Towards enhancing process model visualisation and reducing stakeholder misunderstanding

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Abstract

In the past thirty years, process models have been used extensively and must be intuitive and easily understandable. However, we know surprisingly little about modelling and which factors contribute to a 'good' process model in terms of human understandability. A disinterest in the technical details of process improvement methodologies relates to the miscommunication between the process model's designer and the stakeholder, the intended reader. Process models are not usually designed with different audiences and stakeholders in mind. What visual adaptations can be made to process models serving different stakeholders and uses? More specifically, what visual adaptations can be made to reduce the misunderstanding the stakeholder experiences when reading process model notations? This will be the research gap we will discuss and set out to solve. Four more sub-research question (SRQ) will be discussed, followed by the three study designs. The scientific contribution of this PhD will consist of interdisciplinary work with a focus on the stakeholder when researching what visual adaptation can be made to reduce the miscommunication stakeholders experience when reading process model notations. The practical contribution of this PhD will consist of a result that will help the practical community reduce miscommunication and improve visualisation.
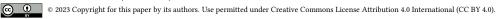
Keywords

misunderstanding, process model, stakeholder, designer, visualisation, psychology

1. Proposal

In this PhD proposal, we lay out the research gap that is intended to be investigated in the next four years and the way we intend to work towards a solution. This research investigates the misunderstanding the stakeholder experiences when trying to read a process model and what kind of visualisation, visual adaptation, or guideline works best when trying to understand a process model. First, the practical and scientific motivations will be discussed. Second, we will discuss the research goal, questions and methods. Third, the scientific and practical contributions and educational relevance are covered. Last, the data management and ethical assessment are explained.
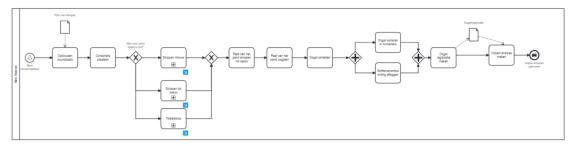
1.1. Practical motivation

On average 76% of companies use some form of business software, when looking at companies with 100 or more employees, this number increases to 90% [1]. On the other hand, Enterprise Architecture (EA) tools with process modelling functionality are only used by 20% to 50% of companies [2]. However, with the transition to a more circular economy, the importance of transparent and understandable processes is growing as illustrated by the VMRG (the industry organisation for metal facades). The VMRG is using a process-based approach to close the leakage flows of materials from supply chains and move towards zero carbon. Fledderman (2023) from VMRG states, "Formulating and modelling processes ... is done from the user perspective. This, knowing that on the one hand, we have to support processes with digitalisation, ..., and on the other hand, that we have 1000+ companies as users, with a very diverse level of knowledge, to include in the communication. We are already experiencing user-(director)-designer communication issues in daily practice. How do we ensure that we do this better and more effectively?"

In the past thirty years, process models have been used extensively and are expected to be intuitive and easily understandable. However, we know surprisingly little about modelling and what contributes to a 'good' process model regarding human understandability [3, 4]. It is often the stakeholder, the intended reader, who has trouble understanding the process model. To improve this misunderstanding, much research surrounding process models has focused on creating guidelines [5, 6]. Most of these guidelines relate to the visualisation of process models and are intended for the designer to use when modelling processes. When choosing a guideline to use the designers have to consider multiple factors, e.g. the audience, the purpose of the process model, and the visualisation of the process model. Unfortunately, this does not always yield the desired effects, as modelling guidelines have not been well tied to experimental findings [7]. As van Gils (2023) states: "[designers] need to create one process model with multiple visualisations for multiple stakeholders at multiple levels of abstraction". For example, a process model as shown in figure 1 might not be understandable to all stakeholders or be interpreted in the same manner.

Figure 1:
Example of a BPMN process model

As shown there are currently several drawbacks and challenges concerning process models when presented to stakeholders. Researchers are taking steps to map and improve these drawbacks and challenges that occur in practice. Mulder [8] highlights this by showing five

cases that lack communicability with different stakeholders using the same process model, based on the Design and Engineering Methodology for Organisations (DEMO). Additionally, models are often misunderstood when presented to business executives (C-level management) [8, 9].

To conclude, while most research on process models focuses on the technical side of processes, experiences from practice show that the human element is often overlooked [10]. Process models are not usually designed with different audiences and stakeholders (e.g. customers, employees, management, board members, investors, media) in mind. Understanding such models is complicated by different notation languages each with their visual elements. This proposed PhD study aims to enhance the understanding of process models by different stakeholders in practice.

1.2. Scientific motivation

As stated in the practical motivation, to avoid problems in practice it is important to enhance the understanding of process models by stakeholders. To work towards solving this practical problem, the scientific community has to become more involved. Current research into this problem mainly consists within the modelling community, with limited studies being interdisciplinary. For example, Gouveia [11] have made steps in an "inspiring direction" in developing improved process models. However, interdisciplinary research has much potential to address some of the larger problems facing organisations [12].

A process model is a broad term, there are a lot of process models with lots of different notations which we will now define. First, we define process models as simplified and abstract representations of systems and their interactions that are essential for a particular purpose [13, 14, 15]. Every notation has its informational payloads which are needed for the different kinds of decisions that stakeholders need to make. Next, we define a stakeholder as a group or an individual that can affect or is affected by process models, inferred from Freeman [16]. Therefore, a notation serves a specific purpose and is not relevant to use in every situation. The designer usually decides what process model notation is used. Last, we define a designer as the person who makes a process model, e.g. architects, process analysts, and others, inferred from Mandelburger [17]. However, these designers do not always keep the stakeholder and their level of understanding in mind.

DEMO is an abstract method, containing a notation to model the construction of an organisation [18]. This method abstracts the organisation from implementation and realisation and gives a view of the "what" of the organisation. DEMO has a payload of e.g. responsibilities, products, roles, functions, data, rules, and dependencies [18]. BPMN is a functional notation of the organisation that shows the activities and decisions of the organisation [19]. This notation focuses on the "how" of the organisation. BPMN has a payload of e.g. functions, activities, decisions, and order [19]. Both notations are complementary and have different payloads serving the various stakeholders. DEMO should be used more. BPMN is used a lot.

Different stakeholders have been found to have different visual needs that need to be met to communicate process models effectively [20, 21]. This requires a balance between human-oriented communication and rational engineering, which can be described as "a challenge and often a bit of a struggle" as you cannot assume that all people are familiar with process models [21]. What often happens is that stakeholders tend to assume they possess a sufficient

understanding of process models. This assumption can stem from multiple reasons, e.g. a course they completed. At the same time, designers often make a similar mistake by too easily considering a process model to be effectively communicated without thorough validation [21].

Why is visualisation so important to understand? The number of people familiar with visualisations is growing. However, the number of people able to read these visualisations is difficult to estimate [22], despite the need in today's society for individuals to become more visually literate [23]. So far, there is no standardised terminology, typology, or classification system for core visualisation concepts anywhere [20]; it can mean various things to people [24]. This study defines visual literacy as the ability to effectively, efficiently, and confidently understand, use, create, and extract information from well-established data visualisations. The more individuals use and encounter visualisations, the more important it is to teach those individuals to construct and interpret that visualisation properly [20]. Visual literacy is becoming as important as the ability to read and comprehend text [25]. Dewan [26] mentions that although text itself is not inherently inferior when we excessively depend on it and underutilise graphics, the outcome may become mediocre. Visualisation plays a crucial and essential role in communicating models [21]. When using process models for communication, it is essential to be aware of the different views people involved have [21]; all meaning is relative to culture [27]. Despite the importance of visualisation and visual literacy, Kiper [23] found that the application and development of visual literacy have not received much attention in research. As far as we know, only a few visual literacy scales exist (e.g. [23, 22, 25]. These scales assist researchers in making better decisions when designing and developing visualisation applications and software [25].

When it comes to examining the way people look at process models, there are multiple ways to measure them. One method that stands out is eye-tracking, which is nowadays mostly used by cognitive psychology. Eye-tracking is an objective way to measure and consequently quantify the outcome in such a way that we can conjecture from these results. In this PhD project, eye-tracking will be used to quantify a baseline for understanding the current situation and to quantify improved artefacts against this baseline. The limited interdisciplinary work on process models has mostly been from the human-model interaction perspective, specifically cognitive psychology. Modelling is cognitively challenging [28, 17]; however, we believe the cognitive perspective is not the only helpful perspective when looking at this problem. By looking from a more social-psychological perspective, we can focus more on the stakeholders and the visual adaptations that might be useful to them. Neurologically, we are wired with an overwhelmingly visual sensory ability to comprehend those vast amounts of data [26, 27]. The part of the brain that processes visuals is bigger than the part that processes words [29]. This results in visuals being more effortlessly recognised, processed and recalled than words [29, 26].

1.3. Research goal

As discussed above, the current method of creating guidelines to improve process models has not been effective, and misunderstanding continues. This PhD aims to contribute to the practical and scientific research gap regarding visual adaptations that can be made to process models serving different stakeholders and uses. We need to combine the domain of process modelling science and social-psychological aspects. Currently, there is no optimal visualisation or visual adaptation of process models that would make them understandable to all stakeholders. Thus,

we need to involve the scientific and practical community to move towards solving this research gap.

1.4. Research question

Based on the previous sections discussing the motivation for this research, the following main research question is formulated:

What visual adaptations can be made to structured process models to facilitate the understanding of stakeholders?

To answer the main research question the following sub-research question (SRQ) are formulated:
SRQ1: What is known about reducing visual misunderstanding in relation to process models?
SRQ2: What is the difference between experts and non-experts (different groups of stakeholders) when reading process models?
SRQ3: What kind of artefact can be designed to be useful in reducing misunderstanding of process models in relation to their visualisation?
SRQ4: What aspects related to visualisation will improve the understanding of process models by stakeholders?

1.5. Research method

This proposed PhD project begins with a systematic literature review (study 1) to further explore the existing research. Consequently, an eye-tracking study with an in-depth interview will be conducted (study 2), followed by the designing and testing of an artefact with Design Science Research (DSR) and eye-tracking (study 3). Figure 2 visually shows the studies. In the planning section the studies will be discussed in more depth.

1.5.1. Study 1

Study one will be a systematic literature review to answer sub-research question (SRQ) one. The study will use the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) approach [30]. This approach was designed by Page et al. [30] to help the researchers transparently report why the review was done, what was done and what they found. This will help us look at the state of knowledge in process modelling regarding visualisation. Additionally, we can examine the role social psychology and eye-tracking have played in research so far and the role they can play in future research. The aim is to create an overview that shows what has been done and highlights what can be done.

1.5.2. Study 2

Study two will be a two-part study to answer SRQ two. The first part will be an eye-tracking experiment. The aim is to find differences in how different groups of stakeholders read process models. The advantage to eye-tracking is its ability to measure physiological responses to visual stimuli and record these responses in real time [31]. The experiment will consist of a
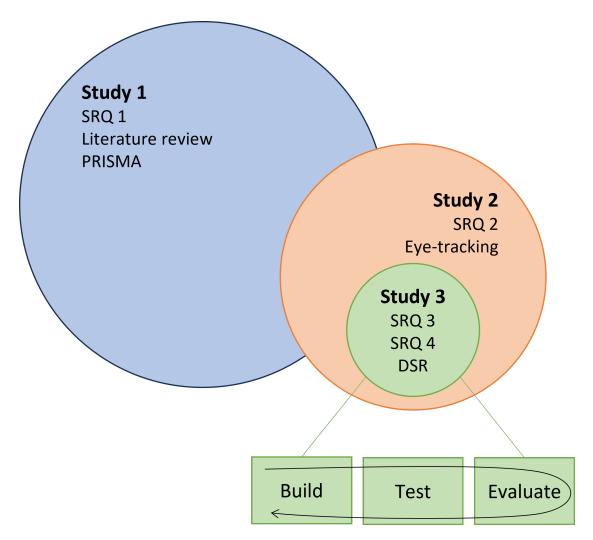
Figure 2: *Note.* Overview of the relation between the studies.

questionnaire about the two process model notations, Design and Engineering Methodology for Organisations (DEMO) and Business Process Modelling Notation (BPMN). The participant will have to answer multiple-choice questions, minimising additional work requirements and the risk of data entry errors [31].

The second part will be an in-depth interview. The participants of the eye-tracking experiment will be interviewed to remark on the way they answered the questionnaire in the first part of the study. The aim is to get a deeper understanding of how they view their process of answering. Additionally, through the interview, we can hear from different stakeholders about what methods they think might be good to reduce miscommunication.

1.5.3. Study 3

Study three will be a DSR study to answer SRQ three and four. In this study, we will be developing and evaluating artefacts. The aim is to create an artefact that will reduce miscommunication. These artefacts will be created based on the results from study two. The insights that study two will give will determine what the focus of the artefact might be. By executing experiments, we aim to reduce miscommunication when a stakeholder reads a process model notation. The different artefacts will be evaluated through an eye-tracking experiment, which will be similar to study two's environment. Thus, the eye-tracking will help ensure that the results can be properly compared.

1.6. Scientific contribution

By combining the domains of processmanagement (modelling) and social psychology, this PhD has the potential to address some of the significant problems facing organisations. Because there is limited interdisciplinary work in combining these fields, this study is one of the building blocks for more studies like these in the future and creates more direction for future research. By focusing on the stakeholders, we can get more focus on the human element, the social side and visualisation. We aim to explore what visual adaptations can help reduce the misunderstanding of process models by stakeholders.

1.7. Practical contribution

While during the past decades process models have been used extensively and must be intuitive and easily understandable, practice has shown that there are currently several drawbacks and challenges concerning process models when presenting these to stakeholders. This study aims to focus on the human element, to help with the understanding of process models by different audiences. It is essential to be aware of the different kinds of stakeholders because the interpretation of models is contextual (e.g. relative to international/organizational culture). The practical contribution of this PhD will consist of a result that will help the practical community reduce miscommunication and improve visualisation...

1.8. Educational relevance

This research explores the visualisation and subsequent understanding of process models. This is not only an essential topic for practice but also education. Using visuals in various learning environments is a vital learning enhancer [29], making it a valuable tool for educational applications. Visualisation will improve how education is taught and help the students prepare for practice. Also, the PhD results will serve as a valuable source of information for guest lectures.

1.9. Data management

All data collected, including audio recordings, survey results, and transcripts, will be securely stored on the HU Research Drive, a server hosted by SURF. The Research Drive meets the

'*Juridisch Normenkader Cloud Services Hoger Onderwijs*' and General Data Protection Regulation (GDPR) standards for data security.

The general and anonymous data suitable for sharing as open-access data will be made available for further research. Personal data will be pseudonymised during analysis to protect individual privacy. Documents containing personal information, such as statements, contracts, and financial documents, will not be shared as open-access data and will be stored securely. These documents will only be used by the researcher and their supervisors for the purpose of this PhD-research project.

After the completion of the doctoral research, all data that is not suitable for open access will be deleted after five years.

1.10. Ethical assessment

This research applies the Dutch Code of Conduct for Research Integrity as the guiding principle for its integrity policy. The following five principles are leading:

- Honesty;
- Diligence;
- Transparency;
- Independence;
- Responsibility.

In addition, research will be conducted, in accordance with GDPR legislation. When appropriate, the HU Ethical Commission Research Social Domain (ECO-SD) will be asked to advise.

More specifically, without having the pretension to be limited, the following guidelines are applied:

- Data is only acquired after receiving upfront permission.
- Interviews will be recorded. Audio files will be deleted after making transcripts.
- All gathered data will be anonymized where possible. If data cannot be anonymized permission will be sought before publication.
- All off- and online tools used for data gathering, interviews, meetings, etc. are approved by the research institutes involved (Utrecht University of Applied Sciences (*Hogeschool Utrecht*) (HU) and the University of Maastricht)
- This research by no means is meant to harm people and/or organisations.

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