vacation in days (previous year) / total Vacation in days (previous year)	Administration	0 / 0 / 0 / 0 / 0	1 / 1 / 1 / 1 /1	**1 / 1 / 1 / 1 / 1**
SUM		**20**	**28**	**48**

We identified three stakeholders within TUM: (i) the *organizational unit of which the requestor is member of, (ii)* the *human resources (HR) unit responsible for the organizational unit*, and (iii) the corresponding *information technology center* (one at the department B and the other TUM wide). Within the organizational unit, there are three action roles: the requestor, the delegate, and the manager. The requestor is the person who demands absence with this process and thereby initiating the whole process. The requestor belongs to an organizational unit. The delegate is the person who represents the requestor during their absence. They need to validate the requestor's vacation to make sure they can comply with the duration of the representation. The delegate also belongs to the organizational unit. The third role is the manager of the organization unit, who is the supervisor of the requestor; therefore she/he needs to validate the absence request. The official in charge (HR agent) is the only role in the HR department involved in the process, responsible for administrating the absence card and processing associated data within the HR system (central or in

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the department B). The IT center of department B provides the system to process absence data. The role of IT can be seen as a service unit.

4.2 Process

We divide the process into four phases: (i) *initialization,* (ii) *validation,* (iii) *processing*, and (iv) *exchange*.

The phase (i) *initialization* represents the begin where the requestor solely performs the start of the absence process. It consists of gathering all necessary data for the process, such as the start and end date of the planned vacation, and the master data for identification purposes to the paper-based absence card. The data for identification comprises of a total of four variables, which the requestor needs to record. Also, the total number of holidays available for the requestor is stated and tracked on the absence card. The requestor hands over the document successively to all involved parties of the (ii) *validation* step. This physical transfer of the artifact is crucial to the transition from (i) *initialization* to (ii) *validation*.

The phase (ii) *validation* is the corpus of activities in the vacation process. The delegate, as well as the requestor's manager, needs to approve the absence application. As the analog process uses paper-based absence cards, this physical artifact can only be at one role at a time. Therefore, the execution is always sequentially and blocks the process during the artifact is at one role. In case the vacation is requested during the lecture period, and the requestor has a teaching role, the validation process requires an additional acknowledgment. The requestor needs to sign this additional acknowledgment confirming that no lectures and tutorials are affected during their absence. Independently, all validation steps have to have permission before the request can be further processed. To continue from the (ii) validation to the (iii) processing phase, the requester needs to send over the absence card to the HR unit. This transaction can either be facilitated via in-house mail of TUM or in person.

The phase (iii) *processing* belongs to the HR unit as the acting role. An official in charge reviews the request on the absence card for completeness. In case any information is missing, the official in charge reaches out to the requestor to fill the incomplete information.

The phase *(iv) exchange* represents this procedure. Once all information is provided, the data from the request is at the department B inserted into an IT application to calculate the duration and check the available holidays the requestor has left. In case the requestor's holidays are not sufficient for the requested vacation, the IT system automatically recalculates the start and end date to fit the maximum available days. After the calculation terminates, the official in charge files the outcome onto the absence card and adds an optional comment. In the case of the general administration (process A) of TUM, the calculation is done manually without a supporting IT system. The last step of this process is again part of the (iv) exchange phase. The official in charge sends the absence card via in-house mail to the requestor, and the process terminates. Figure 1 represents the sequence of phases in the current absence process.

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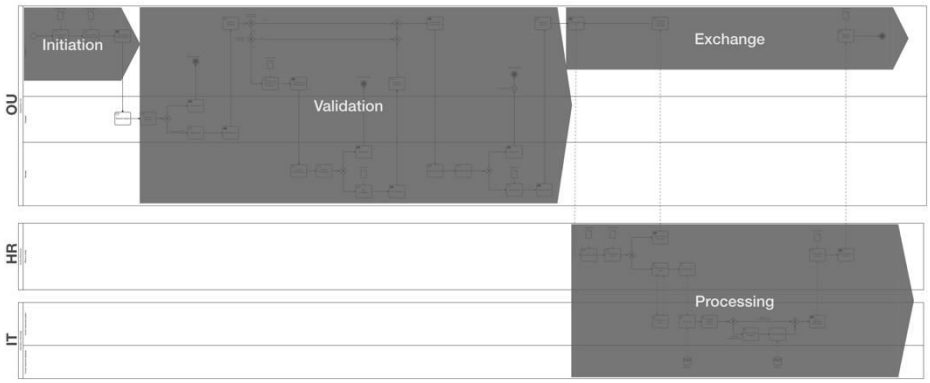

Figure 1: Analog Absence Administration Process

After analyzing the process, we can look at the current analog process in detail according to the identified criteria [6] for digital artifacts to later identify the steps needed for digitalization.

Programmability–The current process takes minimal advantage of embedded software and digital solutions in general. The official in charge within the HR unit of department A is the only role interacting with software at this stage. The requestor itself is not having any possibility to access software in the process, nor can the process accept new stets of logic [6].

Addressability–The absence card is just partially addressable as it is an analog and physical artifact. Whoever has this artifact in his precession can access it and start the process. There is no possibility to grant access to more than one at a time, especially not when these people are not in the same location [6].

Sensibility–The nature of the absence card itself blocks the ability to be sensible within the definition, and only an envelope supports the data protection [6]. Their possibility to monitor this analog artifact is restricted to copies, and in addition to that, the possibility to respond to changes [6]. Solely the possessor of the absence card and the official in charge can detect changes and react accordingly.

Communicability–The absence process, in its current definition, is not able to send or receive messages to or from other artifacts. The official in charge of the HR department is manually bridging this gap by inserting the data manually into the backend system.

Memorizability–The current process is memorizable. The absence card stores the data written on, although there is no qualitative back-up in terms of revision safety and long-term protection of the stored data. The data in the IT system that an official in charge enters manually is fully memorizable and complies with this criterion.

Traceability–During the validation phase, the requestor, delegate, and manager hand the analog absence card to each other manually with no reference to when this has happened beyond the absence card itself. This procedure precludes the process from being traceable in a defined manner [6]. By inserting the data into the IT system, the process gets partially traceable.

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Associability–The absence card is always associated with the requestor, as her/his meta information is part of the information filled during the process. However, the process cannot be associated with the meta-information of the manager nor the delegate as the process never collects their information.

5 Discussion

First, we discuss the documents applied in the process and discuss the approach of consolidating multiple documents into one joint base. Second, we highlight the current process with its advantages and disadvantage. Third, we evaluate the potential of the digital process. Final, we present a potential digital process, analyze the approach used to derive it, and conclude on a possible generalizable solution for digitalizing a business process.

5.1 Documents

The variables collected in both process documents are overlapping in many cases. However, the current process collects some variables only in one or the other document.

One argumentation is that this difference might be a consequence of poor alignment of standard processes at TUM. There are two different processes in place to fulfill the same purpose within one organization, which underlines the assumption of defective alignment. Redundancy in business processes has a negative effect, as already seen in the year 2000, at a point in time where digitalization was less developed [7]. These findings lead us to the assumption that redundancy in processes might be a particular issue for analog processes.

Another argumentation is that this topic did not yet reach the attention of the responsible as efficiency and effectiveness of a digital process might not be in the expected equilibrium. The digitalization of processes can be a large, costly project where the return on investment is a crucial decision factor [8].

Further, the growth of TUM influences the structure of the system architecture landscape. Process A is in a more or less autonomous department, and process B is a more or less autonomous central unit. Thereby, the evolutionary process of growth leads to different systems also in the IT.

In our case, we were able to reduce the number of variables by thirty-five percent while having the same granularity of data in the same quality. This achievement is why we suggest this as a first step when digitalizing processes. More detailed, the first step should identify all variables used or collected at some point in the process. Following, overlapping variables, those that are in more than one document, should be merged into one variable to reduce the redundancy.

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5.2 Evaluation

We derived the new digital process with the same four phases as the analog process while reassigning the phases to different main actors and different sequences.

In the *(1) initiation phase,* the requestor starts the process by opening an interface to the IT system provided for the process. After the authentication with login into the system such as identification management via Lightweight Directory Access Protocol (LDAP), the application displays information like name, department, remaining days of vacation, and many more stored properties automatically. A requestor needs to insert the remaining two input variables, start and end date, or in case of special leave a reason such as the case of death manually. As the IT system is now the main actor managing the absence process, the (3) processing phase starts when a requestor logs into the system. After hitting a submission button, the (1) initiation phase terminates, and the (2) validation starts instantly.

The *(2) validation phase* performs three steps in parallel. In case the requestor is in a teaching role, and the requested vacation is during the lecture period, the IT system notifies the (i) requestor that additional confirmation is needed. The requestor needs to confirm that no lecture, tutorials, or other teaching activities are affected during their absence. Iteratively, the (ii) delegate and the (iii) manager get notifications to validate the vacation process. In case the (i) requestor cannot provide the required confirmation, or either the (ii) delegate, or (iii) manager declines the request, the process terminates, and the system creates a record to inform the associated staff members. In case all three validation steps return positive feedback, the (2) validation phase terminates, and the (3) processing can continue.

The *(3) processing phase* handles the IT system without any required action by either of the involved roles. The application calculates the duration of the requested vacation and checks against the remaining holidays the requestor as at hand on demand. In case the vacation duration is longer than the remaining holidays, the vacation duration adjusts to the maximum possible duration.

The *(4) exchange phase* informs the requestor about this change or the approved holiday. In parallel, the IT system stores all data in the database and informs the requestor about the successful completion of the request. All phases terminate at this point. Figure 2 highlights the BPMN model for the new digital process.

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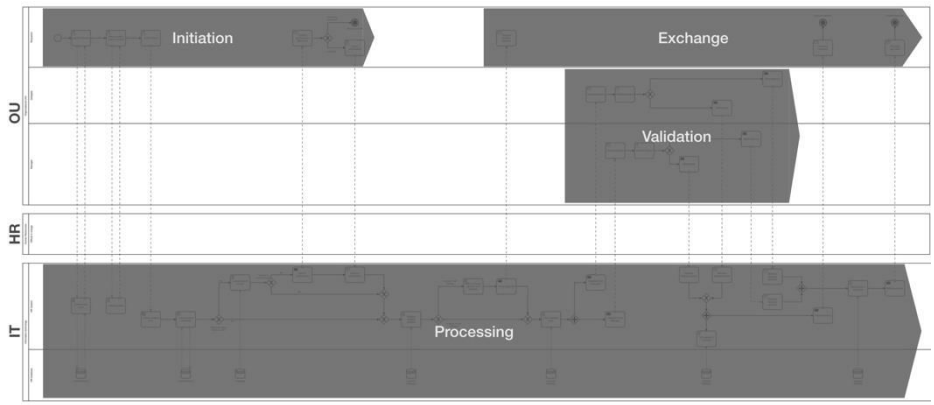

Figure 2: Digital Absence Administration Process

Iterative Steps of Digitalization

We apply the criteria [6] as a basis of analysis in the absence request process at TUM and highlight our findings in detail.

(1) *Programmability*–The newly derived digitalized process makes use of an embedded software system automating the absence process. Besides, the artifact accepts new sets of logic to modify its behaviors [6]. This change affects the process flow as described before, away from a sequential to a parallel process flow.

(2) *Addressability*–The organization's IT infrastructure integrates the newly implemented embedded software system to make it available via the intranet. This integration makes the artifact comply with a standardized protocol and the conditions for addressability.

(3) *Sensibility*–The defined process is monitoring and responding to changes in its environment when inserting or changing a request by the requestor. Additionally, the validation of a request is a change in the environment that the system detects. The software handles this change by continuing with the process itself or waiting for other approvals.

(4) *Communicability*–The absence process sends notifications to the validators in order the notify them of their necessary approval.

(5) *Memorizability* –The digitalized absence management system stores the data in the already existing central IT system. In this sense, it can also an interface directly linked to the central IT system.

(6) *Traceability*–The vacation request process stores a creation time as well as the time of the validation through the manager or delegate. As this is part of the process, it complies with the criteria of traceability. In addition, the applicant can keep track of the state of the process in the system.

(7) *Associability*–Every artifact associates the requestors and validators' name as one of their attributes. This process enables an association with the artifact to a person.

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Consequently, the new process is programmable, addressable, sensible, communicable, memorable, traceable, and associable. The analysis of the analog process using the same criteria shows almost all criteria as unfulfilled. This gap leads to the conclusion that these criteria are an appropriate methodology for the digitalization of business processes [6]. We also can apply them to a process at a HEI, and thereby we can confirm research in this field [5].

Phases of a Digital Process

The newly derived business process represents the three steps for process digitalization [9]. At the beginning of the process, there is the consolidated data recording gathered. For further processing, the data collected in the previous step is used, representing the second step. We found a cross-link between the (ii) validation, (iii) processing, and (iv) exchange phase in our digitalized process. We can confirm that these findings follow the process with the three steps of [9].

This derived digital process, according to the actual analog process, redefines the whole architecture of the process. In the new process, the primary interaction is between the requestor and the IT system, which is then handling the validation process automatically without further involvement of the requestor. The IT system executes the validation process in parallel for the delegate and the requestor. This parallelism is only possible due to the automatic validation handled by the IT system without any analog artifacts. The digital process reduces the duration to completion considerably, not only because of the newly integrated parallelism but also to the missing dependence of the steps within one phase of the process.

By shifting the process core area to the IT system, the role of HR agents is not needed for the standard case and can concentrate on edge cases. The new arranged phases of the process, in comparison to the analog process phases, show this new shift of responsibility. While the analog process follows a consecutive order of the phases with almost no overlap, the new process uses several phases at the same time. As an example, the (3) processing phase now starts right in the beginning and follows the whole process in parallel to the other phases.

Also, the (2) validation phase is now shorter and at a later point in time in parallel to the further (3) processing of the request. Concluding, the responsibility changes from a requestor and HR driven approach with IT system support, to handing over the primary responsibility to the IT system gathering inputs from the requestor and special case treatment from the HR department. Figure 3 discloses the shift of responsibility from the analog absence process (a) to the digital absence process (b).

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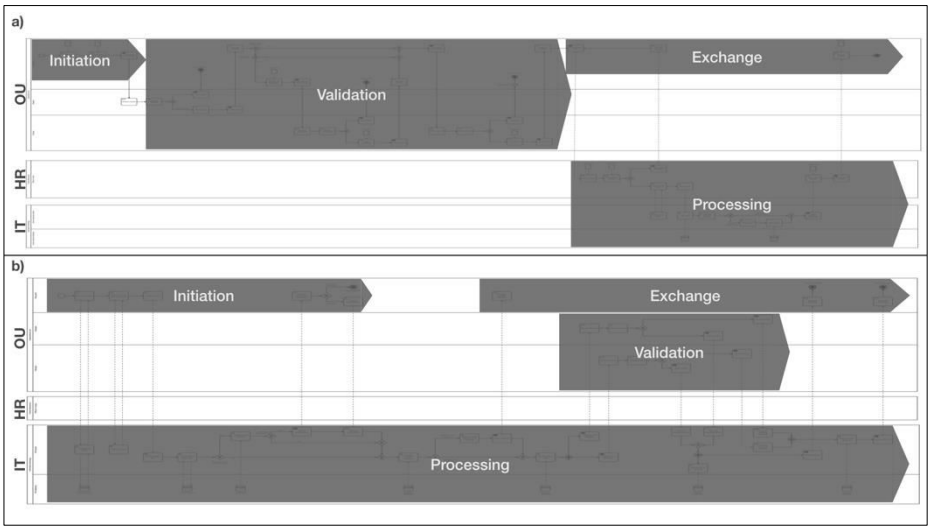

Figure 3: Phases of the Analog Process (a) compared to Digitized Process (b)

The analog process has a strict sequential succession in the three *main phases (1) initiation, (2) validation,* and *(3) processing*. This sequential character results from the physical absence card that needs to be handed to each of the participants of the process one after another while blocking it from other actions during this time.

This behavior shows close similarities to the waterfall model in software development. The waterfall model equally has the characteristics of a linear and sequential progression with a step-after-step approach. Similar to the three principal phases of the analog absence process. Also, the possible disadvantages of such a model can be transcribed to the analog process. It is inflexible in its execution and not protected against late errors that then cause a massive overhead of redoing. Therefore, we can confirm the findings [5] of current research at HEIs.

The new process is no longer sequential, but now has phases that can execute in parallel. Generalizing this shift of responsibility and roles, this model resembles the characteristics of the V-Model XT [10]. Accordingly, the characteristics of the V-Model XT can be transcribed to the digital process. These attributes include the handling of the process of late error occurrence and process demolition.

Notwithstanding, the V-Model XT does not entirely represent the structure of our digital process. One of the critical elements of this methodology is the exchange between the involved participants. Our process does have components of exchange, but it is limited to the (1) initiation and (4) exchange phases. Therefore, we can confirm the findings concerning the similarity to the V-Model, while not confirming the exchange attributes [5].

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5.3 Operationalization: From Analog to Digital

Combining our findings, we applied the seven criteria for digital artifacts as well as the discussed need for phases identification to develop an operationalized methodology for transforming the process from analog towards digital [6].

This methodology aids to define requirements, identify the phases, and finally support the digital transformation. This approach uses three steps to archive the transformation: *(1) Phase Requirements Identification, (2) Phase Identification,* and *(3) Phase Transformation*.

(1) Phase Requirements Identification–For the requirements identification, we use the following seven criteria [6] and iteratively assess the analog process on (i) programmability, (ii) addressability, (iii) sensibility, (iv) communicability, (v) memorizability, (vi) traceability, and (vii) associability. The identified delta of the analog process and Yoo's criteria define the requirements for digitalizing the current process. This iterative assessment defines the requirements for a digital process.

(2) Phase Identification–A process has different phases, such as an initiation, validation, or processing phase. Our methodology foresees the identification of those phases in the to-be digitalized process. The phases are crucial for the transformation as they structure the process. The transformation impacts this structure significantly and modifies the duration and sequence of the phases. Additionally, the phases function as a divide-and-conquer approach to break the transformation into manageable sized pieces.

(3) Phase Transformation–The phases transformation is the final step where the analog process goes digital. For each of the phases (2), we use the identified requirements from the first step (1) and define a digital process to meet all of these requirements. All phases use this approach to digitalize the process step-by-step. Developing a process utterly compliant with the seven criteria is the final aim of this methodology.

Figure 4 illustrates the three steps of the developed operationalized methodology for the transformation of an analog process towards a digital process.

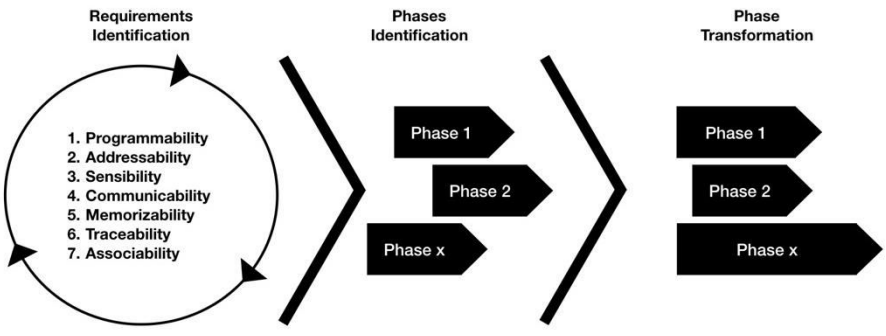

Figure 4: Operationalized Methodology: Transformation from Analog to Digital

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Our study contributes to the literature in two main ways: To the literature on digitalization of processes or business process reengineering, we contribute to research in an administrative business process and discuss what it needs to get from an analog to a digital process and how to perform an operationalized methodology. To companies and HEIs supporting them understanding their analog processes and gives a guideline for the process of digitalization. However, there are a large number of digitalization's opportunities, such as online platforms all digital artifacts that need their security and privacy protection [6, 11].

6 Conclusion, Limitation, and Future Research

We identified the applied documents of the analog absence administration process and analyzed the included variables. For an efficient digitalization, we reduce found variables in the absence administration process to unique variables. The analog process resulted in the identification of four phases, which we consider as necessary finding for the development of a methodological approach generalizing the digitalization of business processes. We also found that these phases keep stable after the digital transformation, although their sequence and duration might vary. Besides, we identified requirements for the digitalization of this process. The exemplary derived digital process fully meets identified criteria so that we conclude these criteria as a basis for requirements identification for the transformation from an analog to a digital process.

These findings lead us to a methodology defining a transformation process from analog to digital for business processes. This approach uses three steps: *(1) requirements identification, (2) phases identification,* and *(3) phases transformation*. The different structural characteristics of the organizational units covered in our work questions the unobstructed transferability of our findings, e.g. to other departments. Not every department can initiate their process for the absence administration with its own IT system due to cost, personal, or political reasons.

Further, there are different approaches to processing the absence request throughout the departments in our case study. This grown diversity at TUM in the various units limits the comparability. Thus, the findings need to be observed with caution. In all conscience, we identified the seven criteria of [6] as the best relevant literature as a basis for our research. However, there could be other approaches as a basis we do not know yet.

Future research can extend our approach to various other processes to derive an integrative business model for the digitalization of processes. This model can enable practitioners to define the requirements for the digital transformation. Additionally, to develop more efficient business processes, practitioners can define guidelines and maturity models for the development of the digital solution.

Moreover, to measure the applicability of the derived methodology and identify the potential for improvement, one can develop a demonstration of the newly defined digital process. This course of action can aid in making the administration processes

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in HEIs more efficient, more reliable, and faster. In addition, future research can use the identified stakeholders and actors to examine new security and privacy issues.

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