Understanding BPMN Through Defect Detection Process

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Abstract: BPMN (Business Process Modelling Notation) diagrams enhance the perception of the business analysts to better understand and analyse the processes of the organizational setting and provide a common communication medium both for business analysts and IT professionals. The changes in the business systems require business analysts to understand the processes and improve them and IT professionals to comprehend and implement these processes as a software system. The main aim of this study is to analyse which type of defects can be detected in a given BPMN diagrams easily by novice users. We believe the results of this study will provide a guide for the educators in teaching, for business analysts and IT professionals in understanding and improving business processes.

1 INTRODUCTION

As diagrams transfer, and leverage knowledge that is essential for solving problems, they can be more powerful than sentential representations depending on the usage. Diagrams provide compressed information; hence, they are very effective in information systems for transferring information between stakeholders of the system.

Business process modelling emphasizes business activities and their interaction. Their purpose may include revealing the problems, changes in the operational issues, improving/understanding systems. These models are used for the communication of the business processes between business analysts and software developers/IT professionals. Therefore, it's crucial for them to be clear and coherent (Figl and Laue, 2011)

In this study, defect detection process in BPMN reviewing process is analysed to obtain insights about the cognitive processes of the first-year Computer Engineering students of Cankaya University who have basic knowledge about computer programming. The research question 'Which types of defects are easy to detect in BPMN representations?' is aimed to be answered.

We intended to answer this question through an experiment in which participants were given a BPMN diagram with different type of defects and they were expected to detect these defects. With the help of the data we collected, we believe that such analysis would provide insights about the design of BPMN diagrams and defect detection process. The results of this study are expected to enlighten the researchers, businesses, and educators to improve BPMN cognitive process. Background section below contains related studies found in the literature, Methodology section explains the experiment, Result section analyses the experiment results and Discussion and Conclusion section talks about the insights gained through this study.

2 BACKGROUND

The Business Process Modeling Notation (BPMN) is an important standard for process modelling and has enjoyed high levels of attention from academia and business world.

There are many studies analysing suitability of various representations' suitability to business domain like UML2.0, BPMLs, BPDM, RAD, EPC and Petri nets (Gou et al., 2000; List and Korherr, 2006). The results state that even though these representations provide adequate capability to represent dynamic behavior, organizational and informational dimensions can be partially characterized.

Many studies have compared the diagrams' understandability based on participants' comprehension of the given diagrams (Birkmeier and Overhage, 2010; Geambaşu and Jianu, 2013; Cruz-

Lemus et al., 2010). They have concluded the superiority of one of the diagram's comprehension of the business process representations. However, none of them mentioned which defects are more important and easier to be comprehended by participants in BPMN diagrams. Usually, in system development process, business process analysis is performed during requirements elicitation phase. As a results, analysts and developers use different visual representations to incorporate information they grasp for the design and development of software artefacts. During this process, they also compare diagrams with textual requirements to reveal discrepancies or incomplete information (Hungerford, 2004). It is important to detect and correct mistakes at the design stage of the system development. Given that; there are also defect types which cannot be detected in the runtime (von Stackelberg et al., 2014). With this research we aim to find out which types of defects are easier to detect by novice users from IT field.

In the literature, there are not many studies conducted to better understand the reviewers' performance during the defect detection process in BPMN models. For instance, Moser and Biffl report that the missing or incorrect type of information is often detected in a later engineering process step (Moser and Biffl, 2010). Hence understanding the defect types that cannot be detected easily could help the software system designers to better represent this type of information in their models. Additionally, this information also can be used to better guide the reviewers in different phases of software development process accordingly.

3 METHOD

We have performed an experiment to observe and collect data for defect detection process of novice participants. The experimental study was conducted with 6 participants using a study material which was derived from the study of Geambaşu and Jianu, which is adapted to the current settings of this study and translated into Turkish (Geambaşu and Jianu, 2013). Moreover, they were provided with the description of the symbols that would be used in the diagrammatic representation. Participants of this study were first year students of Computer Engineering Department of Cankaya University. The inspection against a requirements document is called vertical reading technique (Travassos et al., 1999) which aims to reveal omission, incorrect, inconsistent type of defects which can be applied to all documents in any of the software development stage whenever the necessary documents are available.

We have prepared a scenario about package holiday booking process of a travel agency. According to this scenario 6 defects seeded into the BPMN diagram of the system. The participants have been provided the process description one week before the experiment. During the experiment, participants were asked to find the defects seeded into the BPMN diagram, based on the scenario description.

The defects are categorized into three types: Missing Task (MT), Missing Dataflow or information (MD), incorrect or missing Information (I). Table 1 summarizes the number of defects according to each category defined here.

Table 1: Number of Defects in Each Category.

Code	Description	# of Defects
MT	Missing Task	2
MD	Missing Dataflow/information	2
I	Incorrect/ Incomplete	2
	Total	6

Table 2 depicts the defects seeded into the BPMN with their defect types. Figure 1 shows the locations of the defects.

Table 2: Defect Explanations.

Defect	Description	Defect Type
01	"Receive invoice" is missing	MT
02	"Send travel requests" is missing	MT
03	Data flow to "receive cancel request" is missing	MD
04	Data flow to receive travel documents is missing	MD
05	Instead of "receive unavailability notice", "receive success message"	I
06	Instead of "cancel bookings" , "cancel invoice"	I

In Figure 1, there are several tasks performed by a customer or travel agency. These processes define the top-level diagram of package holiday booking process of a travel agency. The tasks connected to each other through data flows. Moreover, data is accumulated in data stores called customer ac-count, work order/proposal and personnel.

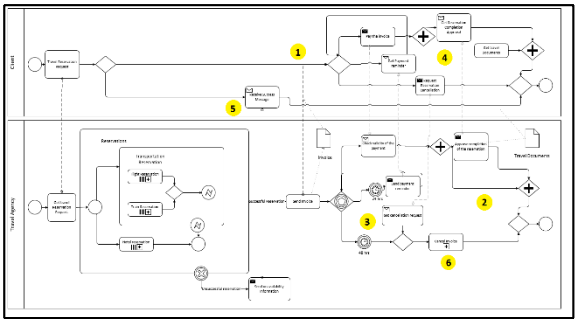

Figure 1: Defects' Placements in BPMN.

The participants were asked to detect the defects by comparing it with the scenario provided to them. In order to note the defects they found, they were asked to use a web-based tool to record the time at which they noticed the defect and its explanation (Figure 2).

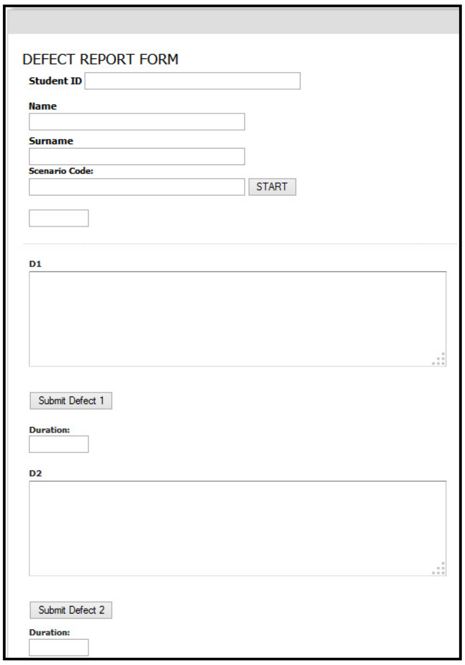

Figure 2: Defect Collection Tool.

In this study, data is collected through defect collection tool by the reviewers, questionnaire and semi-structured interview sessions conducted by each reviewer. The defect detection report generated by the tool includes the defect number, explanation for the defects found and the time of the defect notice. By using this form, the reviewers were asked to note each defect that they detect and describe their opinions about this defect as explained in the explanation document provided in Appendix A. The observations were conducted by one researcher and observation notes were taken during each reviewer's defect detection process. Additionally, questionnaire and a semi-structured interview session was conducted by each reviewer individually. The semi-structured interview questions were formed as below:

1. Which types of defects were easier to detect?
2. Which defects were harder to detect?
3. Which factors do you think helped you to detect the defects easily?
4. Which factors do you think make it hard to detect the defects?

Since the main research question of this study is based on the defects, the results of this study based on 36 cases (6 x 6). Additionally, this study aims to focus on the behaviours of the participants in order to uncover the complexity of human behaviour in such a framework and present a holistic interpretation of what is happening during the review process. Nielsen and Landauer also report that studying with four or five subjects is enough to understand and explain more than 80% of the phenomena (Nielsen and Landauer, 1993). Accordingly, in this study, the participants' behaviours are analysed in depth from different dimensions. In the following section, the results of the defect detection process are provided.

4 RESULTS

Table 3 shows the duration in seconds that each participant (DPij) spent during each defect detection process.

Table 3: Defect Detection Duration Data.

Defect Type	Defect (Di)	Dp1i	Dp2i	Dp3j	Dp4i	Dp5i	Dp6i
MD	3					1500	
MT	1	780					720
MD	4		480	660	1140		60
MT	2	420	420			300	
I	6			240			
I	5	240	180				240

As an example, in this table, Dp1 is calculated from the defect collection tool which shows the duration in seconds that the participant p1 spend time for detecting the defect i (Di). It is the duration starting from the time point of last defect detection process until the defect detection of Di. ADi in Table 4 is the average of the durations spent by each participant to detect defect i (Di). Among the detected defects, type I defects were detected in relatively less time (D_5, D_6). Similarly, the participants spent more time for detecting defects of type MD (D_3) and only one participant could be able to detect MD type defect D_3.

Table 4: Defect Detection Duration Average.

Defect Type	Defect (Di)	ADi	Frequency of Di
MD	3	1500	1
MT	1	750	2
MD	4	585	4
MT	2	380	3
I	6	240	1
I	5	220	3

We have analysed this data according to the defect types, as shown in Table 4. Accordingly, the detection rate for missing Information (I) type of defects is calculated as 4/12=0.33. Defects of type MT were detected mostly; on the other hand, the defects of type MD were detected seldom.

Table 5: Detected Defect Type.

Defect Type	Total Possibilities	Total Detected	Detection Rate
MD	12	5	0.42
MT	12	5	0.42
I	12	4	0.33

The detection frequency Fi of defects is shown in Table 5. In this table, Fi represents the frequency of a detected defect by participants. Its value is calculated by adding 1 point for each defect's detection for defect i (Di). For example, if the defect is detected by only one participant this value is 1, if it is detected by three participants the Fi value for that defect is calculated as 3.

Table 6: Defect Frequency F_i.

Defect Type	Defect	F_i
MD	4	4
MT	2	3
I	5	3
MT	1	2
MD	3	1
I	6	1

Based on the defect detection average duration and order, we have calculated defect difficulty using formula derived by Cagiltay et al. (2011). Difficulty of a defect means how much a participant spend effort to find it in terms of time to find and order to find it.

$$\boxed{DF_j = \frac{D_j \bullet O_j}{\frac{R_j}{m}}} \tag{1}$$

where,

DF_j: Defect detection difficulty level of the j^{th} defect
D_j: Average duration spent by all participants for finding defect j
O_j: Average score of all participants for detecting j^{th} defect
R_j: Number of people who detected defect j
m: Total number of participants

The average frequency of defect detection according to the defect types are given in Table 7. As seen from this table, MD type defect D_3 was the most difficult defect in the diagram found by 1 participant.

Table 7: Defect Difficulty Levels.

Defect Type	Defect	DF_i
MD	3	9000.0
MT	1	3375
MT	2	2026.7
MD	4	1462.5
I	6	1440.0
I	5	733.3

According to Table 7, MD type defects were the most difficult ones whereas I type defects were the easiest defects. 4 of the participants stated that they have followed the scenario to detect the defects which made it easier to find them. 5 of the participants think that the modelling language was complicated for them which made defect detection process difficult.

5 DISCUSSION AND CONCLUSION

In this study, an experiment is conducted to analyse defect detection performance of novice users in reviewing BPMN diagrams. During the experiment, we had provided materials to the participants, one week before the experiment (Appendix A) and requested to find defects on BPMN diagrams compared to the explanations given. The defects they have found recorded through a defect collection tool.

The results of this study show that, missing information type defects (MP and MD) are harder to detect than the incomplete or incorrect type (I) of defects. Hence the defect detection frequency of defects in average is higher for type I defects (2.67) than that of type MP (2.00) and type MD (1.20) defects. Similarly, the detection rate of type I defects (0.67) is higher than that of type MP (0.50) and type MD (0.70) defects.

In this study we used a business process to study the defect detection process. Hence, there is a threat to the validity of the findings in that the study results could be a specific to the nature of the process or the type of the defects that were seeded. A future study would focus on several processes to be able to generalize the results.

According to the results, the business process designers may reconsider their designs especially for the defects of type missing dataflow, which are harder to be detected in the future and may increase the cost of the projects. We believe that further analysis of the BPMN defect detection process is expected to provide more insights to the researchers, businesses, and to the educators to improve BPMN cognitive process.

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APPENDIX A- SCENARIO

In This Experiment;

You are required to find the defects in the diagram, according to the description given below. Defects could be Missing Process (MP), Missing Dataflow/Data (MD) or Incorrect Definition /Data (I).

Travel Reservation Scenario

Travel Agency (TA) makes travel reservation based on the customer requests. TA receives a travel reservation request from a Client including airline transportation and hotel reservation. The request is examined; transportation and hotel availability is checked, reservation is made and accordingly an invoice is created. If reservation is not possible, the Client is informed correspondingly.

Client can make the payment upon reception of the invoice or can request reservation cancellation. If the payment is performed, TA checks the validity of the payment and a confirmation of the reservation message is sent to the customer with travel documents. If Client requests cancellation, TA cancels the reservation.

If Client does not make the payment, 24 hrs after the reception of the bill, a payment reminder is sent. Client can make the payment or cancel the reservation after this reminder.

If Client does not make the payment in 48 hrs after the reception of the bill, TA cancels the reservation.

Questionnaire

Open-Ended Questions

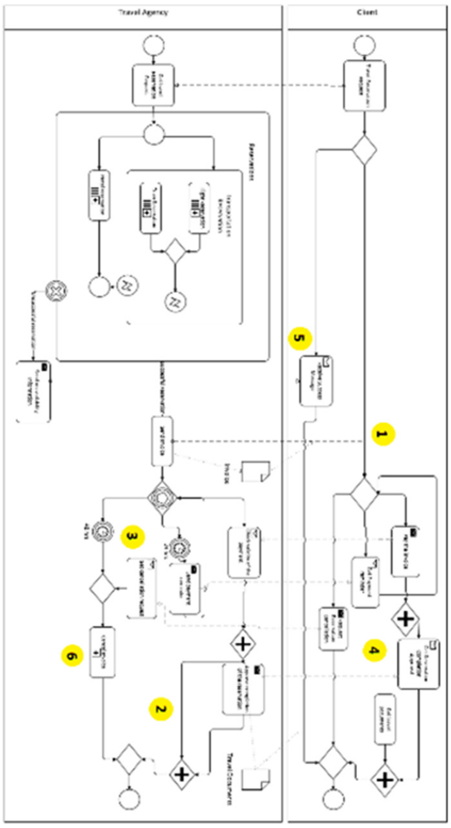
1. Which factors made you find the defects easily?
2. Which factors made it difficult to find the defects?
3. The easiest defect I found is:
   What is the reason?
4. The most difficult defect I found is:
   What is the reason?
5. During defect detection process, which strategy have you followed?
6. While working with the diagram, did you follow any defect order of your choice or the system has forced you to follow a certain order?

7. Which diagram element is easier to understand?
8. Which diagram element is more difficult to understand?
9. Which effect type was easier to find? Missing Process (MP), Missing Dataflow/Data (MD) or Incorrect Definition /Data (I)
10. Which effect type was more difficult to find? Missing Process (MP), Missing Dataflow/Data (MD) or Incorrect Definition /Data (I)

Lickert Scale (5-level) Questions

1. I understand this modelling language well
2. This modelling language is difficult
3. Diagram is complicated
4. Understanding the relationship between Client and Travel Agency is easy
5. The scenario description is compatible with the diagram
6. I understand modelling languages like ER, UML, DFD well
7. Modelling language concept is difficult for me

BPMN DIAGRAM DEFECTS



BPMN Symbols

	Start event- Untyped start event that triggers a new process instance
	Intermediate Error Event- Catches a named error, which was thrown be an inner scope (e.g. subprocess). This event needs to be attached to the boundary of an activity
	Intermediate Timer Event- Process execution is delayed until a certain point in time is reached or a particular duration is over
	Intermediate Multiple Event- Process execution is delayed until one out of a set of possible events is triggered
	Intermediate Cancel Event- Reacts only on a transaction, which was canceled inside an inner scope (e.g. subprocess).
	Task- A task is a unit of work – the job to be performed. It is an atomic activity within a process flow
	Receive Task-wait for a message to arrive from an external Participant
	Send Task-send a message to an external Participant
	Collapsed Subprocess- An event-subprocess is placed within another subprocess
	Collapsed Parallel Subprocess- An event-subprocess is placed within another subprocess working parallel
	Exclusive Gateway- creates alternative paths in a process flow, only one of the paths can be taken
	Parallel Gateway-combines parallel flows
	Sequence flow - connects flow objects in proper sequential order
	Message flow - represents messages from one process participant to another
	Association - shows relationships between artifacts and flow objects
	Data Object- provides information about what Activities require to be performed and/or what they produce
	Text Annotation- provides additional text information