

**Faculty of Economics and Management**  
**Department of Information Engineering (FEM)**



**Česká  
zemědělská  
univerzita  
v Praze**

## **Bachelor Thesis**

**Process models testing by using an eye tracking system**

**Author: Virakboth Khut**

**Thesis Supervisor: Ing. Josef Pavlíček, Ph.D**

© 2022 CZU Prague

# Czech University of Life Sciences Prague

Faculty of Economics and Management

Department of Information Engineering

## BACHELOR THESIS ASSIGNMENT

Virakboth khut

Systems Engineering and Informatics

Thesis title

**Process models testing by using an eye tracking system**

---

### **Objectives of thesis**

The aim of the work is to get acquainted with eye tracking technology and its use in the field of measuring the quality of BPMN models.

### **Methodology**

Study the eye tracking tools used for HCI purposes.

Define a specific process model by BPMN for ordering fly tickets, ordering food from the online delivery service, and ordering new electrical devices (tv, pc, etc) by internet page.

Find a suitable (ideally free to use) web-based tool for eye tracking. If not, use HUBRU laboratory.

Try to test 5 participants to go through the process models and check their eyes movement.

From the movement define, which symbols were difficult to understand.

Define conclusions.

### **The proposed extent of the thesis**

30-40

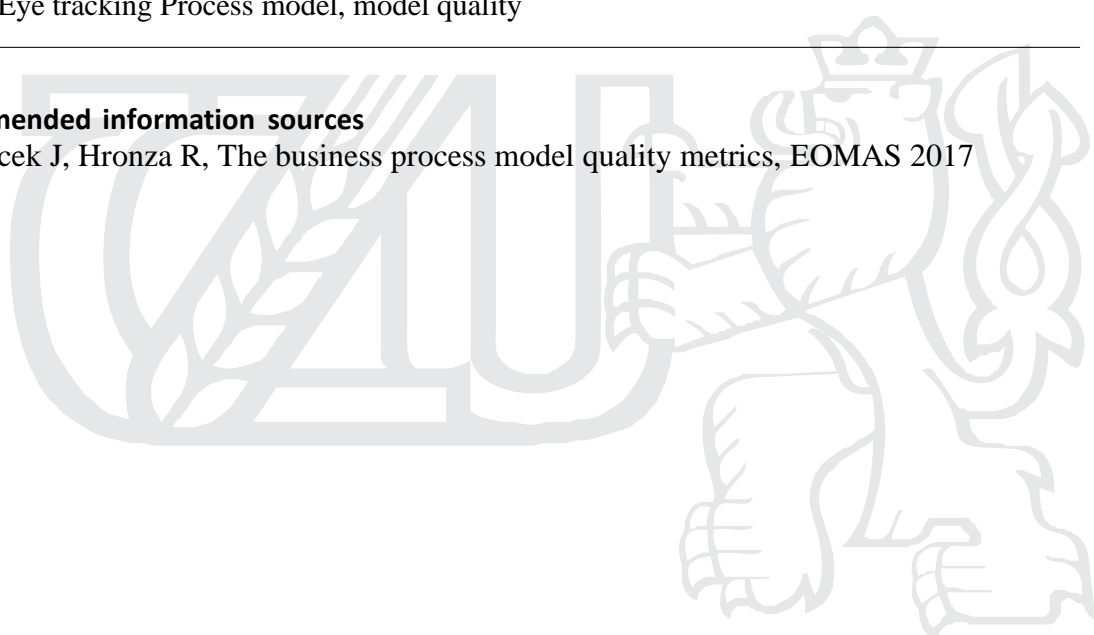
**Keywords:**

BPMN, Eye tracking Process model, model quality

---

**Recommended information sources**

1. Pavlicek J, Hronza R, The business process model quality metrics, EOMAS 2017

**Expected date of thesis defence**

2021/ 22 WS- FEM

**The Bachelor Thesis Supervisor**

Ing. Josef Pavlíček, Ph.D.

**Supervising department**

Department of information Engineering

Electronic Approval: 19.11.2020

---

**Ing. Martin Pelikán, Ph.D.**  
Head of Department

Electronic Approval: 19.11.2020

---

**doc. Ing. Tomáš Šubrt, Ph.D.**  
Dean

Prague on  
16.03.2022

## DECLARATION OF INTEGRITY

I declare that I have worked on my bachelor thesis titled "**Process models testing by using an eye tracking system** " by myself and I have used only the sources mentioned at the end of the thesis. As the author of the bachelor thesis, I declare that the thesis does not break copyrights of any other person.

Signed:

Name: Virakboth Khut

In Prague on date of submission

\_\_\_\_\_15th March 2022\_\_\_\_\_

## **ACKNOWLEDGEMENT**

I would like to thank my supervisor Ing. Josef Pavlíček, Ph.D. for his valuable time helping me with many ideas, great advice and suggestions which help me a lot throughout this thesis.

## **ABSTRACT**

Eye tracking system is a method that can serve as a valuable tool in HCI. The objective of using eye tracking is to understand a user's point of view or we can say it is a technique whereby the individual's eye movements are measured so that we know where a person is gazing at any given time and the sequence in which their eyes are shifting from one location to another. That helps us to understand visual and information processing that can be provided as an objective source of interface evaluation data which can inform the design of improved interfaces. BPMN is considered as a new path for describing business process semantics which the notation is easy to comprehend and highly understandable to managing the organisation.

Our aim of this thesis is to use an eye tracker technology to apply in BPMN which we ask participants to test and by recording the participants focus that can be seen as a graphical representation of data (Heatmap). The test of eyes tracking will be used by a web-based tool which is ideally free to use (GazeRecorder) we can test it at CZU HUBRU laboratory and go through the process model which shows the activities, selections, and possibility interaction in the system. For example: Defining the process of ordering an air ticket, ordering food from an online delivery service, ordering new electrical devices (TV, PC, Smartphone etc). We will define the movement which symbols were difficult to understand and measure the quality of BPMN Model.

## ABSTRAKT

System sledování očí je metoda, která může sloužit jako cenný nástroj v HCI. Cílem použití sledování očí je porozumět pohledu uživatele nebo můžeme říci, že jde o techniku, při které se měří pohyby očí jednotlivce, takže víme, kam se člověk v kteroukoli chvíli dívá a v jakém pořadí jsou jeho oči. přesun z jednoho místa na druhé. To nám pomáhá porozumět vizuálnímu a informačnímu zpracování, které může být poskytnuto jako objektivní zdroj vyhodnocovacích dat rozhraní, která mohou být podkladem pro návrh vylepšených rozhraní. BPMN je považován za novou cestu pro popis sémantiky obchodních procesů, jejíž notace je snadno pochopitelná a vysoce srozumitelná pro řízení organizace.

Naším cílem této práce je použít technologii eye tracker pro aplikaci v BPMN, kterou žádáme účastníky otestovat a zaznamenat zaměření účastníků, které lze vidět jako grafickou reprezentaci dat (Heatmap). Test sledování očí bude využíván webovým nástrojem, který je ideálně zdarma k použití (GazeRecorder), můžeme jej otestovat v laboratoři CZU HUBRU a projít procesním modelem, který ukazuje činnosti, výběry a možnosti interakce v systému . Například: Definování procesu objednání letenky, objednání jídla z online rozvozové služby, objednání nových elektrických zařízení (TV, PC, Smartphone atd.). Definujeme pohyb, jehož symboly byly obtížně pochopitelné, a změříme kvalitu BPMN modelu.

# Table of Contents

<b>CHAPTER 1</b> .....	<b>1</b>
1.1 Brief history of BPMN .....	1
1.2 The purpose of BPMN.....	2
1.3 BPMN diagram elements and symbols .....	4
1.4 Basic BPMN modelling Elements .....	5
<b>CHAPTER 2</b> .....	<b>8</b>
2.1 Eye Tracking Technology.....	8
2.2 How does an eye tracker work? .....	9
2.3 Purpose of eye tracking .....	10
2.4 Eye tracking on HCI.....	11
<b>CHAPTER 3</b> .....	<b>12</b>
3.1 Process Model.....	12
3.2 Problem understanding .....	12
3.3 Method finding.....	12
3.4 Modelling.....	13
3.5 Reconciliation .....	13
3.6 Validation .....	13
<b>CHAPTER 4</b> .....	<b>14</b>
4.1 Objective.....	14
4.2 Materials and methods.....	14
4.3 Verification of the solution in laboratory conditions .....	19
4.3 Eye tracking test on process BPMN.....	21
4.4 Evaluation the solution and discussion.....	29
<b>CHAPTER 5</b> .....	<b>31</b>



5.1 Conclusion .....	31
Table of abbreviations .....	33
Table of Figures .....	34
Figure Sources .....	36
Bibliography .....	37

# CHAPTER 1

## 1.1 Brief history of BPMN

The BPMN 1.0 was upgraded by the Business Process Management institute (BPMI), which is now combined with the object Management Group (OMG) and released publicly in May 2004 and adopted as OMG standard in 2006.<sup>1</sup>

The earliest known research according to the acceptance of BPMN was managed in 2006, which is reasonable since the standard was first launched in 2004. BPMN was recently presented as a standard driven by the demand for a graphical notation that accompanies the BPEL4WS standard for practicable business processes.<sup>1</sup>

Three years after the launch of BPMN, an article from 2007 presented a business process modelling game to learn BPMN 1.0 notation. The article reported that the serious game could be a good opportunity to enrich higher education to stimulate scenarios of the real world and to enhance didactics for students that was addressed in 2008 where the authors declared that BPMN is accepted and used among businesspeople and academics.<sup>2</sup>

There is a perspective of BPMN acceptance which existed in an article in 2008 about BPMN 1.0 was used in groups of several, Well-defined construct clusters but less than 20% of its vocabulary was regularly used and some constructs did not occur in any of the model analysed.

---

<sup>1</sup> “BPMN Introduction and History.” Trisotech, 23 Jan. 2022, [online] trisotech.com. Available at: <<https://www.trisotech.com/bpmn-introduction-and-history/>> [Accessed 15 December 2021]

<sup>2</sup> Kocbek, M., Jošt, G., Heričko, M., & Polančič, G. (2015). Business process model and notation: The current state of affairs. *Computer Science and Information Systems*, 12(2),

<sup>3</sup> Omg.org. 2022. About the Business Process Model and Notation Specification Version 2.0.2. [online] Available at: < <https://www.omg.org/spec/BPMN/2.0.2/About-BPMN/> > [Accessed 18 December 2022].

The version 2.0 BPMN was upgraded in 2010, and the latest version (2.0.2) has been formally announced by ISO as the 2013 edition standard: ISO/IEC 19510.<sup>3</sup> The newest version of BPMN, is a fundamental evolution of the original standard. It enlarges the scope and capabilities of BPMN in several areas, it's not just a modelling notation, it's a model and a notation.<sup>1</sup>

## 1.2 The purpose of BPMN

The primary goal of BPMN is to give a notation which is readily understandable to all business users, from the business analysts that make the introductory draft of the processes, to the specialised developers responsible for actualizing the technology that will perform those processes, and long last to the businesspeople who will oversee and monitor those processes, Hence, BPMN makes a standardardised for the gap between the business process design and process implementation. It can be also stated that, BPMN is a standard for business the modelling process, very common in professional practice due to its expressiveness, the well-defined meta model and the possibility of workflow integration.<sup>4</sup>

The secondary goal, but no less important, is to confirm that XML language designed for the execution of business processes, such as WSBPEL (Web Services Business Process Execution Language) can be envisioned with a business-oriented notation. The BPMN has a corresponding formal XML- based language called Business Process Modelling Language (BPML).

---

<sup>4</sup> Hassen, M. B., Keskes, M., Turki, M., & Gargouri, F. (2017). BPMN 4KM: design and implementation of a BPMN extension for modelling the knowledge perspective of sensitive business processes. *Procedia Computer Science*, 121, 1119-1134.

<sup>5</sup> International Organisation for Standardisation (ISO). (2013). *Information technology-Object Management Group Business Process Model and Notation*.

<sup>6</sup> Martínez-Salvador, B., Marcos, M., & Riano, D. (2015). An algorithm for guideline transformation: from BPMN to SDA. *Procedia Computer Science*, 63, 244-251.

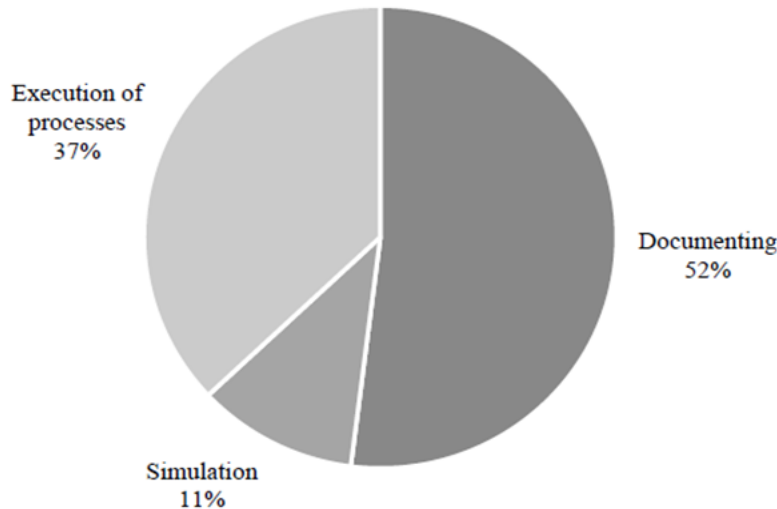


Figure 1: Purpose of use BPMN

BPMN can also be used for description, Example: documenting (52%), simulation (11%), and execution of process (37%).

At a more included level, it is focused on the individuals who will actualize the cycle, giving adequate detail to power exact usage. It gives a standard, basic language for all partners, regardless of whether specialised or non-specialized: business investigators, measure members, supervisor as well as external teams and consultants.

The diagramming would be effortless to understand than the narrative text would be. It authorises uncomplicated communication and collaboration to reach the goal of an efficient process that builds a top-quality result.

However, BPMN has been applied in several fields around the world not just in Business or information technology but also in medical practice. It is broadly acknowledged basically in view of two components, to be specific instrumentality and effortless for making models. Research work utilising BPMN in the clinical area announced speedy and instinctive acclimation with BPMN, and better comprehension for non-specialized staff. Regardless of various reasons for the utilisation of the BPMN, we agree that the essential and most significant purpose behind use remains the description of business processes.

---

<sup>7</sup> Martínez-Salvador, B., Marcos, M., & Riano, D. (2015). An algorithm for guideline transformation: from BPMN to SDA. *Procedia Computer Science*, 63, 244-251.

It is widely accepted mainly because of two factors, namely instrumentality and easiness for creating models. Research works using BPMN in the clinical domain reported quick and intuitive familiarisation with BPMN, and better understanding for non-technical staff. <sup>6</sup> Business Process modelling language (BPML) is a metalanguage for the modelling of business processes. XML is a meta-language for the modelling of business data. BPML gives a detached execution model for collaborative and transaction business processes based on the concept of a transactional finite-state machine.<sup>7</sup>

The Business Process Management conducts the change of the view from production oriented (a large number of products at a low price with a goal to meet the requirements of the market for the price of surplus products - see consumer industry which is called industry 3.0) to the production targeted at the customer needs fully utilising opportunities of the organisations. This production characterised by the product (service) which is not only a tangible object produced according to the defined technological processes. The digital dispatch carried the identifying target customer with their specific demands (for instance: colour of the product is not determined by heuristic estimate of the future need of the market - black cars 20%, white 18% and red ones 5%), technologies procedure required for the realisation of the final product. These are ideas of industry 4.0. These are according to the mechanism of the Cyber-physical system. <sup>7</sup>

### **1.3 BPMN diagram elements and symbols**

A business process model and notation diagram for short, is utilised to create simple and easy to read business process model flowcharts, whilst at the same time being able to handle the complexity inheritance to Business Processes.

---

<sup>8</sup> O.I. Lindland G. Sindre, and A. Solvberg, "Understanding quality in conceptual modelling," *IEEE Sofw.*, vol. 11, no. 2. pp. 42-49, Mar. 1994

<sup>9</sup> Pavlicek, J., Hronza, R., Pavlickova, P., & Jelinkova, K. (2017, June). The business process models quality metrics. In *Workshop on Enterprise and Organisational Modelling and Simulation* (pp. 134-148). Springer, Cham.

These two conflicting requirements were to organise the graphical viewpoints of the notation into particularly categories. These bring a small set of notation categories so that the reader can easily acknowledge the basic types of elements. Additional to this, variance and information can be included to support the requirements for complexity without changing the basic look. <sup>5</sup>

There are 5 basic categories of elements are:

- Flow objects
- Data
- Connecting Objects
- Swim lanes
- Artefacts

Flow objects: They are the main elements which represent all the activities or define the behaviour of a business process. There are three flow objects:

- Events
- Activities
- Gateways

## 1.4 Basic BPMN modelling Elements

**Events:** An Event is something that occurs during the course of a process or a Choreography. They affect the flow of the model and usually have a **trigger** or an impact (**result**). We will notice that Events are Circles with open centres to permit internal markers to differentiate different triggers or results.

There are three types of Events: Start, intermediate, End



Figure 2: BPMN Events Symbols

**Gateway:** A Gateway is utilised to control the divergence and convergence of sequence Flows in a process which means, it will be determined, branching, merging, or joining of path. So, the internal markers will indicate the type of behaviour control. The gateway can be exclusive, parallel or complex.

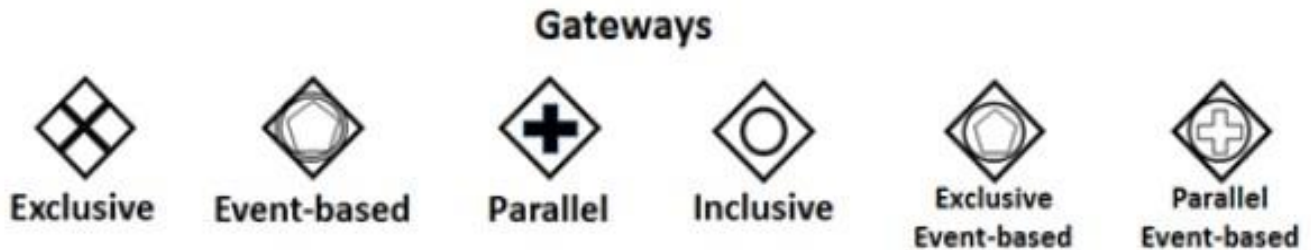


Figure 3: BPMN Gateway Symbols and Types of Gateways

**Activity:** An Activity is a generic term for work that a company performs in the process. it can be atomic or non-atomic (compound). The type of activities contains Sub-Process and Task, that are rounded rectangles.

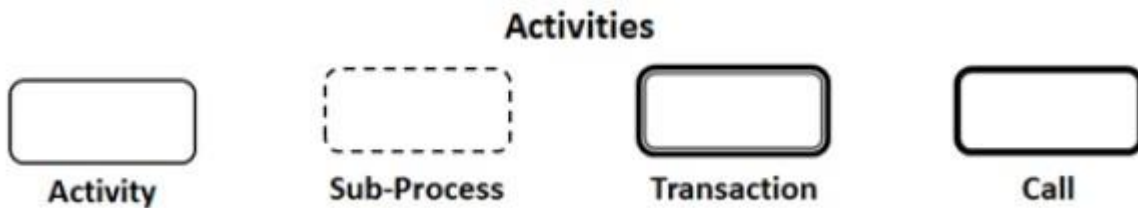


Figure 4: BPMN Activity Symbols

**Sequence Flow:** A sequence flow is used to indicate the order of activities that will be performed in a process.



Figure 5: BPMN Sequence flow

---

<sup>10</sup> Lucidchart. 2016. *What is Business Process Modelling Notation?* [online] Available at: <[https://www.lucidchart.com/pages/bpmn/#section\\_1](https://www.lucidchart.com/pages/bpmn/#section_1)> [Accessed 24 February 2022].

**Message Flow:** A message Flow is used to indicate the flow of messages between two participants that are prepared to send and receive them.



Figure 6: BPMN Message Flow

**Association:** An Association is an act of connecting or linking information and artefacts with BPMN graphical elements.



Figure 7: BPMN Association Flow

Here is the simple workflow BPMN diagram.

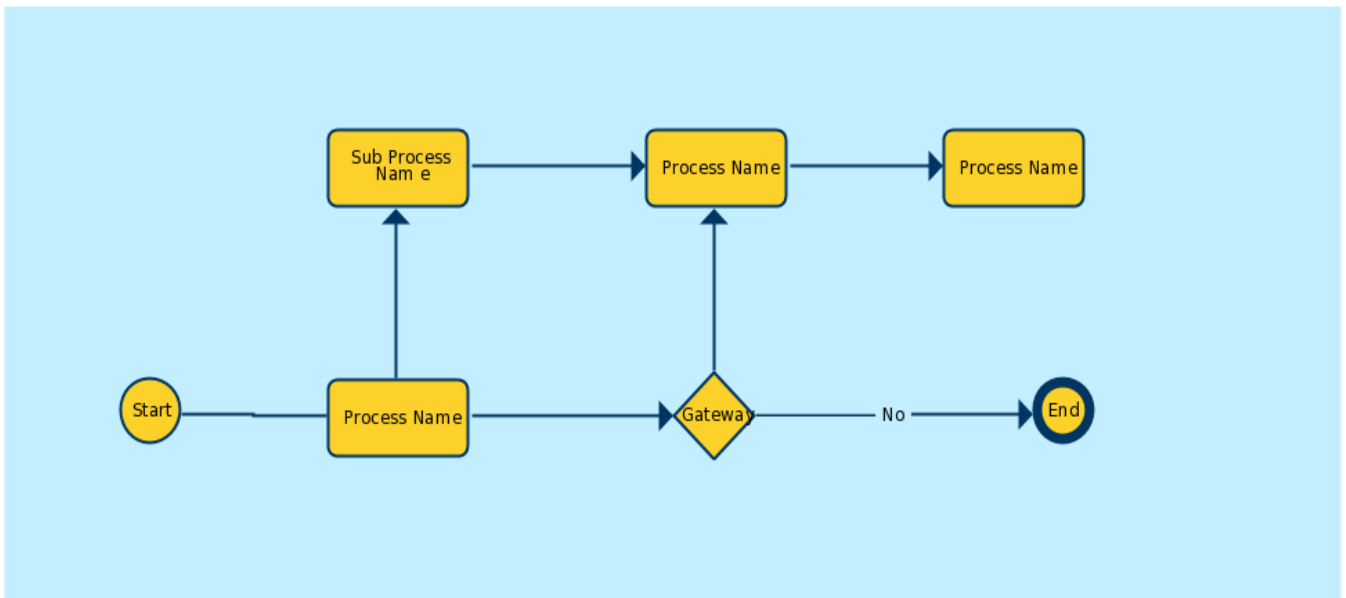


Figure 8: Sample BPMN workflow Diagram

A start **circle** is the beginning point where you started, then moved to the process **name**. From this point you have 2 options to continue: Sub process name and Gateway. If there will be no process, then finish the process (**End**).



## CHAPTER 2

### 2.1 Eye Tracking Technology

The Use of eye tracking technology was first developed in reading research over 100 years ago. It was started in the 19th century. The historical methods need the wearing of huge contact lenses that covered the cornea ( the clear membrane covered the front of the eye) and sclera (the white of the eye which is seen from the outside), with metal coil inserted the edge of the lens, eye movement were then measured by fluctuations in an electromagnetic field when the metal coil moved along with the eyes.<sup>11</sup> These methods had proved invasive, and most modern eye tracking system nowadays utilises video images of the eye to determine where a person is gazing (“point-of-regard”). Many recognizing features of the eye tracking can be utilised to infer point-of -regard, such as corneal reflections (known as Purkinje image), the iris-sclera boundary, and the apparent pupil shape.<sup>11</sup>

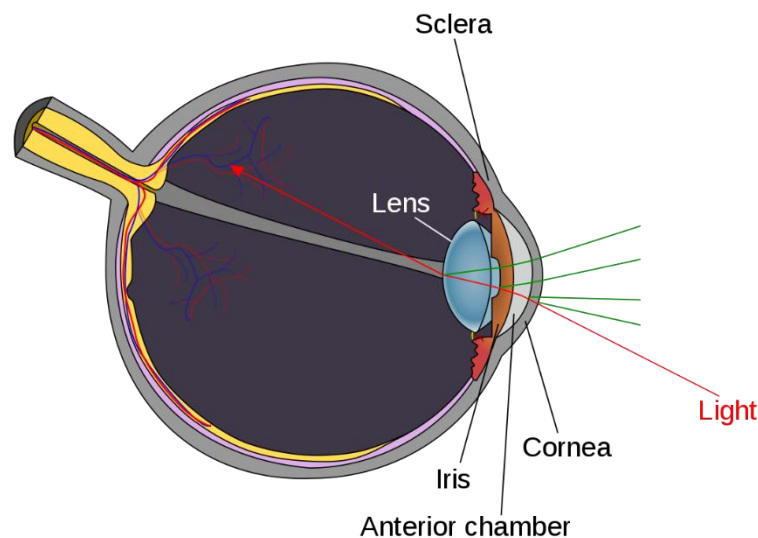


Figure 9: Purkinje Image ([https://en.wikipedia.org/wiki/Purkinje\\_images](https://en.wikipedia.org/wiki/Purkinje_images))

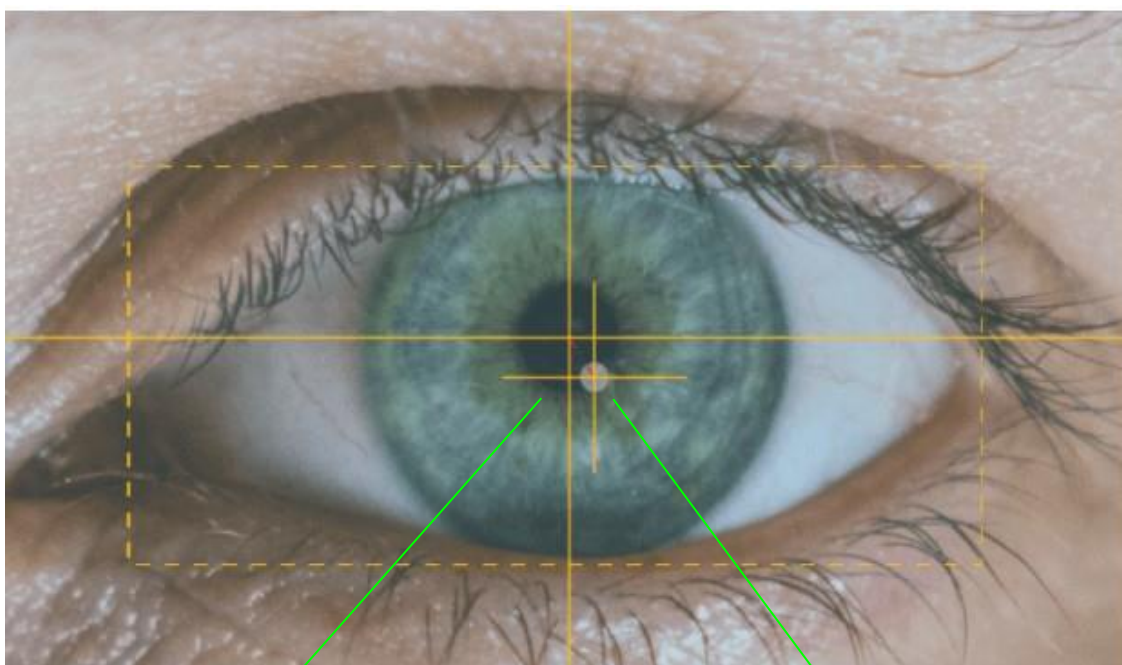
---

<sup>11</sup> Poole, A., & Ball, L. J. (2006). Eye tracking in HCI and usability research. In *Encyclopaedia of human computer interaction* (pp. 211-219). IGI global.

<sup>12</sup> Duchowski, A. T. (2002). A breadth-first survey of eye-tracking applications. *Behaviour Research Methods, Instruments, & Computers*, 34(4), 455-470.

## 2.2 How does an eye tracker work?

Most modern eye trackers use near-infrared technology along with high-resolution cameras (or other optical sensors) to track gaze direction. It is commonly referred to as Pupil Centre Corneal Reflection (PCCR).<sup>12</sup> The infrared light from an LED inserted in the infrared camera is first going through into the eye to build strong reflections in target eye features to make it effortless to track (an infrared light is utilised to avoid dazzling the user with visible light). The light enters the retina and a big proportion of it is reflected, which makes the pupil show as bright. The corneal reflection is also created by the infrared light, appearing as tiny as you see below.



Bright pupil

Corneal reflection

Figure 10: The centre of the eye (pupil centre) is tracked in the corneal reflection.

The image above is about Pupil Centre Corneal Reflection (PCCR). The light reflecting from the cornea and centre of pupil are utilised to give the eye tracker about the movement and direction of the eye.

---

<sup>13</sup> Goldberg, J. H., & Wichansky, A. M. (2003). Eye tracking in usability evaluation: A practitioner's guide. In *The Mind's Eye* (pp. 493-516). North-Holland.

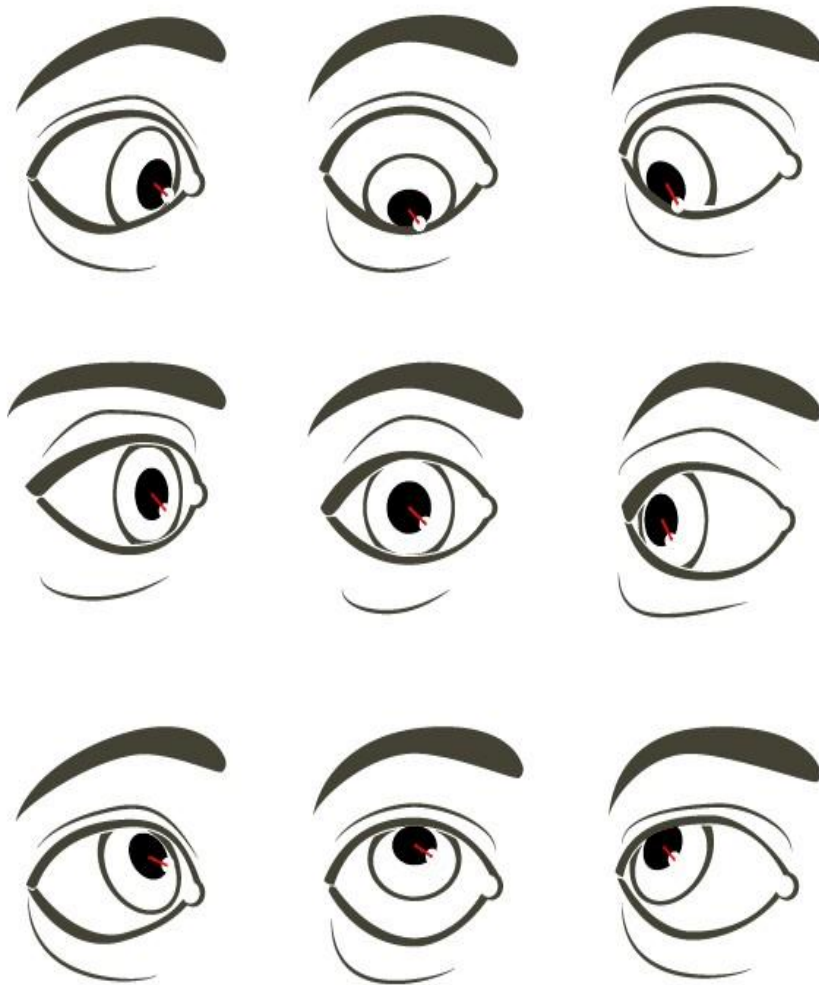


Figure 11: The relative difference in location of the pupil centre and corneal reflection deduction of the gaze direction

## 2.3 Purpose of eye tracking

At this point, when your site guests are connected to eye tracking system, you have the option to tell:

- What they look at on the screen or in the real world
- When attention is set on the certain visual elements
- How long each fixation lasts for
- How their centre moves from thing on your site page

-What parts of the interface they miss

-How they are exploring the length of the page

-How size and arrangement of things on your current site or on proposed structures influences consideration

## 2.4 Eye tracking on HCI

Essentially, HCI research is related to how computers are utilised and designed, and how this correlate to their use by people. For example: laptops, tablets, smart phones and beyond, the use of technology can be evaluated by measuring our visual attention to the device we use. Moreover, Eye tracking understands human behaviour by providing unique insights into what catches our attention and what information we operate on, which is utilised to comprehend what influences behaviour, decision-making and emotions. It also enables hands-free interaction by utilising the eyes as a “pointer” on screen, eye tracking makes interaction easier with computers and different devices when the client cannot or does not wish to utilise their hands as the info structure.

What a person is staring at is assumed to show the thought “on top of the stack” of cognitive processes<sup>13</sup>. This “eye-mind” hypothesis means that eye-movement recording can give a dynamic trace of where a person’s attention is being directed to visual display. Calculating other aspects of eye movements, such as fixations (when the eyes are relating to stationary, taking in “encoding”, can be relevant the amount of operation being applied to objects at the point-regard. In procedure, the process of inferring useful information from eye-movement recording requires the HCI researcher defining “Areas of interest” over exact parts of a display or interface under measurement and analysing the eye movements which fall within such areas. In this way, the visibility, meaningfulness, and placement of specific interface elements can be objectively measurable, and the resulting finding can be utilised to upgrade the design of interface<sup>15</sup>.

---

<sup>14</sup>Just, M. A., & Carpenter, P. A. (1976). The role of eye-fixation research in cognitive psychology. *Behaviour Research Methods & Instrumentation*, 8(2), 139-143.

<sup>15</sup> Ball, L. J., & Richardson, B. H. Eye Movement in User Experience and Human-Computer Interaction Research.

## CHAPTER 3

### 3.1 Process Model

After knowing the purpose of BPMN and Eye tracking, we must understand the definition of the process model. According to existing research on the process model, it is an act of creating a process model as a flexible process which consists of **Five distinct phases** that are relatively performed such as **problem understanding, method finding, modelling, reconciliation, and validation** or we can say it is a graphical representation of processes or workflow, like a flow chart, each single step of the process has an end-to-end overview of the tasks in the process within the context of the business environment. For example: They can be executed time after time and able to be skipped for some iterations as needed. <sup>14</sup>

### 3.2 Problem understanding

To develop a process model, modellers need to understand the problem (for instance, both the requirements and the process model created so far). During problem understanding, modellers build an internal representation (a mental model) of the problem to be modelled within working memory. <sup>14</sup> Additionally, due to limitation of working memory the modeller might be required to commit resources for understanding the notational system. The full process cannot be understood at one point; hence we need to understand it in smaller chunks. Based on the research, integrated chunks of knowledge in long-term memory might influence problem understanding. <sup>14</sup> After the understanding of the problem is created, the modellers can proceed translating the necessities to an actual process model. <sup>14</sup>

### 3.3 Method finding

In this method finding phase, modellers separate the problem into tiny sub-problems and develop a solution that is independent of the concrete modelling notation.

---

<sup>16</sup> J.Claes, I.Vanderfeesten, H.A. Reijers, J.Pinggera, M. Wedlichm, S. Zugal, D. Fahland, B. Weber, J. Mendling, and G. Poels. Trying process Model quality to the modelling Process: The impact of Structuring, movement, and Speed. In Proc. BPM'12, pages 33-48, 2012

It can include the hierarchical structuring of a process model, but also horizontally dividing the problem into sub-problem that are able to be mapped to workflow patterns.

### **3.4 Modelling**

At one point, modellers have improved a solution for the problem, they can associate with a modelling platform to implement it by making an external representation of the problem stored in working memory. <sup>15</sup> For example: when utilising BPMN (Business Process Model and Notation), modellers might put an activity into the model and set it into a conditional branch applying gateway and sequence flows to implement an optional activity. <sup>16</sup>

### **3.5 Reconciliation**

It concerns improving the understandability of the process model and disclosing the subsequent phase easier. It also includes changes to an activity label for resolving non-intention to revealing naming of activities. But also relates to the secondary notation of process models. <sup>17 18</sup>

### **3.6 Validation**

In these validation phases, modellers assess the quality of the externalised process model and proceed toward if the model precisely provides an accurate solution to the considered problem. Especially in line with the SEQUAL framework and grounded in semiotic theory, modellers might perform checks for identifying syntactic, semantic, and pragmatic quality issues in the process model. <sup>19</sup>

---

<sup>17</sup> OMG, Business Process Model and Notation (BPMN) - version 2.0, Beta 1, 2009

<sup>18</sup> M. Petre, why looking isn't always seeing: Readership skilled and graphical programming, *commun. ACM* 38 (6)(1995) 33-44

<sup>19</sup> J. Mendeling, H.H.A. Reijers, J. Cardoso, what makes process models understandable? in *proc. BPM'07*, 2007, pp. 48-63

## **CHAPTER 4**

### **4.1 Objective**

With the title of my thesis and the literature review covered above on the process of model testing by using an eye tracking system. This study will continue following the objectives.

1. The aim of the work is to get acquainted with eye tracking technology
2. To use the eye tracking technology applied in the field of measuring the quality of BPMN models.

### **4.2 Materials and methods**

#### **Research approach**

The research method chosen (eye tracking testing) was qualitative, this method provided information on BPMN eye tracking study via the following:

Collection of information from participants after the eye tracking test.

From the movement define, which symbols were difficult to understand. define conclusion

#### **Participants in the study**

The aim of the thesis was explained to the available students and those willing to participate in the study were taking for the eye tracking testing.

#### **Eye tracking testing focus**

The research was based on participants running eye tracking tests relating to typical real-life situations by focusing on documenting the processes involved in real-life testing of the below areas.

---

<sup>20</sup>J. Krogstie, G, Sindre, H. Jorgensen, Process models representing knowledge for action: revised quality framework, Eur, J, inf. Syst. 15 (1)(2006) 91-102

**Process of BPMN for:**

**- Ordering flight tickets**

• The order process in the Air ordering ticket consists of the following steps:

- Start
- Book flight
- Type a trip (one way or return)
- Destination date and airline class (Economy or Business class)
- Search for flights
- Select cheapest Airline
- Confirm selection
- Customer information
- Detail confirmation
- Proceed to payment
- Select Payment options
- Reserve and pay later
- Reservation completed
- Pay and Check-out
- End

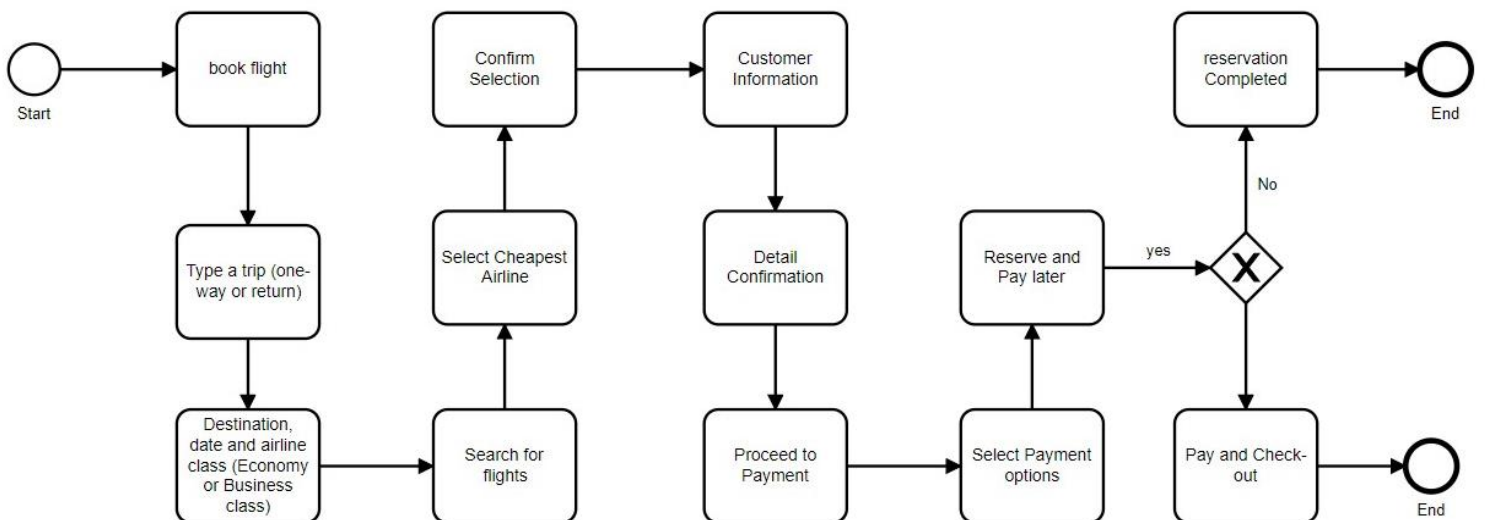


Figure 12: Ordering flight ticket BPMN, showing all the processes involved



chart tool: [www.lucicart.com](http://www.lucicart.com)

## - **Ordering Burger**

The order process in the Burger Restaurant Process consists of the following steps:

- Hungary for good BG
- Choose a BG
- Enter an ODR
- Request PM
- Choose PT
- Pay with Card
- Pay with Cash
- Store Money in the Cash Drawer
- Activate Payment Terminal (POS)
- Pass the Bill to Cust
- Bill with an order number (Message)
  
- Grill a Burger
- Turn the Burger Over
- Place Meat to Bun and Complete by Recipe
- Pack the Burger to Paper
- Notify the order Complete
- Order Completion Notification (Event)
  
- Ask for burger
- Check Order Number on Customer Bill
- Hand Over the package
- Eat the Burger<sup>20</sup>

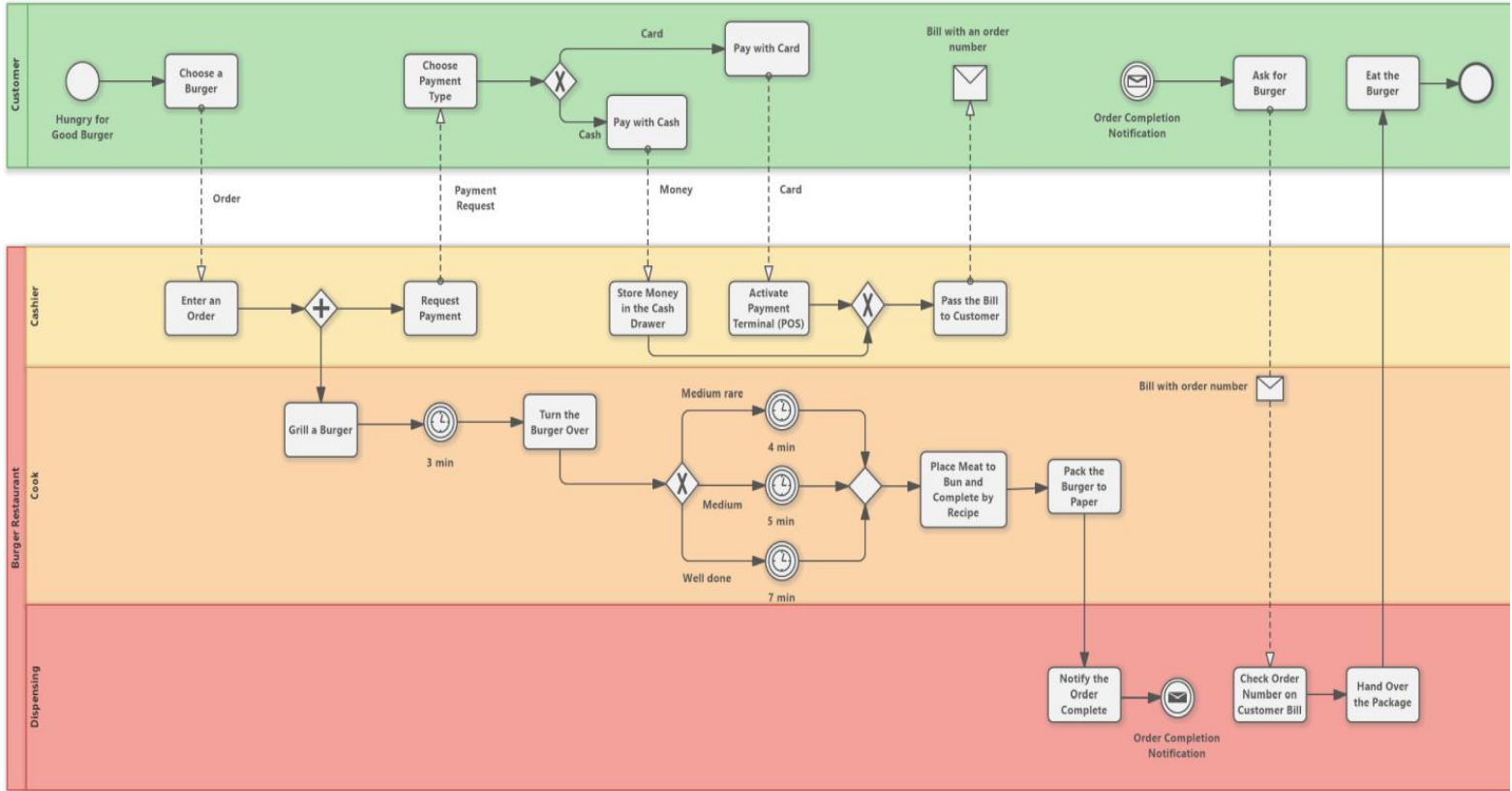


Figure 13: Ordering Burger from the restaurant, BPMN <sup>20</sup>

- **Ordering new electrical devices (tv, pc, etc) in E-commerce**

The process of ordering new electrical devices from Amazon consists of the following steps:

- Customer
- Show cart items
- Validate cart
- Fill customer information

<sup>21</sup> Rodina, D., 2022. Burger Restaurant (BPMN Diagram) - Software Ideas Modeller. [online] Softwareideas.net. Available at:

<<https://www.softwareideas.net/a/1607/Burger-Restaurant--BPMN-Diagram->> [Accessed 7 March 2022].

- Fill shipping address
- Check deliverability
- Fill billing information
- Select shipping mode
- Check shipping mode for address
- Validate order
- Payment
- Register order
- Notify Clerk
- End the message

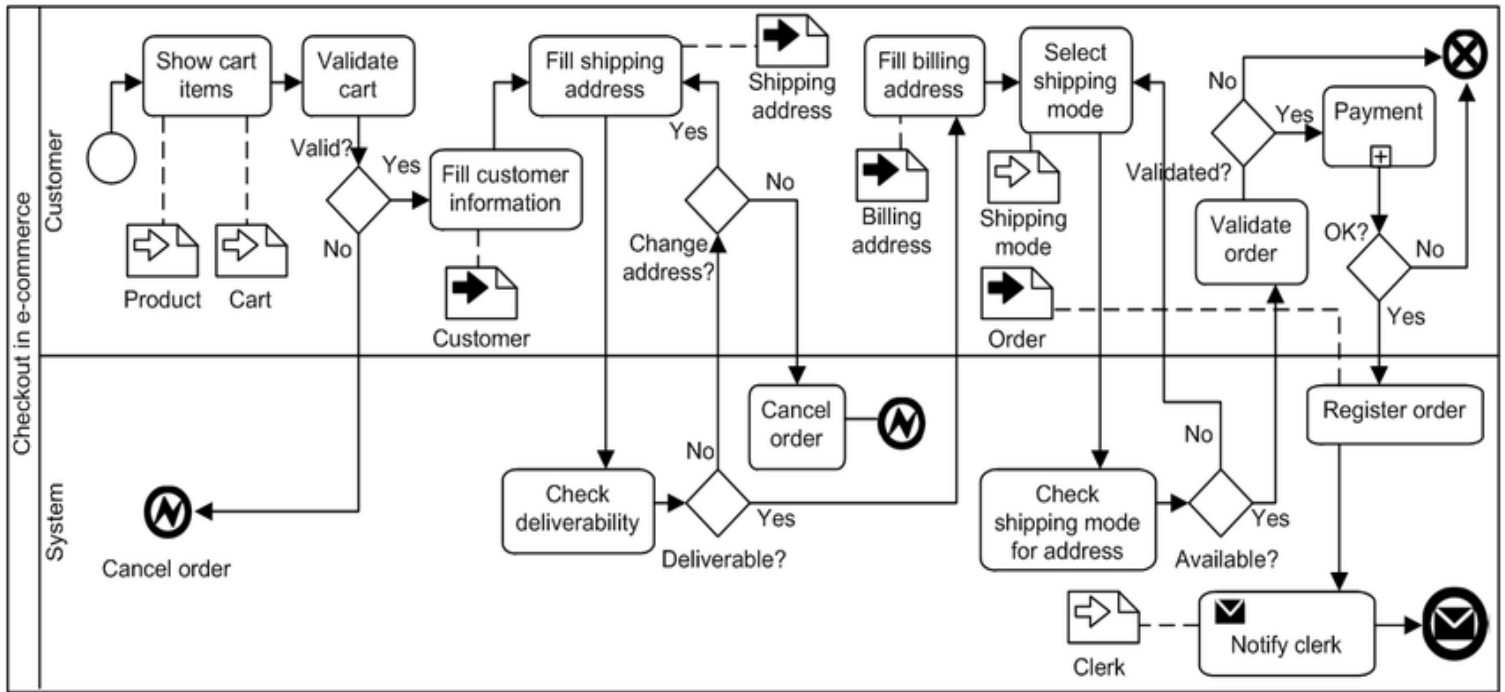


Figure 14: Process model order new electrical devices in E-commerce <sup>21</sup>

<sup>22</sup> B. Bousetta, O. El Beggar and T. Gadi, “A methodology for CIM modelling and its transformation to PIM “in Journal of Information Engineering and Applications, vol. 3, no, 2, pp. 1-21, 2013. ISSN 2224-5782 e-ISSN 2225-0506

### 4.3 Verification of the solution in laboratory conditions

After we know about the process of BPMN, regarding the topic we are going to test all the process models using the eye tracking technology. Below I am going to show you how we proceed with eye tracking testing step by step, so that should let you understand the entire process.

The eye tracking software that I am using for this test is called GazeRecorder. It tracks eye movement via webcam.

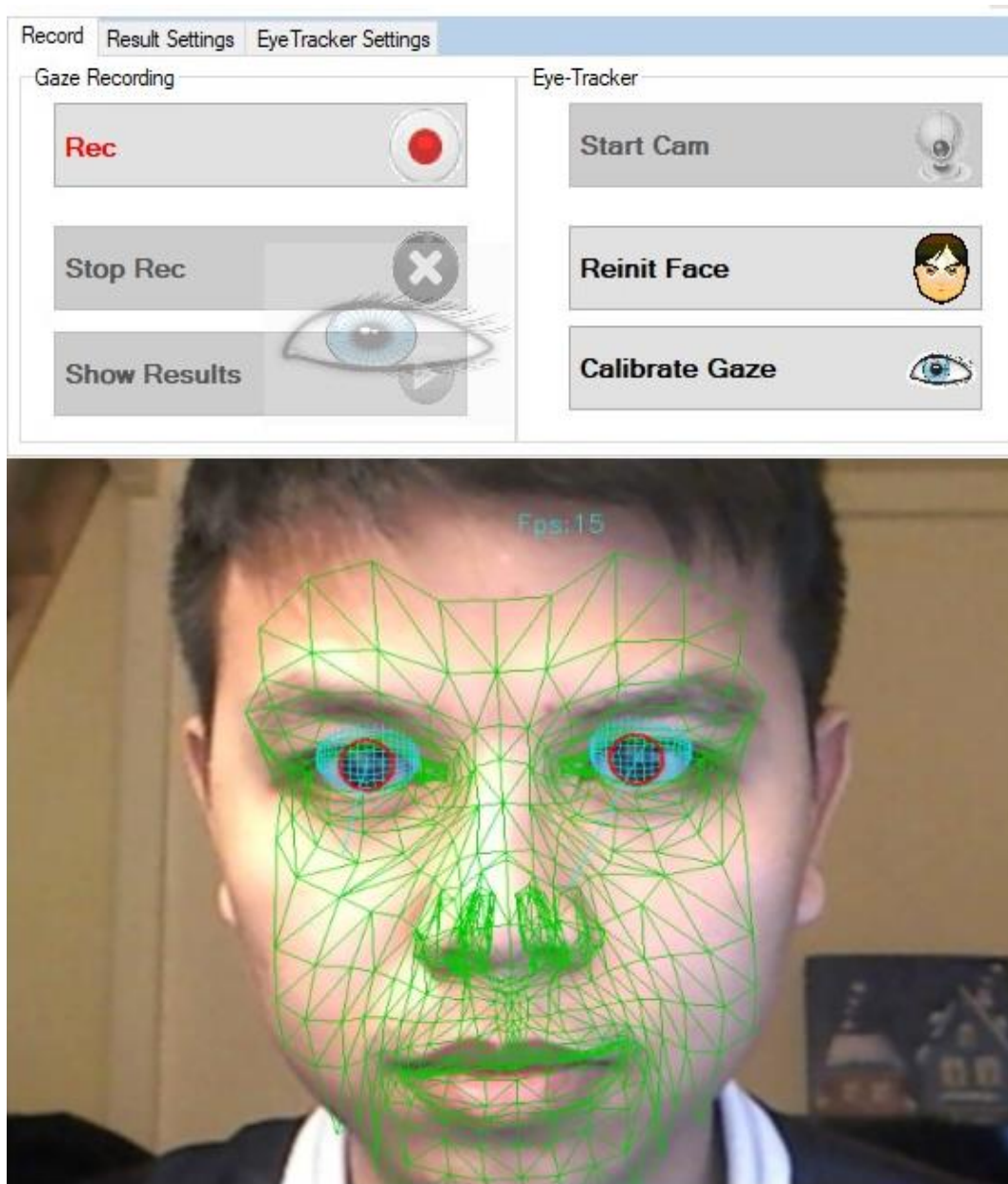


Figure 15: GazeRecorder testing through Webcam 10.03.2022

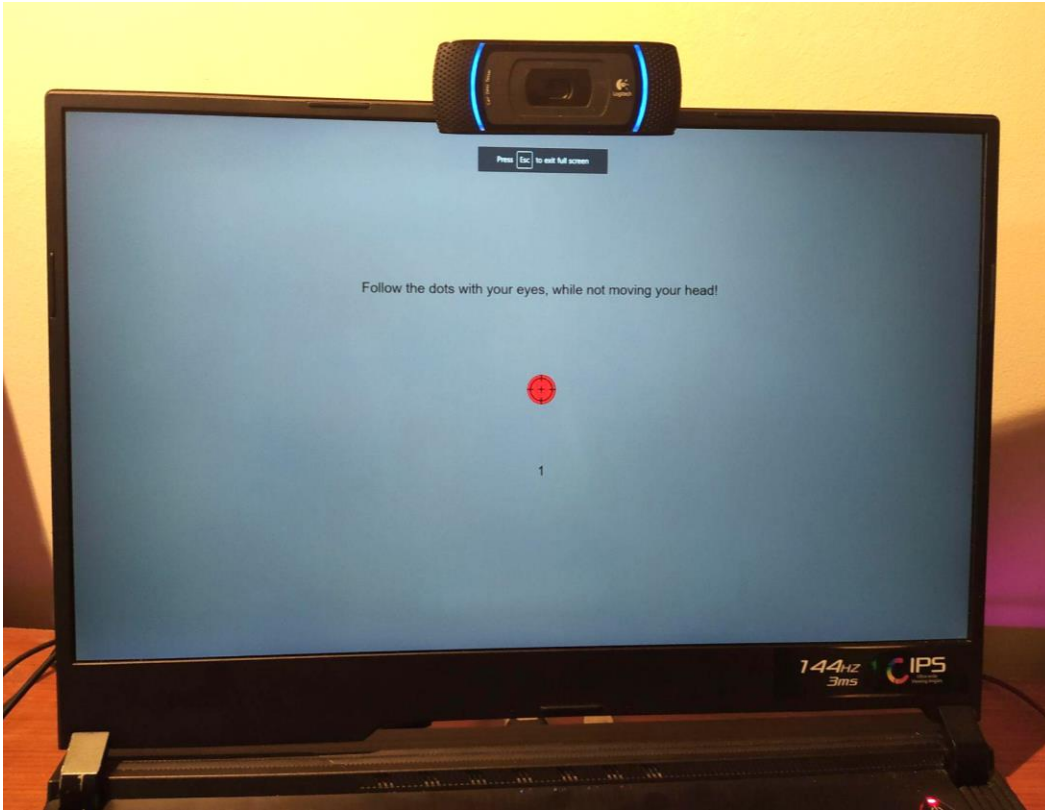


Figure 16: Calibration Process Using Laptop Screen (Follow red dot)

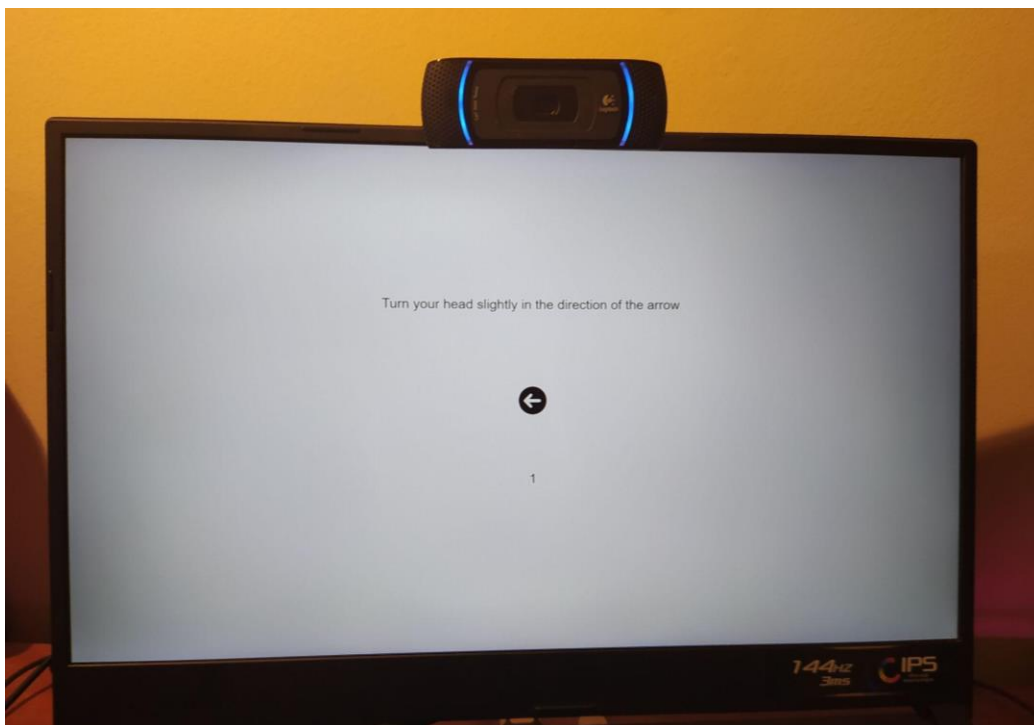


Figure 17: Calibration Process Using Laptop Screen (turn head in direction of arrow)

All experiments were conducted in good lighting conditions. This testing used the Webcam Logitech Carl Zeiss Tessar, and with this app, before using it, we must calibrate the gaze. then it indicates the red circle with a small white dot inside. So, we must look at it for a few minutes and follow the arrow on the screen. After the calibration, eye movements were tracked by the Gaze Flow, and it applied the green shape on our face as you see on figure 15.

### 4.3 Eye tracking test on process BPMN

- We invited 5 participants who took part in this eye tracking study
- Testing on process ordering flight ticket BPMN for 5 participants. (This test contains 30 seconds)

#### First participant

Take more focus on long texts and Diamond Symbol

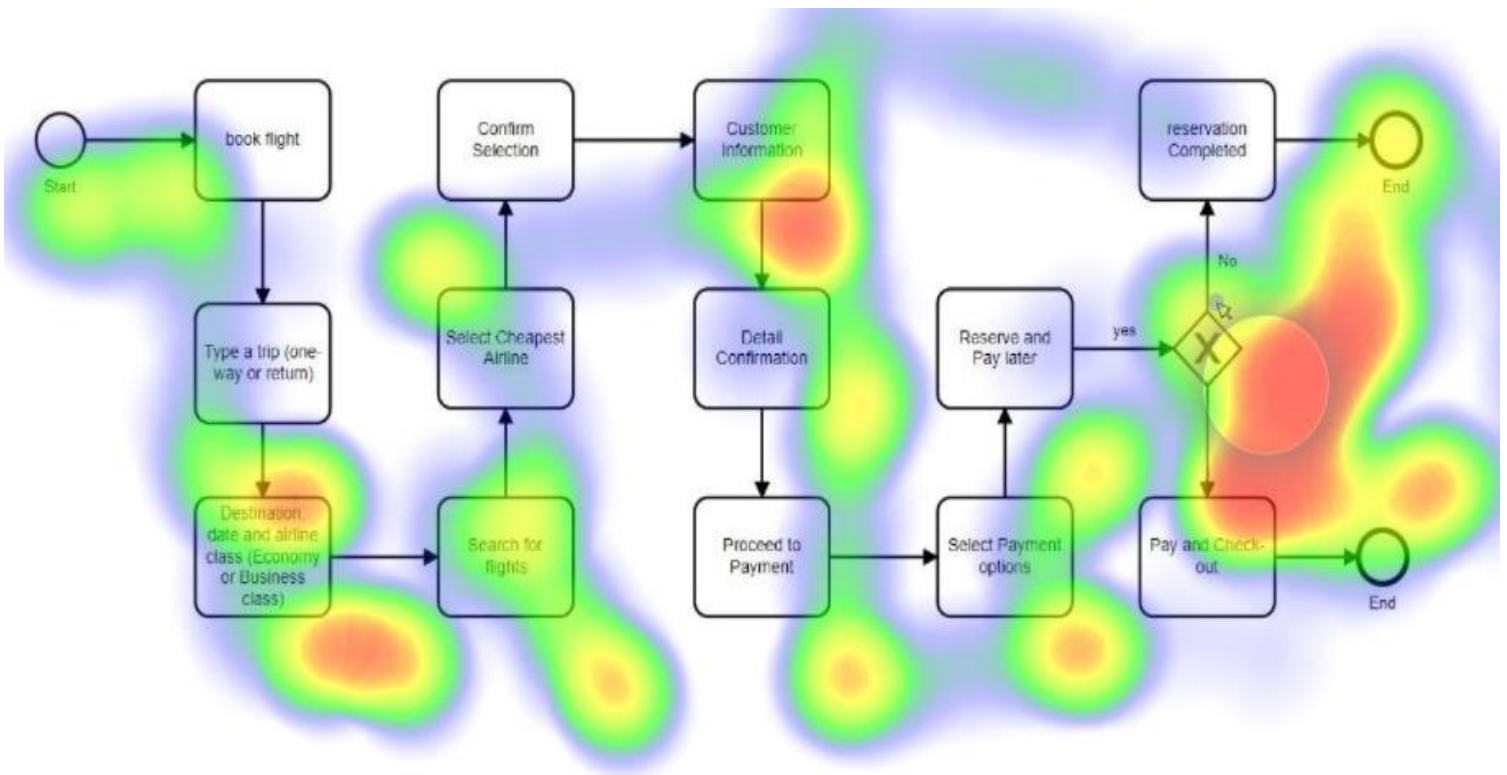


Figure 18: Heatmap on First participant (Process ordering flight ticket) <sup>22</sup>

## Second participant

Bad calibration, his focus: long texts shifted right, and Diamond symbol shifted down

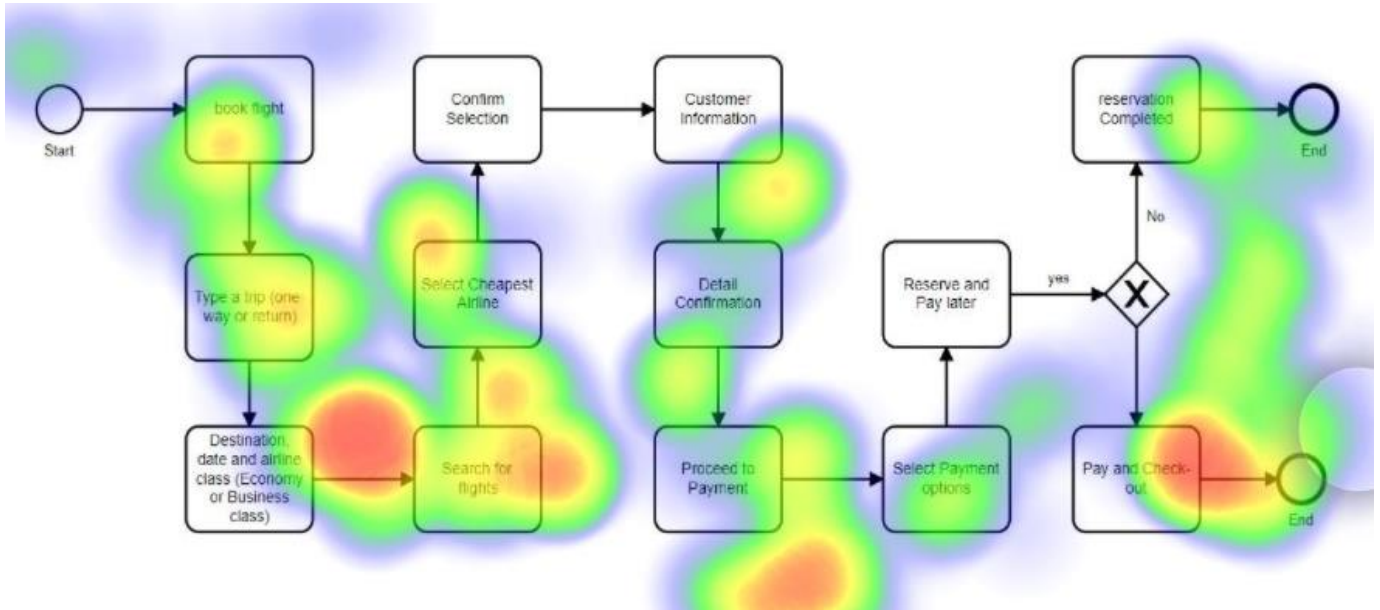


Figure 19: Heatmap on Second participant (Process ordering flight ticket)

## Third participant



Figure 20: Heatmap on Third participant (Process ordering flight ticket) <sup>22</sup>

## Fourth participant

Focusing on long text and diamond

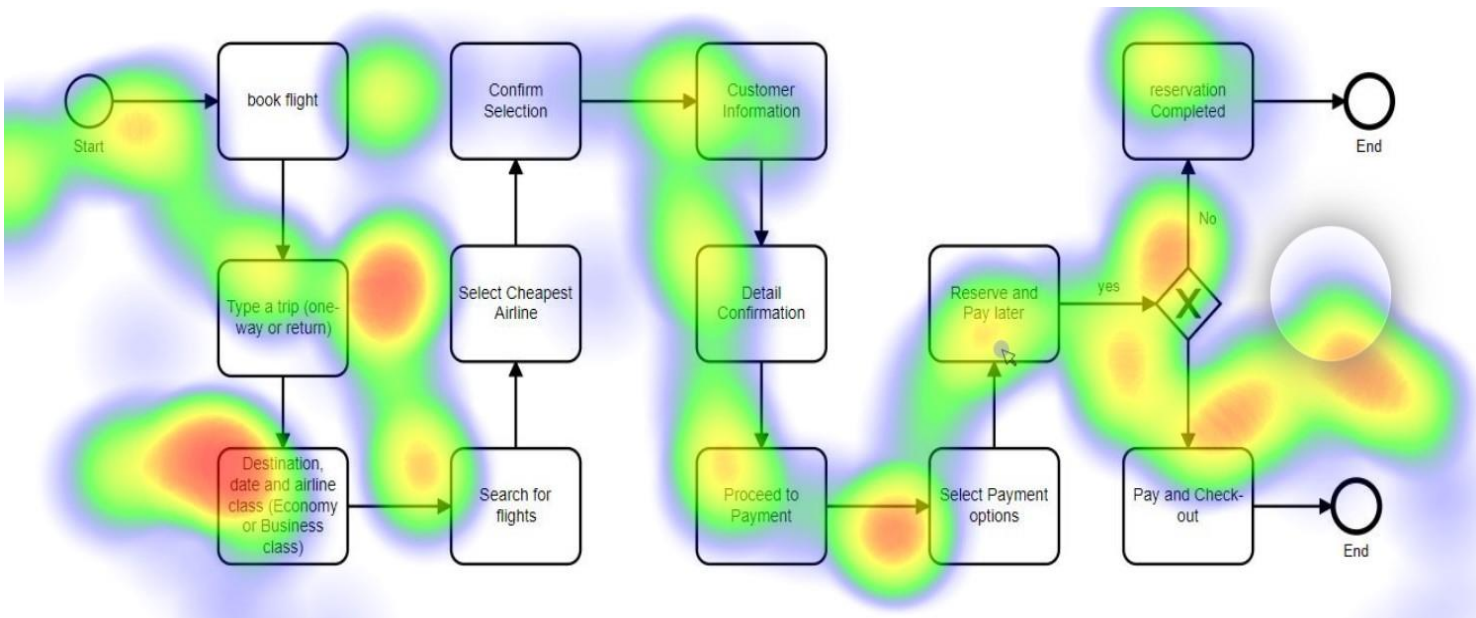


Figure 21: Heatmap on Fourth participant (Process ordering flight ticket)

## Fifth participant

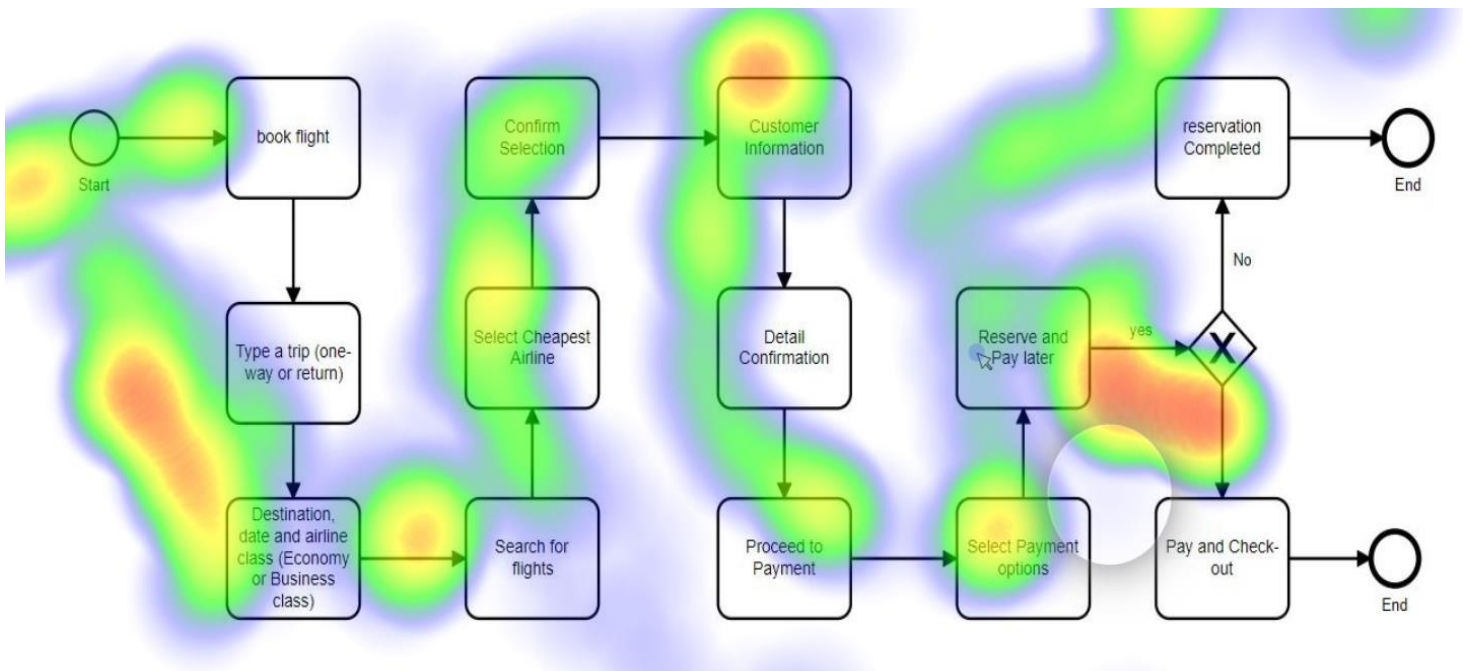


Figure 22: Heatmap on Fifth participant (Ordering burger) 22



❖ Testing on process ordering burger from restaurant (Test contains 70 seconds)  
**First participant**



Figure 23: Heatmap on First participant (Ordering burger)

**Second Participant**

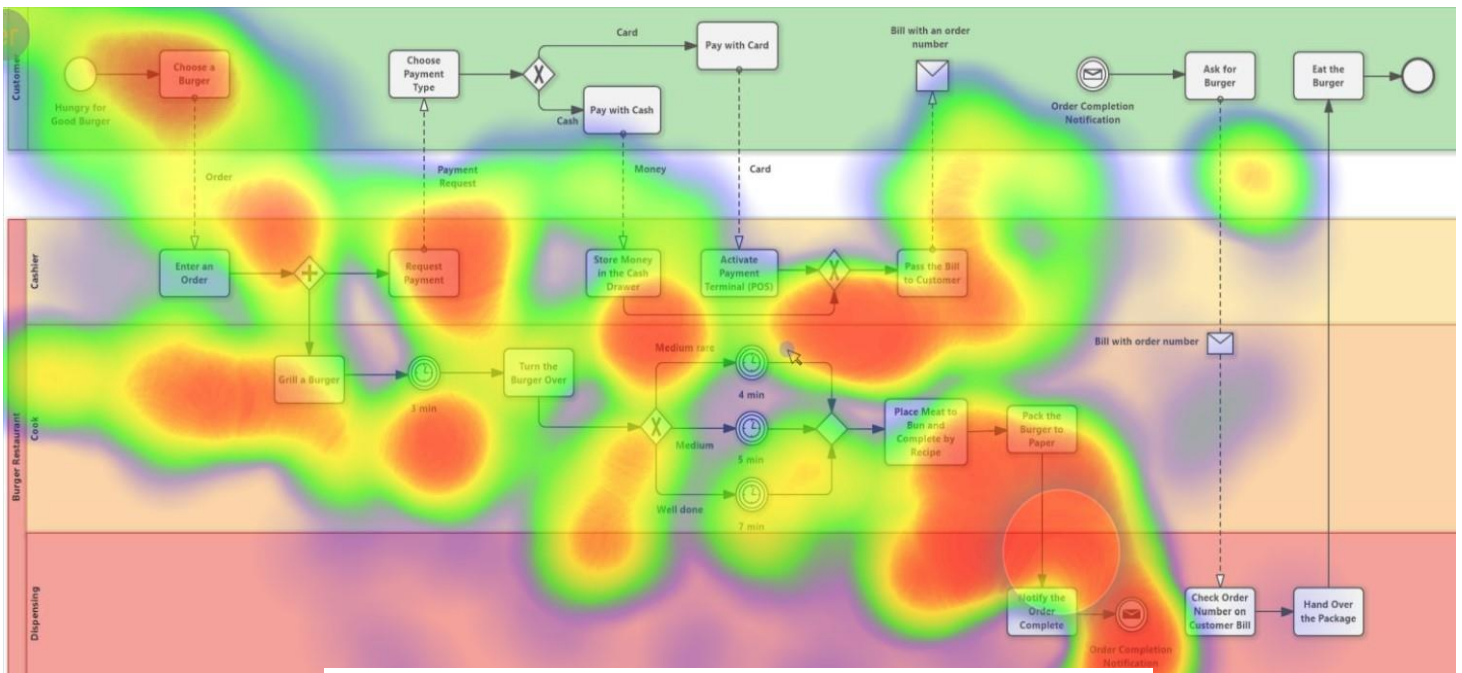


Figure 24: Heatmap on Second participant (Ordering burger)

## Third Participant



Figure 25: Heatmap on Third participant (Ordering burger)

## Fourth Participant

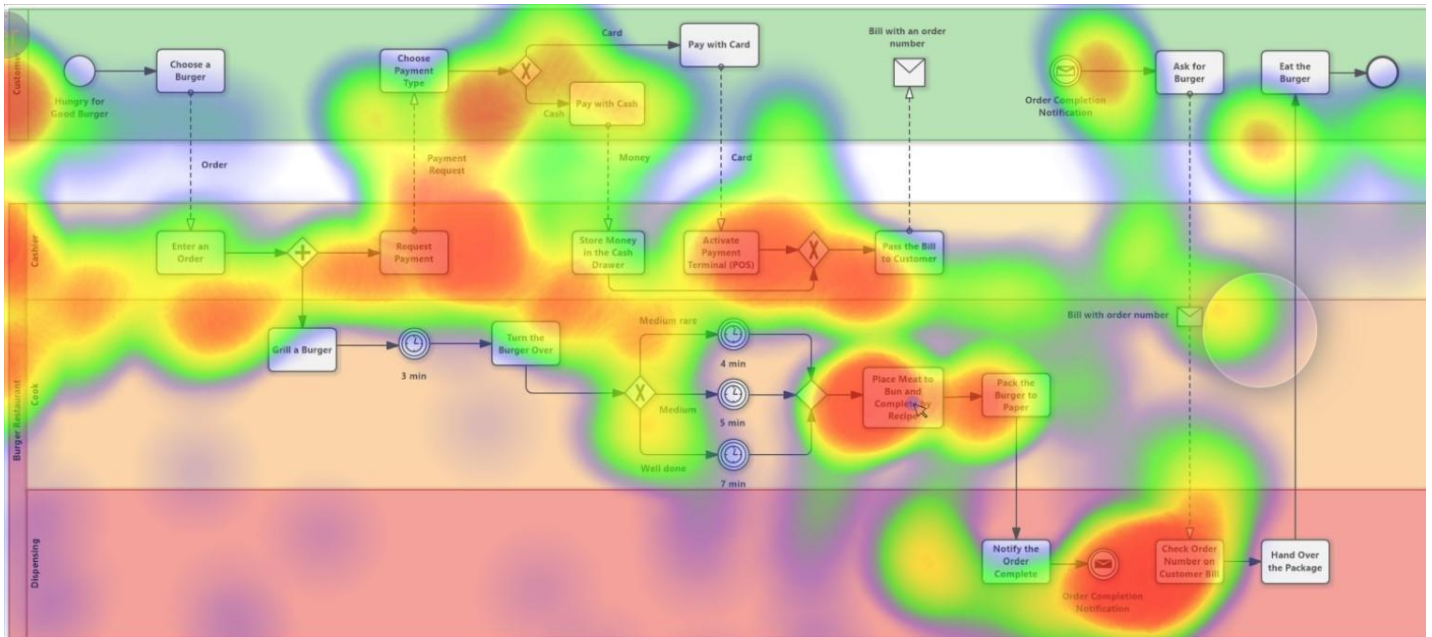


Figure 26: Heatmap on Fourth participant (Ordering burger)

## Fifth participant



Figure 27: Heatmap on Fifth participant (Ordering burger)

- ❖ Ordering new electrical devices in E-commerce (Test for 60 seconds)

## First Participant

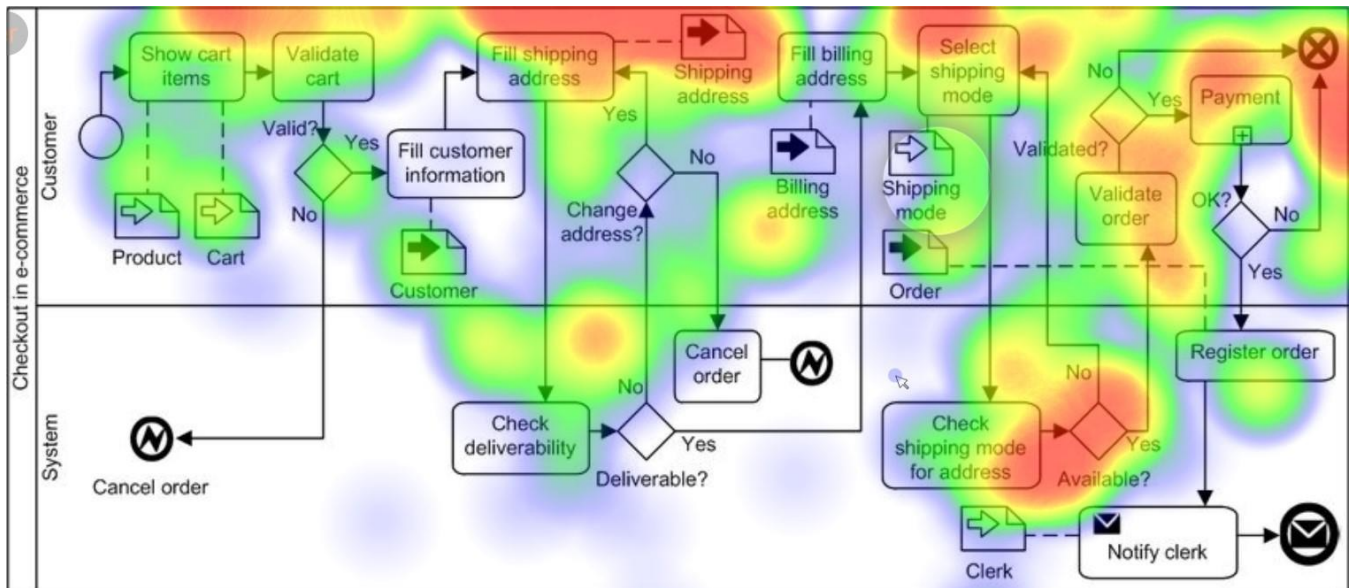


Figure 28: Heatmap on First participant (Ordering new electronic devices)

## Second participant

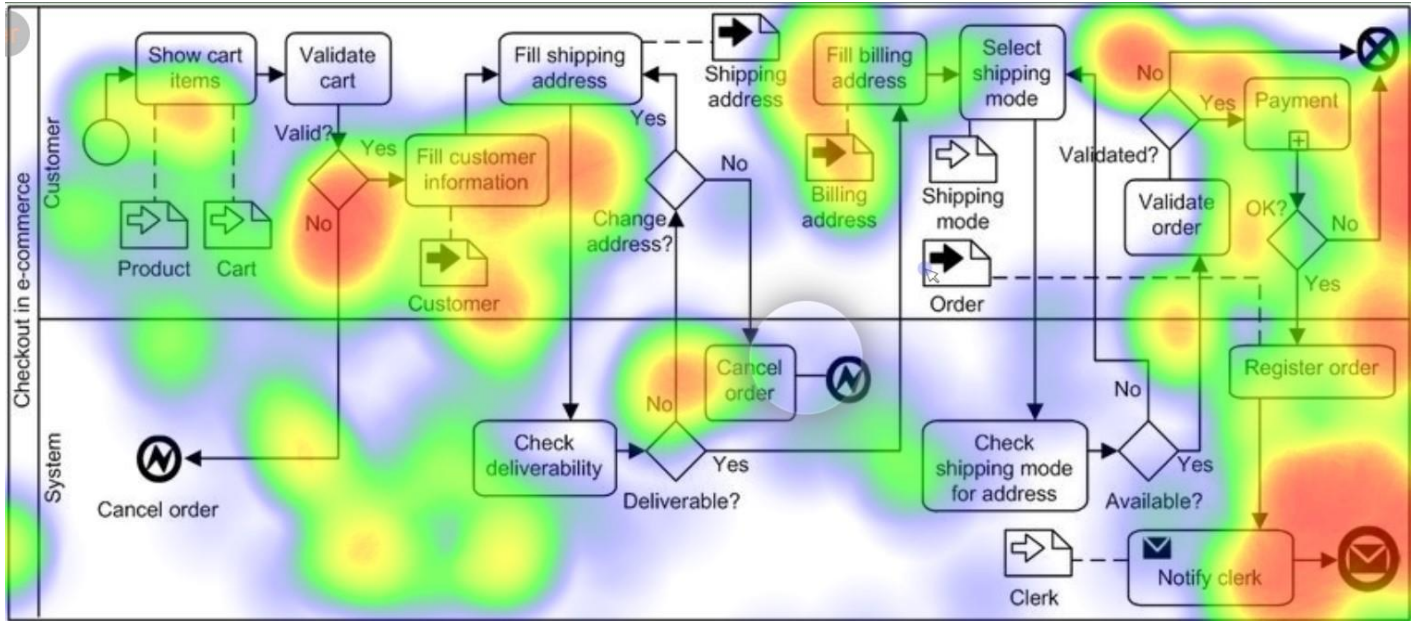


Figure 29: Heatmap on Second participant (Ordering new electronic devices) 22

## Third Participant

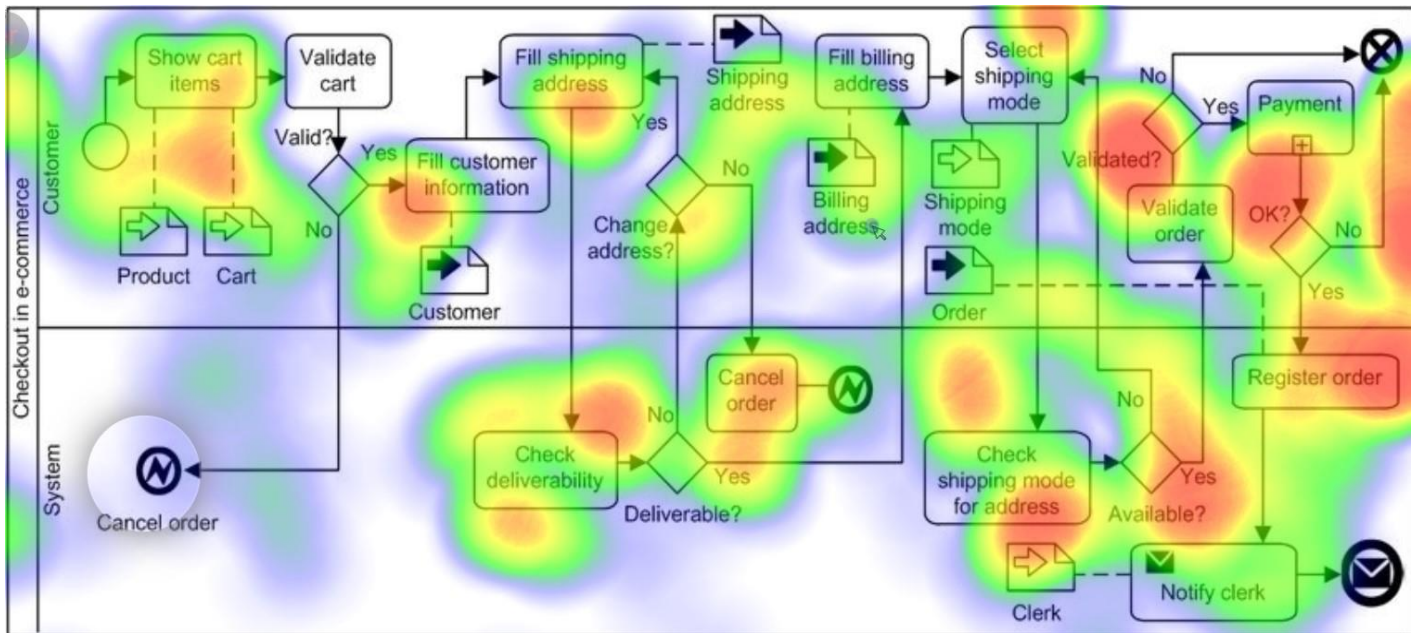


Figure 30: Heatmap on Third participant (Ordering new electronic devices)

## Fourth participant

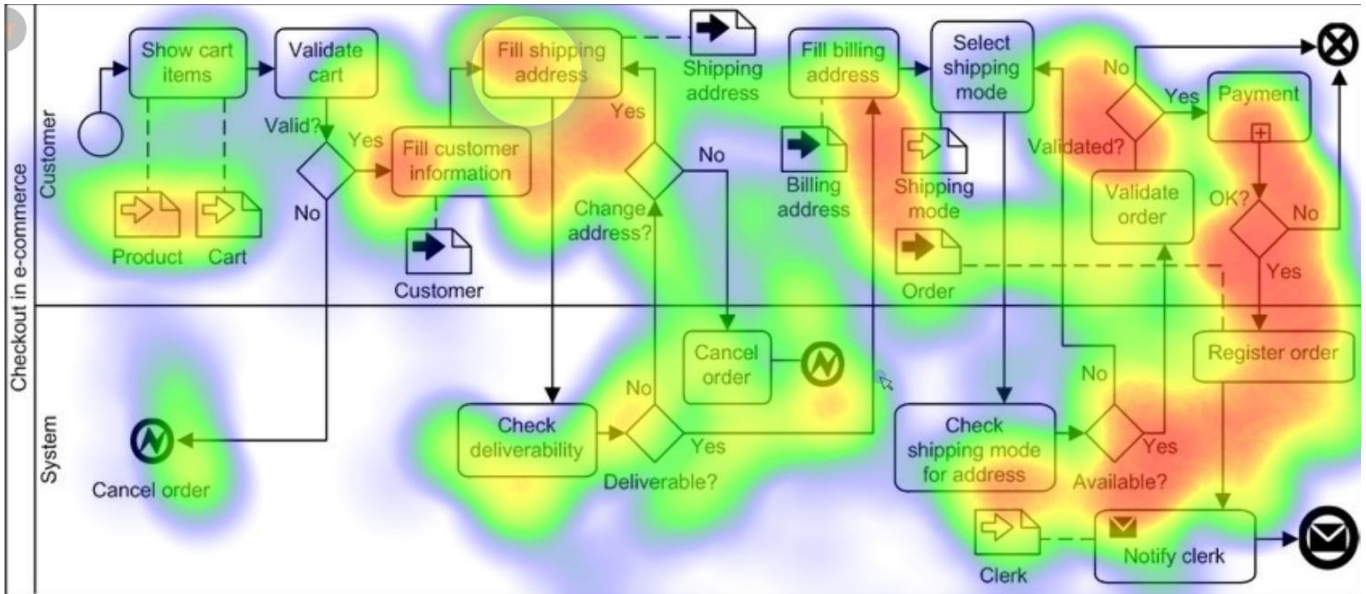


Figure 31: Heatmap on Fourth participant (Ordering new electronic devices)

## Fifth participant

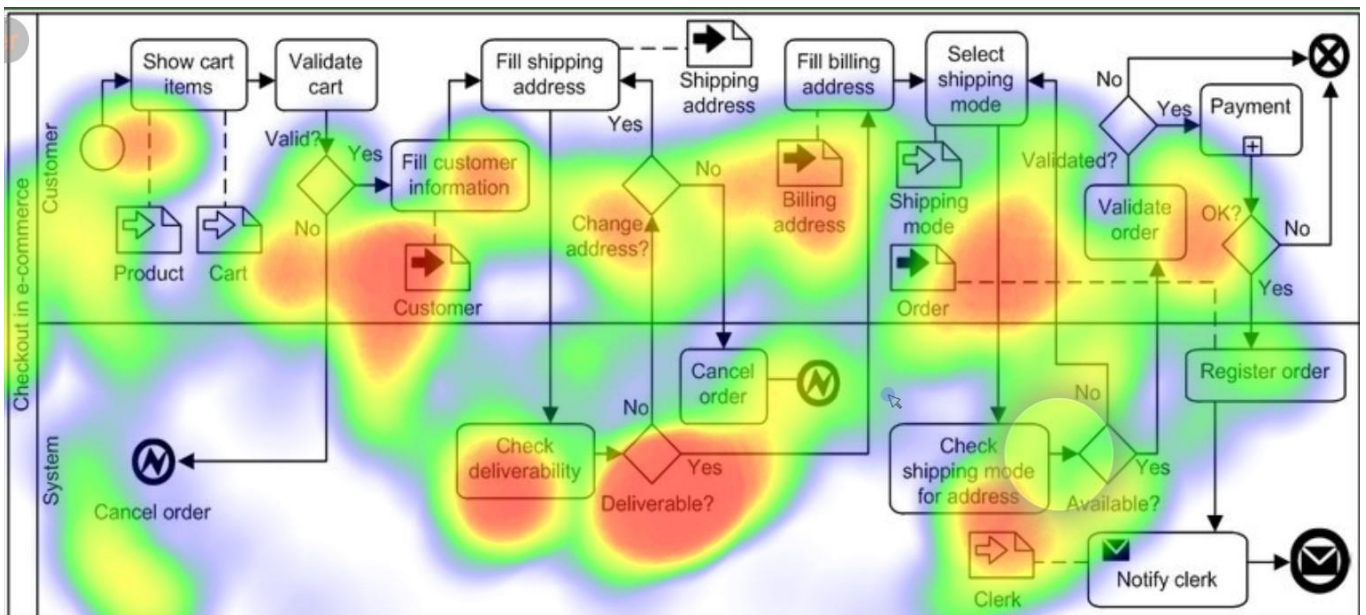


Figure 32: Heatmap on Fifth participant (Ordering new electronic devices)

## 4.4 Evaluation the solution and discussion

These above process BPMN were also presented to participants after the eye tracking test to get their opinions on which symbols or workflow were difficult to understand.

Regarding the result, the participants that engaged in this experiment had limited or no knowledge on information technology and did not know how the flowcharts are created or be able to be understood. So, they spent more time thinking about the workflow that had more words and they tried to understand it before continuing through the next step. Beside this, we see that some participants skipped the **End** part (**Black symbol**).

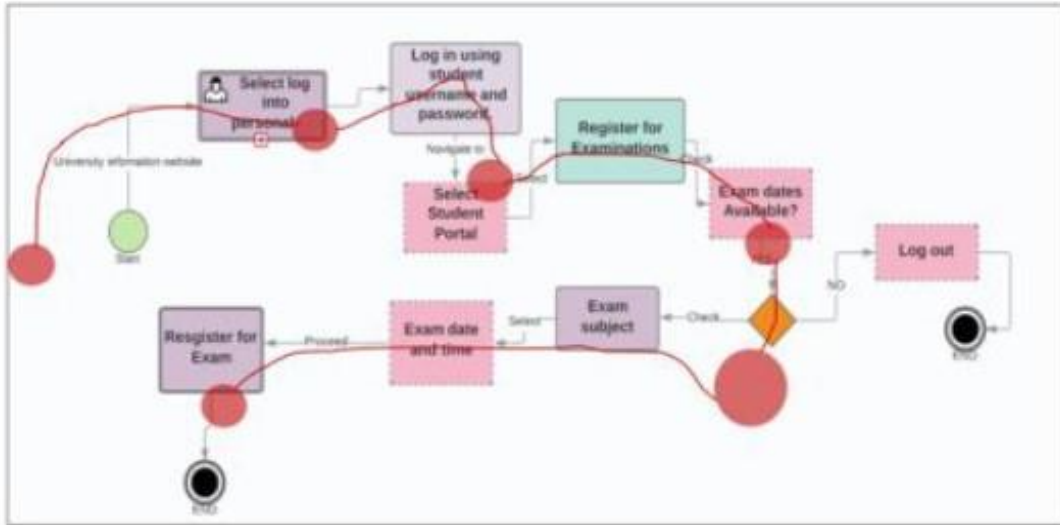
Apart from this, with the **complexity of the process** model (long process) all the participants are lost in the middle of the testing. They were confused with lots of information written there then started to check from the beginning. Due to that, they could not control their time to finish the workflow during testing then chaos about the flowchart they were looking at as you probably know, each test had a limited time (Time was written for each process model).

Nonetheless, in the **short process**, all the participants did not have any problem while testing it. They were well understood and finished all the workflow on time or earlier depending on the intellectual capabilities of each participant.

In addition to this, we see that workflows with the **Diamond symbols** showed a lot of hot colours. Because they were thinking of making a decision in which way they should continue and back to see the differences between their options. These processes take more concentration to acknowledge and process the information .

However, some participants probably had a bad calibration through Webcam because there were some cold and hot colours on the empty spaces. This can be meant they might not focus well on the screen either calibration processes (Fig.16 & 17).

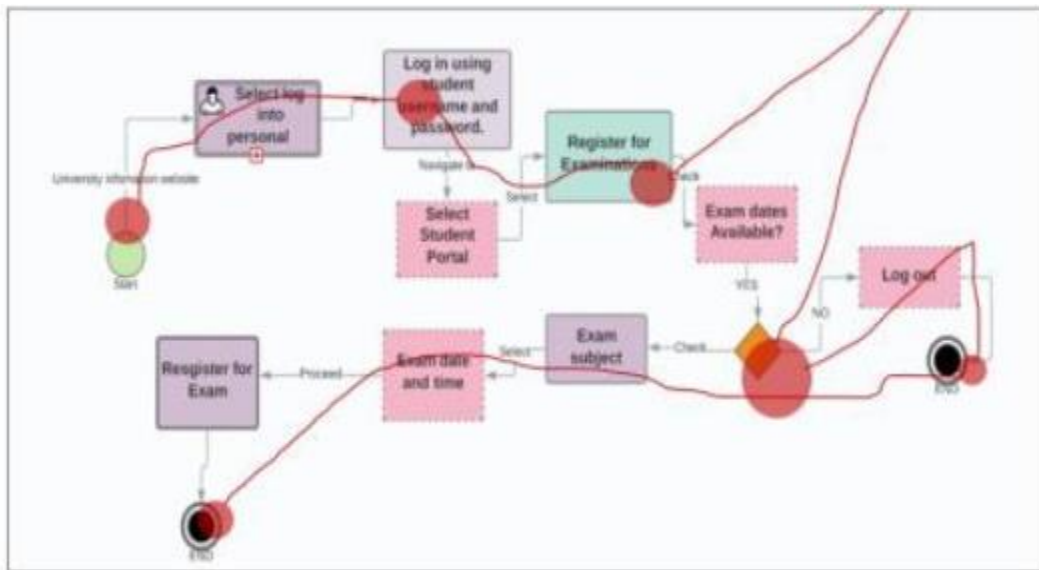
Similarly, due to the article *“Usability Evaluation of Business Process Modelling Standards BPMN and BORM case study by Josef Pavliček”* which tested two participants (C and D) on eye camera record for BPMN, he got a similar result as we did that both parties deliberate for a long time on the decision block (diamond symbol) and one of them had a calibration of ophthalmic camera poorly, and the focus of his attention was transferred down the screen.<sup>23</sup>



### Participant C

Figure 33: Chart of eye camera record of participant C for BPMN

He had a calibration of ophthalmic camera poorly as we see his focusing shifted down below diamond diagrams



### Participant D

Figure 34: Chart of eye camera record of participant D for BPMN

He had a deep focus on long texts and diagram symbols, and we see that for the part (Register for Exam) he skipped it to the end.

To sum up. The technology used has been demonstrated and we are sure that it can be utilised to evaluate the quality of process models in terms of their clarity. A process designer may not want to take part of his working model (usability) or to design it “readable” without having to retreat from maintaining all the required functional requirements for the process.<sup>24</sup>

## CHAPTER 5

### 5.1 Conclusion

Eye tracking can help us record what catches a user’s eye on a visual display. It can give invaluable insight into the process model by BPMN. It has a potential to become an industry standard for designing and developing process models. There has been a perfect start of progress in eye tracking technologies to make participants friendly. As we know that contemporary eye trackers can collect data unobtrusively and remotely without asking participants to wear special tools because tools can affect the participant’s interaction.

Moreover, Collecting, evaluating, and validating data can be an easier and more intuitive interface. Currently there is a great opportunity by using eye tracking technologies on mobile devices through the front camera. As I already tested it, data analysis for mobile devices requires less manual processing, which makes eye tracking data intensive and time consuming.

eye tracking can play a significant role in designing successful and effective process models by BPMN and it has the potential to become an industry standard in best practices. On the other hand, BPMN notation is most likely targeted to the participant who is interested in applied computer science. Beside this, it offers process flow tracking, which is advantageous for step-by-step process-by-process without the need to understand it.<sup>23</sup>

In the future development in the eye tracking is such a great benefit to the testing for many factors like human behaviour research. It is less intrusive, more affordable, more accessible, and

---

<sup>24</sup> Pavlicek, J., Rod, M., & Pavlickova, P. (2021, June). Usability Evaluation of Business Process Modelling Standards–BPMN and BORM Case Study. *In the International Conference on Advanced Information Systems Engineering* (pp. 93-104). Springer, Cham



experimental sessions have grown in popularity and easier to build up.

As we currently know eye tracking is being utilised for variety of purposes by psychologist, neuroscientists, human factor engineers, marketers, architects – etc you name it, it is happening

Likewise, it is a new way for measurement website testing. It is utilised to approach or providing insight how website is viewed and experienced. For instance: How long will it take the users to find the certain product on your site? What type of visual that they skipped? But supposed to see. So, we know what goes wrong with this. Similarity to investigation which applied to Mobile apps on smart phone and products.

What's more, there is a learning behaviour called "chalk and talked" on the digital learning. It is analysed the concentration during the class regarding element catch and hold interest for instance: Do students read, or they scan slides? Do they look at the teacher or their notes? As the result, these can be effectively used to improved instructional design and resources for a better learning experience both in and out of the classroom.<sup>25</sup>

Lastly, after learning about the process models testing by using eye tracking system, I am so excited with the result that I received, and it is interesting. Anyway, I would like to thank for all the participants who spent their valuable time involved in the eye tracking testing for BPMN.

This test is a very significant for me, it brings me a tremendous experience and I am planning to prepare my test for the scientific conference MOBA. It is a part of CAISE international conference. It is a great opportunity to join it and sharing my testing result.

---

<sup>25</sup> Pavlicek, Josef, and Petra Pavlickova. "Methods for evaluating the quality of process modelling tools." *Workshop on Enterprise and Organisational Modelling and Simulation*. Springer, Cham, 2018.4.6

<sup>26</sup> Eye Tracking: The Complete Pocket Guide. (2022). Retrieved 15 March 2022, from <https://imotions.com/blog/eye-tracking/>

<sup>267</sup> <https://moba.hse.ru/2022/>

## **Table of abbreviations**

1. BPMN: Business Process Model and Notation
2. HCI: Human Computer Interface
3. SEQUAL: Semiotic Quality
4. PCCR: Pupil Centre Corneal Reflection
5. LED: Lighting Emitting Diode
6. XML: Extensible Markup language
7. WSBPEL: Web Services Business Process Execution Language
8. POS: Point of Sale
9. Business Process Modelling Language
10. ISO: International Standard Organisation
11. OMG: Object Management Group
12. Model-Driven Organizational and Business Agility

## Table of Figures

Figure 1: Purpose of use BPMN .....	3
Figure 2: BPMN Events Symbols.....	5
Figure 3: BPMN Gateway Symbols and Types of Gateways .....	6
Figure 4: BPMN Activity Symbols.....	6
Figure 5: BPMN Sequence flow.....	6
Figure 6: BPMN Message Flow .....	7
Figure 7: BPMN Association Flow.....	7
Figure 8: Sample BPMN workflow Diagram.....	7
Figure 9: Purkinje Image ( <a href="https://en.wikipedia.org/wiki/Purkinje_images">https://en.wikipedia.org/wiki/Purkinje_images</a> ).....	8
Figure 10: The centre of the eye (pupil centre) is tracked in the corneal reflection. ....	9
Figure 11: The relative difference in location of the pupil centre and corneal reflection deduction of the gaze direction .....	10
Figure 12: Ordering flight ticket BPMN, showing all the processes involved.....	15
Figure 13: Ordering Burger from the restaurant, BPMN <sup>20</sup> .....	17
Figure 14: Process model order new electrical devices in E-commerce <sup>21</sup> .....	18
Figure 15: GazeRecorder testing through Webcam 10.03.2022.....	19
Figure 16: Calibration Process Using Laptop Screen (Follow red dot).....	20
Figure 17: Calibration Process Using Laptop Screen (turn head in direction of arrow).....	20
Figure 18: Heatmap on First participant (Process ordering flight ticket) <sup>22</sup> .....	21
Figure 19: Heatmap on Second participant (Process ordering flight ticket) .....	22
Figure 20: Heatmap on Third participant (Process ordering flight ticket) <sup>22</sup> .....	22
Figure 21: Heatmap on Fourth participant (Process ordering flight ticket) .....	23
Figure 22: Heatmap on Fifth participant (Ordering burger) <sup>22</sup> .....	23
Figure 23: Heatmap on First participant (Ordering burger) .....	24
Figure 24: Heatmap on Second participant (Ordering burger).....	24
Figure 25: Heatmap on Third participant (Ordering burger).....	25

Figure 26: Heatmap on Fourth participant (Ordering burger).....25  
Figure 27: Heatmap on Fifth participant (Ordering burger).....26  
Figure 28: Heatmap on First participant (Ordering new electronic devices) .....26  
Figure 29: Heatmap on Second participant (Ordering new electronic devices) 22 .....27  
Figure 30: Heatmap on Third participant (Ordering new electronic devices).....27  
Figure 31: Heatmap on Fourth participant (Ordering new electronic devices).....28  
Figure 32: Heatmap on Fifth participant (Ordering new electronic devices).....28  
Figure 33: Chart of eye camera record of participant C for BPMN .....30  
Figure 34: Chart of eye camera record of participant D for BPMN .....30

## Figure Sources

<https://app.gazerecorder.com/>

<https://www.lucidchart.com/pages/bpmn>

[https://www.researchgate.net/figure/BPMN-model-of-expanded-checkout-sub-process-adapted-from-17\\_fig4\\_303914739](https://www.researchgate.net/figure/BPMN-model-of-expanded-checkout-sub-process-adapted-from-17_fig4_303914739)

<https://www.softwareideas.net/a/1607/Burger-Restaurant--BPMN-Diagram>

<https://bpmn.io>

<https://imotions.com/blog/eye-tracking-work/>

[https://en.wikipedia.org/wiki/Purkinje\\_images](https://en.wikipedia.org/wiki/Purkinje_images)

[https://www.researchgate.net/publication/226414616\\_The\\_Business\\_Process\\_Modeling\\_Notation](https://www.researchgate.net/publication/226414616_The_Business_Process_Modeling_Notation)

[https://www.researchgate.net/publication/277634419\\_Business\\_Process\\_Model\\_and\\_Notation\\_The\\_Current\\_State\\_of\\_Affairs](https://www.researchgate.net/publication/277634419_Business_Process_Model_and_Notation_The_Current_State_of_Affairs)

[https://www.researchgate.net/publication/321214912\\_Eye\\_Tracking\\_and\\_Web\\_Experience](https://www.researchgate.net/publication/321214912_Eye_Tracking_and_Web_Experience)

## Bibliography

Pavlicek, J., Hronza, R., Pavlickova, P., & Jelinkova, K. (2017, June). The business process models quality metrics. In *Workshop on Enterprise and Organisational Modelling and Simulation* (pp. 134-148). Springer, Cham.

Pavlicek, Josef, and Petra Pavlickova. "Methods for evaluating the quality of process modelling tools." *Workshop on Enterprise and Organisational Modelling and Simulation*. Springer, Cham, 2018.

Pavlicek, J., Rod, M., & Pavlickova, P. (2021, June). Usability Evaluation of Business Process Modelling Standards–BPMN and BORM Case Study. In *the International Conference on Advanced Information Systems Engineering* (pp. 93-104). Springer, Cham.

Al-Debei, M. M., El-Haddadeh, R., & Avison, D. (2008). Defining the Business Model in the New World of Digital Business. Retrieved from <http://bura.brunel.ac.uk/bitstream/2438/2887/1/AMCIS2008.pdf>

Douglas K Barry. (2013). Business Process Modelling Language (BPML). Retrieved February 26, 2018, from [https://www.service-architecture.com/articles/web-services/business\\_process\\_modeling\\_language\\_bpml.html](https://www.service-architecture.com/articles/web-services/business_process_modeling_language_bpml.html)

Just, M. A., & Carpenter, P. A. (1976). The role of eye-fixation research in cognitive psychology. *Behaviour Research Methods & Instrumentation*, 8(2), 139-143.

Goldberg, J. H., & Wichansky, A. M. (2003). Eye tracking in usability evaluation: A practitioner's guide. In *the Mind's Eye* (pp. 493-516). North-Holland.

Poole, A., & Ball, L. J. (2006). Eye tracking in HCI and usability research. In *Encyclopaedia of human computer interaction* (pp. 211-219). IGI global.

M. Petre, Why looking isn't always seeing: Readership skilled and graphical programming, *commun. ACM* 38 (6)(1995) 33-44

J. Mendeling, HH.A. Reijers, J. Cardoso, What makes process models understandable? in *proc. BPM'07*, 2007, pp. 48-63

J. Krogstie, G. Sindre, H. Jorgensen, Process models representing knowledge for action: revised quality framework, *Eur, J. inf. Syst.* 15 (1)(2006) 91-102

B. Bousetta, O. El Beggar and T. Gadi, “ A methodology for CIM modelling and its transformation to PIM “ in *Journal of Information Engineering and Applications*, vol. 3, no, 2, pp. 1-21, 2013 . ISSN 2224-5782 e-ISSN 2225-0506

Hassen, M. Ben, Keskes, M., Turki, M., & Gargouri, F. (2017). BPMN 4KM: Design and Implementation of a BPMN Extension for Modelling the Knowledge Perspective of Sensitive Business Processes. *Procedia Computer Science*, 121, 1119–1134.  
<https://doi.org/10.1016/J.PROCS.2017.12.121>

Kallio, J., Tinnilä, M., & Tseng, A. (2006). An international comparison of operator-driven business models. *Business Process Management Journal*, 12(3), 281–298.  
<https://doi.org/10.1108/14637150610667962>

Kocbek, M., Jošt, G., Heričko, M., & Polančič, G. (2015). Business Process Model and Notation: The Current State of Affairs. *Computer Science and Information Systems*, 12(2), 509–539.  
<https://doi.org/10.2298/CSIS140610006K>

Liping Liu, B. R. (2006). *Management of the Object-oriented Development Process - Liping Liu, Borislav Roussev - Google Books*. (B. R. Liping Liu, Ed.) (illustrate). Idea Group Inc (IGI), 2006. Retrieved from

[https://books.google.cz/books?id=hSG9AQAQBAJ&pg=PA355&lpg=PA355&dq=Prerequisites+of+the+BORM+Model&source=bl&ots=h9qKhY\\_aa7&sig=fOrnuuQt3BLNJqpPC9H0Lff5GR4&hl=en&sa=X&ved=0ahUKEwiszLNgzNzZAhUDPRQKH5UAdEQ6AEIPjAD#v=onepage&q=Prerequisites of the BO](https://books.google.cz/books?id=hSG9AQAQBAJ&pg=PA355&lpg=PA355&dq=Prerequisites+of+the+BORM+Model&source=bl&ots=h9qKhY_aa7&sig=fOrnuuQt3BLNJqpPC9H0Lff5GR4&hl=en&sa=X&ved=0ahUKEwiszLNgzNzZAhUDPRQKH5UAdEQ6AEIPjAD#v=onepage&q=Prerequisites of the BO)

Merunka, V. (2010a). OBJECT-ORIENTED PROCESS MODELLING AND SIMULATION – BORM EXPERIENCE. *Trakia Journal of Sciences*, 8(8), 71–87. Retrieved from <http://www.unisz.bg>

Osterwalder, M. (2004). The Business Model Ontology -a proposition in a design science approach  
11 2 ORIGIN, DEFINITION, PLACE AND ROLE OF BUSINESS MODELS IN THE FIRM.  
Retrieved from <http://www.hec.unil.ch/aosterwa/PhD/2.pdf>

Wong, Peter YH, and Jeremy Gibbons. "A process semantics for BPMN." *International Conference on Formal Engineering Methods*. Springer, Berlin, Heidelberg, 2008.

Mendling, Jan, Brian T. Pentland, and Jan Recker. "Building a complementary agenda for business process management and digital innovation." *European journal of information systems* 29.3 (2020): 208-219.

Djamasbi, S. (2014). Eye tracking and web experience. *AIS Transactions on Human-Computer Interaction*, 6(2), 37-54.

White, Stephen A. "Introduction to BPMN." *Ibm Cooperation 2.0* (2004): 0.

Eye Tracking: The Complete Pocket Guide. (2022). Retrieved 15 March 2022, from <https://imotions.com/blog/eye-tracking/>