ЭКОНОМИКА ФИРМЫ И ПРОИЗВОДСТВЕННЫЙ МЕНЕДЖМЕНТ

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ANALYZING PROCESS ACCEPTANCE WITH IT-ENABLED EXPERIMENTAL RESEARCH

The positive results that are frequently associated with business process management, can only be achieved through triggering of the process by its users and the correct execution by the process operators. Unfortunately, business scandals in various domains have shown that companies, or rather the process operating subjects, sometimes do not execute their processes according to given standards or do not use existing processes at all. This failure in process execution can lead not only to suboptimal performance but also to life threatening disasters. By circumvention of official channels, individuals within the company create shadow organizations. Thus, unofficial processes and shadow IT systems

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emerge, which run alongside the official organization. This in turn has several disadvantages, among others increased complexity and lack of transparency, compliance risks and higher costs.

It is, therefore, of crucial importance to understand, why people accept or dismiss official business processes. Basically, this question calls for an explorative empirical research approach. A possible way of investigation is field studies in business organizations. However, such a form of study is expensive, time-consuming and it is difficult to attract a sizeable number of qualified participants. Moreover, there are known methodical problems with empirical research that relies on questioning people about their own sphere of responsibility. In this paper, we suggest to proceed in a different way to determine whether a process fits the end users. Our methodology is based on setting up process acceptance experiments in a crowdsourcing environment that allow for a more objective investigation at reduced time and cost, as compared to classical field studies. Refs 27. Figs 6. Tables 3.

Keywords: process acceptance, business process management, measuring process acceptance, process acceptance testing, crowdsourcing environment.

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АНАЛИЗ ПРИНЯТИЯ НОВЫХ БИЗНЕС-ПРОЦЕССОВ С ИСПОЛЬЗОВАНИЕМ ИТ ЭКСПЕРИМЕНТОВ

Положительные результаты, связанные с управлением бизнес-процессами, могут быть достигнуты только в случае инициирования процесса его пользователями и правильного осуществления исполнителями. Бизнес-скандалы в различных областях показали, что компании, а точнее, исполнители бизнес-процессов иногда не следуют заданным стандартам или вообще не осуществляют определенные бизнес-процессы. Отказ от выполнения некоторых бизнес-процессов может привести не только к понижению показателей деятельности компании, но и к ситуациям, угрожающим жизни людей. Игнорируя официальные регламенты, работники компаний создают, по существу, теневые организации. Внутри компаний появляются неофициальные процессы и теневые ИТ-системы, функционирующие параллельно с официальными. Это, в свою очередь, влечет отсутствие прозрачности, увеличение рисков и затрат, связанных с достижением поставленных целей.

Следовательно, важно понимать, почему работники принимают или игнорируют официальные бизнес-процессы. Этот вопрос требует эмпирического подхода, одним из возможных путей осуществления которого являются полевые исследования в организациях. Такой вариант анализа является весьма дорогостоящим, отнимает много времени и затруднен в связи с необходимостью привлечения значительного числа квалифицированных участников. Кроме того, существуют определенные методические проблемы эмпирических исследований, посвященных опросам людей, связанных с их сферой ответственности. В статье предлагается новый подход определения степени удовлетворенности новыми бизнес-процессами компании конечными пользователями. Предлагаемая методология по сравнению с классическими исследованиями основана на постановке экспериментов приемки процесса в краудсорсинговой среде, позволяющей объективно исследовать проблему сокращения времени и стоимости бизнес-процессов. Библиогр. 27 назв. Ил. 6. Табл. 3.

Ключевые слова: принятие процессов, управление бизнес-процессами, измерение удовлетворенности бизнес-процессами, тестирование принятия процессов, краудсорсинговая среда.

1. Background and Motivation

During the last twenty years, much attention is paid to the concept of business process management. According to the well-known definition of Becker et al. [2011, p. 5] a process is „a completely closed, timely and logical sequence of activities which are required to work on a process-oriented business object… A business process is a special process that is directed by the business objectives of a company and by the business environment ". It should be noted, however, that here a quite mechanistic view is taken, where a process converts inputs by transformation steps into outputs. Although such a process definition allows the development of appropriate modeling notations, the process is per-

ceived primarily as a technical problem, with organizational and social dimensions being subordinate. We will argue in our paper that this is a too restricted perspective.

Business processes are designed as a blueprint for delivering services or the production of goods. Process orientation and business process management (BPM) are a way for many companies to cope with the current economic challenges. Process innovations, the exploitation of cost reduction potential and increasing customer satisfaction are often the targets [Zairi 1997; Becker et al. 2011]. However, these positive effects can fundamentally only occur when the corresponding processes are accepted, lived and performed correctly.

Unfortunately, in operational practice, process design is often not geared to the needs of process stakeholders. As a result, those affected feel a certain level of frustration when they execute the process. At worst, the anger is so great that the process is not triggered (again). Alternatively, a process is changed in its execution or bypassed completely. Business scandals in various fields show that defined business processes in companies are frequently not executed correctly. They are replaced by unofficial, "shadow" business processes, more convenient and conventional for users.

From such behavior serious consequences may result. For instance, workarounds arise [Alter, 2014], shadow organizations and shadow IT may evolve [Behrens, 2009]. This behavior can lead to higher costs and could render governance, risk, and compliance efforts useless. From a business informatics perspective, these developments complicate data consistency and generate unnecessary organizational overhead. In certain contexts, not following the official guidelines in process execution may even threaten lives. For example, the nuclear disaster of Tokai-Mura can be attributed to a neither communicated nor approved deviation in the filling process of the reactor [International Atomic Energy Agency, 1999].

As a result, unaccepted processes and, consequently, process deviations are not to be underestimated risks for businesses and non-profit organizations. Frei et al. [1999] identified three negative effects in the banking sector, which were caused by process variations. These include a decrease in customer satisfaction, a lower image perception and an increased number of complaints. These results are consistent with the analysis of Tsikriktsis and Heineke [2004] in the aviation industry. They could empirically demonstrate that process deviation negatively correlated with customer satisfaction. Another interesting approach is taken Bendoly and Coteleer [2008], who attributed process variations to an inadequate and inappropriate IT infrastructure. This is also underlined by Markus and Keil [1994], who explain the non-use of IT systems with an inadequate process design.

At the intersection of process management and business informatics this situation calls for research that helps to create accepted processes supported by efficient IT systems. It can be argued that wherever process deviance occurs, the process in its current form is not technically feasible or not accepted by its stakeholders. In general, the value delivered by a business process depends on the social interaction patterns of its stake-holding subjects. This indicates that business processes possess inherent social properties that should be taken into account when processes are designed and implemented in organizations [Müllerleile & Nissen, 2014]. Given these circumstances, it is of particular interest to the BPM practitioner, and researcher alike, to understand why process deviance occurs. In a next step an understanding of how processes can be improved to increase process acceptance by its stakeholders, and thus decrease the likeliness of process deviance, must be reached.

In designing and optimizing processes in companies and other organizations often the topics effectiveness and efficiency are in focus. Insufficient attention is given to the person who ultimately performs these processes. Process acceptance research addresses this issue by taking into account social aspects of process execution and investigates what the acceptance of business processes generally depends upon. As a result the foundations of a process acceptance theory have been developed on an empirical basis [Müllerleile and Nissen, 2014; Müllerleile et al., 2015; Nissen and Müllerleile, 2016; Ritter et al., 2016]. In particular, factors influencing process acceptance were identified. In a next step, it is important to clarify the effect sizes and effects precisely. The results could be incorporated in a general, empirically validated model of process acceptance. Such a model would in turn be potentially very useful, especially in the phases of process design and process implementation, to create the right conditions for correct process execution in business.

A promising way to achieve this goal is the use of process experiments, which is the dominant theme of this paper. As experiments with real processes in companies are difficult and time-consuming to conduct, laboratory experiments offer a relatively straightforward and cheap opportunity to quantify the factors influencing process acceptance and process deviance. The remainder of this paper describes the foundations, experimental setup, and potential impact of such experiments that are currently under development in our research.

2. Basic Terms and Related Work

2.1. Acceptance and Process Acceptance

Acceptance is always an issue where normative statements, e. g., social or legal norms, are implemented, and is therefore discussed at great length in the context of philosophy and the social sciences. Acceptance, in general, expresses that something or someone, or a behaviour, was, is, or can be approved by another person. Acceptance can be partitioned into three different dimensions. These dimensions are the acceptance subject, which constructs the acceptance, the object to be accepted, and the context in which the acceptance takes place [Lucke, 1995]. These dimensions can be further explicated. The subject exhibits, based on its value system, a general potential for accepting something. The object to be accepted, therefore, has to possess a certain acceptability in the context of the value system of the subject. For example, consuming meat, as an acceptance object, would not incorporate a general acceptability for a vegetarian, the acceptance subject.

It follows that acceptance is no inherent property of an object that has a timeless validity. Rather acceptance is actively constructed within this field of tension as a result of a mutual process by the involved parties and represents the result of an act of rational insight and inner conviction [Lucke, 1995, p. 96].

Processes can be considered complex dynamic systems and social constructs [Melão and Pidd, 2000]. This implies that processes interact with the external world and are therefore subjected to social and technical interferences. Inversely, as social constructs, properties can be assigned to business processes. Thus, business processes implement a normative statement for their stakeholders. The inherent social properties, which are assigned by subjects, exposed to the process, result directly from process design.

Processes are carried out by individuals who have different goals, values and expectations. It follows that individuals, based on their experiences and perceptions, construct and interpret processes differently. As a result, the same process is perceived differently by different participants.

Process acceptance is defined here as an attitude of a process stakeholder towards a process. This attitude results in acknowledging and approving the process as designed, which in turn leads to a process conformal behaviour. A lack of process acceptance may lead to process deviance. If process acceptance is missing, process stakeholders may not trigger, be inclined to change, or circumvent the process. While these deviations from the official process may be positive, neutral, or negative in their overall effect, a deviations will always work against standardization efforts. Thus, it can be stipulated that if process acceptance is missing, this can be considered a negative interference variable for executing the process.

2.2. Concepts Related to Process Acceptance Research

One approach to identify process deviance is to employ process mining, or, more specifically, conformance checking [Rozinat & van der Aalst, 2008]. This technique allows for comparing the existing process model with the event log of the same process in the supporting information systems. If there is an event log available for the process under analysis, it can be used to reveal what the process deviance consists in. A further development are deviance mining methods [Nguyen et al., 2014], which can distinguish between normal and deviant process runs by identifying and classifying process patterns (e. g. step X occurs before step Y).

This technology is particularly useful if process logs are available to generate valuable insights on how process deviance occurs. However, reasons leading to the deviation may require a social understanding of the events, which may not necessarily be accessible by algorithms. Also, process mining may only be applied to logs of previously executed and recorded processes. If a process lacks acceptance among its stakeholders, it is unlikely that the process is triggered at all. Therefore, no information can be recorded in process logs. Additionally, not all processes generate process log data. Reasons might include that the underlying information system does not generate log data or that processes include tasks, which cannot be mapped to an underlying information system. This is especially true for processes in the service industry, where customer interaction is often personal.

In general, the value delivered by a business process depends on the social interaction patterns of its stakeholding subjects. Subject-oriented business process management (S-BPM) focuses on subjects, which are responsible for any process variance and their collaboration via structured communication in business processes [Fleischmann et al., 2012]. The subject-oriented approach to business process management as a new field of BPM study underlines the importance of behavioristic aspects as compared to only functional ones. The key difference of methods and tools of this approach is that they are oriented towards end users and create business applications based on the developed model. The S-BPM concept allows modeling and analyzing a business process, and immediately executing it in a form convenient for the end users.

While the mentioned concepts help to better understand *where* people deviate from predefined processes (process mining), respectively support looking at business processes

from the viewpoint of their end users (S-BPM), it appears fair to state that a true understanding of the factors influencing process acceptance and process deviance have not been achieved with either of these techniques, yet. In the next section, we briefly outline the results of our investigations in this direction.

Empirical research on software process improvement (SPI) adoption yielded several critical success factors [Niazi et al., 2006]. These include top management support, training, awareness, and the allocation of resources. Also, possible demotivational factors were identified by Badoo and Hall [2003], including a lack of feedback, high workloads, time pressure constraints, and cumbersome processes.

In BPM, literature on the social aspects of processes remains scarce. A notable exception is research presented by Antunes and Cunha [2013]. They transfer the results of research on SPI problems to the field of business process management. Four dimensions are evaluated (Motivation, Understanding, Value, and Effort) to understand why people ignore processes or see them as a burden. Antunes and Cunha propose a model, based on a questionnaire, to identify pain points in business processes. However, they only present results from two case studies and acknowledge the scarce literature available. Possible other influential factors are not discussed.

The field of Information Systems (IS) is heavily influenced by acceptance research. Especially the Technology Acceptance Model (TAM) [Davis, 1989] and its successors, such as the model by Venkatesh and Bala [2008], which try to give an explanation on why some technologies are accepted while others are not, has had a profound impact on the whole IS field. However, the TAM and similar models have drawn much critique regarding their relevance and usefulness for future technology or system design [Bagozzi, 2007]. In process modelling, acceptance has not yet been discussed at length.

Complementing TAM research in IS, concepts from marketing or service management may be applied. Processes deliver services to customers, therefore, research on SERVQUAL [Parasuranam et al., 1988] and other measurement systems on service quality may be relevant to research. The five dimensions of SERVQUAL (reliability, assurance, tangibles, empathy and responsiveness) cannot be transferred completely to BPM, because they emphasize the personal traits of the employee who delivers the service. However, some properties, such as reliability and responsiveness, can be understood as process traits.

3. Foundations of a Theory of Process Acceptance

3.1. Overview of Methodology

To address the research question which factors lead to process acceptance and process deviance, respectively, a series of 21 semi-structured interviews were conducted in the automotive industry [Müllerleile et al., 2015; Nissen & Müllerleile, 2016; Ritter et al., 2016]. Semi-structured interviews are well suited for explorative research [Kramp, 2004]. The interview guidelines were structured into questions about process creation and implementation and questions about the daily business routine dealing with processes. Care was taken not to influence the interviewee in his answers, rather the interviewee was encouraged to describe freely.

After transcribing the interviews a qualitative content analysis was conducted. This was achieved by using a two-step coding methodology. First, the transcribed text was

annotated with codes using open coding. These codes are one or more words that best capture the meaning of the sentence [Corbin & Strauss, 1990]. Next, all codes were summarized and grouped into categories. As a result a hierarchy of codes, including categories and sub-categories, emerged. In the final step of this analysis, the categories were annotated with properties resulting from the respective codes.

Further insights into the existing codes were gained by axial coding. Using this approach, the already discovered codes are rearranged in new ways by linking categories and sub-categories [Strauss & Corbin, 1990]. This allows the identification of relationships among the categories that pertain to the studied phenomenon. To facilitate these tasks, the coding paradigm proposed by Strauss [1987] was applied. Open and axial coding yielded the factors and their structure as presented in the following.

3.2. Results on Process Acceptance in Brief[1]

The interviews revealed that process deviance is widespread. The application of the described analysis methods to the interviews yielded a structure of the process acceptance phenomenon. This structure enables sorting the factors, identified in the previous coding phase, into an overall logical framework. Reasons for missing process acceptance could be directly derived from the transcribed interviews and classified into four different categories, which can be seen in Figure 1. The categories can be classified in groups preceding and proceeding the process usage. The first two categories include process creation/design and process implementation. The next two categories include process execution and process control and, if necessary, process change. The factors in each category are arranged according to their respective acceptance dimension into subject (process stakeholder), object (the process) and context (organization, business environment).

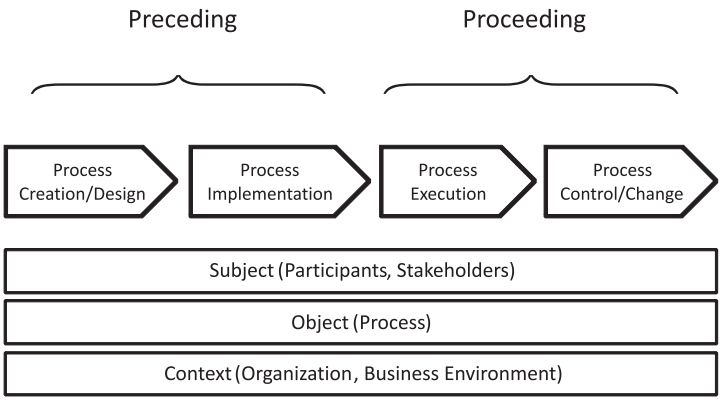

Figure 1. Overall Structure of Process Acceptance Similar in [Müllerleile et al., 2015].

The results reveal that process acceptance is driven by different forces and that their influence varies along the process lifecycle. Table 1 summarises the results. In the beginning of the process lifecycle, process acceptance is mainly driven by the subjects and the process itself (object). Interestingly, context variables become more important during the

[1] For more details on the method and results see: [Müllerleile et al., 2015; Nissen and Müllerleile, 2016].

process execution and maintenance phase. In general, the process implementation and the execution phase incorporate the most factors.

Table 1. **Key Factors for Process Acceptance**

Phase	Subject	Object	Context
Creation/Design	Stakeholder Inclusion, Communication on Involvement		
Implementation	Explain Reasons, Pre-Implementation Training, Peer Group Involvement, Process Guidance	Transparency, Structure	Implementation Strategy, Implementation Context, Information Strategy
Execution	Interdependence, Hierarchy, No. of Organizational Units Involved, Responsibility, Communication	Process Feedback, Failure Tolerance, Task Heterogeneity, Perceived Process Length, Standardization	Cross Process Consistency, Organizational Overhead, Time and Ressource Constraints, Bureaucracy
Control/Change	Stakeholder Inclusion	Process Stability/ Process Age	Management Ignorance/ Override, Process Maintenance

Similar in [Müllerleile et al., 2015; Nissen and Müllerleile, 2016].

Some findings, like the inclusion of process stakeholders in almost all process lifecycle phases, seem self-evident. These factors may appear obvious, but, as results show, are infrequently applied. This is especially the case for all communication pertaining to the process. Stakeholders are keen to be informed, but this communication should take place via the official channels. Unfortunately, managers often avoid direct communication with their employees, especially if unpleasant information is to be disseminated.

During the implementation and execution phase process properties play an important role, and bad process design is revealed. Questionable process design decisions can be prevented by incorporating stakeholders in the whole process lifecycle. This may also help to tap into potential for future process improvements.

The interviews also demonstrated that stakeholders value processes as a normative structure for their daily work routine. To a certain extent, process acceptance requires that these processes can function as a normative structure. If this is threatened by a chaotic and inconsistent context, process acceptance will suffer. Establishing a process friendly organizational structure is therefore important.

Process acceptance can be improved by influencing three basic factors [Ritter et al., 2016]. These factors are the behaviour and attitude of the subjects involved, the process properties, and the context properties. The first option offers potential for short term benefits. The second option, changing process properties, requires redesigning processes, and thus offers potential for medium term benefits. The third option, changing the organizational culture, is a strategic effort, and may only yield benefits in the long run. For example, there may be an optimal level of relaxing time and resource constraints. To an extent, the relaxation will increase short time costs, but may sustainably benefit the organization in the long run.

Improving acceptability, e. g., by incorporating process feedback, reducing the number of participants, interdependencies, and making a process fail-safe, may improve process acceptance. These recommendations can be implemented by adding process patterns to existing processes. For example, a pattern that communicates the present state of the process to its stakeholders can improve process acceptance. Furthermore, it is conceivable that different stakeholders receive different state information. Additionally, process simulation can help to detect unnecessary interdependencies, and fail-safe mechanisms can be implemented during the process design phase by confirming additional information. These measures can be especially useful for processes which are partially outside the organizations' scope of control, e. g., processes that include the customer.

3.3. Measuring Process Acceptance: Results from a Study in e-Mobility

The factors influencing process acceptance were developed and tested in various projects and case studies. Subsequently, the results of a case study in the field of e-mobility are briefly presented, where the process as acceptance object was in focus [Müllerleile et al., 2016]. The objective of this study was twofold. On the one hand, an instrument to empirically measure process acceptance was tested in the form of a questionnaire. On the other hand, it was of particular interest to prove in practice that the change of treatment variables leads to a measurable change in process acceptance.

The application scenario was charging an electric car in two different versions, one with cable and the other one inductively without cable. These experiments took place in November 2015 in a pilot plant for e-mobility within the BIPOL + project of IVK in Stuttgart. 60 subjects, an equal numbers of men and women, interested in e-mobility participated in the experiment.

In both cases, the subjects initially got into the electric car and drove 15m to the charging station. Thereafter, the participants got out and conducted the loading process according to specifications. Then they drove the car back to the starting point and got out. The first group performed at first cable-based charging and then inductive charging. The second group did exactly the opposite.

After completion of the second charging process, a questionnaire was filled in by all participants. The item content was derived from the results shown above, the influencing factors of process acceptance, and the literature on the various dimensions of acceptance [Reichwald, 1978; Dethloff, 2004; London, 1976]. The items were either associated with the affective, cognitive or conative dimension of acceptance. Therefore the measurements reflected how the subjects experienced the process, how they thought about it, and whether they were willing to carry out the respective process again.

Questionnaires were split in two groups for analysis, the first rating cable based charging, after being exposed to inductive type charging, and the other rating inductive type charging after being exposed to cable type charging. The data, resulting from this balanced, randomized design, with two independent variables on a nominal scale, was evaluated through an analysis of variance (ANOVA).

Table 2 summarizes the results. Upon first inspection, prominent outcomes include the absence of significant results for sex and the interaction effect in all three models. This means that a preference for the charging type, in any construct, is completely independent of the sex of the subject. Most striking results, and those of primary interest in this study,

are that there does exist a charging type preference in all three dimensions of acceptance. P-values are smaller than 5% for the factor charging type across three dimensions of acceptance and smaller than 1% for the cognitive and conative dimensions. This indicates that electrical vehicle users feel better (affective dimension) when charging via the inductive process, think that (cognitive dimension) the inductive process is better and harbor a higher intent of repeating (conative dimension) the induction based charging process.

Table 2. **ANOVA-results (Analysis of Variance) for two charging scenarios**

Dimension	Affective				Cognitive				Conative			
	Sum of Squares	(DF)	F-Stat.		Sum of Squares	(DF)	F-Stat.		Sum of Squares	(DF)	F-Stat.	
Charging Type	18.96	(1)	4.362	*	28.17	(1)	7.668	**	39.19	(1)	10.149	**
Sex	1.44	(1)	0.331		0.00	(1)	0.001		1.10	(1)	0.285	
Interaction	0.21	(1)	0.047		0.04	(1)	0.011		0.00	(1)	0.001	
Residuals	217.39	(50)			183.66	(50)			193.04	(50)		

Signif. codesfor p-values: '**' 0.01, '*' 0.05

More generally, the results of this case study show that it is possible to vary selectively treatment variables and measure the impact on process acceptance. Thus the basis is provided to use a completed process acceptance theory for providing design recommendations that will contribute to better accepted business processes in practice. However, field studies like the one described here require a high effort. Thus, a method was sought-after which would similarly allow to change treatment variables and measure the impact on process acceptance on a less difficult and expensive basis. IT-enabled experimental process research addresses this issue successfully.

4. IT-Enabled Experimental Process Research: A New Approach to Investigate Process Acceptance

4.1. Rational and Conceptual Approach

An important aspect from the subject-oriented approach to business process management is to understand why subjects accept business processes and, thus, trigger and execute them, or why they dismiss and circumvent them. Such an understanding would be helpful in designing processes that people accept. Basically, this can be done through explorative empirical research, as was shown above. Field studies of qualitative or quantitative research in business organizations can be conducted, as was also done in [Müllerleile & Nissen, 2014] as an example. However, such a form of study is expensive, time-consuming and there are methodical problems [Bortz & Döring, 2006].

We suggest proceeding in a different way to look at the effect size and mode of action of factors influencing process acceptance, in particular by applying a quantitative IT-based lab research approach. Our methodology is based on setting up process acceptance experiments that allow for a more objective investigation at reduced time and cost, as compared to classical field studies. In lab experiments process users are subjected to processes with different parameter values derived from the identified acceptance factors.

Since these processes are executed in an IT-based process engine, participants really "experience" the process in its different facets. The resulting findings could be integrated into a general process acceptance model. This process model could be used in the BPM lifecycle, especially during the design phase, to improve process acceptance and decrease waste of process resources.

Moreover, influential factors from the lab experiments can be studied in the real world later on. By using a mixed approach of quantitative and qualitative methods, and because other researchers can repeat the lab experiments more easily than field studies, the validity of the research approach as a whole is elevated [Wohlin et al., 2012].

The proposed approach relies on advantages of crowdsourcing [Howe, 2006]. Crowdsourcing is an interactive form of value-added services using modern information and communication technologies. Distinctive feature of crowdsourcing include the breakdown of large tasks into small parts that can be fulfilled by qualified volunteers all over the world using the internet. Generally, workers solve their tasks in short term, and either non-paid or for a low price, which can be extremely profitable or helpful for a company or initiating person. Crowdsourcing offers an interesting platform to implement subject-oriented IT-enabled experiments in process acceptance research. Currently, the only widely known platform that allows conducting such social experiments is Amazon Mechanical Turk [Kittur et al., 2008]. More specifically, we suggest using the following approach for experimental IT-enabled process research:

- The process experiment employs crowd workers through a crowdsourcing platform such as Amazon Mechanical Turk (AMT). Mechanical Turk supports the acquisition of volunteers and implementation of the process experiments. Basically, a large number of workers interact independently with an executable process that is implemented using BPMN[2] process models.
- Process control must be arranged by using a software application that manages the business process (workflow engine). The process models are loaded into and run in this engine.
- Through the REST[3] interface of the process engine interaction with the process is facilitated. The interaction takes place on the user's side with a web application on HTML5 / AngularJS base. All components are integrated into a server application that provides the necessary infrastructure.
- Treatment variables with which the worker interact can be changed individually or together, resulting in different process variants. The acceptance for these process variants is then measured. More specifically, after the worker was exposed to a process, he fills in a questionnaire as a measurement tool. The collected data are complemented with demographic information and stored in a database for later analysis.
- The outcome can be used to determine cause-effect relationships of treatment variables and the acceptance for a given process. This in turn can be exploited in practice to design, implement and manage processes better and to adapt them meaningful to the process participants and the context.

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[2] **BPMN** (Business Process Model and Notation) is a graphical representation for specifying business processes in a business process model.

[3] **REST** (Representational State Transfer) is an architectural pattern to interact with web services by using HTTP calls.

- It is intended to publish the software under an OSS license later and present it to the research community.

In Figure 2 the abstract experimental setup is depicted.

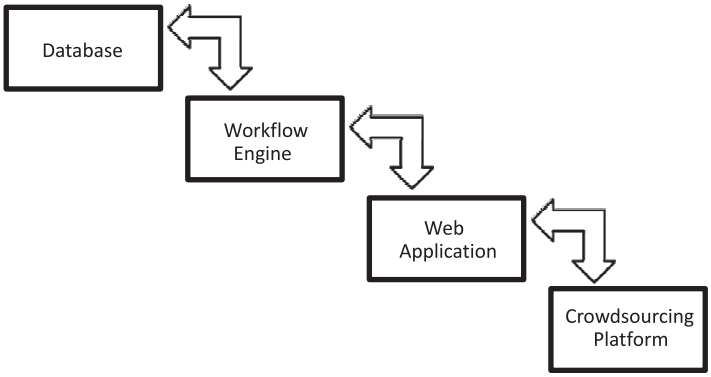

Figure 2. Abstract model of experimental setup (interconnected IT applications)

To implement the approach non-functional and functional requirements were established, which formed the basis for developing a software prototype.

Non-functional requirements on the prototype:

- Experiment can be conducted all over the world in various time zones.
- Software should be based on methods and concepts that will run on different platforms.
- All components of the prototype should be based on open source software solutions to facilitate integration and source code changes.
- Software must be correctly and precisely described in its documentation.
- There must be tests available to check the correct operation of software components.

Functional requirements on the prototype:

- The user interacts with the experiment by using a web browser.
- The prototype must be able to interact with Amazon Mechanical Turk.
- The software must use BPMN-models (XML format) as an input parameter.
- The software must employ a workflow engine with REST-interface necessary to connect between different application parts, such as the open source BPMN Process Engine Bonita BPM.
- All tasks created for Amazon Mechanical Turk must include a possibility to identify participants who do not sufficiently focus on the task and only try to obtain money through deceit, such as a captcha or instructional manipulation check [Oppenheimer et al., 2009].
- The time workers spent on a specific stage of the experiment and for the experiment on a whole should be measured.
- After successful completion of the experiment, a questionnaire must be presented to the participants.
- All relevant experimental data must be saved in a database. The accuracy and consistency of the data must be ensured over its entire lifecycle.

4.2. Key Technical Aspects of Prototype Development

Workflow Engine

Basically, a workflow engine controls the status of activities in a process, distributes tasks among various executors and arranges data communication between process participants. Currently, there are four major competitors on the market of open-source workflow engines: *Activiti*, *jBPM*, *Bonita* and *Intalio*. These engines provide almost the same functionality to manage business processes, but they considerably different in user friendliness and popularity. The most popular are Activiti and jBPM. However, based on the assessment and recommendation of Baina and Baina [2013] as well as available documentation resources, it was decided to use Bonita BPM[4] in our prototype. Bonita BPM includes three major components:

- *Bonita Studio* allows users to graphically build business processes based on BPMN standards, connect business processes to other components of information systems (such as messengers, ERP systems, databases) in order to make the business application available as a web form. Bonita Studio gives an opportunity to create own designs of web forms, through which end users are supposed to interact with business processes.
- *Bonita BPM Engine is a* workflow engine based on Java that allows users to interact with processes based on BPMN.
- *Bonita Portal* allows users to manage tasks that they participate in through an interface similar to a mail service. The portal also allows the process owner to receive process reports.

Another advantage of Bonita is its comprehensive public REST-interface which facilitates integration with other components such as AngularJS.

Web Technology/AngularJS/PsiTurk/Jatos

A single page web application was developed in HTML with CSS and JavaScript. AngularJS — an open source Model-View-* Javascript frontend framework — was used to implement the communication between application components. An important function of the selected framework is the opportunity to work with a REST-interface. Thus, communication of web pages with the workflow engine can be adjusted directly by using AngularJS without any additional components.

Existing tools that facilitate working with the crowdsourcing platform Amazon Mechanical Turk by providing a common development framework for experiments are PsiTurk [McDonnell et al., 2012] and Jatos [Lange et al., 2015]. While PsiTurk is based on Python, Jatos is based on the Java/Scala MVC Play framework[5]. In comparison to Jatos, which can also run in a standalone mode without interacting with Amazon Mechanical Turk, PsiTurk emphasizes on managing experiments and subject reimbursement. Both frameworks enable the researcher to run their experiments on a local server and publish the experiments on Amazon Mechanical Turk.

Crowdsourcing Platform Amazon Mechanical Turk

Amazon Mechanical Turk[6] (AMT) is one of the web sites within Amazon Web Services. AMT is a crowdsourcing platform organized as an Internet-market where private

[4] http://www.bonitasoft.com/ (accessed: 02.04.2016).
[5] http://playframework.com (accessed: 02.04.2016).
[6] https://www.mturk.com/ (accessed: 02.04.2016).

persons and companies alike, acting as "requesters" according to AMT terminology, may coordinate the use of human "workers" to perform tasks that are often difficult for computers to execute. Requesters can post tasks on the platform that are called "HIT" (Human Intelligence Tasks), for instance the selection of the best picture among those proposed or writing an opinion on a given product or service. Workers can search and select tasks most acceptable for them among those available on the web site and perform it for a fee offered by the requester. The interaction diagram between requester and the worker in AMT is given in Figure 3.

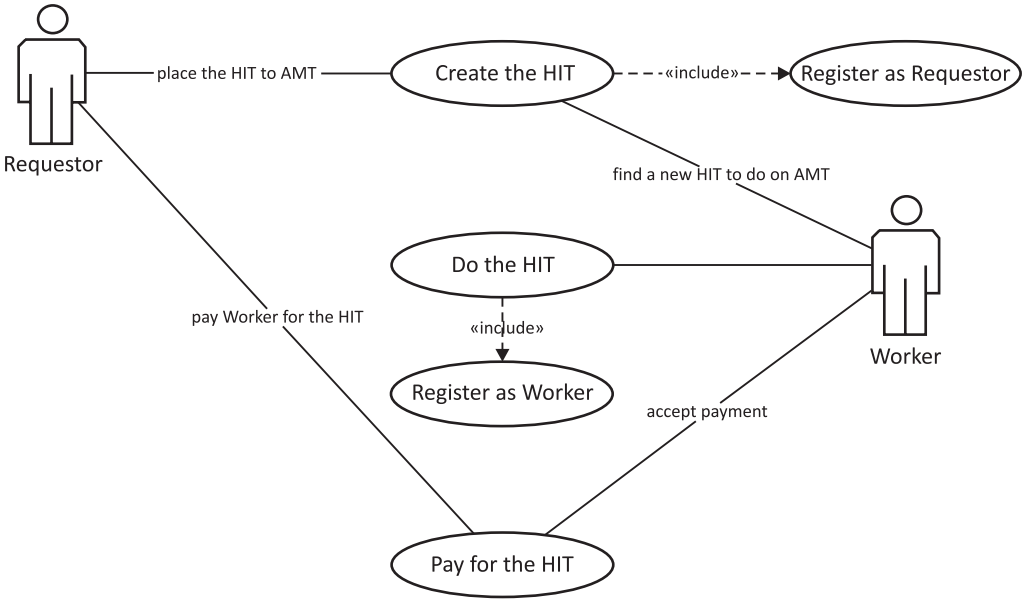

Figure 3. Amazon Mechanical Turk diagram of use options

In order to place a HIT on the site, requesting programs use the application-programming interface (API) or a less capable web site, the AMT Requester (https://requester.mturk.com/). Some major advantages of AMT are as follows:

- **Personnel upon request anywhere anytime:** AMT provides access to a world-wide market of employees that can help completing the task at any moment.
- **Employee qualification.** By using quick tests, AMT allows assessing the worker's qualification before they start to fulfill the HIT.
- **Low costs for requesters.** Costs necessary to engage and control temporary staff in companies are usually high, but AMT allows to significantly decreasing them, as the prices paid per HIT are usually very low.
- **Market mechanisms determine fee.** Workers select those tasks that seem most interesting to them. Requesters set the fee for completed HITs independently. To attract more workers and improve the quality of their work, a higher fee can be granted.
- **Tools for automatic approval.** AMT allows several users to participate in the same HIT. When a sufficient number of users provide identical results, the completed HIT is automatically approved.

Due to these properties, many researchers use Mechanical Turk since 2010 in order to engage people for various experiments. AMT offers an excellent environment to recruit workers for HITs relevant in experimental IT-enabled process acceptance research.

Database. MongoDB

Results of the experiments conducted with business processes must be accumulated and saved for further analysis. Therefore, a database compatible with Bonita is connected to the workflow engine. For this experiment NoSQL technology was selected, namely MongoDB, which is an open-source document-oriented database management system. The major advantage of MongoDB is that it requires no detailed description of the table schemata.

Prototype Conceptual Model

Based on the selected technologies and the described requirements, a prototype conceptual model was developed in the form of a UML sequence diagram (Figure 4).

The experiments themselves are developed as HTLM/Javascript applications. The integration with AMT is achieved by posting an ad for the experiment on the AMT workers page. If an AMT worker accepts the HIT, he is redirected to the experiment and the subsequent measurement instrument, which evaluates the workers process acceptance. After finishing the experiment, in the case of Jatos, a token is generated which enables the AMT worker to claim the task as finished and to get reimbursed.

The proposed process acceptance experiments rely on interacting with the process engine where the process steps are implemented. This interaction is provided by BonitaNG, a module library for AngularJS. Data from the participants of the experiment is collected using web forms while they perform the process steps. After going through the process, the data is transferred as a set of variables to the Mongo database and stored there for further analysis.

4.3. Description of Process Experiment

In the experiment that tests the prototype, a picture analysis is to be performed by the participants on Amazon Mechanical Turk. This experiment was selected because it is easy to implement and therefore suitable to test the prototype. Further studies could exhibit more advanced experimental designs. The aim of this experiment is to reveal which way is the more convenient for participants — answering questions about a given picture "step by step" or answering several questions at the same time ("connected"). In other words, testing two process variants similar in idea, but different in process steps. The idea of this experiment is based on eager or lazy data fetching in databases.

Participants have the opportunity to use the Internet during the survey for finding answers to the questions. Table 3 shows the steps in both process variants. The picture to be analysed is the painting "The Ninth Wave" by I. Ayvazovskiy. However, which picture is analyzed is of no importance, since the process of analyzing it is the focus of the experiment.

Initially, both processes are created and tested in Bonita Studio (Figure 5) using BPMN 2.0.

The interaction of the participants with the processes takes part through a set of web forms. Figure 6 displays a web form from the "connected" process approach as an example.

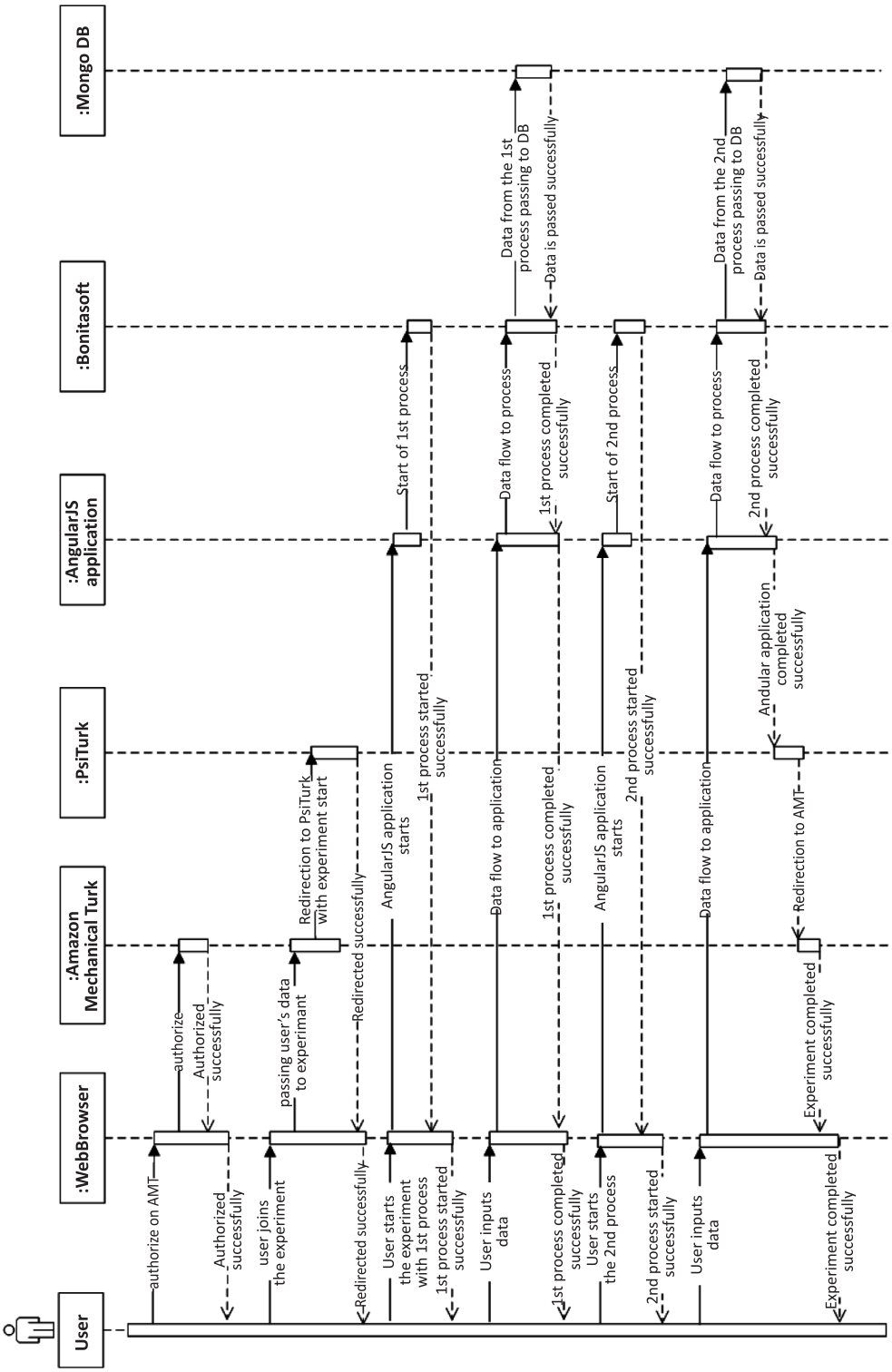

Figure 4. Prototype conceptual model (UML sequence diagram)

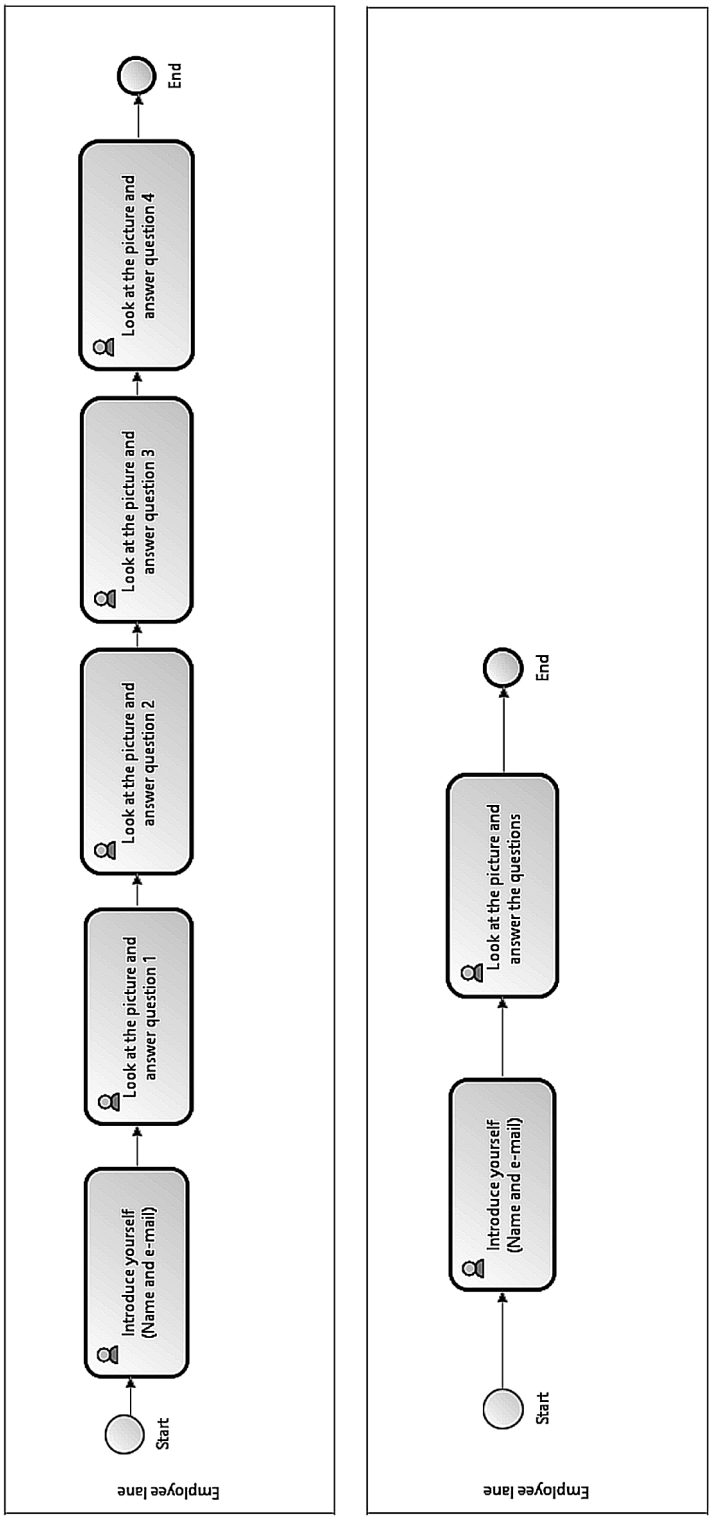

Figure 5. The two process variants modeled in Bonita Studio with BPMN 2.0

Table 3. **Two different process variants for analyzing a given painting**

Process Steps	"Step-by-Step" Approach	"Connected" Approach
Step 1	Input contact details. Go to the next step.	Input contact details. Go to the next step.
Step 2	Answer the first question: "What is the name of the painting?" Go to the next step.	1. Answer the following questions: "What is the name of the painting?" "Who is the artist of the painting?" "In which year was the painting introduced?" "In which museum is the painting now?" Stop.
Step 3	Answer the second question: "Who is the artist of the painting?" Go to the next step.	
Step 4	Answer the third question: "In which year was the painting introduced?" Go to the next step.	
Step 5	Answer the fourth question: "In which museum is the painting now?" Stop.	

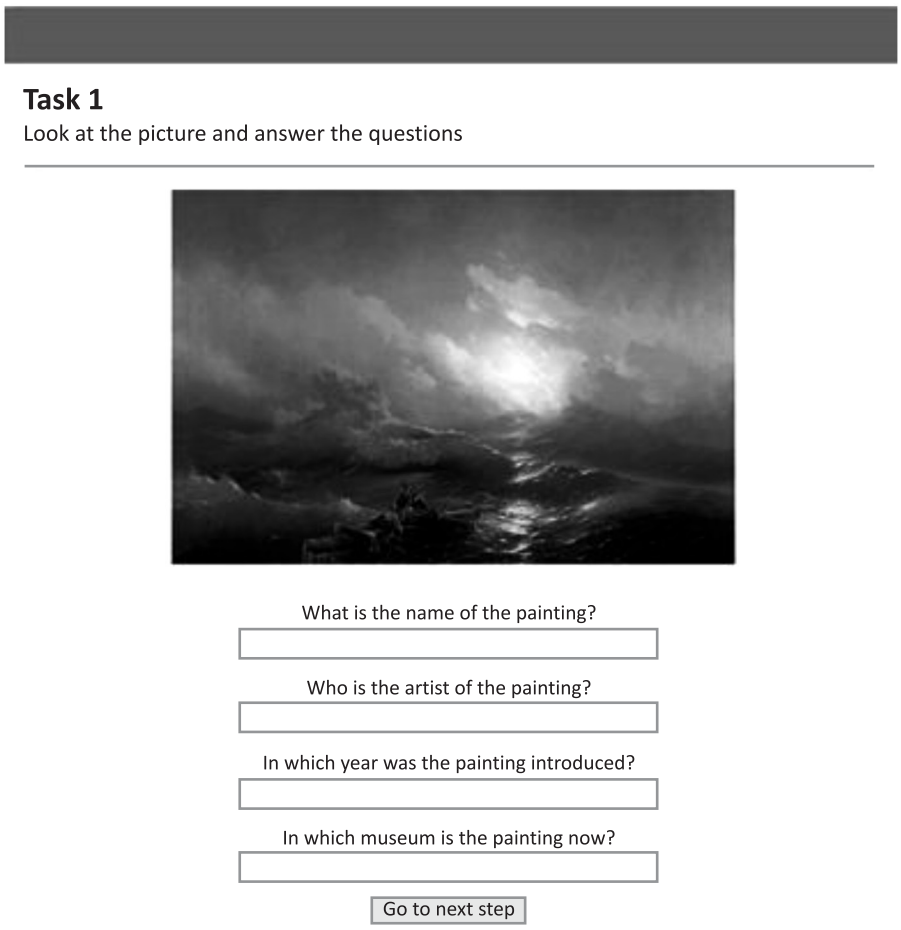

Figure 6. A typical web form as used in this process experiment

After completing the tasks, users are questioned about which variant of the process is more convenient for them and why. Participants are split in two groups. One group performs the "step-by-step" process variant first, followed by the "connected" variant. The other group does vice versa. Questionnaires are consequently split in two groups for analysis, the first rating the "connected" process variant, after being exposed to the „step-by-step" process, and the other rating „step-by-step"after being exposed to the „connected" approach.

For questionnaire design and scale development the C-OAR-SE procedure [Rossiter, 2002] was selected. In comparison to the approach publicized by Churchill [1979], Rossiter favors single item-measurements, which are developed in a concise 6-step procedure that forms the acronym C-OAR-SE [Rossiter, 2010]. In the literature, differences between the approaches' and pros and cons of the procedure are discussed at length [Bergkvist and Rossiter, 2008; Diamantopoulos, 2005].

All questions in the measurement instrument are designed as binary, double level free, individually inferred satisfaction threshold (DLF IIST) items, which exhibit a high stability and predictive validity especially when used for measurements of perceptions and beliefs [Rossiter, 2010, p. 77]. The item content was derived from our process acceptance research and literature on acceptance dimensions.

The proper method for evaluating data, resulting from such a design, with variables on a nominal scale, is an analysis of variance (ANOVA). An ANOVA is usually conducted in two steps. In the first step, a linear model is calculated and an F-test is performed to evaluate if any differences between the factor levels of the independent variables exist. In the second step, t-tests, or analogously confidence intervals, are calculated to determine which differences exist, and how strong they are.

5. Conclusions and Future Work

Business processes and the management thereof can create value for companies. This expected contribution of BPM may only unfold if the processes are executed as designed. Process Acceptance Research investigates factors which influence acceptance throughout the entire process lifecycle. Thus, the ultimate goal is to understand better, why some processes are accepted and others circumvented in order to create processes in practice that are well accepted by their stakeholders.

The present paper discussed ideas about the importance of IT-enabled experimental acceptance testing in the field of BPM. Additionally, a corresponding experiment was developed and the necessary tools were evaluated. Research currently underway focuses on implementing the aforementioned ideas in a runnable experiment and report the results w.r.t. process acceptance. Additionally, a larger set of experiments, with different treatment variables (e. g. level of interdependence, timing, repetition) which are likely to influence process acceptance, could be devised.

However, future work should also evaluate different crowdsourcing services. This is necessary because Amazon Mechanical Turk only offers its services to customers based in the US. This pre-selection of subjects might influence the experimental results. Also comparing the attitude towards a process among different populations with different cultural backgrounds might yield additional insightful results.

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