In search of an appropriate notation to model business process workarounds: The effect of BPMN elements on understandability and user acceptance

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A thesis submitted in partial fulfillment

of the requirements for the degree of

Master of Science in Information Science

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1. Introduction

Workarounds are specific forms of incompliant behavior, during which employees intentionally decide to deviate from the required procedures although they are aware of them [1]. In [2], the authors support that workarounds are often seen as a misfit between the expectations of technology and the applied practices, and they highlight the fact that it is of high importance to contribute to the body of research towards the direction of understanding the effect of workarounds on business processes.

A big step towards this direction would be to identify methods that allow their user to design easily understandable and easy to use models of the business process workarounds. This kind of knowledge would not only enrich the body of research and the current level of understanding of the field, but would also assist organizations and practitioners in various tasks, such as the modelling of workarounds that take place in various business functions, the support of processes that deal with workarounds, and the visualization of non-compliant behavior [3]. Such knowledge could also act as a great tool for analysts that are called to make decisions based on the knowledge that they draw from existing workarounds. For instance, such research could greatly complement existing methods that enable decision making regarding workarounds, such as the one presented in [4] which provides a framework that facilitates the process of decision making on whether a workaround should be prevented, redesigned, adopted, or ignored.

While the field of Business Process Modelling is quite mature, very little attention has been given towards the visualization of workarounds. A dedicated approach is proposed in [3], in which the authors suggest an extension to the widely used Business Process Modelling Notation (BPMN). The aforementioned extension includes a set of elements that enable the modelling of workarounds and other related information, such as the type of the workaround, the risks it introduces as well as its consequences. The remaining notations that were identified in the existing literature [4,5] are not discussed in depth by their authors, as they fall outside the main focus of their work. It is also worth mentioning that none of these methods has been tested so far, thus it is not possible to draw accurate conclusions on their suitability and user satisfaction.

Considering the currently available literature, it is evident that there is a need for putting the above-mentioned notations into testing and discuss their qualities. Therefore, the main goal of our research is to cover this gap by attempting to address the following points: (1) which are the available notations that enable the modelling of business process workarounds, (2) how do these notations compare to each other in terms of their understandability, and in terms of how they contribute to the understandability of the modeled workarounds and their context, and (3) how does the best performing notation in terms of understandability perform against an approach that is being used in the industry when it comes to user acceptance?.

Overall, our report is structured in compliance with the following logical flow: we start by introducing our topic and its theoretical foundations, and we continue by presenting the gap in the existing research. Based on this gap we shape our research objectives and research questions, and we proceed by presenting our research design. Finally, we report on the execution of our design and on the achieved results, which we further discuss along with the limitations of our research as well as possible directions for future work.

2. Theoretical foundation

The following chapter presents the work and the fundamental concepts that form the foundations of workaround modelling. To facilitate a logical flow in our document, we start by introducing the basic principles of business process modelling, as well as the ones of workarounds. We achieve this by presenting a high-level introduction to the ground theory of Business Process Modelling as part of the Business Process Management field and its contribution to the BPM lifecycle, and we proceed by introducing the theoretical foundation of workarounds. This approach enables us to discuss the conceptual background of the conducted research, as well as to present a more detailed introduction to our topic.

2.1. Business process modelling as a part of Business Process Management

Business Process Modelling falls under the broad scientific field of Business Process Management, which we briefly introduce below. Starting with the core terms, we quote the definition proposed by Dumas et al. [6] to define a business process as:

"a collection of inter-related events, activities and decision points that involve a number of actors and objects, and that collectively lead to an outcome that is of value to at least one customer."

Taking into account this definition of a business process, Dumas et al. [6] also define the field of Business Process Management as:

"a body of methods, techniques, and tools to discover, analyze, redesign, execute and monitor business processes"

Taking into account this definition as well as the different activities that it introduces, we are able to introduce the BPM lifecycle, which is presented in *Figure 1*, and can be perceived as a continuous cycle consisting of six phases, namely: process identification, process discovery, process analysis, process redesign, process implementation, and process monitoring and controlling [6]. Considering the nature of these activities, it can be easily understood that process models are a core element of the BPM lifecycle and play a very important role in a number of its phases. More specifically, process modelling is most closely connected to the phases of *Process discovery*, where the as-is models of each process are created to present their current state; and *Process redesign*, where the to-be models of the respective processes are created taking into account the improvement points that were identified up to that point. They are considered vital for their ability to offer an understanding of the company as well as the mechanisms that are used for its operation. [6]

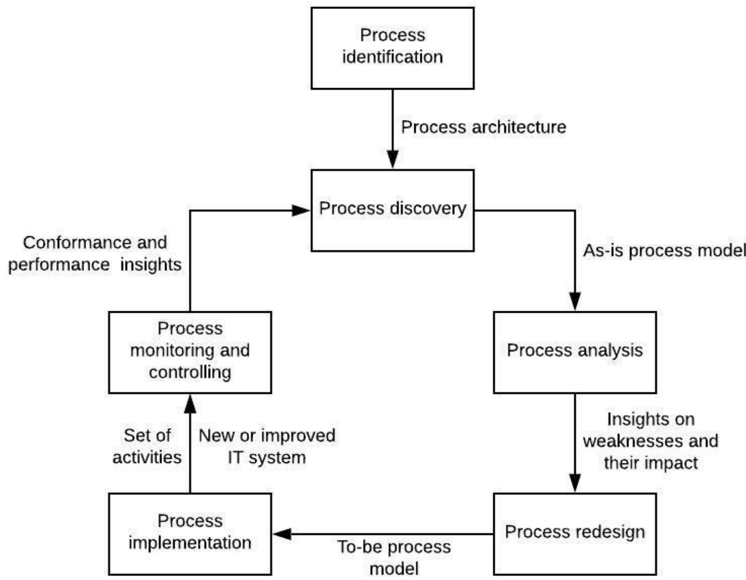


Figure 1: The BPM lifecycle (Reprinted from [6])

Armed with the information presented above and drawing knowledge from [12, 13] we can describe the task of business process modelling as:

"The process of visualizing business processes in the form of a graphical workflow view, having as an aim to depict the current state of the an organization's processes, also known as "as-is processes", in order to further analyze and improve them by designing new versions of the processes, also known as "to-be processes", which can be implemented and monitored".

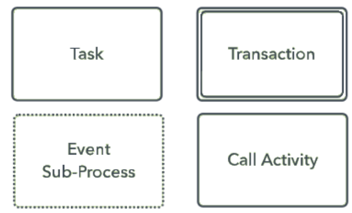
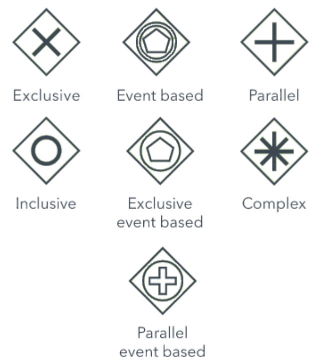
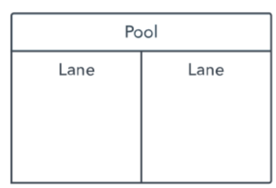
There is a variety of languages that can be used in the process modelling task, with the most common one, among others, being: Business Process Model and Notation (BPMN), Petri Nets, Yet Another Workflow Language (YAWL), Unified Modelling Language Activity Diagrams (UML AD), and Event-driven Process Chains (EPC) [7].

2.2. Business process model and notation

The Business Process Model and Notation (BPMN) was initially introduced by the Business Process Management Initiative in 2004 [8], and, since 2006, is maintained by the Object Management Group (OMG), with its latest version at the time of writing this thesis being 2.0.2 [9]. BPMN is one of the most widely and often used notations in the process modelling task [7]. It is a standard that enables the high-level visualization of business processes and aims at providing a notation that is easily readable and understandable to all business users [9]. These qualities and characteristics acted as the reason to limit the scope of our experiment and test only BPMN-based notations, as it is further explained in *Chapter 5.5*.

To enable the modelling of a process, BPMN offers a number of elements, with each one of them serving a different purpose. The main BPMN elements are categorized based on their type and presented in *Table 1* below, followed by a short description of them according to [9].

Table 1: BPMN elements

Element category	Element	Symbols
Flow objects	Events	
	Activities	
	Gateways	
Connecting objects	Sequence flow	
	Message flow	
	Association	
Swimlanes	Pools and lanes	
Artifacts	Data object	
	Group	
	Annotation	

There are four element categories in BPMN: (1) *flow objects*, (2) *connecting objects*, (3) *swimlanes*, and (4) *artifacts*.

More specifically, *flow objects* are the main describing elements that are used in BPMN and include three subtypes of elements, namely: *events*, *activities*, and *gateways*. *Events* can be seen as triggers that start, modify, or complete a process. They are represented with a circle containing a symbol based on the type of the event. They can also be classified in catching and throwing, when for example an incoming message starts a process, or when a completion message is thrown upon the end of the process. *Activities* are modeled with a rounded-corner rectangle. They represent activities or tasks that are performed by a system or an individual and describe the kind of work that has to be done. Finally, gateways are modeled using a diamond containing a symbol based on the conditions that we want to express. They represent decision points that merge or fork paths based on the conditions.

When it comes to *connecting objects*, there are three main elements, namely: *sequence flows*, *message flows*, and *associations*. More specifically, *sequence flows* are modelled with an arrow and represent the order in which the activities must be performed. *Message flows* are modelled with a dashed arrow with a circle at its start. They represent messages that flow across organizational boundaries, such as pools, and they should never be used to connect activities and events that exist within the same pool. Finally, *associations* are modelled with a dotted line. They are used to represent an association between artifacts or text to events, activities or gateways.

Swimlanes consist of *pools* and *lanes*. A *pool* is used to represent a major participant in a process, such as different organizations, and it contains one or more *lanes*. It is depicted as a large rectangle containing the respective number of *lanes. Lanes* are used to organize and categorize *activities* within a pool. They contain *flow objects*, connecting *artifacts* and *objects*.

The last category of elements is the *artifacts*, which consists of *data objects*, *groups*, and *annotations*. *Data objects* represent the data that is necessary for or produced during an *activity*. *Groups* are used to create groups of different *activities* and they do not affect the flow of the diagram. Finally, *annotations* are used to provide the reader with further information regarding a specific part of the diagram.

2.3. Workarounds

Shaping our way towards our field of research, we move on by shortly introducing the concept of workarounds in business processes, which has met an increased research interest during the past years. There are several definitions for workarounds, ranging from concise ones that can be applied to a wide variety of domains, like the one we adopt throughout our research which was proposed by Halbesleben et al. [10] who define workarounds as *"deviations from prescribed plans of action";* to more detailed and complex ones, like the one proposed by Alter [11] who defines a workaround as *"a goal-driven adaptation, improvisation, or other change to one or more aspects of an existing work system in order to overcome, bypass, or minimize the impact of* *obstacles, exceptions, anomalies, mishaps, established practices, management expectations, or structural constraints that are perceived as preventing that work system or its participants from achieving a desired level of efficiency, effectiveness, or other organizational or personal goals.”*.

Throughout the literature, workarounds are studied as both beneficial phenomena that enhance organizational efficiency, e.g. [2, 16 18, 19], as well as costly and inefficient alternative procedures that cause negative impacts, e.g. [1, 18, 19], with a big part of the available research also focusing on categorizing and rationalizing workarounds, as well as explain how people conduct them.

There are several approaches that propose guidelines to classify workarounds, e.g. [2, 14, 16, 19], often focusing on specific domains. The most extensive and complete approach that covers the broadest spectrum of workarounds is the one proposed by Alter [11]. According to the author, workarounds can be classified in the following types: (1) *Overcome inadequate IT functionality, (2) bypass obstacles built into existing routines, (3) bypass or overcome transient obstacles due to anomalies or mishaps, (4) respond to mishaps with quick fixes, (5) augment existing routines without developing new resources, (6) substitute for unavailable or inadequate resources, (7) design and implement new resources, (8) prevent mishaps, (9) pretend to comply, (10) collude for mutual benefit*, and finally *(11) lie, cheat, or steal for personal benefit*.

3. Research gap, research questions, and hypotheses

While the research fields of business process modelling and of workarounds are quite mature, this is not the case for the field of workaround modelling, which is still rather unexplored. This is evident by the existing literature, which exhibits a significant lack of studies similar to [7], that summarize all the available notations that enable the modelling of process workarounds. Such work could be used as a state-of-the-art report for other researchers, as well as a summary of the available notations for those interested in visualizing process workarounds. This significant gap acted as the initial and main motivation for our research, based on which we shaped our first research objective (RO1):

RO1: *Present the existing proposed notations for modelling business process workarounds;*

which we aim to achieve by answering the following research question:

RQ1: *Which are the available notations that enable the modelling of business process workarounds?*

To address this research question, a systematic literature review was conducted on the existing related research. Thus, in *Chapter 5*, we discuss the literature findings that contribute to the modelling of business process workarounds along with the proposed notations.

The results from our first research question, which are presented in detail in *Chapter 5*, highlight a significantly limited amount of related works, with our systematic literature review resulting in only four notations. Additionally, we observed that there are no empirical studies conducted that test these notations by gathering empirical data from actual users and report how they perform in practice. This additional gap in the existing literature acted as our motivation for the next step in our research. Drawing inspiration from relevant and related studies [16, 17, 18] we decided to investigate how the acquired notations perform when it comes to two crucial traits of business process models, namely: understandability, and user acceptance. Based on this goal we shaped our second (RO2) and third (RO3) research objectives, which are presented below accompanied by the respective research questions.

RO2*: Investigate how these notations compare against each other in terms of their understandability, and in terms of how they contribute to the understandability of the modeled workarounds and their context.*

Based on this objective, we pose the following research question:

RQ2: *How do these notations compare to each other in terms of their understandability, and in terms of how they contribute to the understandability of the modeled workarounds and their context?*

To address this research question, we followed an empirical research approach which is realized in the first phase of our two-phase comparative experiment, the design of which we present in detail in *Chapter 6.* This research question is split into the following sub-research questions (SRQs), which highlight the different variables that were used to measure the understandability of the tested notations. Each SRQ is accompanied by a brief definition of the tested variable as well as the null hypothesis that we formulated.

SRQ2.1: *Is there a difference in Understandability Task Effectiveness (UTE) of the tested notations?* Understandability Task Effectiveness is a quantitative variable defined as the level of understanding that the subjects can demonstrate with respect to the presented model, and it is measured by the achieved number of correct answers of the experimental subject [19]. The null hypothesis that was tested in order to address the aforementioned research question is: ***H_{01}:*** *There is no difference in Understandability Task Effectiveness between the tested notations.*

SRQ2.2: *Is there a difference in Understandability Task Productivity (UTP) of the tested notations?* Understandability Task Productivity is a quantitative variable defined as the level of cognitive resources spent by the subject in understanding the given model [17], and it is measured by dividing the *Understandability Task Effectiveness* score by the time spent for each. The null hypothesis that was tested in order to address the aforementioned research question is: ***H_{02}:*** *There is no difference in Understandability Task Productivity between the tested notations.*

SRQ2.3: *Is there a difference in Perceived Ease of Understanding (PEOUN) between the tested notations?* Perceived Ease of Understanding is a qualitative variable defined as the degree to which a subject believes that understanding a particular notation is free of mental effort [19]. The null hypothesis that was tested in order to address the aforementioned research question is: ***H_{03}:*** *There is no difference in Perceived Ease of Understanding between the tested notations.*

SRQ2.4: *Is there a difference in Perceived Usefulness for Understandability (PUU) between the tested notations?* Perceived Usefulness for Understandability is a qualitative variable and is defined as the degree to which a subject believes that a particular notation provides gains to the user in terms of understandability [19]. The null hypothesis that was tested in order to address the aforementioned research question is: ***H_{04}:*** *There is no difference in Perceived Usefulness for Understandability between the tested notations.*

The first phase of our experiment reported overall significant differences in favor of the connecting object introduced in [4], based on which result we shaped our third and final research objective (RO3). The goal of RO3 is to test how the connecting object notation performs in practice when it comes to user acceptance. To achieve this, we designed and executed the second phase of our comparative experiment which was hosted by the process development department of a Fortune 500 fashion retail company. This allowed us to test how the connecting object notation performs in terms of user acceptance against an approach that is being used in practice. This approach introduces two separate models: one dedicated to the standard process and one dedicated to the workaround process. Based on that, we present RO3:

RO3*: Investigate how the connecting object notation compares against the two separate models in terms of user acceptance.*

Based on our third objective, we define the following question:

RQ3*: How does the connecting object notation compare against the two separate models in terms of user acceptance?*

This research question is split into the following sub-research questions (SRQs), which highlight the different variables that were used to measure the user acceptance of the tested notations in practice.

Each SRQ is accompanied by a brief definition of the tested variable as well as the respective null hypothesis that we formulated.

SRQ3.1: *Is there a difference in Perceived Ease of Use (PEOU) between the connecting object and the two separate models?* Perceived Ease of Use is a qualitative variable defined as the degree to which a subject believes that using a particular method of representation is free of effort. The null hypothesis that was tested in order to address the aforementioned research question is: ***H_{05}:*** *There is no difference in perceived ease of use between the tested notation and the two separate models.*

SRQ3.2: *Is there a difference in Perceived Usefulness (PU) between the connecting object and the two separate models?* Perceived Usefulness is a qualitative variable and is defined as the degree to which a subject believes that a particular method of representation achieves effectively its intended objectives. The null hypothesis that was tested in order to address the aforementioned research question is: ***H_{06}:*** *There is no difference in Perceived Usefulness between the tested notation and the two separate models.*

SRQ3.3: *Is there a difference in Intention to Use (ITU) between the connecting object and the two separate models?* Intention to Use is a qualitative variable and is defined as the degree to which a subject intends to use a particular method of representation. The null hypothesis that was tested in order to address the aforementioned research question is: ***H_{07}:*** *There is no difference in Intention to Use between the tested notation and the two separate models.*

4. Research design

The following chapter presents the research design and the methods that were used during the different stages of this research project. Combined, they build the framework that was used to answer the given research questions.

4.1. Systematic literature review

Our literature review aims at summarizing all existing information on the specified subject in an unbiased and thorough manner. According to [20], literature studies should not be exclusively based on protocol-driven approaches, as there is a high risk of missing a significant number of relevant and useful sources. To mitigate this issue and minimize the risk, Greenhalgh & Peacock's approach was followed [20] by combining the following two methods: (1) a systematic literature review approach which was based on the proposed guidelines of Kitchenham [21], and (2) the snowballing approach, which was conducted by following the steps proposed by Wohlin in [22].

The guidelines of Kitchenham [21] for a systematic literature review can be summarized in the three following steps: (1) planning of the review, (2) conducting the review, and (3) reporting the review. The manual searching was conducted in the Google Scholar search engine which, according to [22], provides sufficient coverage by combining many different sources and eliminates bias in favor of specific publishers. The query that was used is the following: *"business process modelling" AND notation AND ("process workarounds" OR "non-conformance" OR "non-compliance" OR "process deviation")* and it was applied on the entire content of articles.

To make sure that no significant findings were omitted due to the use of a single search engine, the same query was also applied to other relevant sources, namely: ACM Digital Library, SpringerLink, IEEE Computer Society Digital Library, and Science Direct. This time, due to the extended advanced search functionalities of these libraries, the query was applied to the title, keywords, and abstract of the articles.

Finally, the snowballing approach was applied to the most important papers that contribute the most to our research. For instance, [3] proposes a dedicated notation that enables the visualization of workarounds. Additionally, the proposed notation is an extension to the BPMN, which is one of the most widely used notations to model business processes [3]. Taking these facts into account, it can be argued that the chances of this paper citing and being cited by relevant works are very high. During backward snowballing, the reference list of the paper is scanned in order to identify new papers to include. Respectively, during forward snowballing, the papers that cite the paper being examined were checked and considered for review. After each iteration of backward and forward snowballing, the identified papers are put into a pile and go into the next iteration. This procedure is being repeated until no new papers are found, and thus resulting in the final set of papers that were used for the literature review. The filtering of the papers during each step was performed based on their relevance to the topic and their contribution to the given research questions. An overview of the previously described steps of the snowballing process is presented in *Figure 2* below.

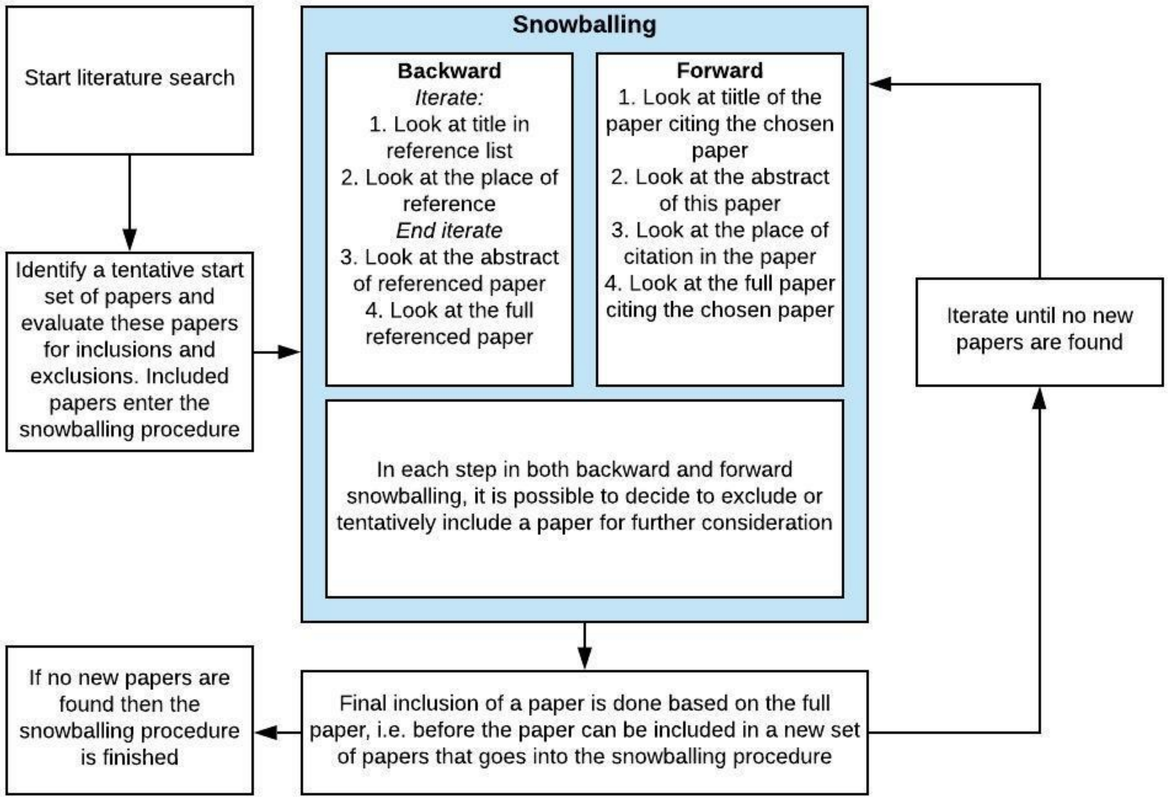


Figure 2: Snowballing literature review procedure (Reprinted from [22])

Furthermore, we present the exclusion criteria (EC) and inclusion criteria (IC) that were applied to all the methods mentioned above. According to the theory of Kitchenham [21], exclusion and inclusion criteria should focus on identifying the studies that contribute to achieving the research objectives and answering the defined research questions. For this study, we defined and applied during the paper selection procedure the exclusion criteria presented in *Table 2* below.

Table 2: Exclusion criteria

No.	Exclusion criterion
EC1	Not written in English
EC2	Not a scientific paper
EC3	Shorter than 4 pages
EC4	Paper already found

EC1 and EC2 were set to filter the starting pool of papers in order to better fit the scope of this research, while EC3 acted as a quality filter. As can be seen, there was no limitation set regarding the publication date of the paper. This was done to make sure that no significant contributions were left out of the literature review.

Additionally, the inclusion criteria presented in *Table 3* were defined and applied to the papers that were left after the application of the exclusion criteria:

Table 3: Inclusion criteria

No.	Inclusion criterion
IC1	The paper proposes a notation that enables the modelling of workarounds
IC2	The paper presents a workaround model

All the papers were checked by reading their title, keywords and abstract. If necessary, the other chapters of the paper were read as well in order to ensure its compliance with the inclusion criteria. When a paper satisfied at least one of the inclusion criteria, it was imported in Mendeley reference management software and it was fully read.

Quantifying our results from the literature review, the manual searching resulted in 298 papers out of which only one complied with our selection criteria [3]. Applying the snowballing approach to our finding, we came across two additional compliant papers during the first iteration of backward snowballing [5, 15], and one during the first iteration of forward snowballing [4]. The second iteration of the protocol did not result in any new findings that comply with our selection criteria, keeping our final set to 4 papers which are presented in detail in *Chapter 5*.

4.2. Empirical cycle

The rest of the research project is based on the empirical cycle guidelines suggested by Wieringa in [23]. This approach is split into two main elements, namely: (1) the research context, and (2) the empirical cycle. These two elements form a rational way of answering scientific knowledge questions by suggesting a sequence of actions that can be followed. At this point, as suggested by Wieringa in [23], It is worth noting that the empirical cycle is not a research process. This means that several of the proposed steps might not be relevant nor feasible for one's research. Thus, only the steps that were deemed appropriate for our research were followed and are described below.

The process initiates by analyzing the research context, during which, we present the knowledge goals of the research project. After addressing the research context, we follow the steps of the empirical cycle presented in *Figure 3* below, which is summarized in the following high-level steps: (1) *research problem analysis*, (2) *research & inference design*, (3) *validation*, (4) *research execution,* and (5) *data analysis*. Upon conclusion of the empirical cycle, we revisit the *research context* in order to check and conclude on the contribution of our actions to the knowledge goals that we defined at the beginning of our research. The aforementioned steps provide an overview of the empirical checklist, which summarizes the suggested actions to answer our knowledge questions.

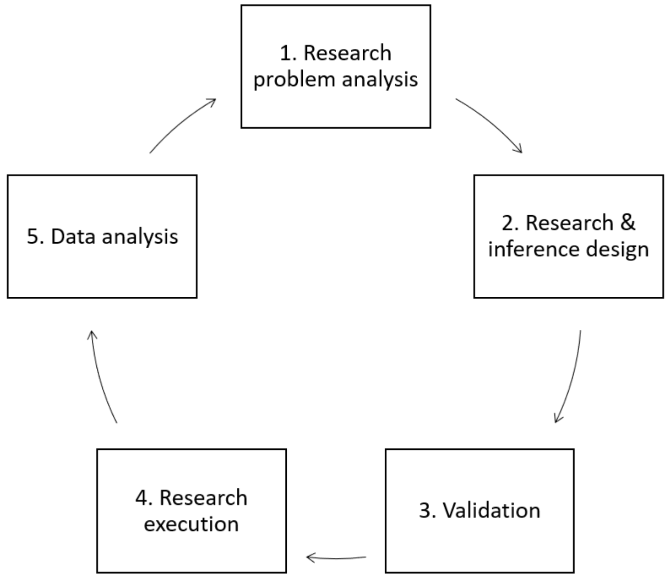


Figure 3: The empirical cycle (Adapted from [23])

More specifically, the first two steps of the checklist, namely: *the research context*, and *the research problem analysis*, are covered by the presented research objectives, the research questions, the research gap that they are aiming to bridge, and the population for which the gained knowledge can be generalized.

For the step of *research & inference design*, we present the design of our experiment as well as the information that we plan to extract from the gathered data. This is covered in *Chapter 4.3* below where we discuss the experimental design.

The step of *validation* refers to the matching between the research setup and the inferences from the data. The main goal of this process is to ensure that the research setup is capable of supporting the inferences that we want to do from the gathered data. Validation also takes care of two more important factors: repeatability and ethics. Repeatability is a characteristic of the experimental design, which should be sufficiently documented and explained so that other peers would be able to recreate it. Finally, ethics concern whether the experimental subjects were treated with respect to ethical norms [23]. These elements are also covered throughout the experimental design which is presented in *Chapter 4.3* below.

The step of *Research execution* includes the execution of the proposed research design. In our case, this entails the execution and documentation of the experimental processes that are described in *Chapter 4.3* below as well as the gathering of the generated empirical data.

Once we have the necessary data, we continue with the *Data analysis* phase during which the inferences that were previously planned are performed in order to answer the posed research questions.

Finally, the *Research context* phase is revisited in order to conclude whether our conducted research and the achieved results contribute to the research questions that were defined at the beginning of the project.

4.3. Experimental design

As described above, a big part of the empirical cycle in this project is the design and execution of the experimental process, which has as a goal to gather and analyze the necessary data that contribute towards answering RQ2 and RQ3. In *Figure 4* below, we present an overview of the distinct steps that were followed during the experimental process.

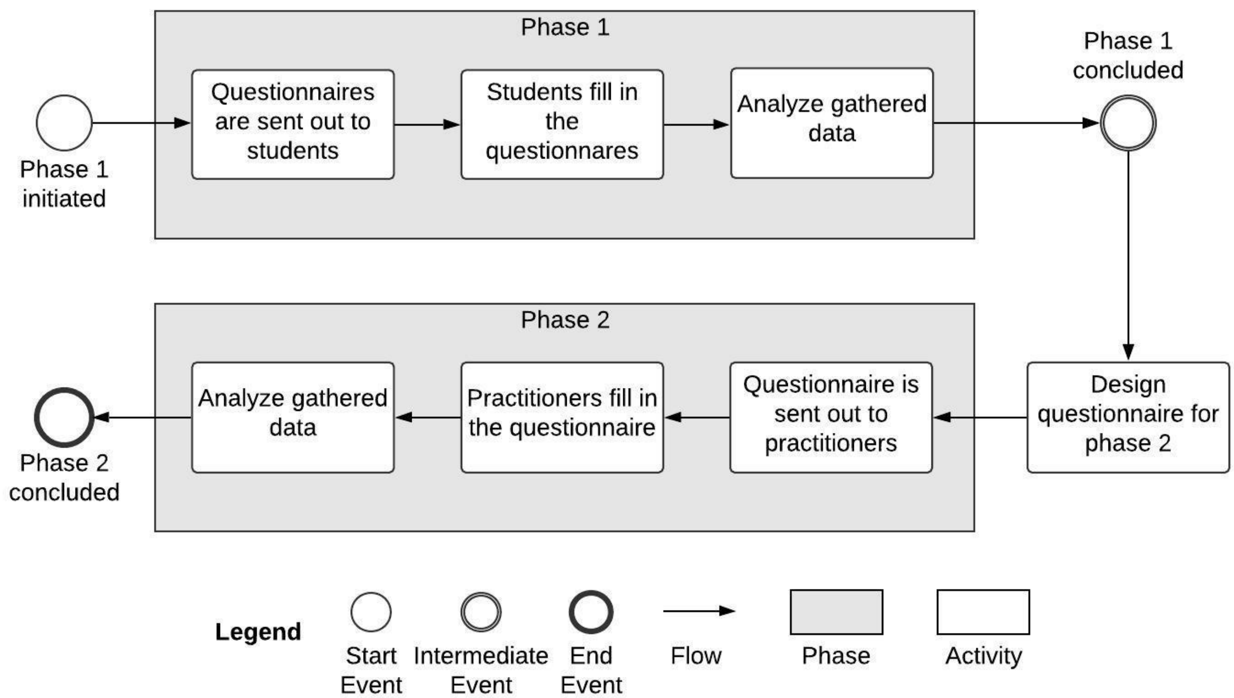


Figure 4: Summary of the experimental process

As can be seen, there are two main, sequential, phases in our experiment. During the first phase, we conduct a comparative experiment which is explained in detail in *Chapter 6.1* below. Going briefly over the process, during the first phase, we run the comparative experiment and we analyze the gathered data to conclude on how the notations compare to each other when it comes to understandability in order to answer RQ2.

Based on the acquired results, we design the second phase of our experiment. Building upon, and drawing knowledge from related studies [13, 14, 15], we compare the best performing notation from Phase 1, against an approach that is used by a Fortune 500 fashion retail company. The aim of this questionnaire is to draw knowledge from practitioners on whether they would prefer to adopt such a notation to visualize workarounds in process models rather than using two separate process models, one for the standard process, and one for the workaround. More information on the data analysis methodology as well as the acquired results can be found in *Chapter 7*, where we present and discuss our results in detail.

5. Literature review

The following chapter is the result of the systematic literature review that we conducted by following the protocols that were previously presented in Chapter 4.1. We present all the notations that we identified in the existing literature by providing a brief overview of each one of them as well as an example workaround model that makes use of the respective notation.

5.1. Workaround process model and notation

Röder et al. [3] propose a notation that is based on the Business Process Model and Notation (BPMN) standard. The authors develop an extension to the BPMN metamodel [27] which introduces a set of symbols that enable the modelling of workarounds and their contextual information, e.g. the workaround type, the business rules that it might violate, and its consequences [11]. This extension is based on the guidelines of the OMG Object Facility (MOF), which defines a framework and an abstract language for constructing, specifying, and managing metamodels [28]. The resulting model is named Workaround Process Model and Notation (WPMN). An overview of the WPMN extension process is shown in *Figure 5* below. As can be seen, the WPMN metamodel is a valid instance of the MOF metamodel extending the BPMN metamodel.

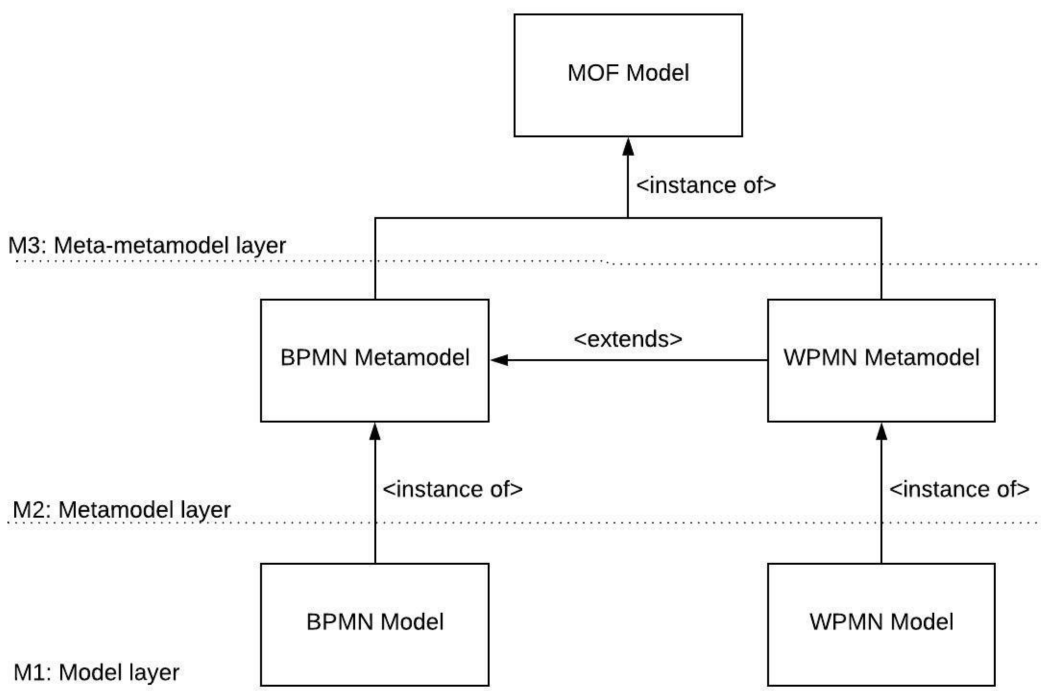
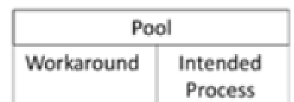
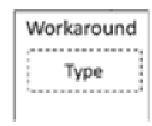
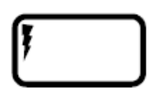
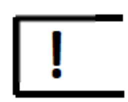


Figure 5: WPMN extension process (Adapted from [3])

Additionally, the authors use the process theory of workarounds [11], in order to better understand the context in which the workarounds are executed as well as how they should be modeled. *Table 4* below provides an overview of the different factors that should be considered when modelling a workaround accompanied by a short description for each one, as well as the respective proposed notation. These constructs include: (1) the *Workaround* which represents all the workaround process steps and is modeled as a BPMN lane in which the process steps that are part of the workaround, (2) the *Type,* which is used to express the different types of workarounds based on their categorization in [11] which was previously discussed in *Chapter 2.3*, (3) *the Risk-Benefit Analysis* which analyzes the pros and cons of working around a process, (4) the *Situational factors*, which determine the risks and the benefits, (5) the *Workaround activity*, which represents an activity that is part of the workarounds process, (6) the *Business rules*, that lay out the formal rules and guidelines that are broken when the workaround is conducted, and (7) the *Consequence*, which highlights the impact of the workaround on the local and broader environment.

Table 4: WPMN Overview (Adapted from [3])

Construct	**Description**	**Representation**
Workaround	Shows the deviation by separating the workaround from the standard process	
Type	Type of workaround based on [11]	
Risk-Benefit Analysis	Factors that influence the risk-benefit analysis. The result of the analysis shows if the workaround is preferred or not.	
Situational Factors	Attributes that influence the risk-benefit analysis	
Workaround Activity	Activities that belong to the workaround process	
Business Rules	Rules that frame the standard process and are violated when the workaround is conducted	
Consequence	Local and broader consequences that highlight the effect of the workaround	

Concluding the foundations of WPMN foundations, *Figure 6* presents the constructs that have been added to the meta-model which are modelled in blue squares, as well as the core elements, modelled in white squares, and their relationships. As can be seen, situational factors, business rules, and consequences are generalizations of artifacts; workaround activities and risk-benefit analysis are generalizations of flow objects, and types of workarounds are treated as lane constructs together with the predefined processes.

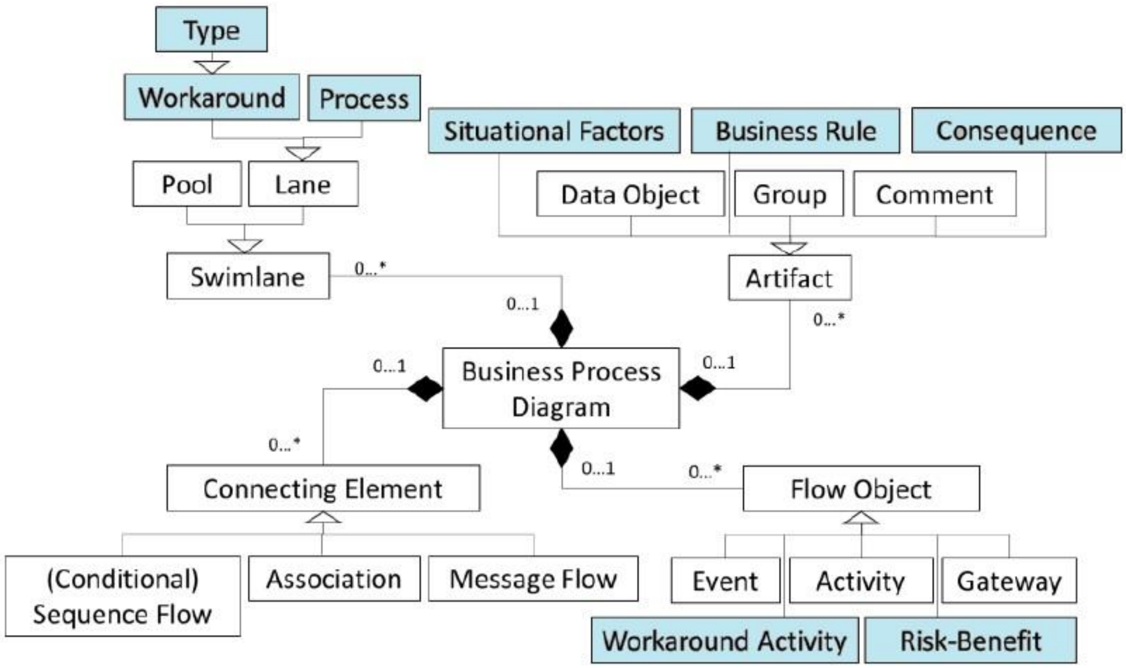


Figure 6: WPMN metamodel extension (Reprinted from [3])

Putting the above concepts into practice, they result in the model presented in *Figure 7* below. The specification that was used for the model is a real-world scenario from the healthcare domain [3]. It concerns a Patient Care Information System (PCIS) which stores and processes all patient data. The hospital complies with policies in order to ensure the confidentiality of the data. Despite the strict policies, some of the physicians use external storage devices and their personal e-mail accounts in order to transfer patient records and share them with colleagues or work on their cases remotely, which conflicts with the hospital and the data privacy laws. To mitigate this problem, the IT architect of the PCIS implemented a VIP flag which disables the download of patient data when it is activated.

Concluding, it can be argued that WPMN is a rather complete notation that enables its user to model the standard process and the workaround process, to include in the model information regarding the risk-benefit analysis for the risk and the benefits that are introduced by the workaround, to model its consequences, and to model additional information for managing the workaround, such as the violated business rules [3].

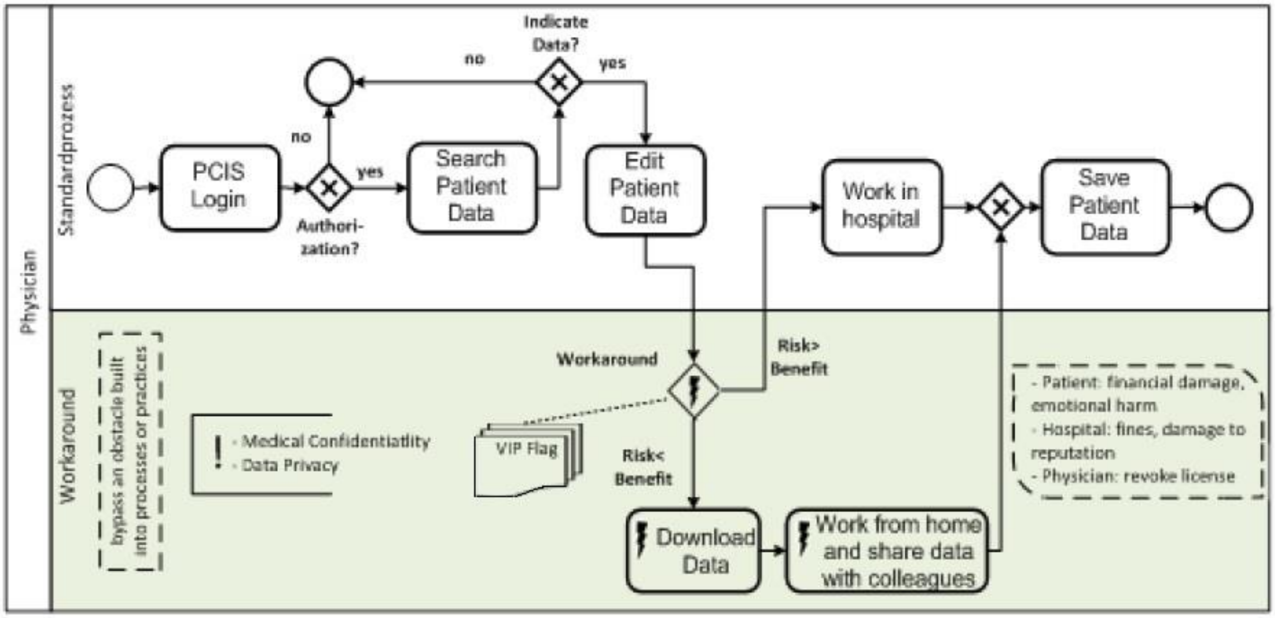


Figure 7: WPMN model instance (Altered from [3])

5.2. Workarounds in BPMN

Another approach that is also based on BPMN is used in [4]. The authors, during their research work on improving healthcare using knowledge on workarounds, they came up with the notation presented in *Table 5* below.

Table 5: BPMN workaround notation

Construct	Description	Representation
Prescribed process	A connection between objects that represents the prescribed process	
Workaround	A connection between objects that represents the workaround process	

The authors make use of the two connection types presented in *Table 5* combined with the exclusive gateway of BPMN, to model the prescribed and the workaround processes. For instance, in *Figure 8* below, according to the prescribed process, the physician is responsible for entering the medication information of the patient in the HIS. Sometimes, this does not happen correctly or does not happen at all, which is considered to be a workaround. This leads to the nurse contacting the physician at a later time in order to ask, receive, and fill the necessary information, which are workaround processes as well since they deviate from the prescribed process. These workaround processes are modelled using the red dotted connections.

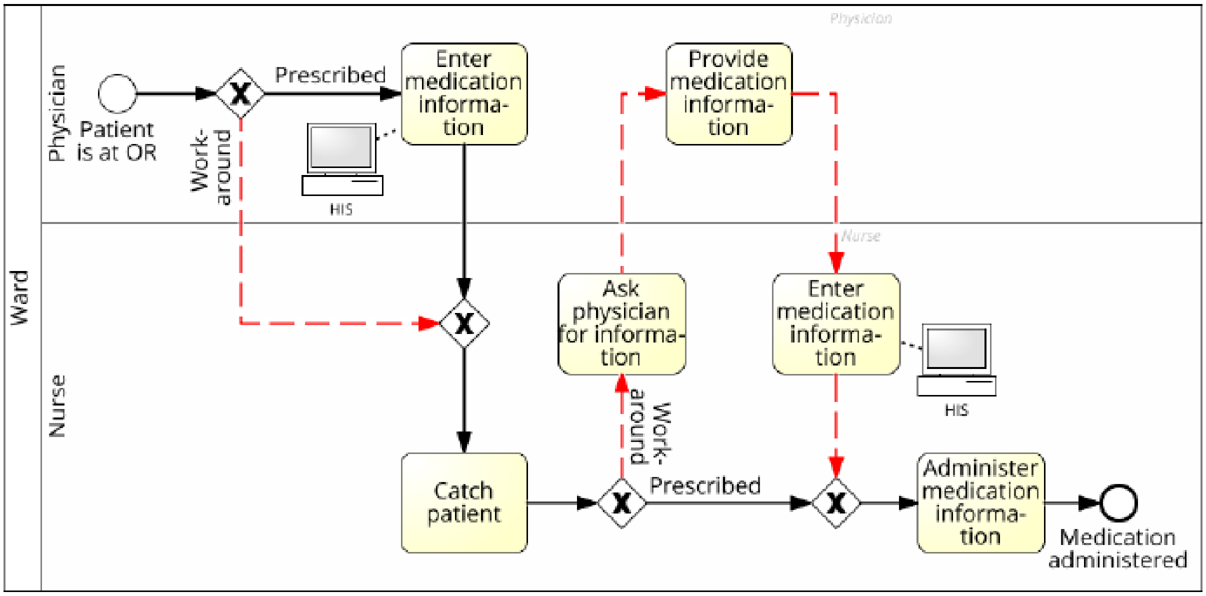


Figure 8: Workaround in BPMN instance (Reprinted from [4])

5.3. Workarounds in interaction-oriented processual maps

A similar notation to the one presented in [4], is used by Azad & King in [15]. The authors, as part of their research on computer workarounds in Information Systems (IS) and Health Information Systems (HIS), propose a theoretical understanding of workaround practices which is based on a contextual healthcare study. They draw on their knowledge and understanding of the context to create an interaction-oriented processual map. This processual map shows the primary tasks, the associated information transfers, the social interactions, and the workarounds observed during the users' interaction with a Pharmacy Dispensing System (PDS). An overview of the notation used by the authors to model the workarounds is presented in *Table 6* below. As can be seen, the notation is use-case specific as the constructs are adjusted to the workaround example studies in [15]. For understandability purposes, we present the full set of notations used in the interaction-oriented processual map to represent the related tasks along with the dedicated dotted arrow that is used to represent the workaround.

Table 6: Processual map notation [15]

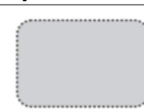
Construct	Description	Representation
PDS Task	A task that is performed by the user through the PDS	
Computer Workaround	A workaround action performed in a HIS	
Non-PDS Pharmacy Task	A task performed by the pharmacy, not though the PDS	

Figure 9 presents an instance of a workaround that was modeled using the notation presented above. As we can see, the PDS user reviews the orders for the next day and he is required to fill a form in order to give or deny permission to dispense the doses for the next day. However, a workaround is visualized as well, during which the PDS user grants a verbal signature to dispense the doses for the next day, instead of filling in the required form in the PDS.

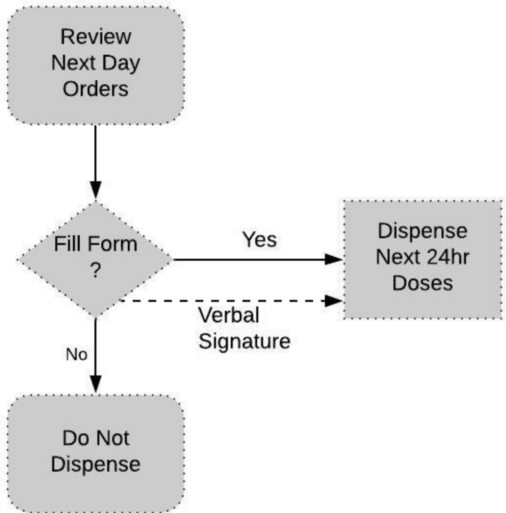


Figure 9: Instance of workaround in a processual map (Adapted from [15])

5.4. Workarounds in workflow models

An approach based on workflow models is suggested in [5], where the authors, during their study of workarounds and their effects in a hospital environment, introduce the symbols presented in *Table 7* below, which enable the modeler to incorporate workarounds in workflow models.

Table 7: Workflow model workaround symbols (Altered from [5])

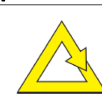
Construct	**Description**	**Representation**
Workaround	Represents the workaround. The symbol is accompanied by a short textual description of the respective workaround	
Breakdown	Represents a problem in communication or coordination. The symbol is accompanied by a short textual description of the respective breakdown	

Figure 10 below presents an instance of a workaround modeled in a workflow model using the proposed notation. The circles represent people whose role is defined in bold letters. Beneath their role, there is a list of the tasks that are assigned to them. The breakdown and workaround symbols are used to represent and shortly describe the problem in coordination and the

workaround process respectively. In this case, two roles are represented: (1) the *Attending Surgeon,* and (2) the *Attending Anesthesiologist;* and each one of them is responsible for a number of tasks. The breakdown represents the problem, which, in this case, is that the surgery goes longer than expected. Because of this breakdown, the *Attending Anesthesiologist* has to conduct a workaround, which is to keep the patient sedated for a longer time than the predefined so that the *Attending Surgeon* can finish the surgery.

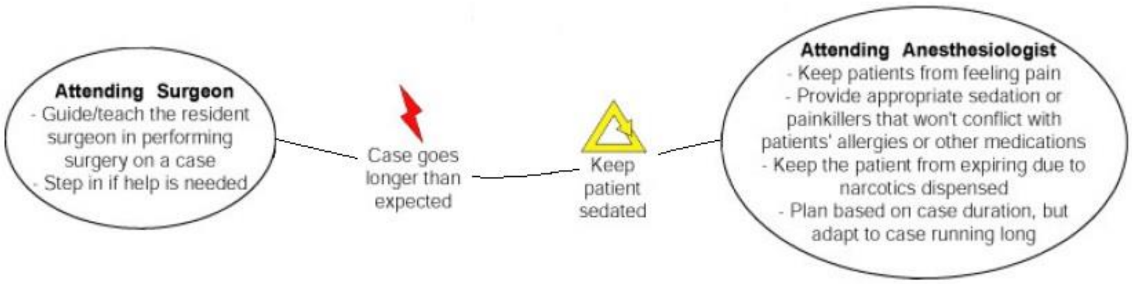


Figure 10: Workaround in workflow model instance (Altered from [5])

5.5. Adaption to the BPMN standard and categorization

To avoid anomalies in the results of the experiment caused by the testing of different notations, we attempt to adapt the previously presented constructs to the BPMN v2.0 standard. We chose to limit our scope to BPMN, as it is a widely used and accepted notation both in academia as well as in the industry, and, as can be seen from the participants' background data that we gathered and that are presented later on, the vast majority of our experimental subjects have at least basic understanding of the notation.

Summarizing the notations found in the literature, *Table 8* shortly presents the context of each article as well as its contribution to the field of workaround modelling. one of them proposes the use of a BPMN lane to split the workaround from the intended process [3], two of them propose the use of a dashed arrow that is used to indicate and split the workaround from the intended process [4, 15], and one of them proposes the use of a symbol that indicates the workaround tasks that are part of the workaround process [5].

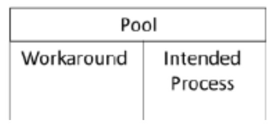
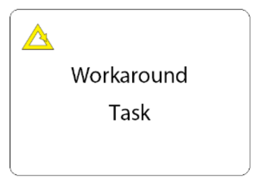
Table 8: Contributing works to workaround modelling

Source	**Research context**	**Contribution**
Röder et al. [3]	Extending BPMN by conducting a metamodel transformation and by building on the theory of workarounds [11]	A set of constructs in the form of a BPMN extension, that enables the modelling of workarounds and their context
Beerepoot & Van de Weerd [4]	Development and evaluation of three artifacts that use workaround knowledge to address the misalignment between health information systems and healthcare processes.	A connecting object for BPMN models used to denote the workaround process

Azad & King [15]	Theoretical understanding of workaround practices in a healthcare study	The use of a dashed arrow to denote a computer workaround
Kobayashi et al. [5]	An ethnographic study on workarounds and their effects in a medical center, and identification of workarounds that could be addressed with the use of technology	Introduction of a symbol, accompanied by a brief title, that represents a workaround process

Based on this categorization, the different types of constructs found in the literature can be clustered into three groups, as presented in *Table 9* below.

Table 9: Workaround constructs clusters

Cluster No.	**BPMN Element category**	**Representation**
1	Swimlane	
2	Connecting object	
3	Flow object	

Regarding the notations that these constructs are based on, two of them are already based on BPMN v2.0. The construct proposed by Röder et al. in [3] makes use of *BPMN swimlanes* [9], and the construct proposed by Beerepoot & Van de Weerd in [4] makes use of *BPMN connecting objects* [9], thus there is no need to alter them and adapt then to the BPMN v2.0 standard. The dashed arrow proposed in [15] is based on a processual map. Since this construct serves a similar purpose and shares similar notation with the red dashed arrow *BPMN connecting object* proposed in [4], we cluster them in the same group and we use the latter construct to represent it. Finally, the notation proposed by Kobayashi et al. in [5] is based on workflow models. Taking into account the meaning and the syntax of the proposed notation, it can be concluded that they are very similar to the ones of an activity from the *flow object* element category of BPMN. Thus, we use the proposed symbol and we incorporate it into a rounded-corner rectangle that is used to represent *activities* in BPMN, which results in the cluster no. 3 construct, which is shown in *Table 9*.

6. Experimental design

In the following chapter, we present in detail the design of our experimental research. We dive deeper into details for each of the two phases by providing information regarding the data that we are gathering, the independent and dependent variables as well as the respective research questions that they aim to answer, the experimental subjects, and the experimental objects and measuring instruments. The full versions of the questionnaires that were used in the experiment can be found in Appendices A and B at the end of this document.

6.1. Phase 1

Phase 1 entails a between-subjects comparative experiment, meaning that each participant will only be tested in one out of the notations. We consider such a design suitable for this phase of our experiment since it reduces the duration of the experiment for each participant, thus making it less repetitive and more interesting; and it also minimizes the learning effects across conditions.

In *Figure 11*, we present a conceptual research model that reflects the logic between the main concepts of the first phase of our experiment, which are explained in detail in the following sub-chapters. Briefly, we have one independent variable (IV) and we test four hypotheses (H_{01} – H_{04}) by measuring four dependent variables (DV1- DV4), while on the right part of the figure we present what was used to measure each one of them.

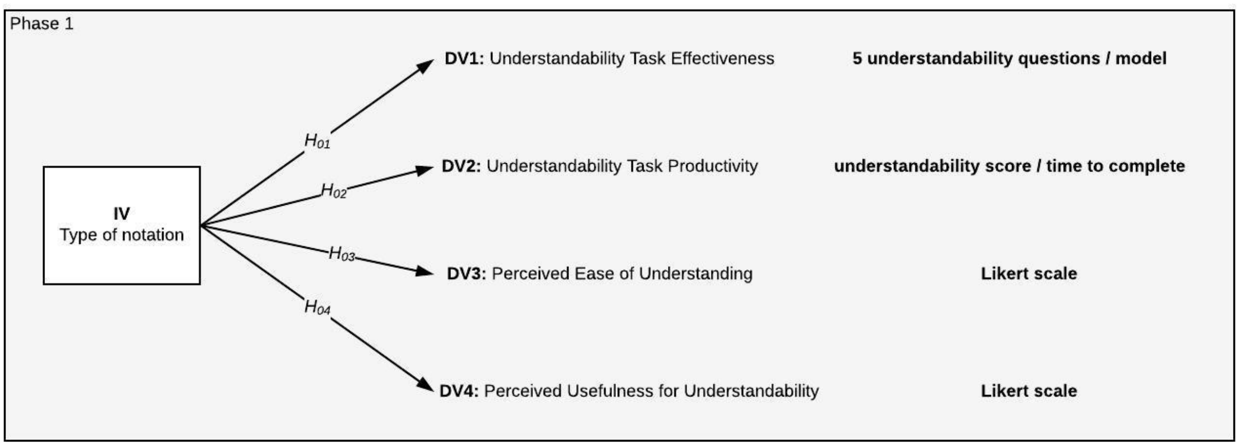


Figure 11: Conceptual research model – Phase 1

6.1.1. Participants' background data

In order to be able to characterize our population, the subjects filled in a questionnaire regarding their background. *Table 10* presents an overview of the data that were gathered during Phase 1 of the experimental process.

Table 10: Participants' background data gathered during Phase 1

No.	Question	Metric
1	How many courses related to Business Process Management / Business Process Modelling have you followed?	Number of courses
2	How many process models have you created/edited within the last 12 months?	Number of models
3	Overall, I am very familiar with process modelling.	5-point Likert scale
4	I feel very confident in understanding BPMN models	5-point Likert scale

6.1.2. Independent variable

The independent variable has 3 levels, corresponding to the clusters of constructs being compared, namely: (1) swimlane, (2) flow object, and (3) connecting object. A detailed description of the notations that formed our independent variables as well as the methodology and the rationale behind their clustering was previously presented in *Chapter 5.*

6.1.3. Dependent variables

In this first phase of the experiment we test four dependent variables, namely: (1) *Understandability Task Effectiveness*, (2) *Understandability Task Productivity*, (3) *Perceived Ease of Understanding,* and (4) *Perceived Usefulness for Understandability.* In order to test *Understandability Task Effectiveness*, we use a number of understandability questions based on the given models, and we use the achieved score and divide it by the time spent to express the *Understandability Task Productivity*. For the remaining two dependent variables we use a number of perception-based questions that aim at capturing the opinion of the subjects. An overview of the dependent variables, the questions used to measure them, as well as the research questions and hypotheses to which they respond, can be found in *Table 11* below.

Table 11: Summary of RQs, hypotheses and dependent variables for Phase 1

RQ	Hypothesis	Dependent Variable	Mean of measuring
SRQ 2.1	H_{01}	*Understandability Task Effectiveness*	Understandability questions on the given models, e.g.: *"Who performs the workaround"* *"From how many tasks does the workaround consist of?"* *"How many standard tasks are bypassed when the workaround is conducted?"*
SRQ 2.2	H_{02}	*Understandability Task Productivity*	= *Understandability Task Effectiveness* score / *Time*

SRQ 2.3	H_{03}	*Perceived Ease of Understanding*	*"I found the given workaround examples difficult to understand because of the used notation"*
			"I am confident that I am able to understand workarounds in this type of process models in practice"
			"Overall, I found the notation clear and easy to understand"
SRQ 2.4	H_{04}	*Perceived Usefulness for Understandability*	*"I believe that using models of this notation would contribute to the understanding of the workarounds and their context"*
			"Using this notation would make it easy to communicate and discuss workarounds with end-users"
			"Overall, I believe that the notation contributes to the understandability of workaround models"

Regarding the measurement instruments that were used, Understandability Task Effectiveness is measured by the number of correct answers that the experimental subject achieves. For *Understandability Task Productivity*, we ask the subjects to state the starting and ending time of each task, and then divide the *Understandability Task Effectiveness* score with this time to calculate *Understandability Task Productivity*. The remaining two dependent variables were measured by using a 4-point Likert scale with the possible answers being: *Strongly Disagree, Disagree, Agree, and Strongly Agree.* There are a lot of studies that investigate the reliability of the different versions of the Likert-scale, with their findings being contradictory depending on the needs and the context of each case [31]. In this phase of our experiment, we consider the 4-point scale as the most suitable option for several reasons. As can be seen from the statements that were previously presented in *Table 11*, giving a neutral answer would not stand to logic due to the context of the questions. Taking into account that participants often choose the neutral value as the easiest option due to lack of motivation and effort, not providing a middle point reduces the rater "error of central tendency" [32] and forces them to engage in the experiment and think critically.

6.1.4. Experimental subjects

The study participants are bachelor students in the field of Information Sciences from Utrecht University in the Netherlands, who have previously completed at least one course that involves process modelling practices and, thus, they are familiar with the basic concepts of the field.

6.1.5. Experimental objects and measurement instruments

The objects used in the experimental investigation are three BPMN models, each one of them presenting a different process workaround scenario and featuring one of the three tested notations. The questionnaires are in digital form and were implemented in MS forms, an online survey tool. They were then sent via email to the subjects, who answered the questionnaire by a given deadline. The online questionnaires that were sent out to the subjects can be found in Appendix A at the end of this document.

6.2. Phase 2

In the second phase of our experiment, a digital survey was sent out to practitioners working in the field of Business Process Management in order to test the likelihood of adoption of the most successful notation in practice [16], and compare it to the approach that makes use of two separate models as a means of representing workarounds. According to [29], such an approach would result in reaching out to a more representative sample population, and would also provide a check on the external validity of our findings regarding the notation's likelihood of adoption in practice.

In *Figure 12*, we present a conceptual research model that reflects the logic between the main concepts of the second phase of our experiment, which are explained in detail in the following sub-chapters. As it can be seen, in this phase, we have one independent variable (IV) and we test three hypotheses (H_{05} – H_{07}) by measuring three dependent variables (DV5- DV7), while on the right part of the figure we present what was used to measure each one of them.

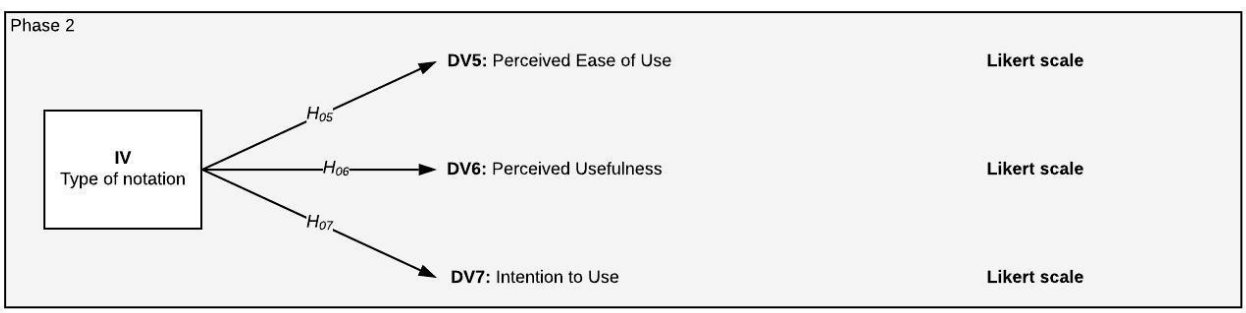


Figure 12: Conceptual research model – Phase 2

6.2.1. Demographic and participants' background data

Following a similar approach as in the first phase, the subjects filled in a questionnaire with demographic questions, as well as a number of questions regarding their background, that helped us in characterizing our population. Additionally, the available response options for question 9 were proposed and validated by employees of the process development department to make sure that they are applicable. *Table 12* presents an overview of these data that was gathered from the participants.

Table 12: Demographic and participants' background data gathered during Phase 2

No.	Question	Metric
1	Age	Age in years
2	Role in the company	Job title
3	Years of working experience in business process modelling?	Number of years
4	Number of process models created/edited within the last month	Number of models
5	Proficiency in Business Process Modelling	5-point Likert scale
6	Familiarity with the BPMN notation	5-point Likert scale
7	Competency in using BPMN for process modelling	5-point Likert scale
8	Confidence in understanding BPMN process models	5-point Likert scale
9	The end purpose of subject's process models	a. To communicate business processes b. Business process auditing c. Business process re-engineering d. Business process optimization e. Other:

6.2.2. Independent variable

The independent variable has 2 levels corresponding to the representation methods of the workaround, namely: (1) the best performing notation from Phase 1, and (2) the two separate models. At this point, it is worth mentioning that the approach that makes use of two separate models, one for the standard process and one for the workaround, is also part of the existing scientific literature [30], but it did not pass our first inclusion criterion (EC1), as this approach does not really suggest a new notation, but leans more towards approaches that introduce and study modularity in process models [19].

6.2.3. Dependent variables

During the second phase of the experiment, and by building upon Moody's approach [29], we test three dependent variables, namely: (1) *Perceived Ease of Use*, (2) *Perceived Usefulness*, and (3) *Intention to Use. All three* dependent variables are measured by asking the subjects a number of perception-based questions that aim at capturing their opinion. An overview of the dependent variables, the question used to measure them, and the research questions and hypotheses to which they respond can be found in *Table 13* below.

Table 13: Summary of RQs, hypotheses and dependent variables for Phase 2

RQ	Hypothesis	Dependent Variable	Mean of measuring
SRQ 3.1	H_{05}	*Perceived Ease of Use*	*"I believe that the process of model design when using the connecting object to model workarounds would be easier and less complex to follow when compared to the two separate models"*
			"I am more confident that I could use the connecting object to model workarounds in practice when compared to the two separate models"
			"Overall, I believe that the connecting object is easier to use when compared to the two separate models"
SRQ 3.2	H_{06}	*Perceived Usefulness*	*"I believe that I am able to make better and more informed decisions regarding the workaround when it is modeled by using the connecting object instead of the two separate models"*
			"Overall, I believe that the connecting object notation provides a more effective solution to the problem of representing workarounds when compared to the two separate models"
			"Overall, I found the connecting object notation to be more useful when compared to the two separate models"
SRQ 3.3	H_{07}	*Intention to Use*	*"I would suggest the connecting object notation to my colleagues instead of the two separate models"*
			"Overall, I would prefer to use the connecting object notation to model workarounds instead of the two separate models"
			"I intend to use the connecting object in preference to the two separate models if I will have to model workarounds in the future"

In this case, we use a 5-point Likert scale with the possible answers being: Strongly Disagree, Disagree, Neither Agree or Disagree, Agree, and Strongly Agree. Following Moody's methodology from [29], we use the neutral value as a zero point of scale to which we compare the final scores in order to conclude on which method is more preferable as well as on the significance of the results.

6.2.4. Experimental subjects

The online questionnaire was sent out to practitioners who are involved in the field of Business Process Management and, thus, have on-field experience in various process modelling techniques. To recruit our participants, we used the professional contacts of the author of this thesis from a large retail company with a dedicated process improvement department.

6.2.5. Experimental objects and measurement instruments

The participants were presented with an overview of the tested notations and three workaround cases, which were represented in models using the tested notation as well as by using two separate models. After going through the given material, they were called to answer the respective questions that we previously presented in Table 6. All the material that was sent out to the participants and was used in the second phase of the experiment can be found in Appendix B at the end of this document.

7. Results

The following chapter presents the results from the two phases of the previously described experiment. For each phase, we start by presenting descriptive statistics and visualizations of the participants' background data that characterize our population, and we proceed with the analysis of the collected data per dependent variable.

7.1. Phase 1

Figure 13 presents an overview of the background data that were acquired from the 137 participants during the first phase of our experiment. More specifically, there are four charts that show the distribution of the 137 participants when it comes to: (1) the number of BPM-related courses that they have followed (top left), (2) the number of process models that they have created or edited within the last twelve months (top right), (3) self-reported familiarity with process modelling (bottom left), and (4) self-reported confidence in understanding BPMN models (bottom right).

As can be seen, the majority of our population has followed at least two courses related to business process modelling, has created or edited business process models within the last twelve months, and claims to be familiar with process modelling as well as feels confident in understanding BPMN process models.

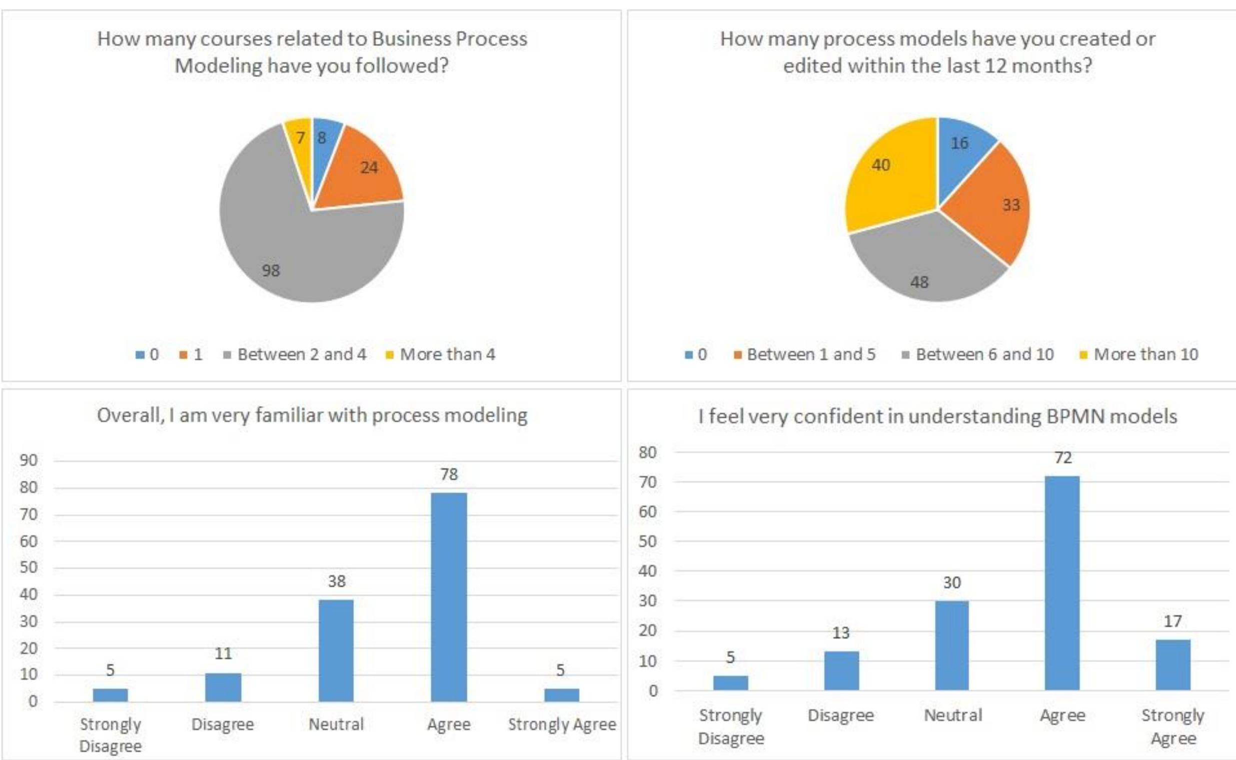


Figure 13: Overview of the acquired participants' background data - Phase1

Furthermore, in *Table 14* we present the descriptive statistics for the variables that were tested in the first phase of our experiment.

Table 14: Descriptive statistics – Phase 1

Dependent Variable / **Independent Variable levels**	**N**	**Understandability Task Effectiveness** *(Scale: [0 : 15], higher is better)*		**Understandability Task Productivity** *(Scale: (0 – ∞), higher is better)*		**Perceived Ease of Understanding** *(Scale: [1 : 4], higher is better)*		**Perceived Usefulness for Understandability** *(Scale: [1 : 4], higher is better)*	
		Mean	S. Dev.	Mean	S. Dev.	Mean	S. Dev.	Mean	S. Dev.
Connecting object	40	11.48	2.56	1.74	0.84	3.26	0.54	3.18	0.49
Swimlane	47	10.02	3.10	1.27	0.77	2.89	0.71	3.00	0.55
Flow object	50	9.70	3.93	1.48	0.95	2.87	0.82	2.97	0.62

In order to test our hypotheses, we first check the distribution of the acquired data in order to identify the appropriate statistical tests for which the data conform with the necessary assumptions. For this purpose, we applied the "Shapiro-Wilk" normality test, which reported significant deviations from the normal distribution for each level of all four dependent variables, resulting in $p < 0.003$ for each dataset. Because of that deviation from normality, we applied nonparametric statistical tests for each dependent variable, in particular, the "Kruskal-Wallis" using R. Additionally, since we test between three levels of one independent variable, and since the "Kruskal-Wallis" test does not report exactly between which levels the statistically significant or insignificant differences are observed, we used the post-hoc "Dunn" statistical test for the cases where the Kruskal-Wallis test reported significant differences with $p < .05$.

Table 15 presents the results of the statistical analysis that test our first hypothesis H_{01}. The Kruskal-Wallis statistical test indicates that there are significant differences in Understandability Task Effectiveness between the three notations [$x^2 = 6.965$, $p = 0.031$].

Table 15: Understandability Task Effectiveness – Statistical analysis results

Dependent variable	Understandability Task Effectiveness		
Kruskal - Wallis	$x^2 = 6.965$, $p = 0.031$*		
Post-hoc Dunn test		**Connecting object**	**Swimlane**
	Swimlane	$p = 0.018$*	
	Flow object	$p = 0.023$*	$p = 0.885$

**p < .05, ** p < .01, *** p < .001*

Since the Kruskal – Wallis reported significant differences, we used the *Dunn* post-hoc test to identify between which notations we observe these differences. The results report significant difference between the groups: *Connecting object – Swimlane [p* = 0.0177*] and Connecting object*

– *Flow object [p* = 0.023*]);* and an insignificant difference between groups: *Flow object – Swimlane [p* = 0.8849].

Thus, we are able to **reject** our null hypothesis ***H₀₁*** *which claims that there is no difference in Understandability Task Effectiveness between the tested notations,* and we can conclude that the *Connecting object* performs significantly better than both the Flow object and the *Swimlane*.

Table 16 presents the results of the statistical analysis that test our second hypothesis H_{02}. The Kruskal-Wallis statistical test indicates that there are significant differences in Understandability Task Productivity between the three notations [x^2 = 8.272, *p* = 0.016].

Table 16: Understandability Task Productivity – Statistical analysis results

Dependent variable	Understandability Task Productivity		
Kruskal Wallis	x^2 = 8.272, *p* = 0.016*		
Post-hoc Dunn test		**Connecting object**	**Swimlane**
	Swimlane	*p* = 0.004**	
	Flow object	*p* = 0.081	*p* = 0.225

**p < .05, ** p < .01, *** p < .001*

Since the Kruskal – Wallis reported significant differences, we used the *Dunn* post-hoc test to identify between which notations we observe these differences. The results report a significant difference between the groups: *Connecting object – Swimlane [p = 0.004];* and insignificant differences between groups: Connecting object – Flow object [*p* = 0.081], and *Swimlane – Flow object [p* = 0.225].

Thus, we are able to **reject** our null hypothesis ***H_{02}*** *which claims that there is no difference in Understandability Task Productivity between the tested notations,* and we can conclude that the *Connecting object* performs significantly better than the Swimlane.

Table 17 presents the results of the statistical analysis that test our second hypothesis H_{03}. The Kruskal-Wallis statistical test indicates that there are significant differences in Perceived Ease of Understanding between the three notations [x^2 = 22.864, *p* < .001].

Table 17: Perceived Ease of Understanding – Statistical analysis results

Dependent variable	Perceived Ease of Understanding		
Kruskal Wallis	x^2 = 22.864, *p* < .001***		
Post-hoc Dunn test		**Connecting object**	**Swimlane**
	Swimlane	*p* < .001***	
	Flow object	*p* < .001***	*p* = 0.938

**p < .05, ** p < .01, *** p < .001*

Since the Kruskal – Wallis reported significant differences, we used the *Dunn* post-hoc test to identify between which notations we observe these differences. The results report a significant difference between the groups: *Connecting object – Swimlane [p < .001],* and Connecting object

– Flow object [p < .001]*;* and an insignificant difference between groups: Connecting object – Flow object [p = 0.938].

Thus, we are able to **reject** our null hypothesis ***H_{03}*** *which claims that there is no difference in Perceived Ease of Understanding between the tested notations,* and we can conclude that the *Connecting object* performs significantly better than both the Swimlane and the Flow object.

Table 18 presents the results of the statistical analysis that test our second hypothesis H_{04}. The Kruskal-Wallis statistical test indicates that there are significant differences in Perceived Usefulness for Understandability between the three notations [x^2 = 10.801, p = 0.005].

Table 18: Perceived Usefulness for Understandability – Statistical analysis results

Dependent variable	Perceived Usefulness for Understandability		
Kruskal Wallis	x^2 = 10.801, p = 0.005**		
Post-hoc Dunn test		Connecting object	Swimlane
	Swimlane	p = 0.009**	
	Flow object	p = 0.002**	p = 0.625

**p < .05, ** p < .01, *** p < .001*

Since the Kruskal – Wallis reported significant differences, we used the Dunn post-hoc test to identify between which notations we observe these differences. The results report a significant difference between the groups: Connecting object – Swimlane [p = 0.009], and Connecting object – Flow object [p = 0.002]; and an insignificant difference between groups: Connecting object – Flow object [p = 0.625].

Thus, we are able to **reject** our null hypothesis ***H_{04}*** which claims that there is no difference in Perceived Usefulness for Understandability between the tested notations, and we can conclude that the Connecting object performs significantly better than both the Swimlane and the Flow object.

Wrapping up the first phase of our experiment by taking into account the results acquired from the statistical analysis of acquired data, we can conclude that the Connecting Object performs significantly better overall than both the Flow object and the Swimlane.

7.2. Phase 2

Table 19 presents an overview of the demographic and the participants' background data that were acquired during the second phase of our experiment. As it can be seen, our participants' age ranges from 25 to 50 years old, with the average age being close to 33; their experience on process modelling ranges from 0 to 14 years, with the average being close to 5; and the number of models that each of the participants edited or created within the last month ranges from 0 to 15, with the average being close to 4.

Table 19: Demographic and participants' background data – Phase 2

Characteristic / Descriptive Statistic	Age	Years of working experience in process modelling	Number of process models edited/created within the last month
Mean	33.13	5.27	3.59
Median	32.5	5	3
Standard Deviation	5.46	3.56	2.93
Range	[25:50]	[0:14]	[0:15]

When it comes to their role within the process development department, we can see in the left part of *Figure 14* that it covers a wide seniority spectrum, ranging from Junior Process Analysts up to the Vice President of the department. We consider such a variety to be of significant importance and interest for our research since we were given the opportunity to capture opinions that originate from different perspectives from within the same department.

We also gathered some interesting pieces of information when it comes to the end-use of the process models that our participants create. As can be seen in the right part of *Figure 14*, the majority of the process models are used to optimize, communicate, and re-engineer business processes; while there are some cases where the models are used for auditing and other purposes.

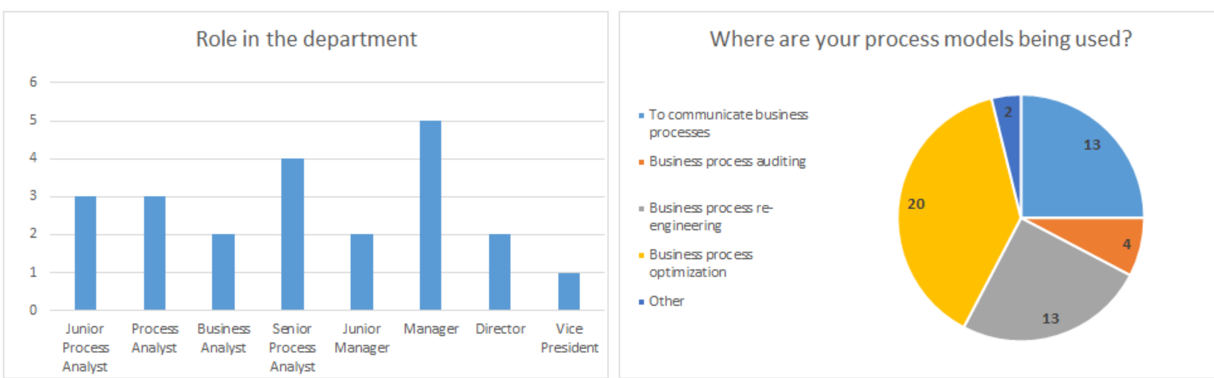


Figure 14: Participants' roles (left) & end-uses of their process models (right)

Concluding the data that we acquired,

Figure 15 presents an overview of the self-reported familiarity of the participants with process modelling and BPMN. As it can be seen on the top-left graph, most of the participants (20 out of 22) report to be familiar with process modelling; and according to the right part of the figure, more than half of the participants report to be familiar with the BPMN notation (12 out of 22) as well as confident in understanding BPMN process models (15 out of 22). Finally, the graph on the bottom left corner reports that more than half of the participants (12 out of 22) does not feel competent in using BPMN for process modelling.

Overall, we could say that the participants' self-reported familiarity with process modelling and BPMN corresponds to the wide variety of experiences that we previously observed between them, with the average participant being at least familiar with these fields.

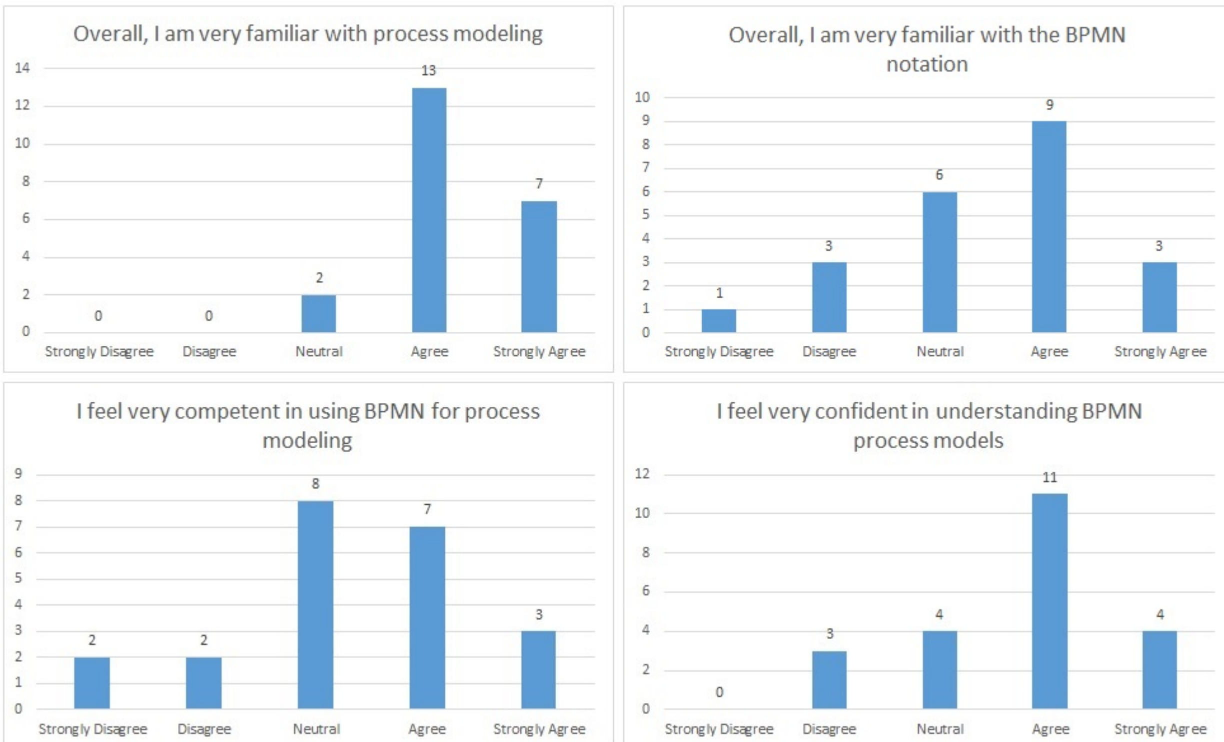


Figure 15: Familiarity of participants with process modelling and BPMN

Moving on with the statistical analysis of the data acquired from the 22 participants, *Table 20* presents the descriptive statistics for the three dependent variables that were tested in the second phase of our experiment.

Table 20: Descriptive statistics – Phase 2

Dependent Variable / **Independent Variable levels**	**N**	**Perceived Ease of Use** *(Scale: [-2 : 2]*)*		**Perceived Usefulness** *(Scale: [-2 : 2]*)*		**Intention to Use** *(Scale: [-2 : 2]*)*	
		Mean	S. Dev.	Mean	S. Dev.	Mean	S. Dev.
[Separate models vs. Connecting Object]	22	0.86	0.63	0.98	0.73	0.91	0.74

**-2= Strongly prefer two separate models, 2 = Strongly prefer connecting object*

Following the same approach as in the first phase of our experiment, we first check the distribution of the data in order to identify the appropriate statistical tests for which the data conform with the necessary assumptions. We applied the "Shapiro-Wilk" normality test, which reported significant deviations from the normal distribution for all three dependent variables, resulting in $p < .001$ for each dataset. Because of this deviation from normality, and due to the fact that we use a single 5-point Likert scale to capture the preference between the two notations, we applied the non-parametric "Wilcoxon Signed-Rank" statistical test which allows us to compare the achieved mean with the neutral point 0.

In Table 21 below we present the results of our statistical analysis for the three dependent variables that were tested during the second phase of our experiment.

Table 21: Statistical analysis results – Phase 2

Dependent Variable / Statistical Test	Perceived Ease of Use	Perceived Usefulness	Intention to Use
Wilcoxon signed rank	V = 1176, $p < .001$***	V = 1445, $p < .001$***	V = 1287, $p < .001$***

*$p < .05$, ** $p < .01$, *** $p < .001$

More specifically, all three test results report significant differences between the two notations, with the Connecting Object performing significantly better against the two separate models in terms of Perceived Ease of Use, Perceived Usefulness, and Intention to Use.

Taking into account the aforementioned results we can:

reject our null hypothesis H_{05} which claims that there is no difference in Perceived Ease of Use between the tested notations, and we can conclude that the Connecting object performs significantly better than the two separate models;

reject our null hypothesis H_{06} which claims that there is no difference in Perceived Usefulness between the tested notations, and we can conclude that the Connecting object performs significantly better than the two separate models;

and **reject** our null hypothesis H_{07} which claims that there is no difference in Intention to Use between the tested notations, and we can conclude that the Connecting object performs significantly better than the two separate models.

Wrapping up the statistical analysis of the acquired data from the second phase of our experiment, we can conclude that the Connecting Object performs significantly better overall than the two separate models.

Additionally, we requested from the participants to mention any extra comments that they might have regarding the two tested notations. In *Table 22* we quote those comments along with the role of the participant that submitted each one of them.

Table 22: Additional comments from participants

Role	Comment
Senior Process Analyst	"Using one overview gives better insights."
Senior Process Analyst	"A limitation that could prevent us from using the red line in practice, is that it is not supported by some of the tools that are used for process modelling and they only allow the official BPMN notation."
Manager	"It all depends on what is the purpose of the modelling. If you want to use the model to present a process to business stakeholders, you could confuse them with two separate models. However, if you need to analyze two solution options, there are situations where two separate models are more relevant, you can be more confident that you haven't missed a step, or you can do the re-engineering more easily."
Director	"Connecting object models are nicer to work within the design and development phase, whereas two separate models usually work better in training/communication situations."
Vice President	"Both are useful, but the connecting object models do a better job in giving the full picture."

According to a senior process analyst, the single model that results when using the connecting object provides better insights when compared to the two separate models. Also, another senior process analyst pointed out the fact that such a "custom" notation as the connecting object, which is not part of the official BPMN symbols, would be hard to use due to lack of support from various modelling tools. To the eyes of one of the managers, the two separate models have both advantages and disadvantages and it all comes down to the end-use of the model. According to him, he would prefer to use the connecting object model when communicating processes to stakeholders, because, based on his experience, presenting two separate models might cause confusion. On the other hand, he believes that the two separate models offer additional value in cases where you compare two different options, or during process re-engineering. Finally, according to the Vice President of the department, both approaches can be useful, but, for him, the models that use the connecting object do a better job in providing the full picture.

8. Discussion and conclusions

As discussed throughout the previous chapters, business process models are core elements of the BPM lifecycle. Naturally, the same applies to workaround models in the field of business process workarounds, which increasingly keeps attracting attention from both academia and businesses, where workaround models can play a crucial role by enabling various activities like decision making, process re-engineering, and business process auditing. Thus, characteristics around their understandability, as well as their usefulness, are of significant importance both for the modelers as well as the end-users of the models.

Our work extends existing studies that suggest notations that enable the modelling of process workarounds [3, 4, 5, 15] but they do not provide empirical data on how these notations perform. Shifting away from existing studies that investigate various effects between process models and textual descriptions [24, 25, 26], we attempt to research how understandability and user acceptance are affected between different BPMN elements as well as versus an approach that introduces an element of modularity in the BPMN model [19] by splitting the standard process and the workaround into two separate models [30].

We start by listing all the available notations that are found throughout the relevant scientific literature and which enable the modelling of business process workarounds. By defining the type of notation as our independent variable, we design a two-phase experiment during which we put these notations into testing. More specifically, during the first phase of our experiment, we perform a between-subjects experiment using 137 Information Science bachelor students. We test four hypotheses that focus on understandability; each one of them measured with a dependent variable between the three levels of our independent variable: connecting object, flow object, swimlane. The outcome of the first phase reported the connecting object notation as the best performing element between the three. The results of this phase are comparable to the ones presented in [19], where the authors test the understandability of process models between three levels of modularity. They conclude that fully flattened models that do not make use of sub-groups perform better. In our case, the concept of sub-grouping could be compared to the one of the swimlane notation to model workarounds, where we group all the workaround-related tasks into a dedicated swimlane. As presented in the results of our experiment, the swimlane approach is never significantly better performing than the rest two fully flattened approaches.

During the second phase of our experiment, we keep the connecting object as the best performing notation in terms of understandability that was found in the literature, and by utilizing relevant studies [16, 29], we test it against an approach that is being used by practitioners. We hosted our experiment in a Fortune 500 fashion retail company where we recruited 22 employees as experimental subjects. The goal of this phase was to see how the two approaches perform against each other in terms of user acceptance.

To achieve this, we shaped three hypotheses (H_{05}, H_{06}, H_{07}), each one of them tested by a dependent variable. The outcome of the second phase reported, once again, the connecting object as the best performing approach. The lesser performing notation could also be categorized as a modular approach to workaround modelling since it completely separates the standard process and the workaround. Thus, our results expand and complement existing work which investigates the effect of modularity on understandability. More specifically, [33] identifies a positive influence when it comes to large models, while [19] claims that, overall, there is a negative influence as such models turn out to be harder to understand.

Additionally, we contradict studies that propose a more modular approach to model workarounds as the basis for methods to analyze workarounds [3, 30], as according to our results there is a more suitable notation to support such activities.

Table 23 presents an overview of the tested hypotheses and the corresponding dependent variables, as well as the achieved outcome accompanied by a short description of the results.

Table 23: Overview of tested hypotheses

	Hypothesis	**Dependent Variable**	**Outcome**	**Description**
Understandability	H_{01}	Understandability Task Effectiveness	Rejected	Effectiveness is higher when using the connecting object than when using the flow object or the swimlane. There are no differences between the flow object and the swimlane.
	H_{02}	Understandability Task Productivity	Rejected	Productivity is significantly higher when using the connecting object than when using the swimlane. The rest of the comparisons do not result in significant differences.
	H_{03}	Perceived Ease of Understanding	Rejected	Connecting object models are perceived as easier to understand than the respective flow object and swimlane ones. No differences are observed between flow object and swimlane models.
	H_{04}	Perceived Usefulness for Understandability	Rejected	The connecting object is perceived as more useful for the understandability of the model than the flow object and the swimlane. No differences are observed between the flow object and the swimlane.
User acceptance	H_{05}	Perceived Ease of Use	Rejected	The connecting object is perceived as easier to use than the two separate models.
	H_{06}	Perceived Usefulness	Rejected	The connecting object is perceived as more useful than the two separate models.
	H_{07}	Intention to Use	Rejected	The connecting object is more appealing to use than the two separate models.

As it is evident by the given overview, we found that using the connecting object to model workarounds positively influences the understandability when compared to models using the flow object and the swimlane, and also positively influences the user acceptance when compared to the two separate models approach.

More specifically, models that make use of the connecting object to model process workarounds appear to be more effective in communicating information(H_{01}), facilitate productivity for the end-users(H_{02}), are easier to understand(H_{03}), and are believed to enhance the overall understandability of the model(H_{04}).

Finally, when compared to the two separate models in terms of user acceptance, the connecting object notation is considered to be easier to use (H_{05}), more useful (H_{06}), and is more appealing to be used by practitioners (H_{07}).

However, our research has a number of limitations that can act as inspiration and open the way for future research. For the first phase of our experiment, the fact that we had a high number of participants who were tested on process models from real-world processes, has a positive effect on the generalizability of our results. However, all of our participants were students from the same program, which is something that counters this effect. The same applies to the second part of our experiment where we use industry practitioners as our experimental subject, something that adds points to the external validity of our research. On the other hand, the fact that all of the practitioners work for in the same company department reduces those points. Thus, future research could focus on testing such notations with a wider variety of participants, when it comes to their background and their field of expertise. Additionally, our study did not segment our subject group to sub-groups based on data such as role or years of experience. Future research could dive deeper into this kind of analysis and investigate whether significant differences are observed between such sub-groups.

Additionally, the fact that we based our experimental design on fundamental studies on understandability and user acceptance, combined with the rigorous approach in developing, and validating the questionnaires that were used to measure our dependent variables, enhances the construct validity of our research. However, our study is limited to notations that fall under the BPMN 2.0 standard, and to process models of similar complexity. Thus, future work could expand this scope by exploring and testing different modelling standards as well as different levels of process complexity and how they affect the understandability and the user acceptance of the models.

Furthermore, the modelling approaches were applied to three specific process models: one from the field of healthcare, and two from the field of software development. Future research could explore how these notations perform across different fields or even use the categorizations of workarounds suggested by numerous studies, e.g. [2, 14 16, 19], and test the performance of the notations across different workaround categories.

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Appendices

Appendix A – Phase 1 questionnaires

Experiment version 1 – Connecting Object

Introduction

Did you ever use an information system and felt that it doesn't do what you want it to do? You can probably think of examples where you came up with an alternative to solve such a problem or to do something quicker; in a sense, you deviated from the standard process. We refer to such deviations as 'workarounds'.

Through this experiment, we aim to find the best way of visualizing workarounds. At first, you are asked to answer a number of questions regarding your background that will help us characterize our group of participants. You will then be presented with three different process models that include workarounds, and be asked a number of questions about them.

The whole process is estimated to take around 20 minutes.

Instructions

Please:

- use a computer and NOT a mobile phone or a tablet to answer this questionnaire. It includes models that require a large screen to be clearly visible;

- make sure that you answer all the questions honestly and according to the given instructions;

- be accurate to the minute when asked to fill in the current time throughout the experiment;

- do not hurry to finish the questionnaire. Take as much time as you think is necessary to understand the given models and to properly answer the questions;

- find a quiet place so that you can stay focused without any interference;

- complete the questionnaire without taking a break to help us get an accurate estimate of the time you spent.

Questions regarding your background

- How many courses related to Business Process Management / Business Process Modelling have you followed, including "Information systems" in BSc Informatiekunde?
    a. 0
    b. 1
    c. Between 2 and 4
    d. More than 4

- How many process models have you created/edited within the last 12 months?
    a. 0
    b. Between 1 and 5
    c. Between 6 and 10
    d. More than 10

- Overall, I am very familiar with process modelling.

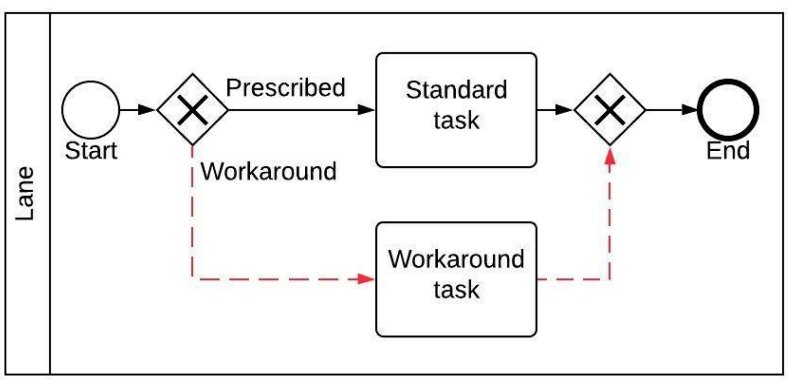
Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
☐	☐	☐	☐	☐

- I feel very confident in understanding BPMN models.

Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
☐	☐	☐	☐	☐

Introducing the notation

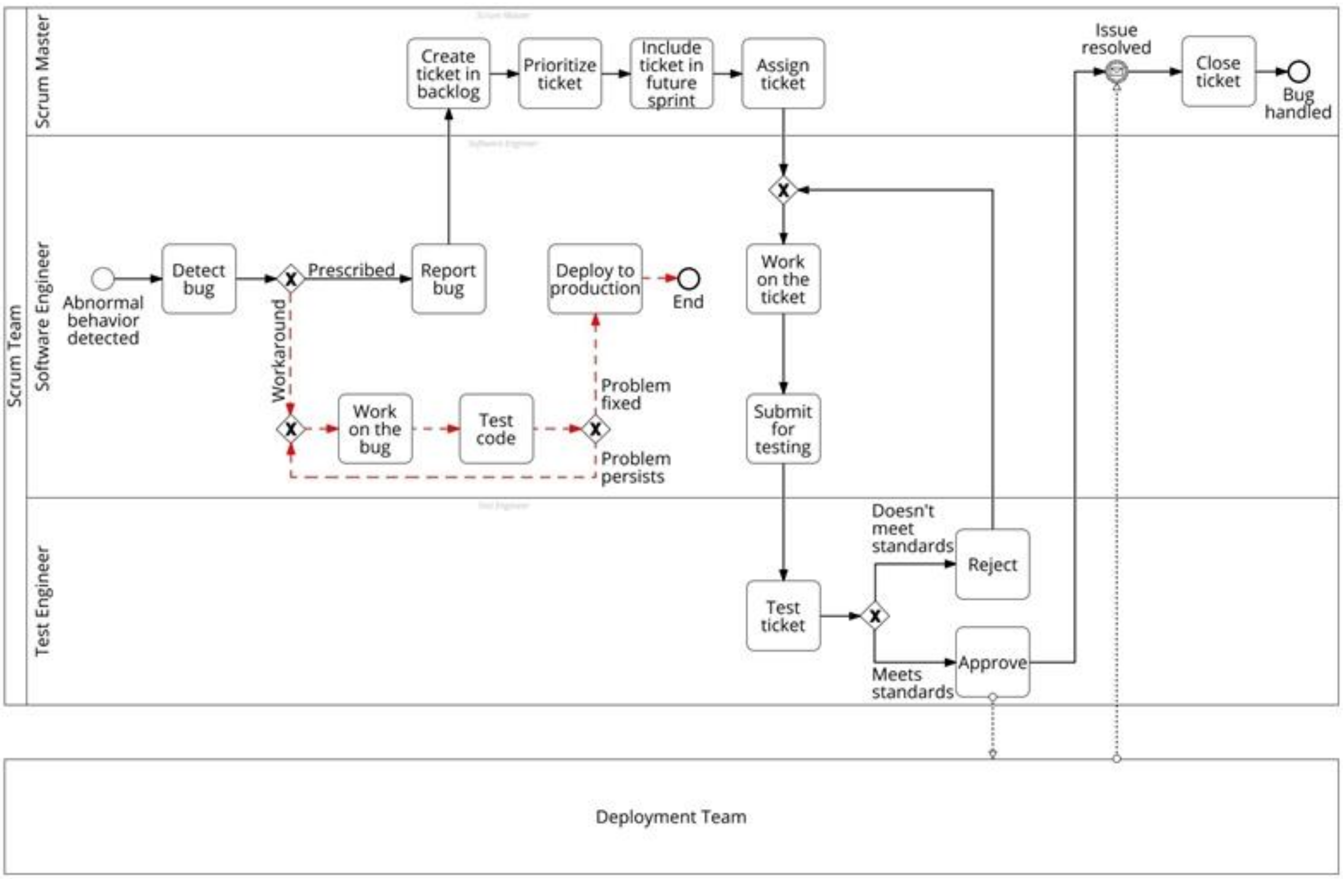
As it can be seen in the example model below, the workaround task is framed by red dotted arrows and marked with the condition "workaround" on the exclusive gate, while the standard task is marked with the "prescribed condition" on the exclusive gate.



Current time [HH:MM] : ___________________________________

Example no.1:

The figure below presents an overview of the standard tasks, as well as the workaround tasks that are followed within a software development company when a bug is detected in a piece of software.



1. Who initiates the workaround?
    a. The Scrum Master
    b. The Software Engineer [X]
    c. The whole Scrum Team
    d. The Deployment Team

2. When does the Deployment Team participate in the workaround?
    a. Once the patch passes the testing performed by the Test Engineer
    b. Never [X]
    c. Always
    d. Once the Software Engineer tests his code

3. Who takes part in the workaround?
    a. The whole Scrum Team
    b. The Software Engineer [X]
    c. The Test Engineer
    d. Everyone

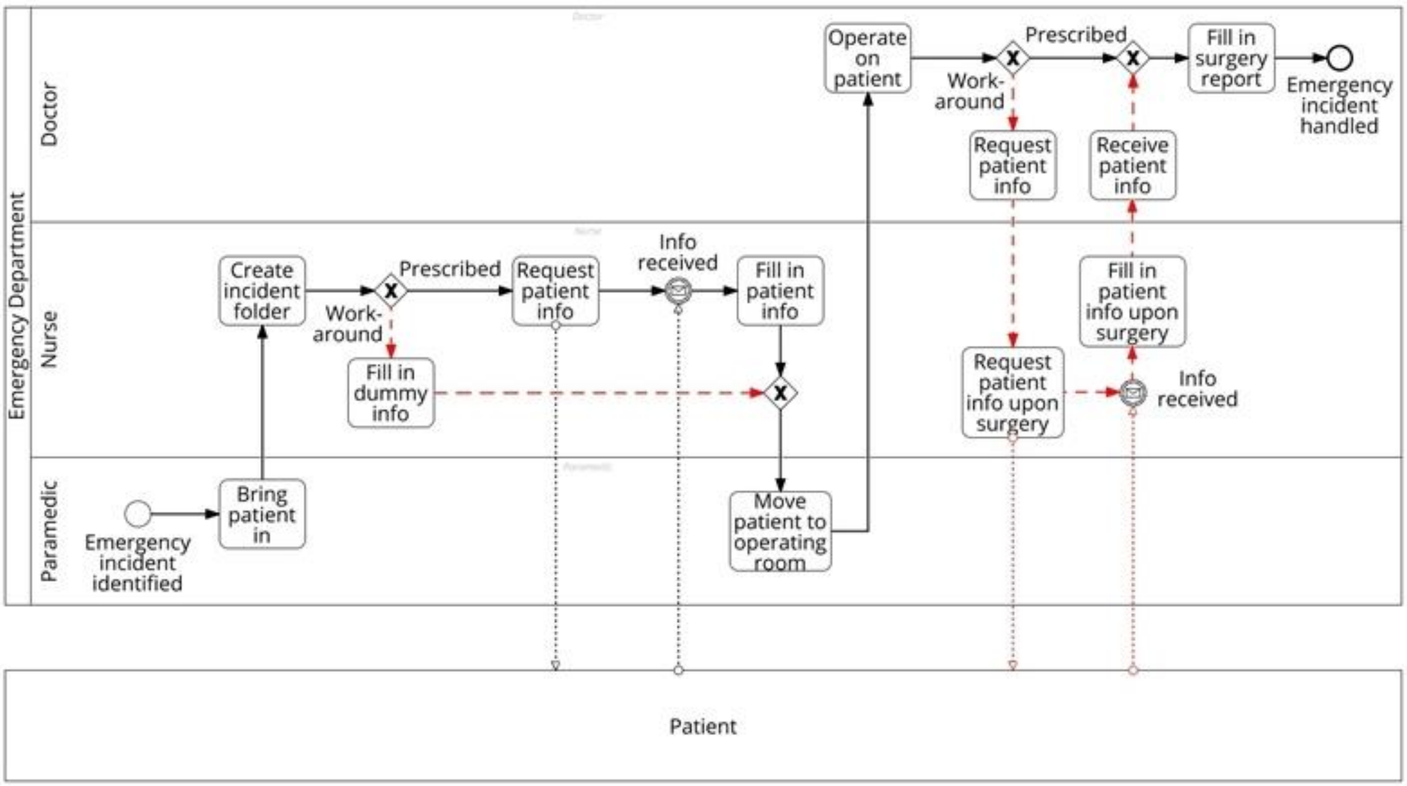
4. Which set of tasks constitutes the workaround?
    a. Work on the bug, Test code, Deploy code to production, Close ticket
    b. Work on the bug, Test code, Deploy code to production [X]
    c. Work on the bug, Test code
    d. None of the above

5. When the workaround is performed, for how many workaround tasks is the Software Engineer responsible?

    Answer: _________________ ***[Correct answer: 3]***

<u>**Example no.2:**</u>

The figure below presents an overview of the standard tasks, as well as the workaround tasks that are being followed within a medical center when an emergency surgery incident is brought in.



6. Who initiates the workaround?
   a. The Nurse [X]
   b. The Patient
   c. The whole Emergency Department
   d. The Nurse and the Doctor

7. After the task that initiates the workaround, how many other workaround tasks do you count?

   Answer: _________________ ***[Correct answer: 4]***

8. Who gets involved in the workaround?
   a. Everyone
   b. The Doctor and the Nurse
   c. The Doctor, the Nurse, and the Patient [X]
   d. The Doctor and the Patient

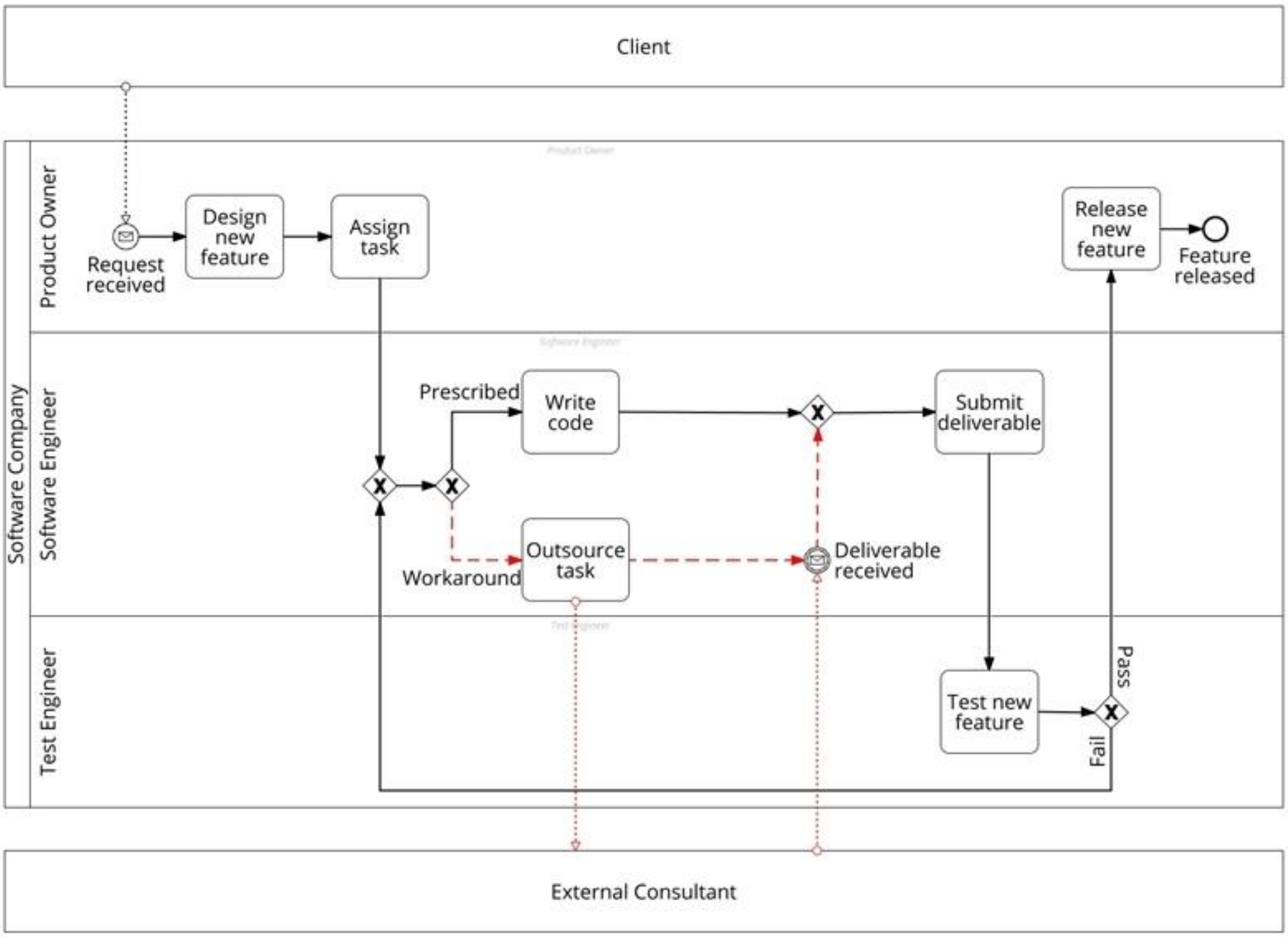
9. How many standard tasks are bypassed when the workaround is performed?

   Answer: _________________ ***[Correct answer: 2]***

10. When does the Patient participate in the process?
    a. Only when the workaround is conducted
    b. Always [X]
    c. Only when the workaround is not conducted
    d. None of the above

Example no.3:

The figure below presents an overview of the standard, as well as the workaround tasks that are being followed by a software development company when they are asked to develop a new feature by one of their clients.



11. Who initiates the workaround?
    a. The Client
    b. The Software Engineer [X]
    c. The Product Owner
    d. The Test Engineer

12. From how many tasks does the workaround consist of?

    Answer: _________________ ***[Correct answer: 1]***

13. When does the External Consultant participate in the process?
    a. Always
    b. Only when the workaround is performed [X]
    c. Only when the Product Owner assigns him the task
    d. Only when the testing of the new feature fails

14. How many standard tasks are bypassed when the workaround is performed?

    Answer: _________________ ***[Correct answer: 1]***

15. When the workaround is performed, …
    a. the Software Engineer works on the task in parallel with the External Consultant
    b. the Software Engineer does not write code [X]
    c. the Test Engineer is responsible for at least one workaround task
    d. the Product Owner and the External Consultant are involved in the workaround tasks

Current time [HH:MM] : ___________________________________

Please indicate the degree to which of agree or disagree with the following statements:

16. I found the given workaround examples difficult to understand because of the used notation

Strongly Disagree	*Disagree*	*Agree*	*Strongly Agree*
☐	☐	☐	☐

17. I am confident that I am able to understand workarounds in this type of process models in practice

Strongly Disagree	*Disagree*	*Agree*	*Strongly Agree*
☐	☐	☐	☐

18. Overall, I found the notation clear and easy to understand

Strongly Disagree	*Disagree*	*Agree*	*Strongly Agree*
☐	☐	☐	☐

19. I believe that using models of this notation would contribute to the understanding of the workarounds and their context

Strongly Disagree	*Disagree*	*Agree*	*Strongly Agree*
☐	☐	☐	☐

20. Using this notation would make it easy to communicate and discuss workarounds with end-users

Strongly Disagree	*Disagree*	*Agree*	*Strongly Agree*
☐	☐	☐	☐

21. Overall, I believe that the notation contributes to the understandability of workaround models

Strongly Disagree	*Disagree*	*Agree*	*Strongly Agree*
☐	☐	☐	☐

Experiment version 2 – Swimlane

Introduction

Same as in version 1

Instructions

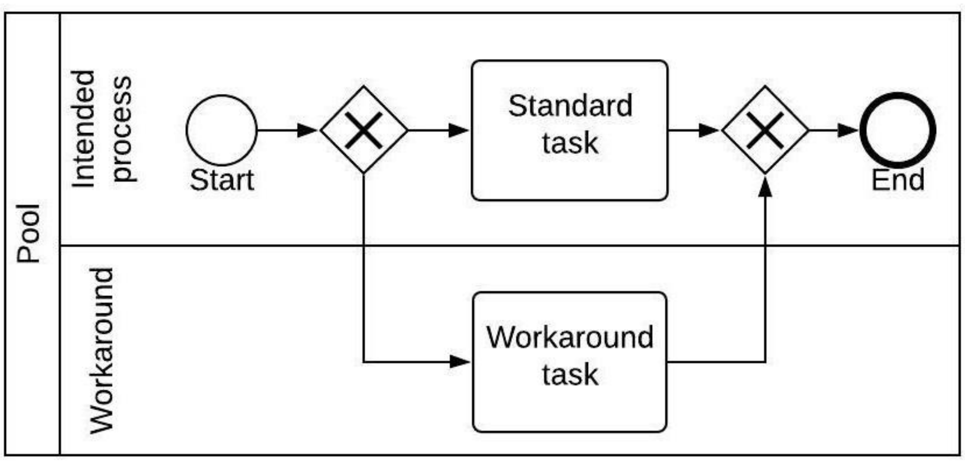
Same as in version 1

Questions regarding your background

Same as in version 1

Introducing the notation

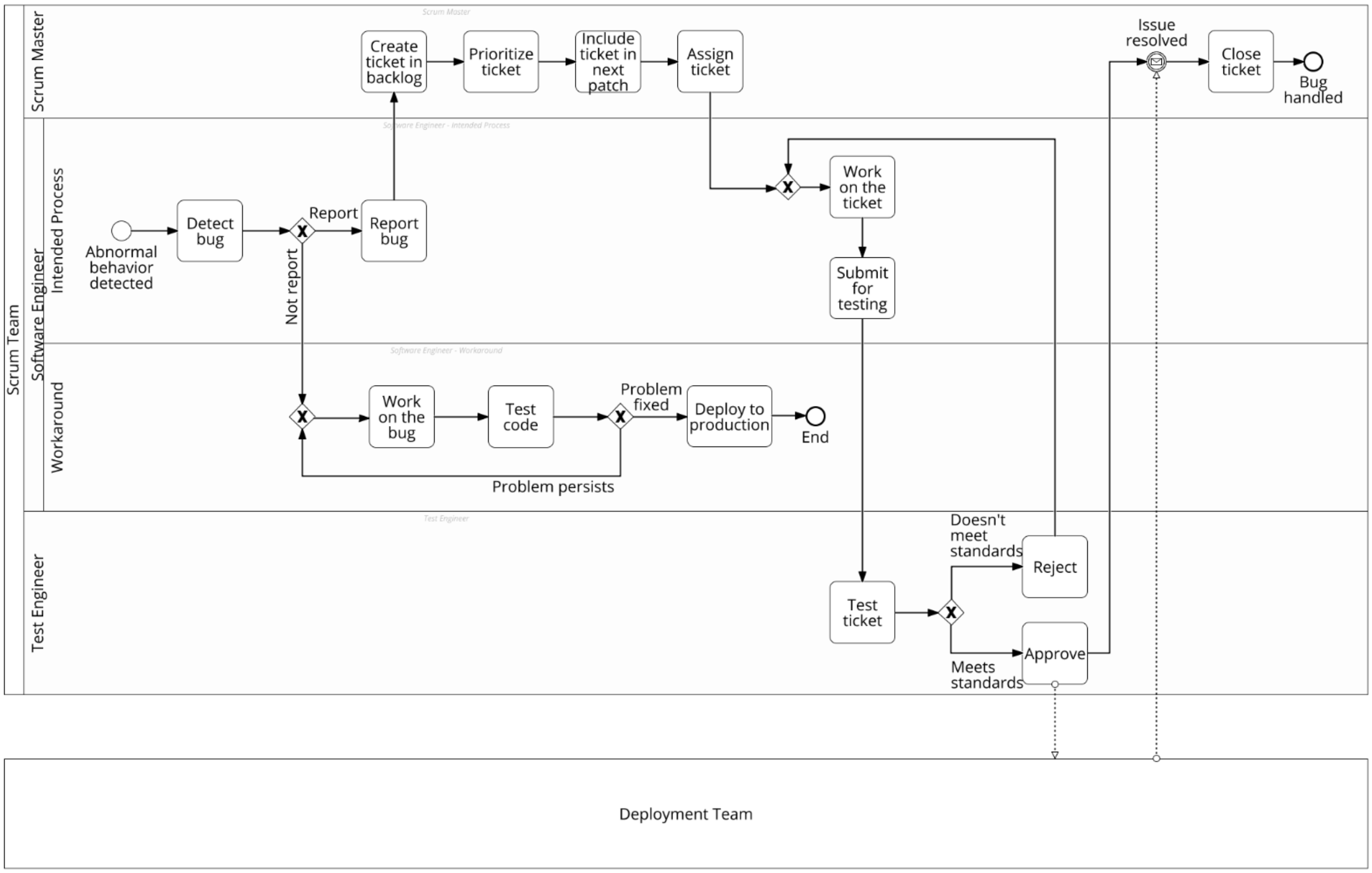
As can be seen in the example model below, there is a dedicated swimlane named "Workaround" which contains the respective workaround task, while the standard task is contained in a swimlane named "Intended process".



Current time [HH:MM] : ____

Example no.1:

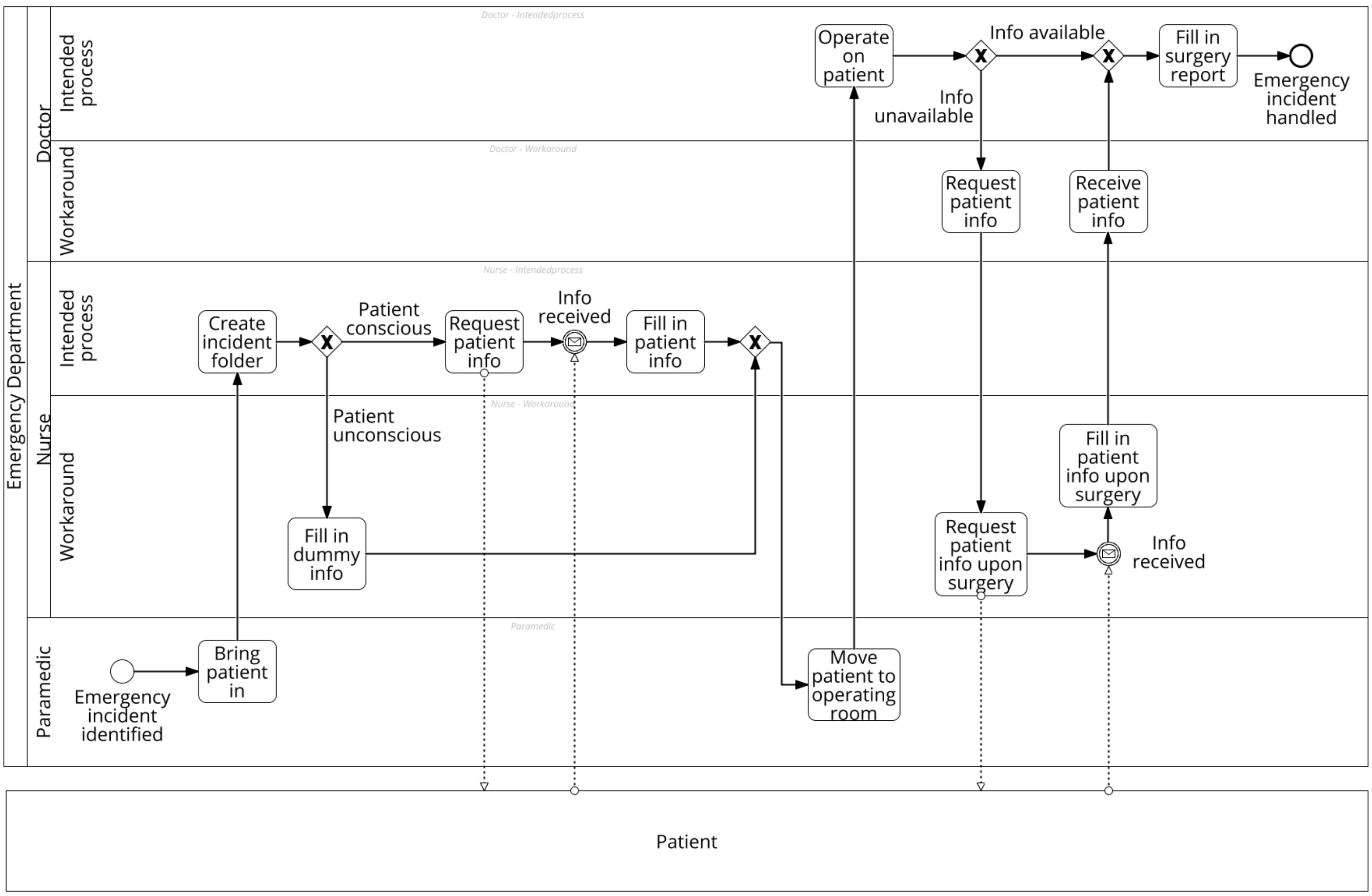
The figure below presents an overview of the standard tasks, as well as the workaround tasks that are followed within a software development company when a bug is detected in a piece of software.



Repeat questions 1-5 from version 1

Example no.2:

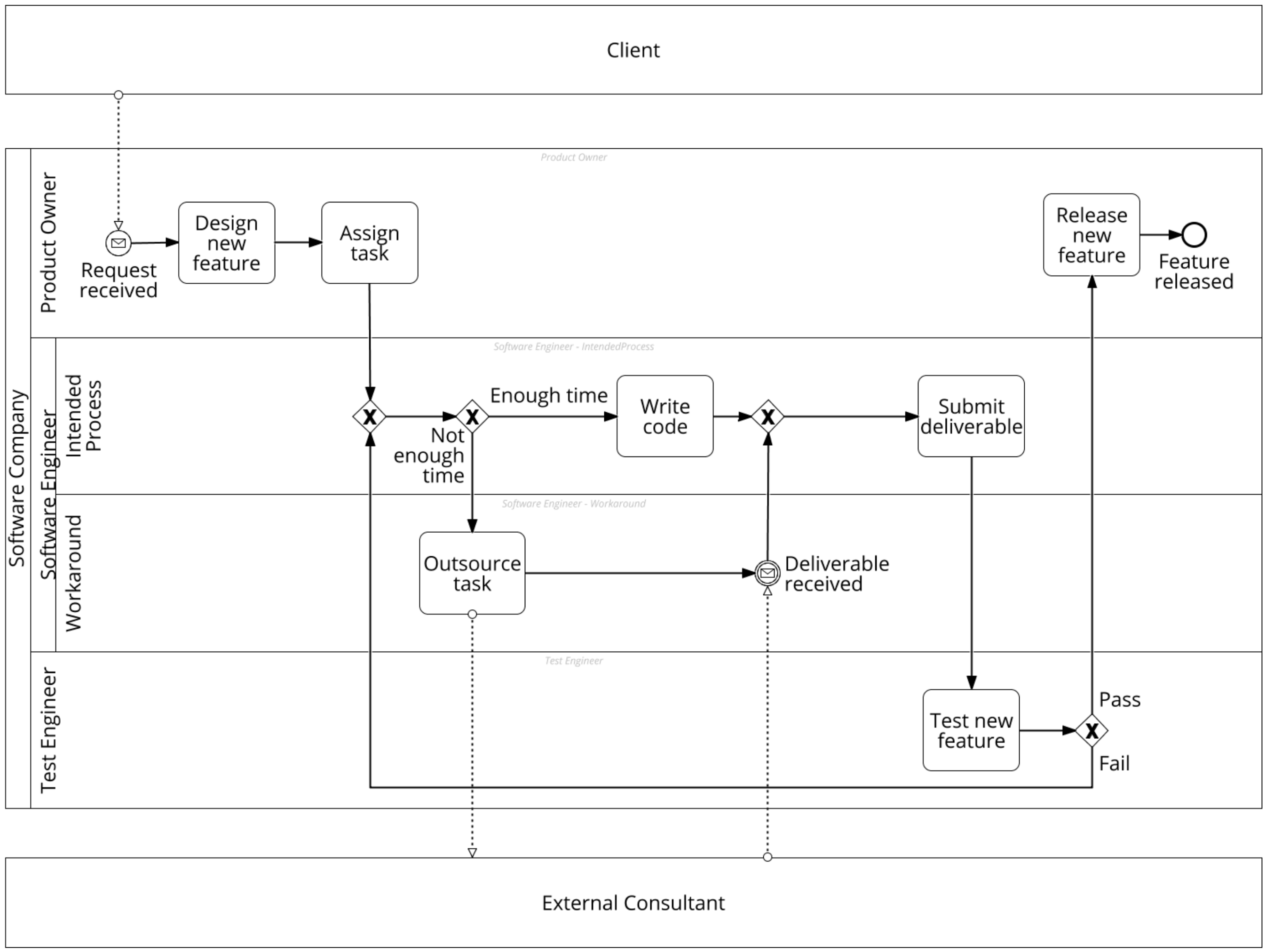
The figure below presents an overview of the standard tasks, as well as the workaround tasks that are being followed within a medical center when an emergency surgery incident is brought in.



Repeat questions 6-10 from version 1

Example no.3:

The figure below presents an overview of the standard tasks, as well as the workaround tasks that are being followed by a software development company when they are asked to develop a new feature by one of their clients.



Repeat questions 11-15 from version 1

Current time [HH:MM] : ________________________________

Repeat questions 16-21 from version 1

Experiment version 3 – Flow Object

Introduction

Same as in version 1

Instructions

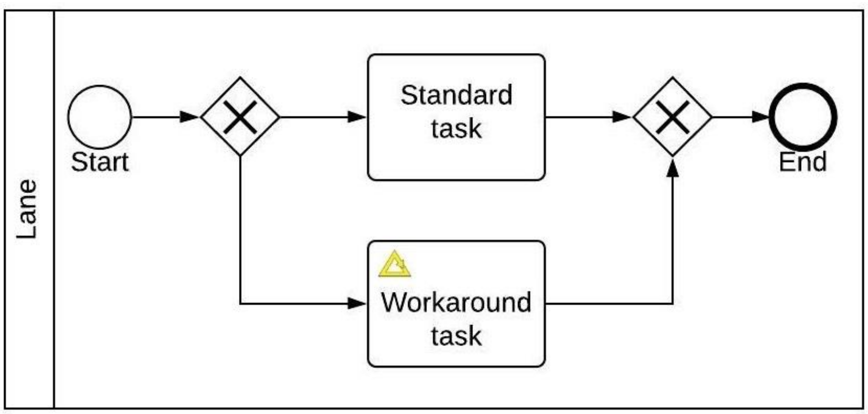
Same as in version 1

Questions regarding your background

Same as in version 1

Introducing the notation

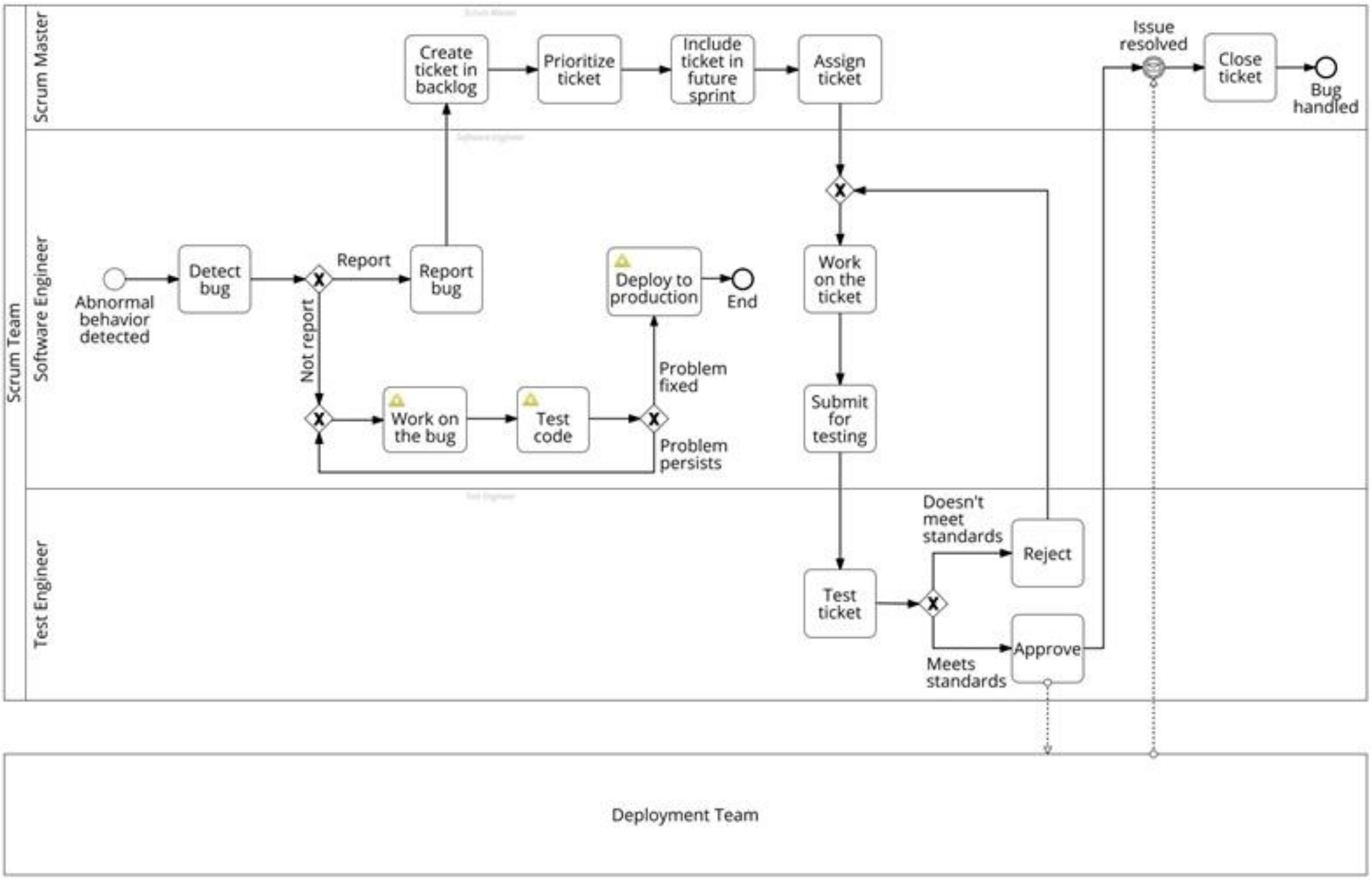
As can be seen in the example model above, the workaround task is represented by a rounded-edge rectangle, which is marked with a yellow triangle at its top-left corner.



Current time [HH:MM] : __________________________________

Example no.1:

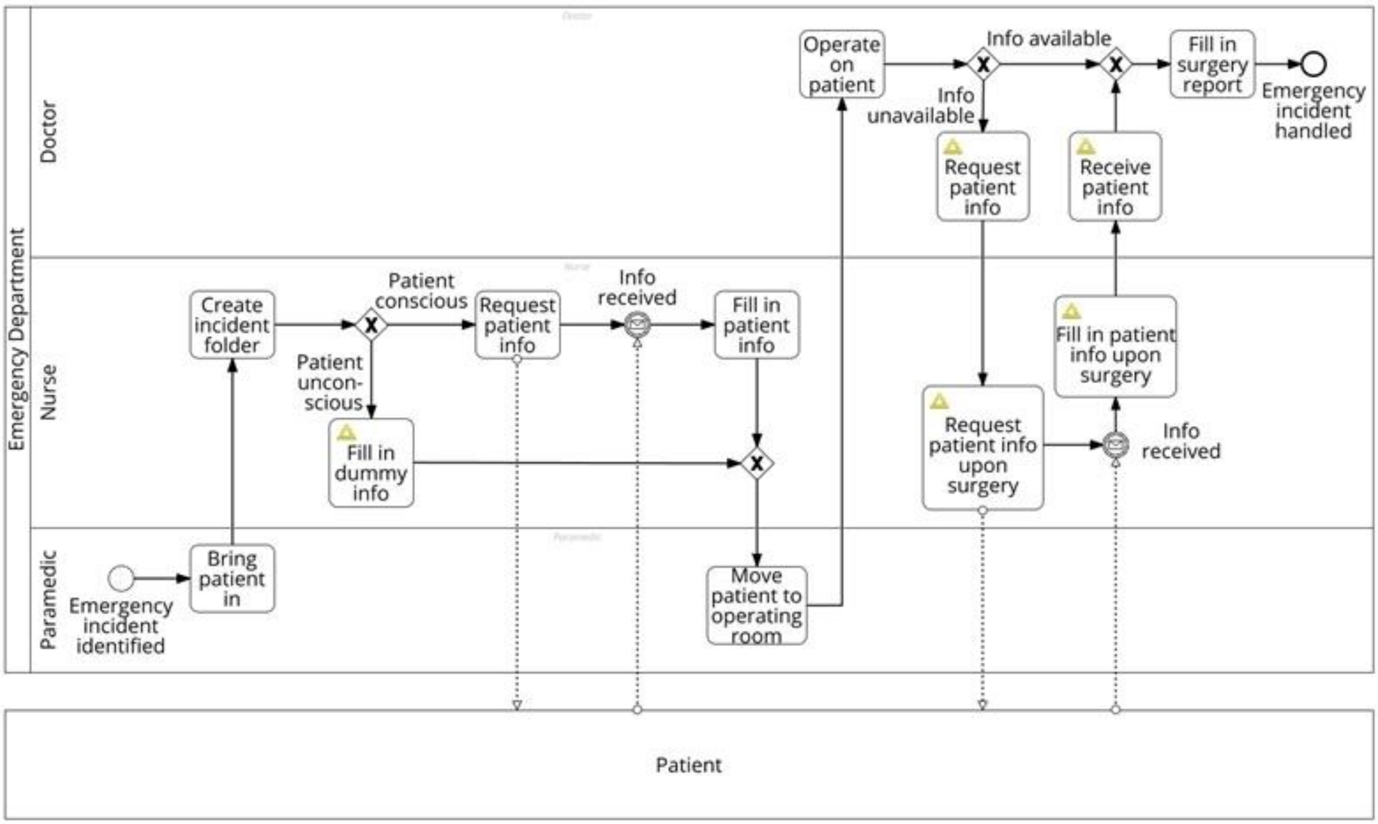
The figure below presents an overview of the standard tasks, as well as the workaround tasks that are followed within a software development company when a bug is detected in the source code.



Repeat questions 1-5 from version 1

Example no.2:

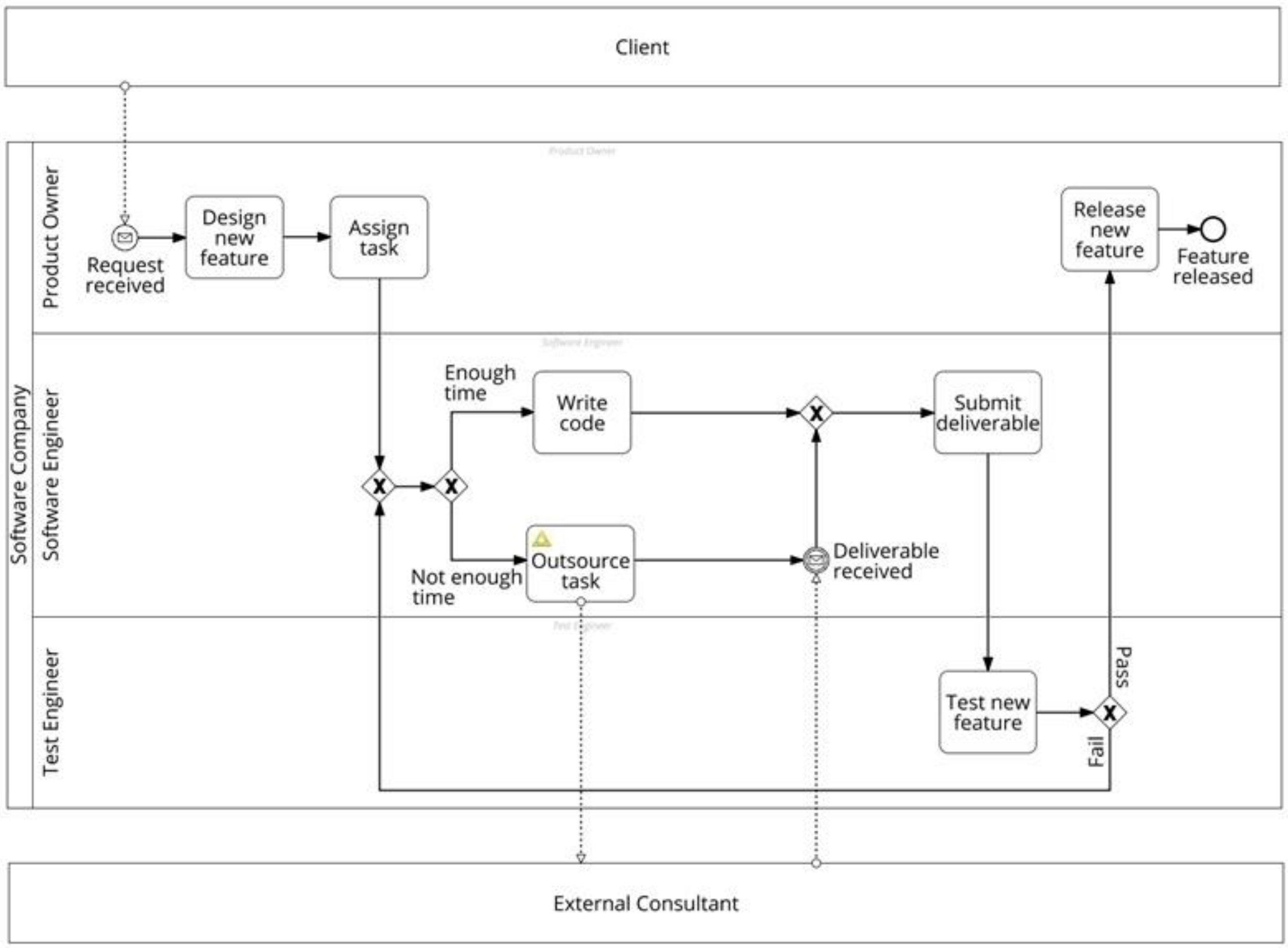
The figure below presents an overview of the standard tasks, as well as the workaround tasks that are being followed within a medical center when an emergency surgery incident is brought in.



Repeat questions 6-10 from version 1

Example no.3:

The figure below presents an overview of the standard tasks, as well as the workaround tasks that are being followed by a software development company when they are asked to develop a new feature by one of their clients.



Repeat questions 11-15 from version 1

Current time [HH:MM] : ___________________________________

Repeat questions 16-21 from version 1

Appendix B – Phase 2 questionnaire

Introduction

Have you ever been part of a process and you felt that you're not able to do what you want because of rules and/or restrictions? You can probably think of examples where you came up with an alternative to solve such a problem or to do something quicker; in a sense, you deviated from the standard process. We refer to such deviations as 'workarounds'.

As you can imagine, workarounds are quite common in all kinds of organizations. But, what do they mean for the business and how do you deal with them? Should you embrace it as part of your business process, or should you reject it and prohibit employees from using it? In many cases, people lack the information to make such decisions. Through this experiment, we aim to find the best way of modelling workarounds and pave the way for using such models as a tool for well-informed decision making regarding these workarounds.

At first, you are asked to answer a number of demographic questions, as well as some questions regarding your background, that will help us characterize our group of participants. You will then be presented with three different process models that include workarounds. Each model is visualized in two different ways. Please take some time to go through these models and observe how the use of the two different approaches affects the model and the information you perceive.

In the end, you are called to express your opinion on a number of statements regarding your perception on: 1) the ease of use, 2) the usefulness, and 3) the intention to use these approaches. The whole process is estimated to take around 20 minutes.

Demographic and participant's background questions

1. Please fill in your age in years rounded to the closest integer

   Answer: _________________

2. Please fill the title of your role within the company

   Answer: _________________

3. How many years of working experience do you have in business process modelling?

   Answer: _________________

4. Please enter the (approximate) number of process models that you have created/edited within the last month

   Answer: _________________

5. Overall, I am proficient in Business Process Modelling

Strongly Disagree	*Disagree*	*Agree*	*Strongly Agree*
☐	☐	☐	☐

6. Overall, I am very familiar with the BPMN notation

Strongly Disagree	*Disagree*	*Agree*	*Strongly Agree*
☐	☐	☐	☐

7. I feel very competent in using BPMN for process modelling.

Strongly Disagree	*Disagree*	*Agree*	*Strongly Agree*
☐	☐	☐	☐

8. I feel very confident in understanding BPMN process models

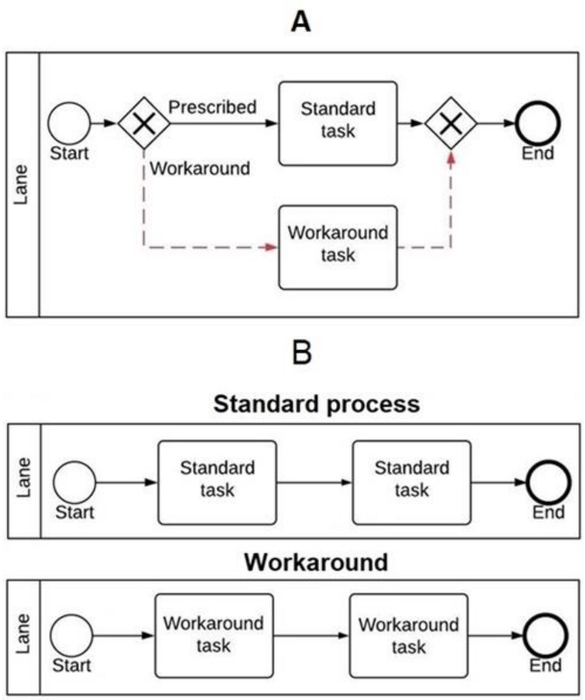
Strongly Disagree	*Disagree*	*Agree*	*Strongly Agree*
☐	☐	☐	☐

9. What is the end purpose of the process models that you create? Where do you see them being used?
   a. To communicate business processes
   b. Business process auditing
   c. Business process re-engineering
   d. Business process optimization
   e. Other: ____________________

Introducing the two modelling approaches

The first approach (A) introduces a new BPMN connecting object, the red dotted arrow, which is used to frame the workaround tasks, along with the respective conditions on the exclusive gate to mark the "prescribed" and "workaround" paths in the model.

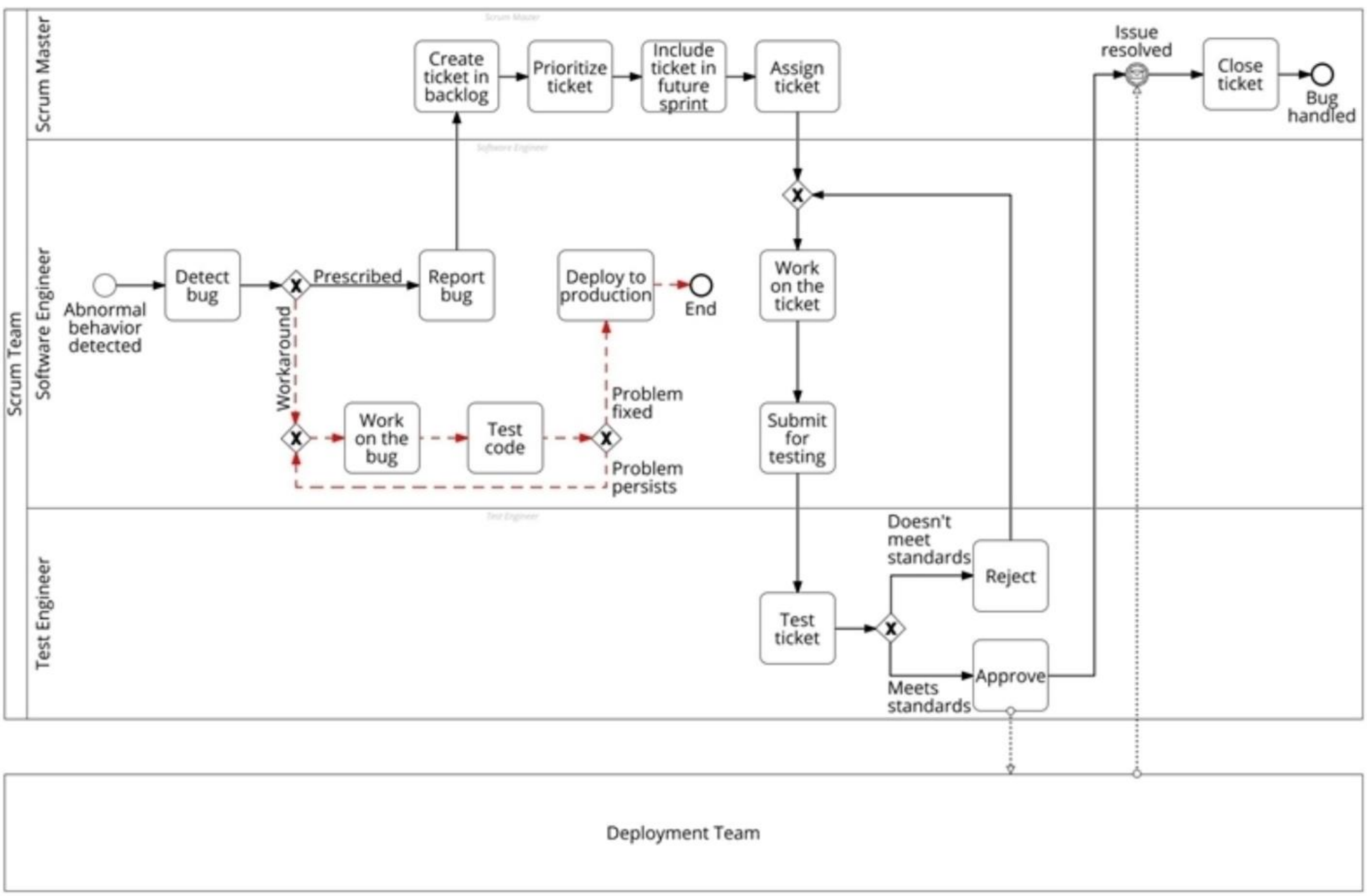
The second approach (B) suggests the use of two separate BPMN models, one dedicated to the standard process, and one dedicated to the workaround.



Example no.1

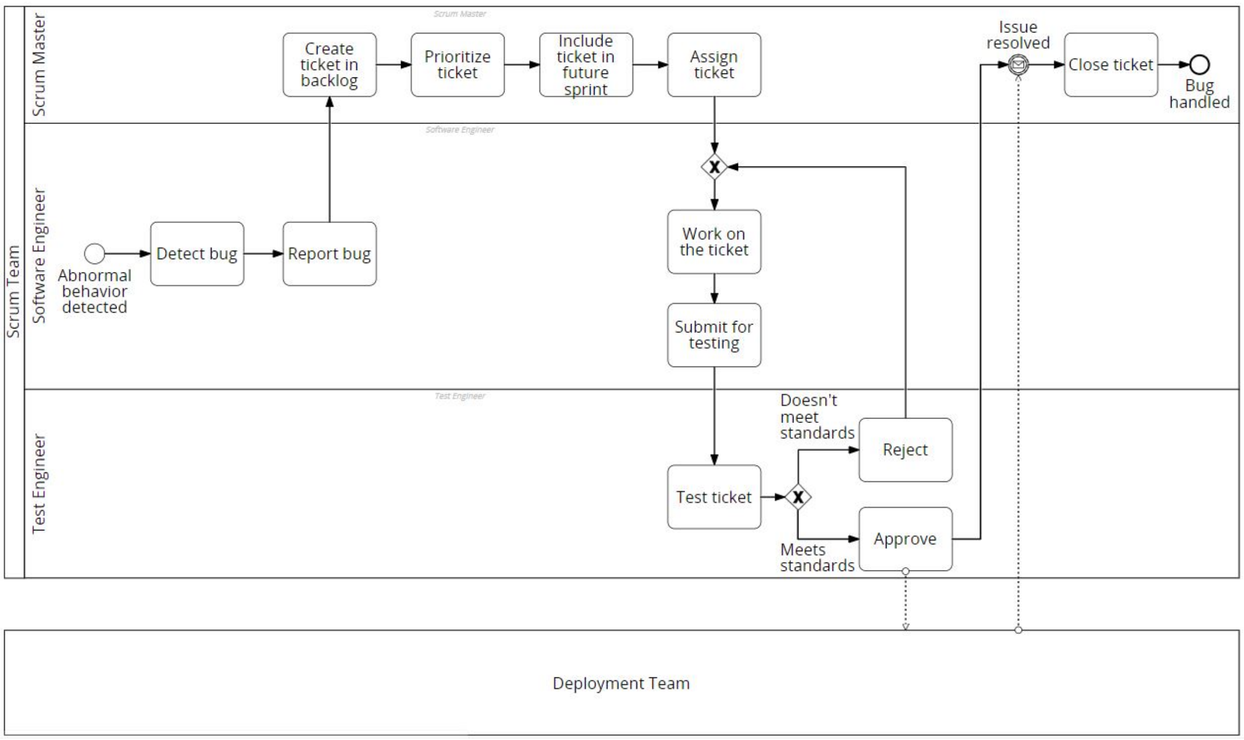
Approach A – Connecting Object

The models below present an overview of the standard tasks, as well as the workaround tasks, that are followed within a software development company when a bug is detected in a piece of software.

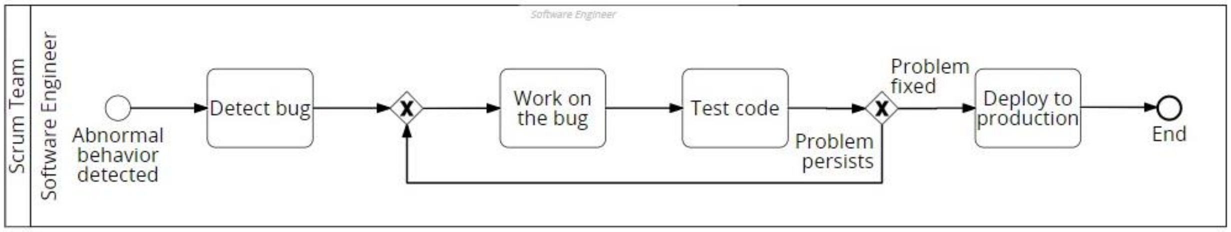


Approach B – Separate Models

Standard process



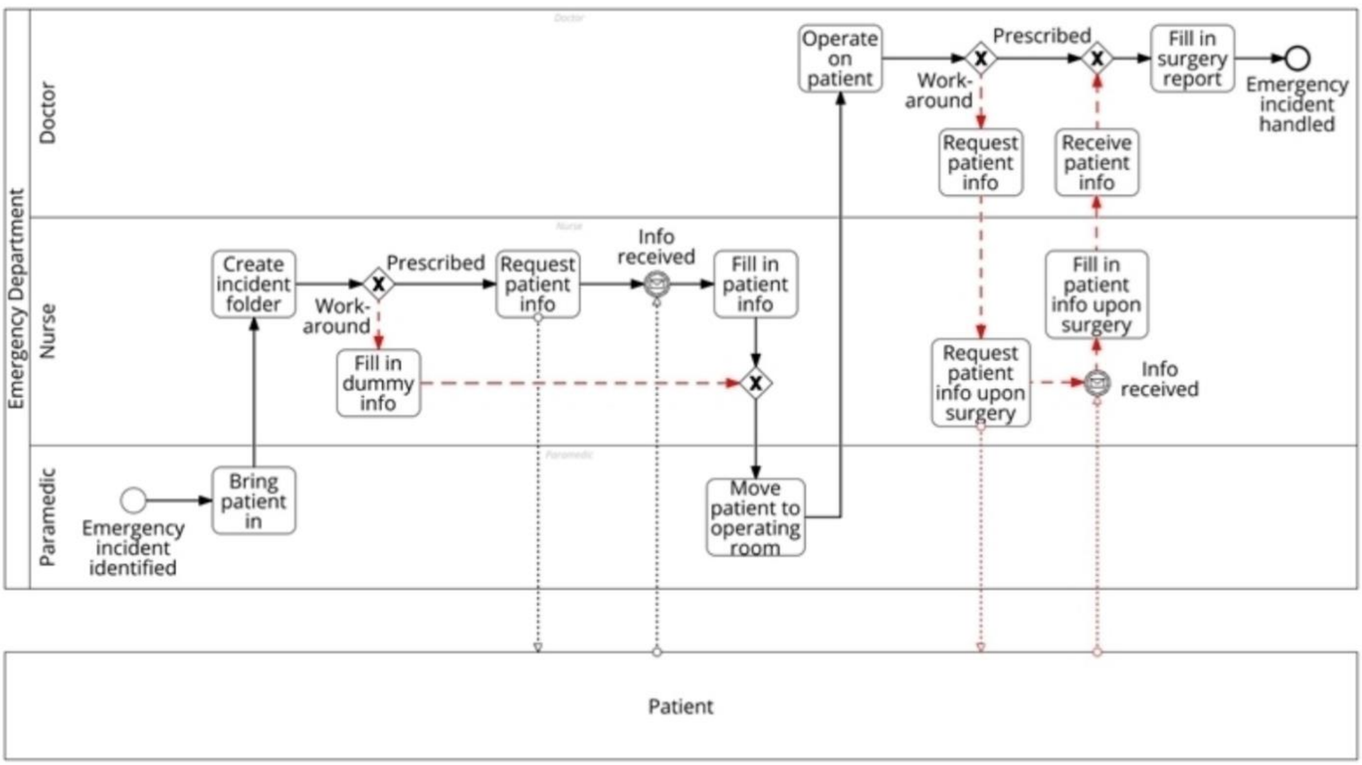
Workaround



Example no.2

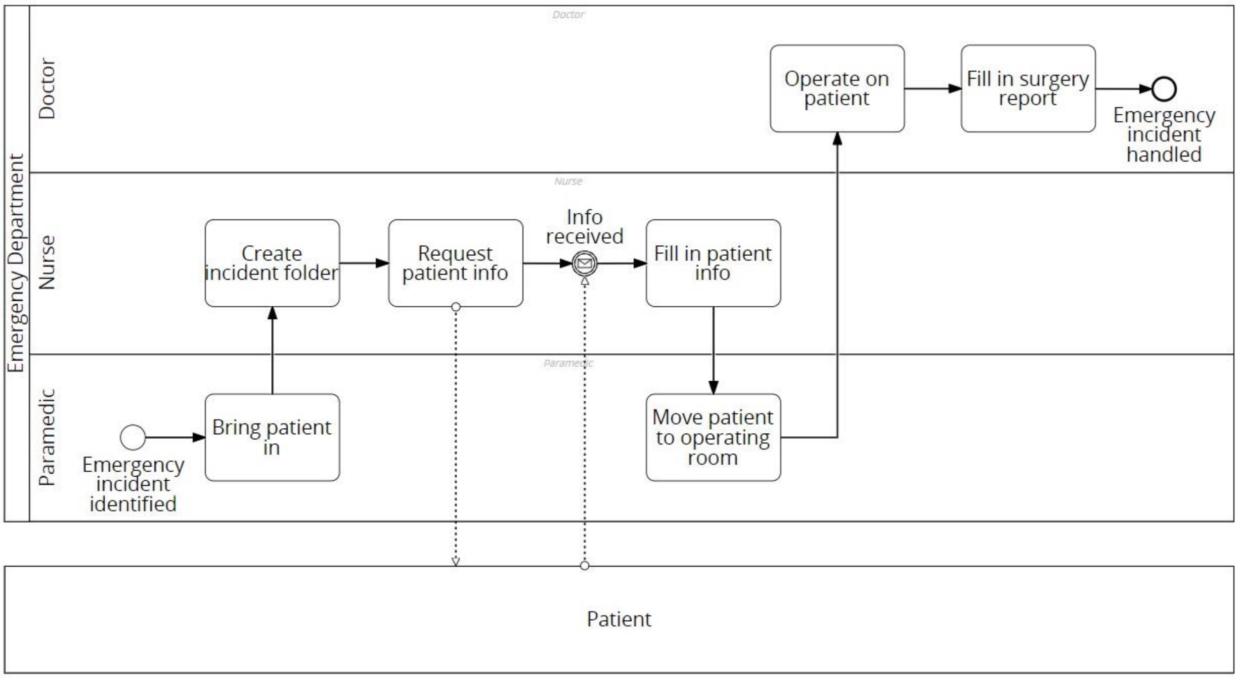
The models below present an overview of the standard tasks, as well as the workaround tasks that are being followed within a medical center when an emergency surgery incident is brought in.

Approach A – Connecting Object

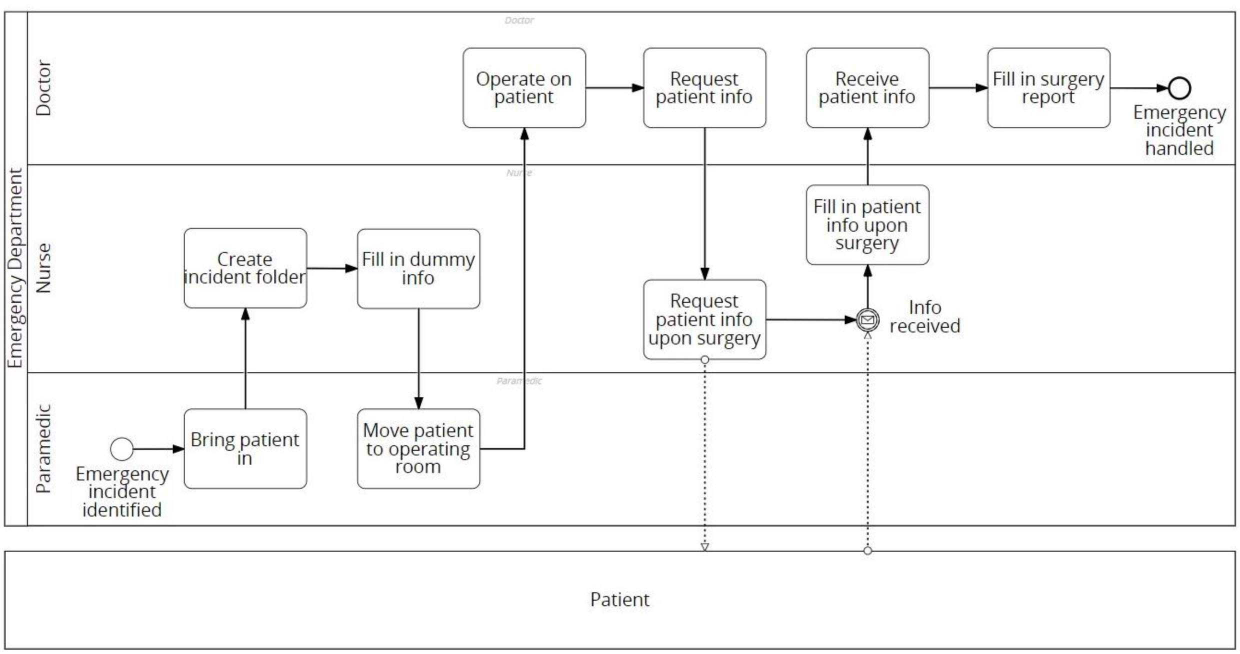


Approach B – Separate Models

Standard process



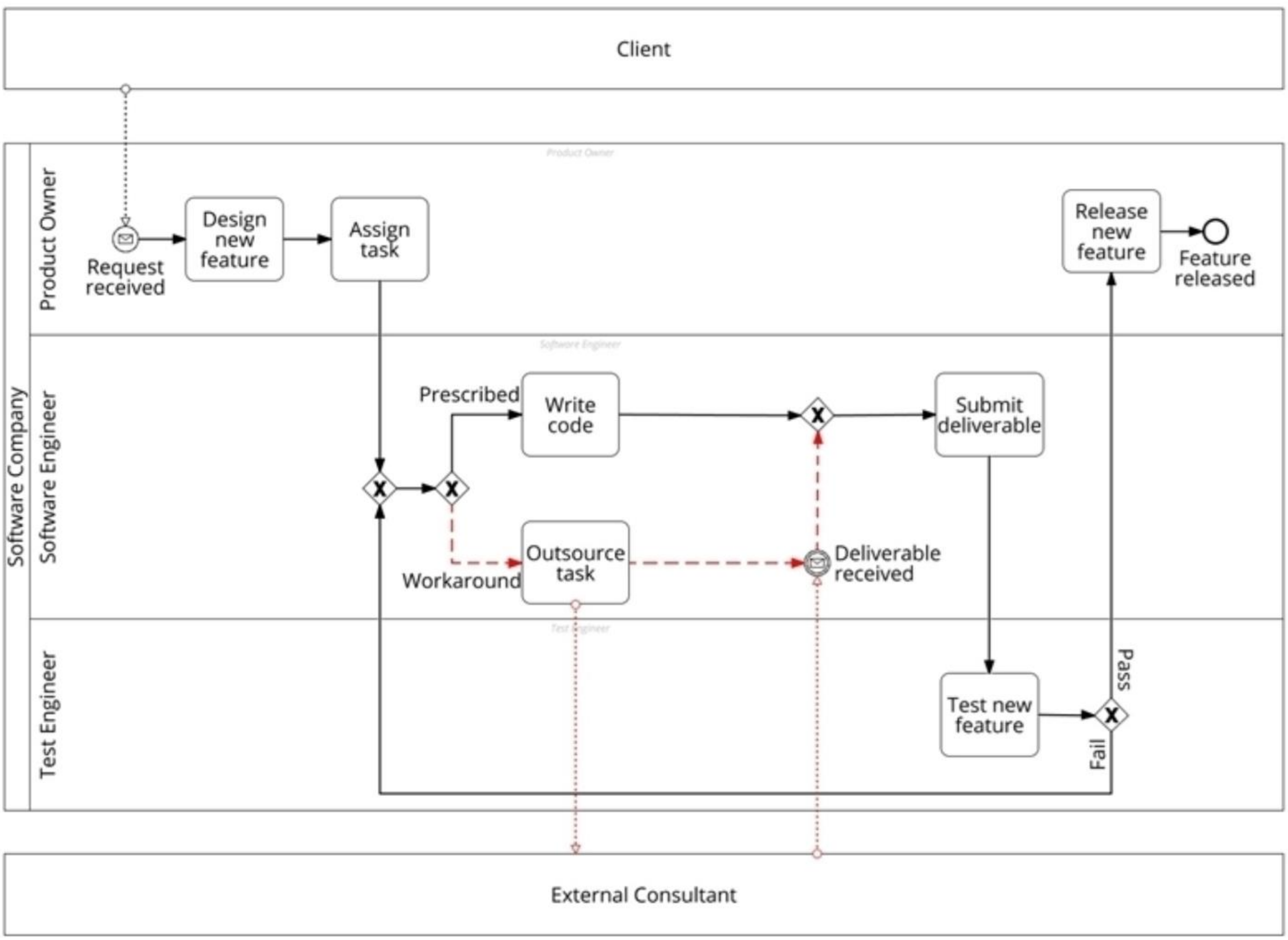
Workaround



Example no.3

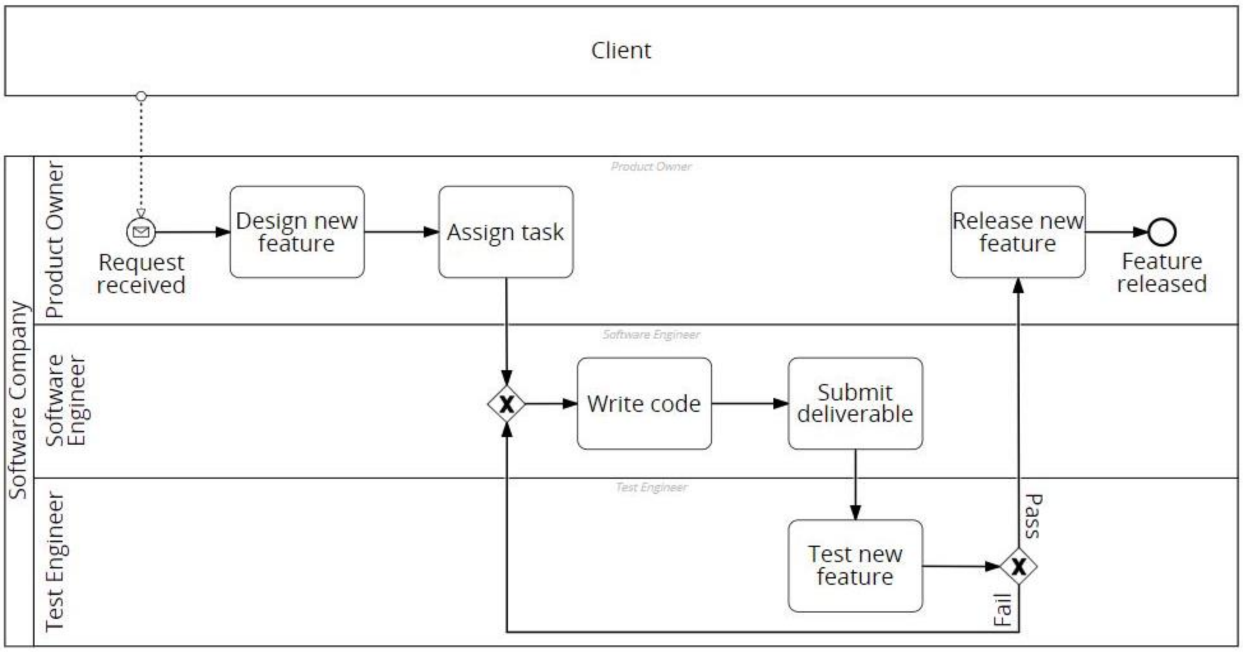
The models below present an overview of the standard tasks, as well as the workaround tasks that are being followed by a software development company when they are asked to develop a new feature by one of their clients.

Approach A – Connecting Object

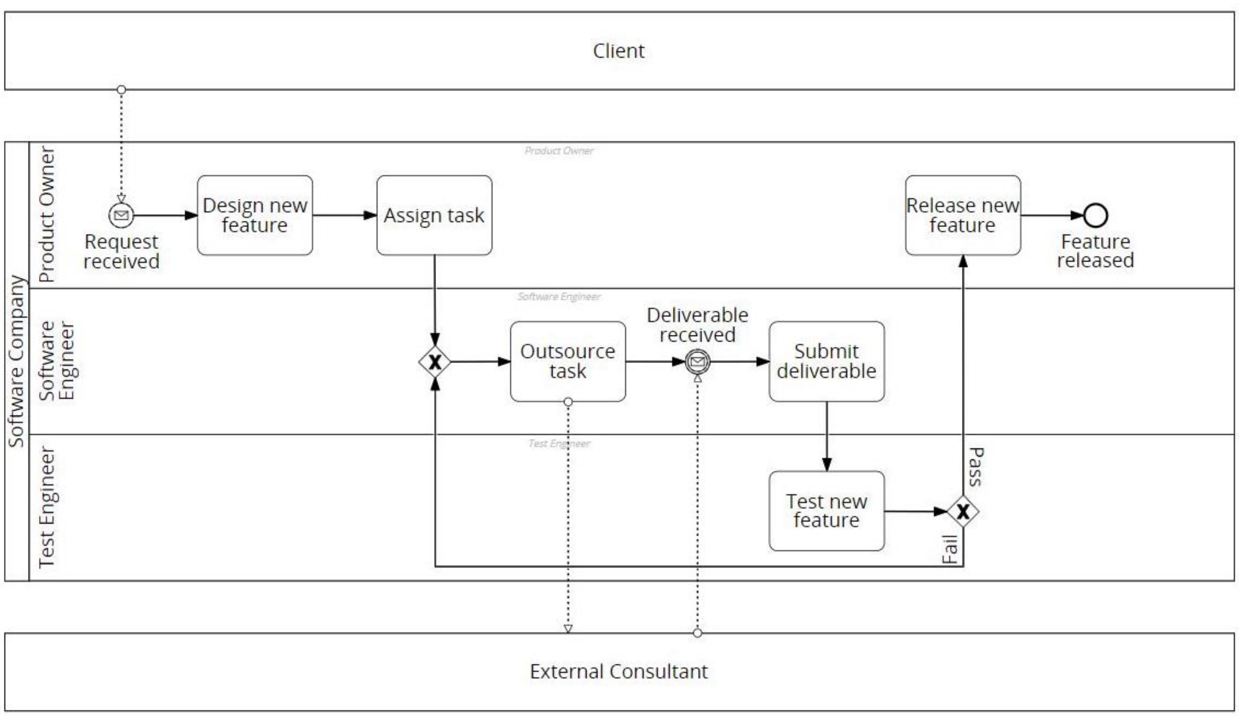


Approach B – Separate Models

Standard process



<u>Workaround</u>



Please indicate the degree to which you agree or disagree with the following statements regarding your perception on the ease of use of the introduced approaches.

1 I believe that the process of model design when using the connecting object to model workarounds would be easier and less complex to follow when compared to the two separate models

Strongly Disagree	*Disagree*	*Agree*	*Strongly Agree*
☐	☐	☐	☐

2 I am more confident that I could use the connecting object to model workarounds in practice when compared to the two separate models

Strongly Disagree	*Disagree*	*Agree*	*Strongly Agree*
☐	☐	☐	☐

3 Overall, I believe that the connecting object is easier to use when compared to the two separate models

Strongly Disagree	*Disagree*	*Agree*	*Strongly Agree*
☐	☐	☐	☐

Please indicate the degree to which you agree or disagree with the following statements regarding your perception on the usefulness of the introduced approaches.

4 I believe that I am able to make better and more informed decisions regarding the workaround when it is modeled by using the connecting object instead of the two separate models

Strongly Disagree	*Disagree*	*Agree*	*Strongly Agree*
☐	☐	☐	☐

5 Overall, I believe that the connecting object notation provides a more effective solution to the problem of representing workarounds when compared to the two separate models

Strongly Disagree	*Disagree*	*Agree*	*Strongly Agree*
☐	☐	☐	☐

6 Overall, I found the connecting object notation to be more useful when compared to the two separate models

Strongly Disagree	*Disagree*	*Agree*	*Strongly Agree*
☐	☐	☐	☐

Please indicate the degree to which you agree or disagree with the following statements regarding your intention to use the introduced approaches.

7 I would suggest the connecting object notation to my colleagues instead of the two separate models

Strongly Disagree	*Disagree*	*Agree*	*Strongly Agree*
☐	☐	☐	☐

8 Overall, I would prefer to use the connecting object notation to model workarounds instead of the two separate models

Strongly Disagree	*Disagree*	*Agree*	*Strongly Agree*
☐	☐	☐	☐

9 I intend to use the connecting object in preference to the two separate models if I will have to model workarounds in the future

Strongly Disagree	*Disagree*	*Agree*	*Strongly Agree*
☐	☐	☐	☐