THE EFFECT OF EMPATHY ON THE INTEGRATED DESIGN PROCESS OF INFRASTRUCTURE PROJECTS THROUGH COMMUNICATION

USING SERIOUS GAMING TO SIMULATE THE COMMUNICATIVE PROCESSES DURING THE INTEGRATED DESIGN PROCESS

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PREFACE

During the past few years of study, I was confirmed time and again in the importance of the interaction between people and technology. Technical solutions are often innovative and have a lot of potential. However, they will always need to be implemented and used by humans. So, when I started looking for a topic for my thesis, I knew I wanted to put the social side of technology on the map. When I got in touch with Guus and he told me about his research I was immediately fascinated. Empathy in construction is a new but very important subject with still many knowledge gaps and unanswered questions. I did my best to answer one of those questions with this thesis on empathy in the integrated design process through communication.

Writing this thesis would not have been possible without help. First of all, my thanks to Prof. dr. Hans Bakker who enthusiastically embarked on this adventure with me even in the last months before his retirement. Thank you for your extensive feedback and for chairing the important meetings with the committee. It was extra special that I could use your course participants to play my serious game. This saved me a lot of time in assembling a test group. In addition, many thanks to my first supervisor Dr. Erik-Jan Houwing from whom I learned some important advice: "when you are completely stuck in your thoughts or work, close your laptop, make a cup of tea and go watch the birds outside for an hour. And if you still can't work it out, send me an email and we will talk again tomorrow". Your quick responses and flexible availability helped me a lot during my thesis period. Thirdly, I would like to thank Dr. ir. Geertje Bekebrede for her perspective on this research as a second supervisor. I had no experience with serious gaming when I started this research, which made it quite an adventure. However, Geertje made sure that it was a very enjoyable process. The help during the game design and extensive feedback ensured that the game worked well in the end. Finally, my thanks go to ir. Guus Keusters from the company Dura Vermeer for the opportunity to do my thesis on the topic of his PhD research. His availability for questions and interesting perspectives on the topic from his own knowledge and research were of great value. It was also very helpful that I could use the network of Dura Vermeer for interviews with experts from the industry and questions on my research.

I have sometimes compared the graduation process to learning to swim. At the beginning, you're thrown into a pool with swimming straps on and it feels like you're still floundering a bit. But as the process goes on you get a better grip and eventually the floaties can come off and you swim independently. I look back with pride on the past few months and what I have learned and accomplished. The swimming diploma is in my pocket, now on for the big work!

Anniek Bertels
July 26, 2022

MANAGEMENT SUMMARY

The purpose of this study was to understand the effect of empathy in the project team on the outcome of the integrated design process of infrastructure projects. Despite years of experience, many infrastructure projects are still underperforming. Within the project lifecycle, the design process has an important role in this. Decisions made in this process affect the rest of the project. It is therefore that improvement of this design process is important for the overall performance of infrastructure projects. Unfortunately, improving the design process is hampered by the complexity of projects. The projects experience complexity on both internal (disciplinary) and external (stakeholder) levels. To tackle this complexity, integration is needed. Integration of the design process means that the various disciplines and stakeholders collaborate towards a shared goal in which both the internal and external complexities are tackled. It is therefore important to look for ways to improve the integrated design process. This thesis focuses on communication as a means for integration. Successful communication and information sharing would enable integration and thus the performance of the design process. The competency of empathy and communication are strongly correlated by the literature. Empathic people are said to be more communicatively skilled. With this, empathy could be an important tool to improve the outcomes of the integrated design process through communication. Research on empathy in the construction sector is still scarce, thus this study represents one of the first steps towards a better understanding of this competency as an important tool for project success. Therefore, the question central to this study is as follows:

"How does empathy influence the integrated design process of integrated infrastructure projects through communication?"

To find an answer to this question, this study was split into four parts. The first part focuses on the introduction and research design of the study. From this follows the problem statement and appropriate methodology. Part two is dedicated to expanding the theoretical framework that underpins this research. Through literature review of the concepts of communication and empathy and the potential of both, background is first outlined. Additionally, interviews were conducted with experts to get a good definition of successful communication in the integrated design process. The integration of interviews and literature showed that at least two categories of communication identified by Thomas et al. (1998) are also important specifically for the integrated design process. It involves good understanding of information expectations and the ability to cope with communicational barriers such as logistics, accessibility and interpersonal difficulties. With knowledge of the characteristics of empathy and what is important for successful communication in an integrated design process, hypotheses were established at the end of the second part.

Empathy has proven to have great correlation with communication skill. Hypothesis 1 therefore assumes that empathy has a positive effect on the communication in the integrated design process. From the theoretical framework, it has also been proven that communicative success works out on the outcome of projects through integration. Hypothesis 2 therefore says that communicative success ensures a better outcome of the integrated design process. When that line of reasoning is continued, one arrives at hypothesis 3, which is that empathy has a positive effect on the outcome of the integrated design process.

The third part of this study focuses on data collection through serious gaming. A serious game is designed to test the hypotheses in a simulated environment. The serious game was used in a game session with 24 experts from the process industry who played in 6 groups. Their empathic ability had been measured beforehand and they were divided into teams based on this. This created 3 low-empathy groups and 3 high-empathy groups. During a game session, independent observers observed and noted their behaviour in qualitative and quantitative observations.

From the observations, the following conclusions could be drawn. It was found that empathic teams score better on their understanding of information expectations and how they deal with the built-in barriers. This seems to be determined primarily by the cognitive side of empathy. In particular, the hindrance experienced due to the logistical barrier was significantly less with the low-empathy teams. However, the differences were small and reasonably good communication was also seen among the low-empathy teams. Nevertheless, hypothesis 1 was confirmed and it can be concluded that empathy showed a positive effect on communication in the integrated design process. Their communicative success was not entirely reflected in the game result. The results of the design process in the simulated environment did not improve once communicative performance improved. However, the results did indicate that a minimal amount of communication is required for solid project results. Other factors will determine the project outcome, but without sufficient communication, good project performance will be difficult. Finally, this study could not establish a direct link between empathy and the outcome of the integrated design process. That is, the line from empathy to project outcome through communication is not reflected in direct results. This is also to say that empathy has not been shown to determine outcomes significantly through other processes. However, this study also cannot rule out that there was no positive effect of empathy on the outcomes of the integrated design process. Further research with larger datasets needs to conclude what the proportion is of other confounding variables being dominant in game success and how empathy relates to them.

This research proves to be of value to both science and the construction industry. It became clear that empathy enters the integrated design process through communicative processes. With this it takes important first steps in the research on empathy in the construction sector. In addition, it provides insights for the sector on how they can use empathy in their projects. Empathy makes it possible to better deal with barriers present in projects and in particular logistical ones. Projects with many of these barriers will benefit more from empathic project members. Besides, it can also be useful to strengthen poorly performing projects on communication with empathy. This can be done on the one hand by selecting for empathic people, but also by encouraging empathic behaviour more. Finally, this study has once again raised the issue that awareness of the importance of communication in the industry is low. Scientific insights will have to find their way into the workplace, or they will not start to have an effect on real-life projects.

The study also generated suggestions for future research. Follow-up research could first focus on strengthening the current conclusions. This can be done by increasing the size of the test group allowing confounding variables to be better identified and general validity to be increased. In addition, follow-up research could build on the results from this study. First of all by putting focus on the affective side of empathy and soft criteria in the design process. There may well be a strong connection between them. Secondly, the relationship between empathy and design quality could be further explored in response to tentative results in this study and indication from the literature. Finally, although empathy shows positive effects in this study, it seems that there are also choices associated with it. Future research could focus on potential trade-offs of empathy and also the interaction of empathy with other competences in the project team. From this, the value of empathy for practice can be further investigated. All in all, this research has taken first important steps toward recognizing the value of empathy in construction projects and it provides much reason for follow-up research into this topic.

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PART I: RESEARCH INTRODUCTION

1. Introduction

Despite years of experience, many projects in the construction sector are still underperforming (Elsayegh & El-adaway, 2021; Takim & Akintoye, 2002). They fail to complete projects within time, budget or with the right quality. The poor performance of projects is a complex problem with many causes and it is therefore difficult to solve. This research will focus on improvement of the integrated design process of infrastructure projects, as it has been proven that this phase has a major impact on the project performance (Koutsikouri et al., 2008; Takim & Akintoye, 2002; Yang & Wei, 2010). It will discuss the value of empathy during the integrated design process of Dutch infrastructure projects from the contractor's perspective. This chapter will outline the context that lead to the topic of this thesis in 1.1. After describing the context to the subject, the chapter concludes with a problem definition in 1.2 and a conceptual model of this thesis in 1.3.

1.1 Context
Many projects in the construction sector are still underperforming (Elsayegh & El-adaway, 2021; Takim & Akintoye, 2002). Projects are running late (Yang & Wei, 2010), have major cost overruns or are not meeting client expectations (Lindhard & Larsen, 2016). The causes of this can often be traced back to the design process of the projects (Koutsikouri et al., 2008; Takim & Akintoye, 2002; Yang & Wei, 2010).

The design process can be defined as the total of activities that must be carried out before actual construction can begin (Gilliland, 2019). However, it should be noted here that many other definitions exist. The research of Batelaan (2021) has explored this phase further for the contractor Dura Vermeer. The process begins with the tender phase in which both the client as well as different representatives from the contractors side participate. After the contract has been awarded, the design phase starts. This consists of project control with 5 processes that function side by side. They use multiple gate reviews to assess whether the sub-processes are still aligned and to make decisions about how to proceed. All this is guided and overseen by a higher layer of project managers. An overview of this phase can be found in Appendix A: The design process. For this research, the tender phase will be out of scope.

The design process is important for project performance because decisions are made that carry through to the rest of the project. Consider defining its scope and client requirements. This determines, for example, the contracts worked out by the contract management team, the approach of the stakeholder management team but also the technical design. This is then reflected in the project planning, budgets and the final design. Despite its importance, there are often flaws in the design process. Think of poorly aligned project goals or a poor scope definition (Haponava & Al-Jibouri, 2009). Such failures are often a result of poor coordination and communication between the many project parties (Elsayegh & El-adaway, 2021). However, solving this is not easy and is strongly related to the complexity of the projects.

Complexity during the preconstruction phase
It has long been known that many problems in projects arise from complexity (Baccarini, 1996). Projects experience complexity at the technical, organizational and environmental levels (Bosch-Rekveldt et al., 2011). A later study of Bosch-Rekveldt (2013) identified four aspects perceived to be the most determinant of project complexity in the construction industry specifically. The two highest-scoring are complexities related to interfaces and external influences. Complexity related to interfaces

comes from diversity in technical disciplines, dependencies on sub-projects, interfaces between the disciplines and also interfaces with other projects. These can be called internal complexities. Complexity related to external influences arises through the number and diversity of external stakeholders and political influences (Bosch-Rekveldt, 2013). These are the external complexities. The complexities create inefficiency and ineffectiveness when not properly tackled. This is ultimately reflected in the success criteria of time, money and quality (Baccarini, 1996). The design process also deals with these complexity. Many disciplines and stakeholders are involved in determining the scope and creating the design. Complexity, therefore, also causes inefficiency and ineffectiveness in coordination and communication here. So a way must be found to get a grip on that complexity. Then room is created to further improve the design process.

Integration in infrastructure projects

The design process suffers from the effects of the complexity in infrastructure projects. Therefore, there is a growing body of research on the positive impact of integration as an important means of coping with complexity (Baccarini, 1996). In fact, working integrally has already proven to contribute to the over-all project performance of construction projects (Che Ibrahim et al., 2015; Demirkesen & Ozorhon, 2017; Franz et al., 2017).

"Integration can be considered as the merging of different disciplines or organisations with different goals, needs and cultures into a cohesive and mutually supporting unit" (Baiden et al., 2006).

It requires individuals of the different disciplines and organisations to collaborate towards a shared goal through information sharing (Baiden et al., 2006). Thereby contributing to effective teamwork, collaboration and cooperation (Che Ibrahim et al., 2015). This is very important for complex projects, as they rely heavily on good collaboration and coordination among the many stakeholders and disciplines. Ultimately, this improved collaboration through integration results in higher productivity, better product quality, and more successful projects (Baiden et al., 2006). Integration of the design process is therefore highly desirable to improve the quality of the final design before going to execution.

The word integration in the integrated design process says something about the need for integration, and nothing about the degree to which integrated work is actually done. An integrated design process can still have high or low levels of integration. It is therefore important to know when to speak of a successfully integrated design process. The paper of Keusters et al. (2022) links integration to the ability to adopt the context of the design problem into an optimum design solution. It is: "the course of all human activities transforming an existing situation into a new one to satisfy needs, including and balancing all parties' interests and disciplines involved" (Keusters et al., 2022). In effect, this means that both the external and internal complexities are taken into account and tackled.

Design as a social process

To make the integrated design process more successful, it is necessary to understand the process better. Bucciarelli (1988) was one of the first to acknowledge design as a social process. He found that the design process is a *social construction* of interpretations of the design coming from different *object worlds*. Meaning that the discourse of the individual disciplines and interests is critical to the quality of the design. The paper of Smulders et al. (2008) elaborates on the implications of the different object worlds in the social process. Each individual carries implicit knowledge of himself and perceptual knowledge of others. By making implicit knowledge explicit and thereby decreasing the perceptual knowledge of stakeholders, a better level of understanding is achieved. There should be two-sided learning: transmitter and receiver must be aware of their own implicit knowledge and that the other

has it too from their perspective (Smulders et al., 2008). By communicating in both directions, the knowledge of both increases and mutual understanding improves.

The value of communication in achieving integration as a solution to complexity was mentioned earlier by Baccarini (1996). The paper of Koutsikouri et al. (2008) even describes his respondents using the words communication and integration interchangeably: "which shows that rich communication is believed to contribute to breaking down discipline as well as hierarchical barriers". Communication thus appears to be an important means by which the degree of integration in the design process can be increased.

Unfortunately, communicating and understanding each other's interests still often goes wrong in the design phase of projects (Hoezen et al., 2006; Koutsikouri et al., 2008). This can be attributed to the organisation of the construction process but mainly to the stakeholders themselves (Hoezen et al., 2006). This is because each communicating party often has their own internal motivations (Elsayegh & El-adaway, 2021). These are based on their attitude towards, for example, risk mitigation, knowledge sharing, their stakes in the problem or the availability of tools and capabilities (Elsayegh & El-adaway, 2021). Whether the interests are the same or opposite, they have a great deal of influence on the parties communication in either case (Hoezen et al., 2006). Optimizing communication processes in the design phase can ensure that there is mutual understanding, that fewer mistakes are made and, very importantly, that there is integration between the parties and disciplines in the project (Koutsikouri et al., 2008). Communication is therefore an important component with which the degree of integration in the design process can be improved and the disruption caused by complexity can be reduced.

Empathy in the communication process

The paper of Hoezen et al. (2006) gives a first suggestion towards the added value of the factor empathy in construction projects as a solution to the communicative problems that arise there. This competency is also mentioned in other sectors. It is believed that empathy is an important quality in design thinking (Gasparini, 2015; Köppen & Meinel, 2015). In the case of product design, it plays a role in learning to understand another's background, situation and feelings in order to design the best product for their needs (Kouprie & Visser, 2009). These studies prove the value of empathy in design and communication. However, these have not been brought together in previous research. It is therefore interesting to explore what the value of empathy can be in communication during specifically the integrated design process of infrastructure projects.

1.2 Problem statement

The information obtained from the context of this chapter allows the problem to be well delineated into a clear problem statement. This reads as follows:

The poor performance of projects in the infrastructure sector is cause for concern. Problems arise during the integrated design process of the projects due to poor integration between stakeholders and disciplines. Communication can help to improve this integration but is hampered by lack of knowledge and divergent interests. The competence of empathy seems to offer a solution to these problems because empathizing with the other person's emotional world allows for greater understanding. However, the influence of empathy via communication on the integrated design processes has not yet been investigated.

1.3 Conceptual model of thesis

The context and problem statement can be summarized in a conceptual model of this thesis. This model can be found in Figure 1. It describes the purpose of this research, what assumptions were made in the reasoning, and the hypothesis to be tested that follows from the context.
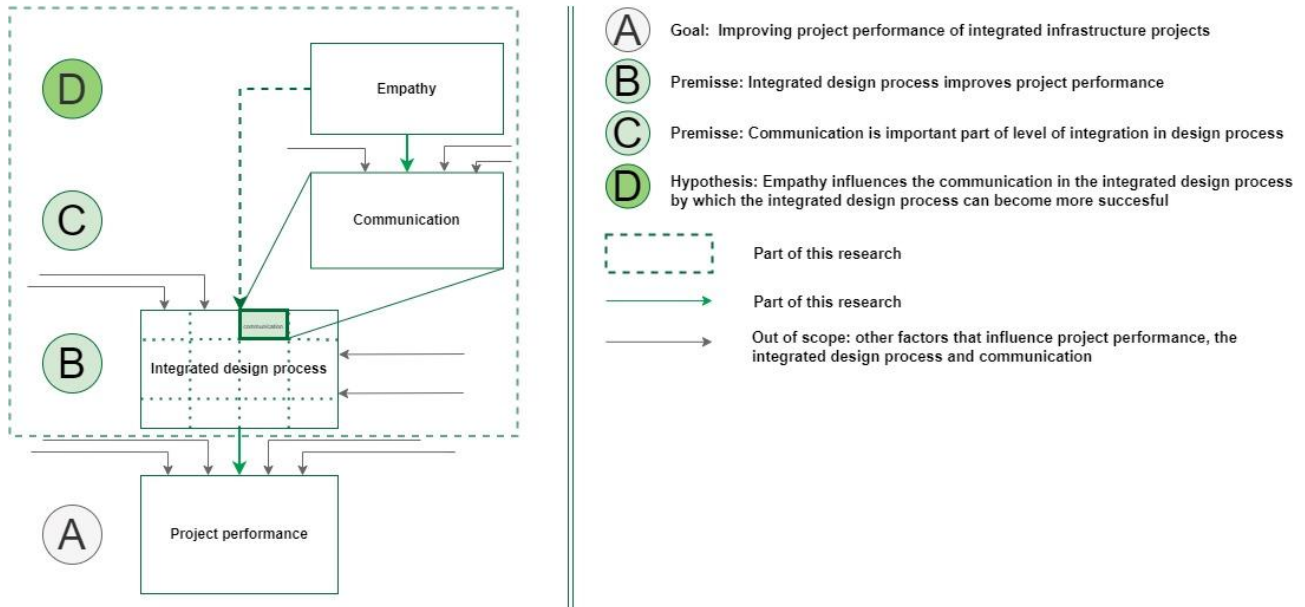
FIGURE 1 CONCEPTUAL MODEL OF THESIS (OWN FIGURE)

2. Research design

This chapter will elaborate on the research objective of this study in 2.1. In chapter 2.2 the research questions will be presented. How the answer to these research questions will be found is described in the methodology in 2.3. Finally, an outline of this thesis is presented in chapter 2.4.

2.1 Research objective

This research aims at filling the knowledge gap on the value of empathy on the integrated design process through communication. To research this influence, the communication in the integrated design process will be simulated in a game environment. By using empathy as input variable to the game, its effects on the result of the game will be tested. With the information gathered in the simulated environment, the first steps can be taken in researching the influence of empathy on the integrated design process of infrastructure projects through communication.

2.2 Research questions

The research question that will be answered in this report is:

> *"How does empathy influence the integrated design process of infrastructure projects through communication?"*

In order to find an answer to the main research question, the following sub-questions were formulated:

SQ1: What does the communication in a fully integrated design process entail?
This research question will be answered to identify the communicational processes within a fully integrated design process. By a literature review on the concept of communication and interviews with design managers of different projects, the communication requirements within the design process will be outlined. This question provides an overview of the system being investigated in this study.

SQ2: What are the key characteristics and skills associated with the competency of empathy?
Once the system is identified in the first sub-question, the second sub-question will be used to gather more information on the input variable of empathy. Through a literature study the key characteristics and skills associated with empathy will be looked into.

SQ3: What is the potential of empathy in communication during the integrated design process?
The third sub-question dives deeper in the opportunities of empathy for the communication within integrated design process. By combining the knowledge obtained from the first two sub-questions with literature, an answer to this question is sought and also the hypotheses are formed.

SQ4: How can the communication within the integrated design process be simulated to research the influence of empathy?
The fourth sub-question focusses on designing a serious game for this research. First, extensive thought is given to the game requirements. Specifications are drawn up that the game must meet. After this the game development can begin. Due to the limited time during the thesis, the choice was made to adapt an existing game and not to invent a completely new game. Through game criteria, existing games are evaluated for their suitability. This results in the most suitable game for this study. This game is studied and adapted where necessary. The adjustments and choices made will be explained and justified. Finally, the in-game data collection and setup of the game session are described. The deliverable of this question is a concept serious game.

SQ5: What is the influence of empathy on the outcome of the integrated design process through communication in the simulated environment?

The final sub-question was formulated to evaluate the results from the game environment. In the serious game, the hypothesis will be tested with a group of people working in the process industry. With these results, a conclusion on the influence of empathic abilities on the simulated environment can be given.

2.3 Research methodology

To answer the formulated research questions from 2.2, this thesis is divided into four parts. The combination of methods used in these parts ensures that a good answer to the main question can be formulated at the end of Part 4. Part 1 uses a *literature review* to identify what is already known about the topic of this study and where the problem lies. Part 2 expands on the theoretical framework of the study through follow-up literature reviews and *in-depth interviews* with industry experts. At the end of Part 2 it is then possible to formulate hypotheses. In Part 3, these hypotheses will be tested by means of the *serious gaming method*. The results of this game make it possible to make statements about the hypotheses and ultimately the main question in Part 4. This research is based on a deductive approach where existing theories will be further developed through hypotheses (Verhoeven, 2018). The literature review and interviews are forms of qualitative data collection. In the serious game, however, quantitative data will also be collected. Therefore, the over-all research method can be classified as a mixed-methods research. The advantage of this is that it removes the limitations of using only one method. In doing so, it is often used with social phenomena because they are so complex (Creswell et al., 2003). Because this research tries to bridge the gap between social competence and process outcome it is very valuable to use a mixed method for dealing with complexity.

Research method Part 2: Literature study & In-dept interviews

The purpose of Part 2 of the study is to answer sub-questions 1, 2 and 3. These form the theoretical framework on which the hypotheses and the rest of the study are based. First, the concepts of communication and empathy were further delved into with *literature reviews*. This provided an answer to sub-question 2 on the characteristics of empathy. Then *in-dept interviews* were conducted with industry experts. The purpose of this was to find out what is important for communication in specifically the integrated design process of infrastructure projects. Integration of the theory on communication and the information retrieved from the interviews formed an answer on sub-question 1. The answers to sub-questions 1 and 2 made it possible to answer sub-question 3 and formulate hypotheses in this study.

In-depth Interviews were chosen to be used as additional data collection for Part 2. From the literature, nothing was yet known about the definition of communication in integrated design processes specifically. Kendall (2008) describes how, of all the methods, interviews are the most appropriate for investigating meaning. The flexibility and possibility of follow-up questions gives the opportunity to really get to the bottom of how the interviewee views something. Since the goal of sub-question 1 is to make sense of communication in integrated design processes, the method of interviews is very appropriate. By interviewing 3 experts with working experiences in-depth, it is assumed that the results are sufficiently well-founded to be used for continuation of this study.

The choice was made to conduct the interviews in a semi-structured manner. The ability to ask follow-up questions based on answers provided much valuable information. An attempt was made to ask the questions about communication as broadly as possible so as not to transmit any bias from the researcher to the interviewee. However, the interviews did have some structure by mentioning target groups based on literature. This ensured that each interviewee had the same communication streams

in mind when answering the questions. The combination of fluency and structure provides the most valuable information.

The interview questions used in conducting the interview can be found in Appendix B: Interview setup. The interviewees were all design managers working for the graduating company Dura Vermeer. They were all Dutch-speaking so the interviews were conducted in Dutch. An effort was made to give interviewees as little information as possible about the study in advance to avoid bias. However, the contact was made via the supervisor within the company and they were already aware of the topic of his PhD research on empathy in construction. Since the focus of the interviews was communication and not empathy it is not expected that this influenced the results.

Research method Part 3: Serious research gaming

Although the literature review and interviews were very important to the theoretical framework of this study, the focus of the data collection is in Part 3. This part aims at answering sub-questions 4 and 5. Here *serious gaming* is used as a research method to test the hypotheses. From the literature review it can be concluded that the identified problem is quite complex. The technological, organisational and environmental complexities of construction projects create a difficult context in which the projects must succeed (Bosch-Rekveldt et al., 2011). Gaming offers the possibility to capture the complexities of problems: "simulation games are representations of real-world complex systems, which can take into account the network complexity of multiple stakeholders with a variety of values, means and resources in a simulated physical or virtual reality" (Lukosch et al., 2018). This means that the previously problematic complexity can be tackled through gaming and there is room to delve into underlying factors in the problem and look for new connections.

In simulation gaming, reality is reduced to a simplified representation through reduction, abstraction and symbolization (Peters & van de Westelaken, 2011). In the simplified reality (the game) new insights about the nature of the complex problem are gained through play. To then translate the lessons from the game back to reality, the debriefing was devised (Peters & van de Westelaken, 2011). During the debriefing, the experiences and lessons from the game are evaluated and written down. In addition, the debriefing is also very important to find out the game's quality and validity.

In this research an existing game will be adjusted to fit the research. This choice was made because designing a completely new serious game takes a lot of time and this was not possible within the time available for the thesis research. Many choices were made in the design of the serious game and the setup. Because the serious game is such a large part of this study, a separate chapter is devoted to it. Further explanation of the method and choices made can therefore be found in Chapter 6.

2.4 Thesis outline

This thesis is composed of four parts. An overview of the thesis is shown in Figure 2. Part I introduces the context of the research and presents the research design. Part II answers the first three sub-questions that form the theoretical framework of the study. Through a literature review in chapter 3 and conducted interviews in chapter 4, after integrating both in chapter 5, answers are given to sub-questions 1, 2 and 3. Part III revolves around serious research gaming. In Chapter 6 the serious game is chosen, adapted and explained. Chapter 6 forms the basis for sub question 4. With a well-functioning serious game, game sessions are played in which both qualitative and quantitative data are collected. This data is presented and analysed in chapter 7. The conclusions from this chapter form the answer to sub-question 5. The final part IV will present the results of this research through a discussion in Chapter 8, the conclusion in Chapter 9, and a reflection in Chapter 10.
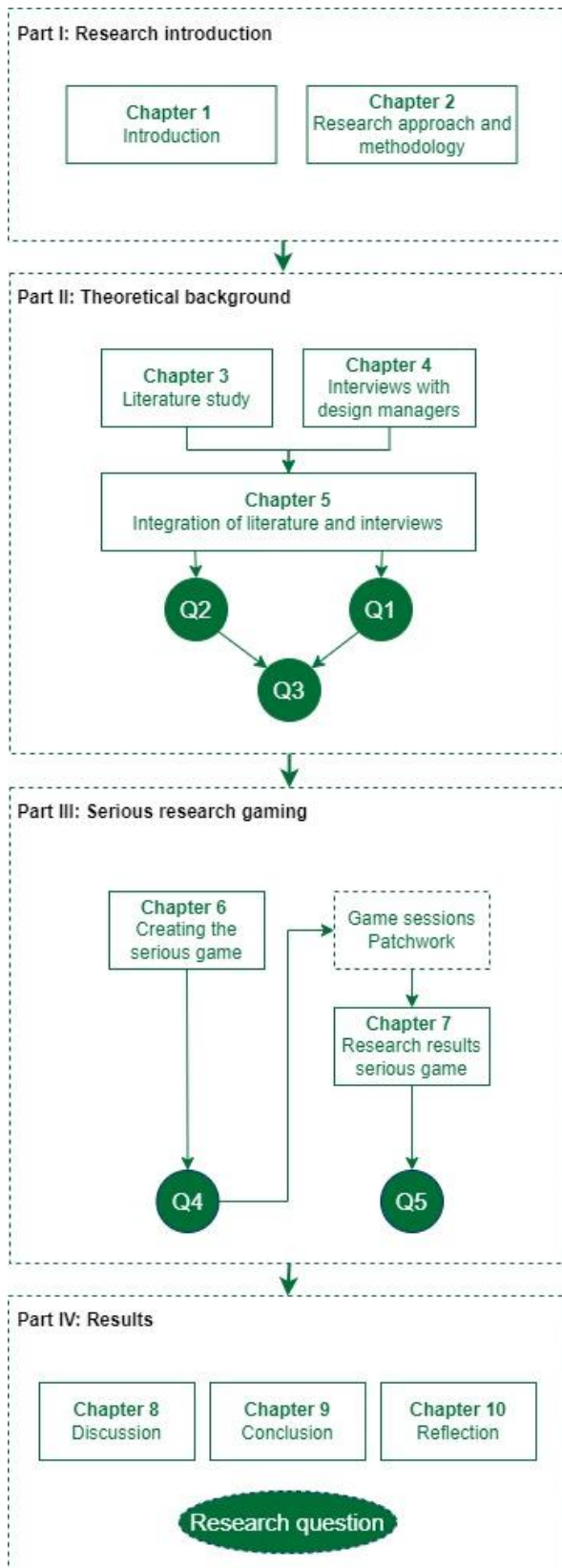
FIGURE 2 THESIS OUTLINE (OWN FIGURE)

PART II: THEORETICAL BACKGROUND

3. Literature review

Chapter 3 is aimed at expanding the knowledge of the concepts in this study. Chapter 3.1 explains the concept of communication. Chapter 3.2 describes effective communication theory specifically focused on engineering and construction projects. Chapter 3.3 explains the concept of empathy, and then chapter 3.4 describes the potential of the competency.

3.1 Communication as a concept

Despite the fact that people often have an association with the concept of communication, it requires further definition. "Communication simply refers to the exchange of information and other resources such as ideas, knowledge, skills, and technology among team members and organizations" (Safapour et al., 2019). Although the authors use the word simple here, it is precisely this simplicity that provides the pitfall in this definition. It lacks the interaction between sender and receiver, which is an important part of successful communication. It was therefore decided to use a definition in this research that covers this interaction:

> *"Communication is the sharing of meaning to reach a mutual understanding and to gain a response" (Emmitt & Gorse, 2006).*

It is added here that "the creation of meaning between two or more people is an intention to have ones informative intention recognised" (Emmitt & Gorse, 2006). Exchanging information and other resources is an important part of this, but it is not the core. Without understanding and confirming it in a response, there is no way of knowing whether the message got through properly and the communication may not be effective (Zulch, 2014).

To understand the concept of communication even better, the article of Thomas et al. (1998) is introduced. It provides a model of communication consisting of seven aspects (Figure 3):
- *The sender*
  The sender is the originator of the communication and has to encode his ideas in the message.
- *The receiver*
  The receiver must decode the message into his own understanding. His understanding depends on background knowledge on the topic, receptivity to the message and the level of trust between sender and receiver.
- *The message*
  The message is the encoded idea, either verbal or nonverbal.
- *Channel*
  The channels are the streams in which the messages are communicated. The channels can be both formal and informal. In addition, a distinction is made in the direction in which the flow is moving. There are horizontal and vertical flows.
- Media
  Communication needs media with which the message is conveyed. A distinction can be made between hard and soft media. Hard media are often structured, have formal control and use formal channels. Examples are contracts, procedures and policies. Soft media are less structured, often verbal and less formal. Examples include team sessions and person-to-person exchange.
- Barriers and filters

Barriers and filters influence the message that is being transmitted. Filters can come from interpersonal issues but also a lack of skills in terms of education. Besides, project characteristics can form barriers due to poor organizational structures, size or locations.

- Feedback
  Feedback is important since it gives the sender information on the understanding of his message. Without feedback there is no response and mutual understanding cannot be confirmed.

The model of Thomas et al. (1998) shows that communication is a process in which the number of senders, receivers, messages, channels, media, barriers and feedback is dynamic. During projects, the number of project members is variable, and so are their channels. Besides, through training and better skills, the barriers and filters can be reduced (Thomas et al., 1998). These dynamics in communication during projects also explain why it is so difficult to optimize this process.
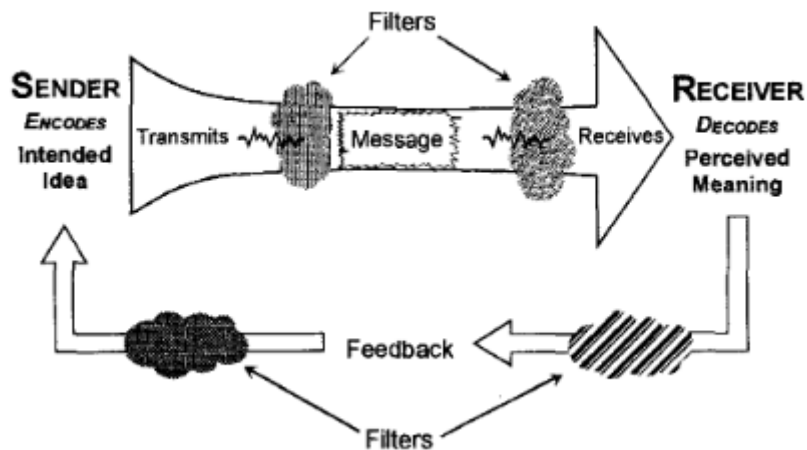
FIGURE 3 COMMUNICATIONS PROCESS (THOMAS ET AL., 1998)

The aspects of the communication process form the basis of communication. Herein it is already mentioned that a distinction can be made between formal and informal communication, as well as horizontal and vertical and verbal or nonverbal communication. These differences can be explained through the concept of communicational levels, types and means. There are different *levels* of communication in which different *types* of communication exist (formal - informal). Each of these types of communication can occur through different *means* (verbal - non-verbal). In fact, it is a layered system. Due to scope considerations, this thesis will focus only on the top layer, communicative levels. The communicative levels will be further explained below.

Communicational levels
Within the design process communication is needed on various levels. A distinction can be made in inter- and intra- organisation communication and vertical and horizontal communication.

Intra-organisational versus Inter-organisational communication
Communication occurs within organisations, but is also necessary between organisations. This difference is also marked as internal versus external communication (Zulch, 2014). Internal communication involves the communication within for example the contractor (Safapour et al., 2019). This includes contact with one's own team but also other teams and disciplines within the organization. External communication covers the interaction with other stakeholders such as the client, residents or subcontractors. This contact is usually between organizations with which it is called intra-organizational communication. In reality, organisational boundaries are constantly changing due to team changes in size and format (Emmitt & Gorse, 2006). This makes it especially important that communication is well established both inter and intra organisational.

Vertical versus Horizontal communication

Vertical and horizontal communication are important for the direction of communication (Zulch, 2014). Vertical communication moves from top to bottom or vice versa. It can be further divided in downward and upward communication. With downward communication the information flows starts at the top and flows down the project levels (Zulch, 2014). Upward communication is this same process but from bottom to top. Vertical communication often takes place between the layers of an organization or stakeholder (Safapour et al., 2019). Horizonal communication involves messaging between people at the same level or hierarchy (Zulch, 2014). It often takes place between peers in organisations, but it also occurs between the same layers of different organisations and/or stakeholders (Safapour et al., 2019). Within the inter- and intra-organisational levels a distinction can then again be made between the horizontal and vertical flows. However, this study chose to leave them out of scope.

Because this research is written from the contractor's perspective in the design process, it was decided to zoom in on the organizational structure that exists there with associated communication levels. The organisation is split up in disciplinary departments. The organizational levels of external parties are deliberately bundled into one. This results in the distinction between three communication levels defined for this study:

(1) *Same department communication:* this includes communication within the disciplinary teams. There is same department communication in the technical management teams, but also in the contract management team and the stakeholder management team.

(2) *Multi department communication*: this includes communication with the other disciplines in the design process.

(3) *Multi organizational communication:* this includes communication with external parties. A distinction is again made here between the client and other stakeholders. The other stakeholders may vary from project to project.

An overview of these levels from the contractor's perspective is shown in Figure 4.
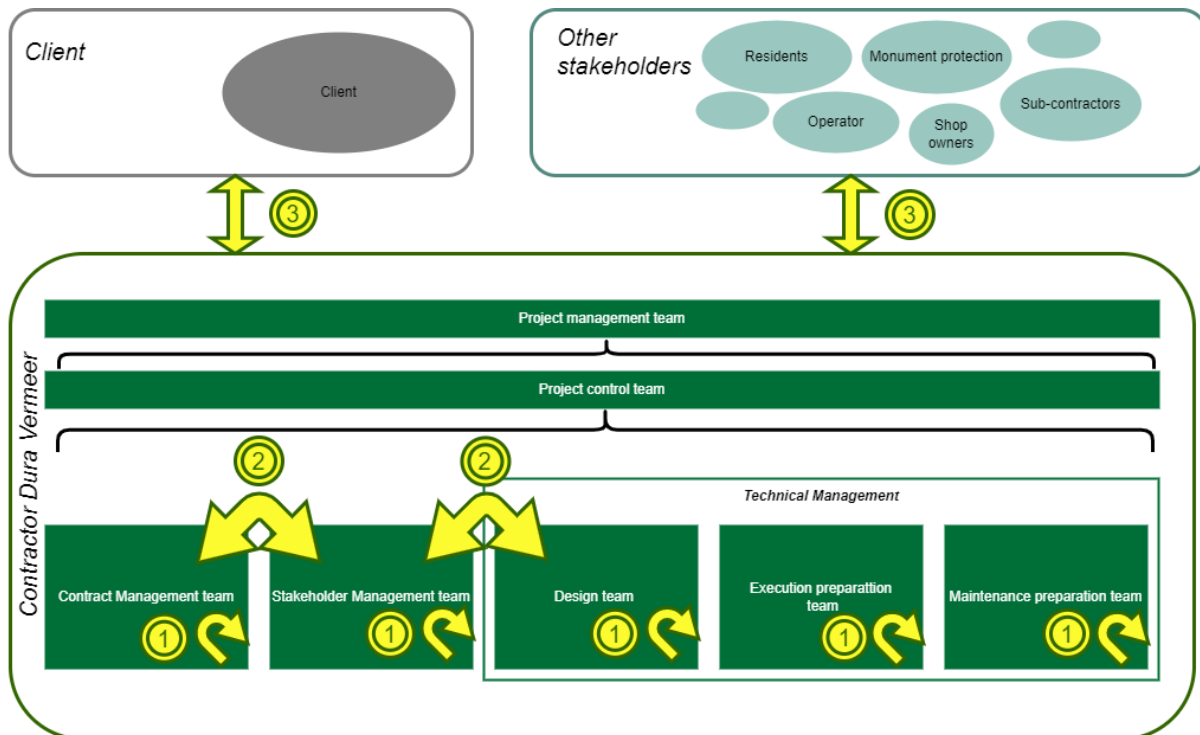
FIGURE 4 COMMUNICATION LEVELS CONTRACTOR (OWN FIGURE)

3.2 Effective communication in engineering and construction projects

The recognition that communication influences project performance began to grow at the end of the last century. Yet there was still much ambiguity on effective communication for project performance. The research of Thomas et al. (1998) has taken an important step in this regard by identifying six critical categories of communication for engineering, procurement and construction projects. In addition, they also determined the share that each of these categories has in determining the effectiveness of communication. This research has since formed the basis of many studies to increase the effectiveness of communication (Cheung et al., 2013; Chinowsky et al., 2008) . An overview of these categories and weights can be found in Table 1.

Category	Description	Weight
Accuracy	The accuracy of information received as indicated by the frequency of conflicting instructions, poor communications, and lack of coordination	2.1
Procedures	The existence, use and effectiveness of formally defined procedures outlining scope, methods etc	1.9
Barriers	Presence of barriers (interpersonal, accessibility, logistics etc) impeding communications between supervisor or other groups	1.8
Understanding	Understanding information expectations with supervisors and other groups	1.6
Timeliness	Timeliness of information received including design and schedule changes	1.4
Completeness	The amount of relevant information received	1.2

TABLE 1 CRITICAL CATEGORIES OF COMMUNICATION (THOMAS ET AL., 1998)

The most critical category of communication is the accuracy of the information received. The accuracy can be indicated by the frequency of conflicting instructions and poor communication. By poor communication is meant miscommunication and misinformation. The second most important category is the existence, use and effectiveness of formally defined procedures. This category focusses on the formal communications. The third category is about barriers. This one is also the most difficult to identify and resolve because personal motives often come into play. In the fourth category of understanding informal communications play a bigger role. It takes more than procedures to really understand what information one needs properly. The bottom two categories deal with timeliness and completeness of the information received.

3.3 Empathy as a concept

Empathy has become an umbrella term over the years, under which many emotions, behaviours and processes are subsumed (Hall & Schwartz, 2019). It originated in the early 1900s as a translation of the German word *Einfühlung* (Titchener, 1909), which started a long period of research into this concept (Eisenberg & Strayer, 1990). Empathy is multidimensional with almost as many definitions as authors in the field. The research of Cuff et al. (2016) did an extensive review of the concept. It is about perceiving, experiencing, understanding, grasping and sharing another's emotional state. With sometimes a response, reaction and action as a result of it. It is about distinction but also merging, instinctive but controlled. Therefore it is no surprise that, to this day, there is no consensus on an unambiguous definition (Cuff et al., 2016; Hall & Schwartz, 2019).

Despite the lack of an agreed-upon definition, there is agreement in literature on the multidimensional nature of empathy (Hall & Schwartz, 2019). A distinction is often made between an affective and cognitive component. Affective empathy is an immediate instinctive emotional response to the emotions of the other (Gasparini, 2015; Kouprie & Visser, 2009). It describes the feelings and

sensations we experience as reaction to others emotions. Cognitive empathy is about the ability of the observer to understand the other person's feelings and imagine the situation from his own perspective (Gasparini, 2015; Kouprie & Visser, 2009). Cuff et al. (2016) describe it as the affective component being the content, and the cognitive component the process through which the content is formed. Although affective and cognitive components can be distinguished, empathy is believed to be about creating a balance between both (Kouprie & Visser, 2009).

Empathy can be seen as the ability to put oneself into the mental shoes of the other to gain understanding. Here, the affective and cognitive components provide the interaction between recognition of the feelings and being able to transform them into understanding. Remaining detached from self and other is important in this process. From the large number of existing definitions of empathy, therefore, one has been chosen in which many converge:

> *"Empathy is the ability to experience and understand what others feel without*
> *confusion between oneself and others"(Decety & Lamm, 2006).*

The process of empathy

The research of Kouprie & Visser (2009) dives deeper into the subject by describing the process of empathy, consisting of four phases. The first phase is about discovery and entering the other persons world. There is a willingness to engage with other's situations and experiences. The second phase is about immersion. This involves actively stepping into the other person's world and seeing it from their perspective. The paper describes it as: "wandering around there". In the third phase connection is important. By reflecting upon one's own experiences it is possible to resonate with the other person and create an understanding. The affective side of empathy will make it possible in this phase to *understand feelings* and the cognitive side of empathy is more about *understanding meanings*. Finally, detachment takes place and it is time to leave the other person's world with an increased amount of understanding. Through discovery, immersion, connection and detachment empathy takes place. The process is shown in Figure 5.
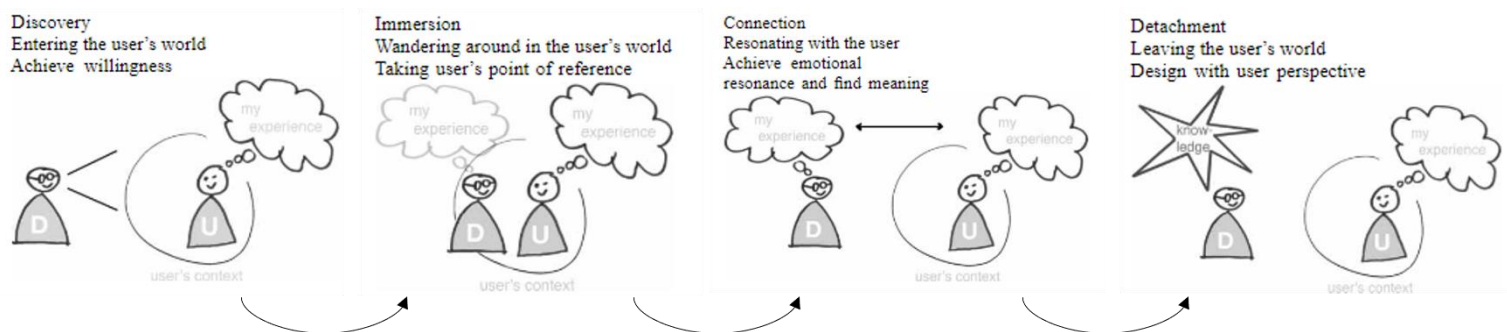
FIGURE 5 THE PROCESS OF EMPATHY (KOUPRIE & VISSER, 2009)

Empathic ability and propensity

It is important to distinguish between the ability and propensity to empathize. "Ability is the upper boundary beyond which a person can no longer generate empathy, and propensity is the tendency for a person to feel empathy in a given situation" (Cameron, 2018). Kouprie & Visser (2009) link the ability to empathize to the so-called *empathic horizon* people have. This horizon is determined by genetic and development factors (Cuff et al., 2016) such as nationality, background, age, gender, culture and education (Kouprie & Visser, 2009). Through training and experience the horizon can change over time with which the upper boundary of empathy shifts. Propensity has to do with to what extent people want to show empathy. Cameron (2018) calls it regulation of empathy and Kouprie & Visser (2009)

mention it as willingness to empathize. Factors that can influence the propensity are for example personal connection and similarity with the other, a person's mood and perceived need for the empathy (Cuff et al., 2016). When talking about empathy, it is good to distinguish between when one does not have the ability to empathize, or has chosen not to express it in that moment.

Empathy vs Sympathy

The concepts of empathy and sympathy have much in common. Consequently, they are often used interchangeably. Yet there is a substantial difference, which has to do with the last part of the given definition above: ".. without confusion between oneself and others". When a person sympathizes with another person, he not only empathizes with his emotions, but he also experiences it (Olinick, 2014). Sympathy is non-objective (Olinick, 2014), uncontrolled and a purely emotional and affective response (Ioannidou & Konstantikaki, 2008). With empathy alone, there remains a certain amount of distance between understanding the other person's emotional state and going through it yourself and taking on the concerns (Chismar, 1988). Empathy is characterized as objective, detached but with a cognitive-affective understanding of the others feelings (Olinick, 2014).

Skills associated with empathy

Empathy is a skill in itself. It is seen as a positive character trait that allows you to learn in life through effective and constructive relationships (Ioannidou & Konstantikaki, 2008). However, underlying this are a number of other qualities associated with empathy. First of all, empathy emerges through listening. Empathy has been shown to influence listening as a communication skill. Instead of merely waiting for a moment to share your own experience in response to the other person, listening is used to really understand what the other person is saying (Ioannidou & Konstantikaki, 2008). This makes your response more thoughtful and improves communication. Another skill is defined by Davis (1980). He indicates that the cognitive side of empathy in particular is associated with good interpersonal functioning and also self-confidence. Over-all it can be said that empathy is often associated with social competence (Davis, 1980).

3.4 The potential of empathy

The competence of empathy exerts influence on people's behaviour. Information was extracted from the literature on current knowledge of the application of empathic behaviour in design thinking, infrastructure projects, and communication skills.

The potential of empathy in design thinking

Bucciarelli (1988) was one of the first to acknowledge design as a social process. He found that the design process is a *social construction* of interpretations of the design coming from different *object worlds*. Meaning that the discourse of the individual disciplines and interests is critical to the quality of the design. The paper of Smulders et al. (2008) elaborates on the implications of the different object worlds in the social process. Each individual carries implicit knowledge of himself and perceptual knowledge of others. By making implicit knowledge explicit and thereby decreasing the perceptual knowledge of stakeholders, a better level of understanding is achieved. There should be two-sided learning: transmitter and receiver must be aware of their own implicit knowledge and that the other has it too from their perspective (Smulders et al., 2008). By communicating in both directions, the knowledge of both increases and mutual understanding improves.

The competency of empathy is believed to be a valuable skill in this. As such, several studies already exist on the positive effects of empathy on design thinking. The research of Kouprie & Visser (2009) presents a framework for empathy in design. The framework is based on gaining knowledge on the user (user-centred design). By stepping in and out of the user's life through the process of empathy one can understand another's background, situation and feelings in order to design the best product for their needs. Köppen & Meinel (2015) focus on the influence of empathy on a key component of

design: understanding the user's needs. Not only cognitive needs but also the emotional experiences when using the product are discovered with empathy. With this knowledge, more value and sense is created in the designs. Gasparini (2015) expands on this in the different dimensions of designerly thinking and how empathy can enhance it. For example, affective or emotional empathy adds to the creativity and innovation of design whereas the cognitive component of empathy helps in problem-solving and the creation of meaning in the design.

The potential of empathy in infrastructure design

In the academic field, little has been written about the effects of empathy on the performance of infrastructure projects specifically. One of the few search hits was the article by Durdyev et al. (2018). They showed that empathy has positive influence on client satisfaction in infrastructure projects through understanding of their needs and personalized attention. Secondly, the paper of Butler & Chinowsky (2006) identifies empathy as a key component of the emotional intelligence needed by leaders in the construction profession. It is noted here that this is at least as important as the classical intelligence and experience that contributes to the development of tomorrow's leaders. However, Batelaan's (2021) recent graduate research was the first to directly show that empathy would contribute to project performance, particularly in the relationship between client and contractor and external stakeholders. The design process improves by understanding each other's interests but also by understanding how to communicate with each other in an open way. This is where the article of Hoezen et al. (2006) connects. It gives a first suggestion towards the added value of the factor empathy in construction projects as a solution to the communicative problems that arise there.

Although the existing literature is still scarce on the value of empathy in infrastructure, it can be concluded that the first steps have been taken. Empathy is said to help develop better leaders, achieve higher client satisfaction and ultimately even deliver more successful projects through better communication.

Empathy and communicative abilities

The characteristics of empathy have a great deal of influence on the communication of people (Valente, 2016). Applying the concept of empathy to the construction sector, experiencing and understanding others perspective is crucial for their communication. "If designers and constructors do not experience how their choices affect the use and maintenance of the product, it is difficult to communicate about these topics" (Hoezen et al., 2006). This increases the likelihood of a design that does not meet the client's requirements. Empathy therefore provides the added value in this to understand what you need to communicate about. On the other hand, the way of communication will also improve through empathy. Empathy has been shown to influence listening as a communication skill. Instead of merely waiting for a moment to share your own experience in response to the other person, listening is used to really understand what the other person is saying (Ioannidou & Konstantikaki, 2008). This makes your response more thoughtful and improves communication. Empathy thus seems to be able to add value not only within a design process, but it also affects a process within this design process namely communication. With this, it can be of great value.

4. Results interviews with experts

To get a better idea of what the communication processes entail in specifically an integrated design process, three interviews were conducted with experts from the industry. The experts were all in the position of design manager, which means they are at the head of technical management in the design process. The interview setup can be found in Appendix B: Interview setup and the quotes supporting the results in this chapter can be found in Appendix C: Quotes on success criteria and factors of communication in the IDP from interviews and Appendix D: Quotes on communicational barriers in the IDP from interviews.

As described in chapter 3.1, communication takes place at three levels in the design process: within departments, between departments and with other organisations. At this last level, there is an important distinction to be made between the client and other external organizations. This is also shown in Figure 4. Because the client has an unique role and opinion in the design process, it is conceivable that the communication with this external organization should be handled differently. It was therefore chosen to treat communication with the client separately. With this, the interviews used a total of four levels of communication at which the questions are asked. Finally, the interviewees were also asked about their views on the competency of empathy in the design process. Therefore, the results of this chapter are divided into the following sections.

    4.1 Communication within the teams
    4.2 Communication between different disciplines
    4.3 Communication with client
    4.4 Communication with external stakeholders
    4.5 Added value of empathy in the integrated design process

At each communicative level, questions were asked about what constitutes successful communication with this actor. The information obtained was categorized into *success criteria*, *success factors*, and *barriers*. Success criteria are about: when is communication with this actor successful? Success factors are means to contribute to communicational success. Finally, barriers are aspects that hinder successful communication.

4.1 Communication within teams

When asked about the communication in their current project within their teams, a few things were mentioned. First of all, they mention *understanding* as success criterion for communication. When one understands the interests, views and work of the other, communication was successful. Besides, a lot of answers can be traced back to having a *functioning structure* within the team. This can be seen as both a success criterion as well as a success factor to good communication. However, it was chosen to name it as a factor. The structure makes sure that relevant information is distributed to the right people and that the purpose of consultation becomes explicit.

The interviewees mentioned struggles with their communication as well. *Distance* was mentioned as a barrier for successful communication. Working from home during the COVID pandemic resulted in the loss of much informal communication. While there is a lot of value in that. A second barrier mentioned was forming a new team. In the beginning of projects people still have to get to know each other, and communication is more difficult. Added to this is the fact that the teams are often large. The size of teams was also a barrier according to interviewee (3). It is simply not possible to be in contact with everyone all the time. Finally, it was mentioned that communication in the teams was often difficult due to the different interests of the specialists. They are often more focused on content and do not like to communicate in the group and seek each other out.

Success criteria	Success factors	Barriers
Understanding of interests and views	Functioning structure	Distance Newness Team size Different interests

4.2 Communication between disciplines

When asked about communication between disciplines in one's project, the most mentioned was *being understanding* towards each other. People need to understand each other's interests. If you understand what the other needs and are able to come to 1 workable solution, the communication is successful. What is mentioned in this regard is *clarity of responsibilities and expectations*. When the expectations associated with each person's responsibilities are well aligned, the likelihood of overlap and errors decreases. Clarity on information expectations and responsibilities is therefore essential in the assessment of communicative success.

The interviewees mentioned factors that contribute to communicational success. Taking time for communication is important to really get to know each other and it contributes to better informal communication. Secondly, *physical* presence is mentioned. Being physically present helps in picking up on nonverbal communication better. The next thing mentioned was *asking questions and explain* why you are asking them and how the given information will be used. The last factor is *awareness* that work is being done not only for yourself, but also for others.

The interviewees mentioned struggles with their communication as well. The first interviewee acknowledges that the other disciplines require a lot of interaction. The success of that interaction depends heavily on the people with whom you interact. Poor communicative *competences* of those people were very influential in his project. Secondly, the communication is negatively influenced when people are only focussed on their selves. This challenge for communication is summarized as *egoism.* Lastly, a big challenge in the communication with other disciplines is the time at which they operate. The different disciplines are mobilised at other times in the process. For teams that are at the front of that process it is difficult if they have to wait for information from teams that are not yet set up. *Different peak moments* are therefore the last challenge.

Success criteria	Success factors	Barriers
Understanding of interests Clarity of responsibilities	Time Physical presence Asking questions and explain Awareness of the another	Lack of communicative competences Egoism Different peak moments

4.3 Communication with the client

In the communication with the client two success criteria can be identified from the interviews. *Understanding* once again came forward as important. It was linked here to understanding each other and from there also being prepared to grant each other something. The second aspect can be captured as having *openness and transparency* between communicative parties. When communication is open and transparent, there will be fewer hidden interests to the detriment of effectiveness and efficiency. In addition, there is more room for constructive relationships and clarity in tasks and requirements.

The interviewees mentioned several success factors that contribute to communicational success. *Awareness* was mentioned. Being aware that both parties come from different worlds helps. Also

frequent communication helps to find each other and keep the conversation going. *Physical presence* is again mentioned to stimulate informal communication and talk about problems. Lastly, having *multiple communication means* is mentioned as a success factor for communication.

Several challenges exist in the contact with the client. First of all, *physical segregation* of the people representing the client and the contractor made it difficult to communicate. In addition, it is noted twice that the *different interests* create communicative challenges. Each organization has their own motivations that sometimes need to be kept hidden. Those motivations influence the communications heavily. *Capacity* problems within the client organization caused communicative problems in one project. There were not enough people from the client involved in the project. This was at the expense of communication which reduced the accuracy and completeness of information. Lastly, a lack of informal contact caused problems. This lack came on the one hand from *physical distance* due to the pandemic and on the other hand from *lack of familiarity* with each other.

Success criteria	Success factors	Barriers
Mutual understanding Openness & Transparency	Awareness of the other Frequent conversation Physical communication Having multiple means	Segregation of staff Different interests Capacity Distance / Unfamiliarity

4.4 Communication with external stakeholders

A first criterion of successful communication with external stakeholders is *clarity.* Communication with stakeholder is successful when there is no ambiguity about the agreements that are and have been made. Secondly, one interviewee mentioned *understanding* again. When there is a full understanding of where the other person is coming from, room for compromise is created.

The interviewees also mentioned success factors that contribute to successful communication. The first success factor mentioned was having *good documentation.* It helps because then it is always possible to fall back to the agreements made earlier. Secondly, *frequent conversation* is mentioned. Involving the stakeholders into the conversation frequently helps in validating their requirements. *Broad communication* refers to the stakeholder conversation partners. Not only the stakeholder manager should be communicating to them, but from the whole project conversation is helpful. Lastly, it is helpful to *explain intentions.* Explaining what is done and why it involves the stakeholder is very helpful in making the communication successful.

Communicative challenges regarding stakeholders were often related to the different interests. External stakeholders again have different interests than the client. As a result, a great deal of communication was required to represent the interests of the stakeholders within the limits of the contractual agreements with the client. Their own interests, hidden or not, greatly influence the necessary communication. Finally, it was mentioned that as a contractor it is often difficult to communicate with external stakeholders because they are not in the same 'system'. It requires becoming part of their (experienced) world before they can be set in motion. Here, the fact that the parties have *different backgrounds* hinders communicative success.

Success criteria	Success factors	Barriers
Clarity on agreements Understanding of viewpoint	Record-keeping Frequent conversation Broad communication Explain intentions	Different interests Different background

4.5 Added value of empathy in the integrated design process

In the interviews conducted with the experts, they were also asked if and how empathy could contribute to communication in the design process. The supporting quotes to the findings all have the interviewee's number in bold.

The experts immediately agreed when asked if empathy could be of importance in the integrated design process.

Is empathy of importance in communication during the design process?

> *"That understanding of each other that I put under the heading of empathy for a moment, that is incredibly important to make success." (1)*

> *"I think empathy is necessary in everyone." (2)*

> *"I do think empathy can contribute something yes." (3)*

When asked who should have empathy, they also all gave the same answer. In fact, a certain degree of empathy should be shown over the entire design process. Both with the contractor, the client and the external stakeholders.

Who in the integrated design process should have empathy?

> *"Having empathy applies everywhere, it is important that the content designers understand from each other what is needed but in addition that we from the clients understand what they are playing with." (1)*

> *"I think empathy is necessary in everyone." (2)*

> *"Of course, it contributes to the client, contractor and stakeholders." (3)*

After this, the experts were asked why empathy is so important and could contribute. The answers vary widely. First, an interviewee implies that empathy with people causes one to know more. From that knowledge, it becomes easier to understand each other and improve decision-making. It helps to *sense* what the other person is dealing with from a gut feeling. Then it is possible to take action sooner. It also helps to improve cooperation by better *understanding* why the other person is doing what they are doing at that moment. One interviewee mentioned the power of *proactive thinking*. Instead of rejecting someone because you cannot yet provide the right information, think along in what you can already do for the other person.

Why is empathy important and how can it contribute?

> *"It helps if people know what's going on, to keep understanding it." (2)*

> *"A minimal dose of empathy must also be there to be able to assess what the other person is struggling with to see: he is worried about this" (2)*

> *"Making decisions together goes 10 times easier with someone whose story you understand and of whom you think I'll grant it to you" (3)*

> *"That certain resignation I was talking about, you're less likely to do that in front of immediate colleagues or when you know how someone else has been working on it." (3)*

"And not necessarily on a personal level, but mainly from the gut feeling of: no, this doesn't sit well with me or I'm fed up with always being addressed like this by the design leader. And that it is important that you can feel each other out in this respect." (2)

"I've noticed that it matters a lot that they understand from each other why they do something at a certain time. And if you have put structure in there that is when the cooperation starts running" (1)

"Being able to say: what kind of input can I already give you because I notice that you need it instead of saying: I can't give that yet because that is not at all what I am doing now". (1)

5. Interpretation of research results part II

In this chapter, the results from literature and the interviews will be interpreted and brought together in answers to sub-questions in 5.1, 5.2 and 5.3. Each section concludes with answers to the first three sub-questions of this study. At the end of the chapter the hypotheses are presented in 5.4.

5.1 Communication in the integrated design process

The model of Thomas et al. (1998) describes six critical categories for communication in engineering, procurement and construction projects for the benefit of project performance. These describe what is needed in communication throughout the project. However, this thesis research focuses on only one part of the project life-cycle, namely the design phase. For this reason, interviews were conducted to find out what is needed for effective communication in specifically the integrated design process.

On all four communicative levels, the interviews revealed that understanding the other person is very important for successful communication. When one understands the other's interests, needs and responsibilities, better communication will be possible. When one understands why someone needs something from you, it will become easier to communicate the right information in a timely manner. In addition, barriers played a major role in successful communication on all communicational levels. New, large teams create unfamiliarity and difficulties to really connect with each other. Physical absence and distance also makes communication difficult. Finally, it was also mentioned that the different interests of actors in the process make communication difficult, especially when they are hidden. In addition, other criteria are mentioned, however, these are not recognized at all levels and it was decided not to include them for the sake of scope and time limitations. In addition, it was chosen not to include the aforementioned factors either. Because these are merely means to achieve successful communication they do not add in the answer to the question of what successful communication in the design process entails. However, they are of value once it is proven that communicative success contributes to the results of the design process.

The interviews show that at least two of the critical categories that Thomas et al. (1998) identify for whole engineering projects also apply to all communicational levels in specifically the integrated design phase. These are: *understanding* the information expectations and the presence of *barriers*. The first category is confirmed by the experts statements on understanding interests and needs. The barriers in the interviews are linked to new, large teams and physical absence and distance. Thomas et al. (1998) further outlines possible barriers into interpersonal, accessibility, and logistical ones. The barriers mentioned by the experts scale well under these. New teams and unfamiliarity can be related to interpersonal barriers; the size of teams to accessibility and physical absence and distance to logistical barriers. It can thus be concluded that barriers, in addition to understanding information expectations, play an important role in communication during the integrated design process.

It is worth mentioning that the interviews say something about the categories understanding and barriers, but not about the other four categories of Thomas et al. (1998). It does not mean that the other four categories are not important, but there is no information retrieved about their role in the process.

The integration of interviews and literature results in the answer of sub-question 1:

SQ1: What does the communication in a fully integrated design process entail?

Communication is needed at all levels of the integrated design process. Four important levels can be distinguished; communication within the own team, between disciplines, with the client and with other external stakeholders. At each level, both formal and informal communication takes place in a variety of ways. Communication can be synchronous, as in meetings and dialogues. But it can also be asynchronous, as in mail contact or documents. Besides, the integrated design process uses both electronic and traditional channels to communicate. These specific perspectives on communication were used during interviews with experts to obtain information about what is important at these levels for communication in the integrated design process. This specific information was connected back to concepts at a higher level of abstraction.

Effective communication in engineering projects is determined by the combination of six categories: accuracy, procedures, barriers, understanding, timeliness and completeness (Thomas et al., 1998). Interviews with experts revealed that at least two of these are important for the success of the integrated design process. It can be concluded that successful communication in the integrated design process has:
-   a good understanding of the information expectations of others
-   few hindrance from barriers in terms of interpersonal relations, accessibility and logistics

If there is a good understanding of information expectations and little communicative hindrance experienced due to barriers, this is an indicator of the overall success of communication in the integrated design process.

5.2 Key characteristics and skills of the competence empathy

The literature review conducted in this chapter provides the opportunity to draw a conclusion on sub-question two of this study.

SQ2: What are the key characteristics and skills associated with the competency of empathy?

Empathy is about the ability to put yourself in the other person's emotional shoes and learn from it. Despite the fact that an exact definition of empathy is difficult to distinguish, there seems to be agreement on its multidimensional nature. Both an affective as a cognitive component can be distinguished in the concept of empathy. Affective empathy is the instinctive emotional response people experience to feelings of the other. Cognitive empathy is more about being able to have an understanding of the other person's emotions.

Empathy can be seen as a skill itself, but it is also the propensity to show empathy that is important. Without the will to show it, there will be little empathy left. When both ability and propensity are present, it is often associated with communicative and social competence. One is better able to listen in communication by which the responses have higher quality and contribute more. In addition, putting yourself in someone else's situation also makes communication more effective. Being able to empathize with another's needs make us better able to meet them. People who score higher on the cognitive side of empathy often have more self-confidence which improves their interpersonal functioning.

5.3 Empathy reflected in the integrated design process

The results of the literature review and interviews with the experts provide the answer to sub-question three.

SQ3: What is the potential of empathy in communication during the integrated design process?

It was shown in Chapter 5.1 that the success of communication in the integrated design process depends on the degree to which one understands the information expectations of the other and the degree to which communicational barriers have hindered communication.

The literature revealed that having knowledge about someone's background helps in understanding what to communicate about. In fact, you use stepping in and out of the other person's life to increase your perceptual knowledge. With more perceptual knowledge, it is easier to know what knowledge needs to be made factual and explicit as well. Making this knowledge explicit happens through communication. So without empathy, one has less perceptual knowledge, which makes converting to factual knowledge and also communication much more difficult. Through this way, empathy then provides better understanding of information expectations.

The barriers that affect communication are often broken down into logistical, accessibility, and interpersonal barriers. The literature has proven that the cognitive side of empathy in particular allows one to function better interpersonally. This should make that barrier less frequent and improve communication. In contrast, logistical or accessibility barriers are more difficult to mitigate with empathy. When communication is difficult due to logistics and or accessibility, it is often externally determined. Empathy, however, can help to better cope with these barriers through increased knowledge and understanding of the other. If managed well, logistics and accessibility issues will be seen less as a problem for communication.

The interviews with experts confirm the potential of empathy in the integrated design process. They indicate that it is important in all parties. It helps to understand what is going on in the other person's life and why they act the way they do, so that proactive communication and action can take place.

5.4 Hypotheses

With the information obtained from Chapters 3, 4, and 5, the following expectation was established:

Showing empathy through better understanding of information expectations and reduction of disturbance due to communicative barriers has a positive effect on the integrated design process of infrastructure projects.

This expectation can be broken down into two parts. First, empathy is expected from the literature to make communication in the integrated design process more successful. This constitutes the first hypothesis H1. In addition, it has been shown from the literature that successful communication ensures better project outcomes. This forms the second hypothesis H2, namely that successful communication leads to better results of the integrated design process. Following the reasoning from H1 and H2, H3 predicts that empathy has a positive effect on the results of the integrated design process. A complete overview of the hypotheses in this study can be found in Figure 6 and Figure 7:

H1	Empathy has a positive effect on communicative succes during the integrated design phase
H2	Communicative succes has a positive effect on the results of the integrated design process
H3	Empathy has a positive effect on the results of the integrated design process

FIGURE 6 HYPOTHESES
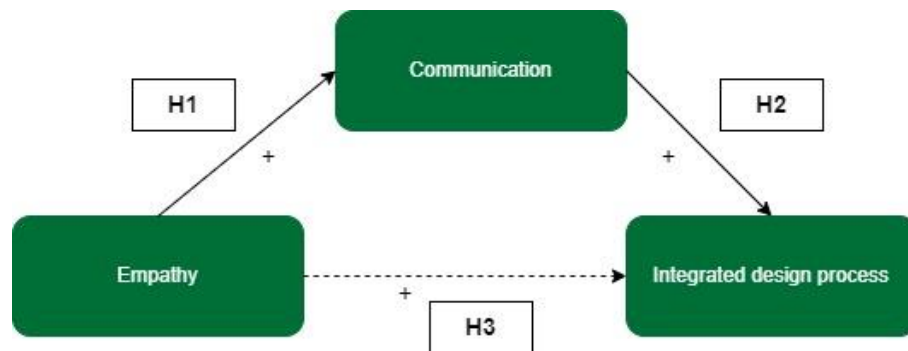
FIGURE 7 CONCEPTUAL MODEL OF HYPOTHESES (OWN FIGURE)

The hypothesis is further delineated in Figure 8. Empathy would influence the integrated design process through communication. Empathy is defined as experiencing and understanding what others feel. This comes from stepping in and out of the other person's life, communicating better, listening better and picking up nonverbal cues, and finally functioning better interpersonally. It is expected that this characteristics will influence the success of communication during the process. From the previous chapters it is found that particularly understanding of information expectations and the ability to cope with communicational barriers is determining the success. Increase of those categories will eventually lead to better performance of the process in terms of time, cost, quality and process interruptions.
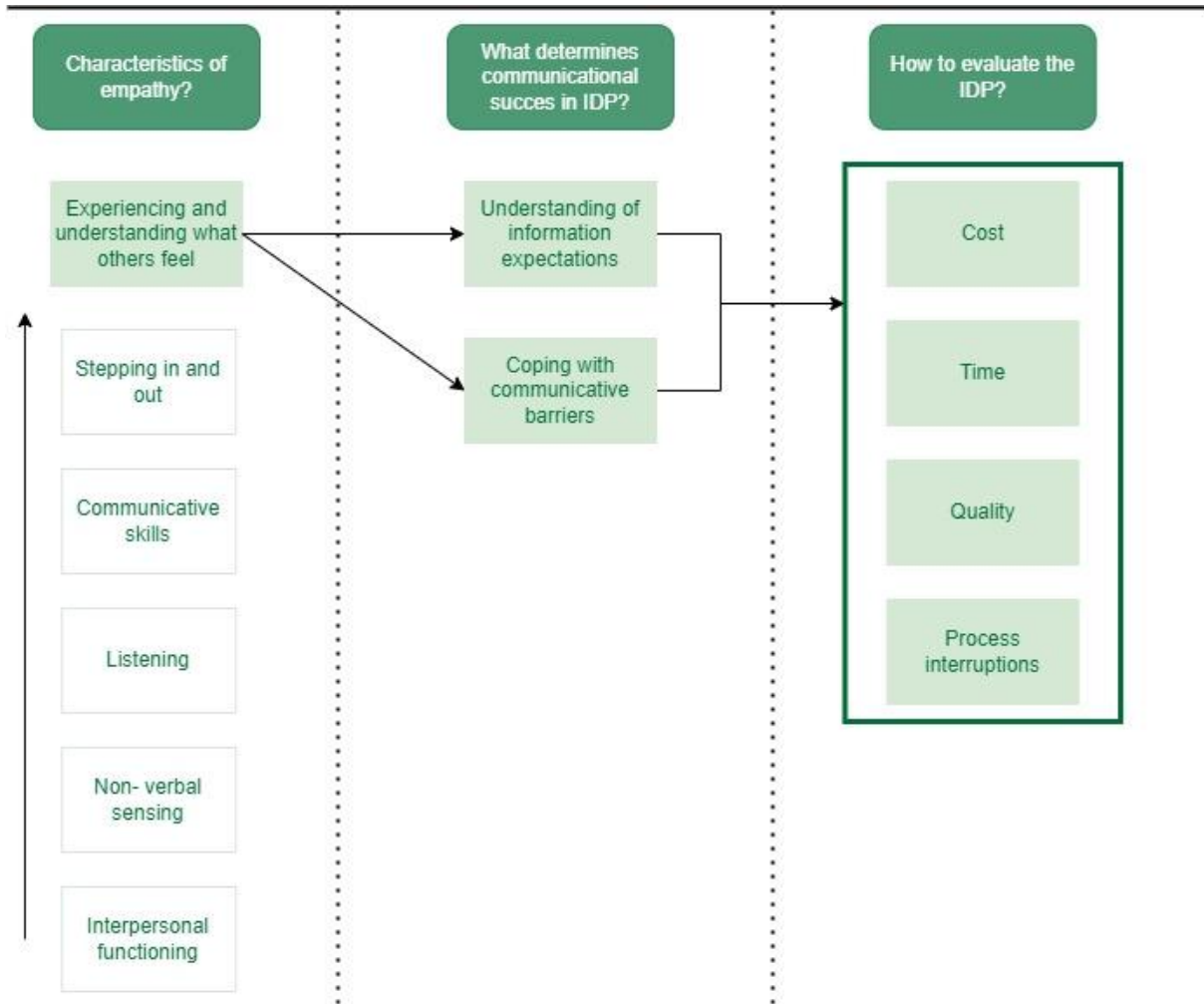
FIGURE 8 DELINEATED MODEL OF THE HYPOTHESIS (OWN FIGURE)

6. Creating the serious game

To test the hypotheses presented in Chapter 5, serious gaming is used. This chapter describes the steps taken in designing the game. First in chapter 6.1 the game specifications are designed. Chapter 6.2 describes the decision process to select the appropriate existing game. In Chapter 6.3 the chosen game is adapted and tested. Chapter 6.4 describes the setup for the game session and Chapters 6.5 and 6.6 add how the quantitative and qualitative data is collected during the session. Finally, Section 6.7 validates the game. Section 6.8 answers sub-question 4 through a conclusion of the chapter.

6.1 Game specifications

Before a suitable game could be chosen, it is important to define what specifications it must meet. From the theoretical background information was gathered on the concepts of the study and the hypotheses. From this, the following artifact specifications follow.

General

AS01: The game should be a physical board game containing physical content

A physical game better fits the system this researching is focussing on because it facilitates simultaneous communication. In addition, the designer does not have the resources to have all participants play a game digitally. The game should therefore be physically playable.

AS02: The game should be playable within an hour

Because all participants are from the field and must attend at the same time, their time is limited. Added to that is the explanation of the research and the game and the debriefing afterwards which also take time. The game itself should therefore not take too long.

AS03: The game must be easy to learn

Since time is limited with the testing group, it is important that the game is not too hard. Not much time is then lost in explaining and learning the serious game. In addition, with an easier game, lack of experience is less likely to play a role.

Communication

AS04: The game should include necessary communication

To test the hypothesis, it is important that participants must communicate to achieve the common goal. The outcome of the game must depend on the success of the communication whereby the communication is therefore necessary.

AS05: The game should include communicational dependencies

To say anything about the degree of understanding of communication expectations, there must be dependencies between the players. Without dependencies, there will be no need or added value of understanding communication expectations and the effects on this aspect will not be able to be measured properly.

AS06: The game should contain communicational barriers

Since the theoretical background has confirmed that communicational barriers are important for effective communication in the integrated design process, this aspect should be covered in the game.

Participants should be tested on how they deal with and try to manage these barriers. The barriers that need to be present in the game include interpersonal, logistic and accessibility obstacles.

Integrated design process
Section 6.5 further explains the quantitative measurement methods. From this, 4 success criteria for the integrated design process follow. These should be implemented in the game, according to the following artefact specifications.

AS07: The game should measure success in terms of cost
AS08: The game should measure success in terms of time
AS09: The game should measure success in terms of process interruptions
AS10: The game should measure success in terms of quality

6.2 Setting up the serious research game – inspiration and approach
With the defined specifications a suitable game was sought. The researcher thought of games that could potentially fit the specifications based on own experiences. Table 2 lists existing board or card games and how they fit the specifications with their current rules.

Artifacts	Settlers of Catan	Kwartet	Hanabi	Wie ben ik?	Jokeren	Dixit	Patchwork
AS01	Y	Y	Y	Y	Y	Y	Y
AS02	~	Y	Y	Y	Y	~	Y
AS03	N	Y	N	Y	Y	~	Y
AS04	Y	Y	~	Y	~	Y	N
AS05	Y	~	Y	~	N	N	N
AS06	N	N	~	N	N	~	N
AS07	Y	N	Y	N	N	N	Y
AS08	~	~	Y	~	~	~	Y
AS08	~	N	Y	N	N	~	~
AS10	Y	Y	Y	Y	~	Y	Y
# Yes	5	5	7	5	3	3	6

TABLE 2 OVERVIEW OF POTENTIAL GAMES AND THEIR SCORES ON SELECTION CRITERIA

The two games that score the highest are Hanabi and Patchwork. These two games were further assessed for their ability to be made appropriate for the research purposes.

Hanabi is a cooperative card game. All participants must work together to place the cards in the correct order and colour in the centre. Giving hints costs money, and laying a wrong card costs a joker. The game ends when the suit pile is empty. The advantage of Hanabi is that all aspects of game success are reflected in the Hanabi game and are easily measurable. In addition, good communication is crucial to the successful running of the game. The disadvantage of Hanabi is that it is purely cooperative and quite complicated. The game has a long learning curve which means that the results of the game can be strongly influenced by inexperience. In addition, the game relies heavily on luck, which can strongly influence the results.

Patchwork is a tactical and competitive board game. Two participants compete against each other in building a patchwork blanket. They do this by puzzling pieces of fabric on the map. The bricks must fit exactly and cost money and time to lay. The game is over when time runs out. The advantage of patchwork is that many of the aspects of the design process are also reflected in Patchwork. It is also easy to play. The downside to patchwork is that it does not require communication in the current rules, and it is purely competitive.

The disadvantages of Hanabi are difficult to manage. It is not easy to also implement a self-interest in the game, and the dependence on the experience of the players and the component of luck can have a great undesired impact on the results of the game. Because Patchwork has no aspect of communication and is purely competitive, it does not seem suitable at first. However, it is relatively easy to modify these features in the game rules. It was therefore decided to continue with the game Patchwork.

6.3 Adjusting the original game

The game that will be played is a version of the existing game Patchwork. Patchwork is a tactical game that is normally played with two players. The current game from 999 games is not yet suitable for use for this research due to its competitive nature, lack of communication, and small player base, among other things. In order to make the game suitable for the subject of this thesis it has been tested several times. For each round of testing, adjustments were made based on the experiences of the players and researcher. This process is described in this chapter. At the end of the chapter, the rules of the game to be played will be presented.

Before the first testing round was played, a few basic rules were already adjusted to fit the requirements of the subject of this thesis. These were the following:

From purely competitive to individually cooperative
One of the biggest changes the game needed was the change from a competitive game to a cooperative game. For this reason, it was decided not to have the players fill their own board with pieces of fabric but to have them form 1 blanket together. The players then have the common goal of creating 1 patchwork in which as many squares as possible are filled with pieces of fabric. In addition to a common goal, it is also important to simulate that everyone has their own part in the project. It was therefore decided that in addition to the common goal, everyone should also meet their individual requirements. For this reason it was decided that each player must have at least X boxes filled on the board.

Including communication (barriers)
In the original game patchwork, it is not necessary to communicate with each other. However, this is necessary to test whether empathy affects communication for the sake of the end result. By having people work together on 1 patchwork, communication is already stimulated. To further stimulate communication, but also make it more difficult due to a barrier, it was decided to have people play separately from each other. The players now all have an empty patchwork board in front of them and, due to a physical barrier, cannot see the boards of the others. It becomes even more important to communicate well so that no boxes are occupied twice. To simulate interpersonal barriers it was decided to let the people playing be unfamiliar with each other. Newness creates a natural interpersonal barrier. Finally, the barrier of accessibility is simulated by the size of the teams. In real-life projects it is often hard to communicate with every team member since the teams are so big. By adding two players to the game, it will become naturally more difficult to communicate equally with all the team members. By playing with many new people on separate playing boards all barriers will be represented in the game.

Including process interruptions
In the original game of patchwork the concepts of time, money and quality are already present. For this thesis research, it is important to simulate process disturbances as well. A process disruption occurs when there is no good communication, and manifests itself when a square on the game board is occupied twice. When this happens, it will be to the detriment of the final product and the result of the game played.

Test round 1: 2 players

The first testing took place with two participants: the researcher and another MSc student. The purpose of this test was to come up with the first rules and to remove the biggest errors from the game. As a result, the following things were decided and/or adjusted.

Action when buying is not desirable or possible
The first obstacle arose in the basis of the steps of play. In the original game, if you don't want to or can't buy fabric, you can choose to move the time stone forward in exchange for money. You must then take the number of steps you need to get ahead of the other player. Because in the new version only 1 patchwork board is built and therefore no other players walk on the road map it is not possible to use this rule. Therefore it was decided to give the players the option to take between 2 and 5 steps instead of buying a piece of cloth.

When one fails to meet the individual requirement
Besides the cooperative goal, each player also has their individual requirement to fill at least X pieces on the tile board. For the first test it was chosen to require at least 18 pieces per participant when played with four. During the first test this requirement was adjusted to 36 because there were only two players. It turned out to be too difficult, and the individual requirements were not met. This resulted in two conclusions. First, there had to be a consequence when the individual requirement was not met. In real projects all parties must also always meet the minimum requirements. If the design team does not deliver a complete design, it cannot be built. Therefore, it was decided to nullify the game results when all did not meet the individual requirement. With this, the individual requirement should be well achievable. It was therefore decided to adjust the minimum number of boxes per person to be filled to 15 instead of 18.

No infinite process disruptions
It was decided to include process disruptions into the final scoring of the game. With this rule it became an option to consciously choose for a process disruption. In doing so, one "trades" process disruptions for quality. The team loses points on process disruptions but gain some on the dimension of quality. However, choosing a process disruption should not be too easy and it should remain undesirable. Therefore it was chosen to allow a maximum of three process disruptions. If the team, accidently or on purpose, has three process disruptions the game results will be nullified as well.

The 7x7 tile does not participate
In the original game it is possible to earn extra money by being the first to complete a 7x7 square on their game board. In the adjusted game this rule has no added value and it was decided to skip it.

Measuring game results on 4 dimensions
The original patchwork game measures game success by counting the money owned at the end of the game and subtracting the number of unfilled boxes. For the purpose of this research it is desirable to let the game success be dependent on the four dimensions of the previously defined success criteria for the integrated design process. Costs is measured through the owned money at the end of the game. Quality is measured through the number of empty tiles on the game board at the end of the game. Process disruptions are measured through the number of times a piece on the game board was occupied twice, accidently or on purpose. Time however was more difficult since in the original game time is represented by a time board where the game ends when the last square is reached. From own experience with the game, it can be said that you basically always need all the time units. Therefore, another way of measuring time must be found. It was decided that people could lose points on the time dimension if they wanted to use more time units. Each extra time unit costs them points.

<u>Buying fabric can only be for yourself</u>
Starting the test game it still had to be determined whether it would be allowed to buy pieces for others in your turn. It was chosen to only use the fabric pieces available for one's own board. This worked out very well.

Test round 2: 4 players

The second testing round took place with four participants: the researcher and her parents and brother. The original patchwork game is designed for two players, so the dynamics were expected to change when added two. This purpose of this testing round was to find out the dynamics and limitations of playing the new game with four people. As a result of this round, the following things were decided and/or adjusted.

<u>The dimension of time should be scored with real-time</u>
The results of the second testing round were very good. When asked what determined their success it appeared that having infinite time gave them opportunity to communicate very precise. The duration of the game doubled compared to the first test round, since with four people communication takes more time. Besides, the concept of "trading" time units for quality appeared to be difficult to achieve and of little value. It was therefore chosen to use real-time as scoring system for the time dimension. It will still lead to a trade-off that can be made between time and process or time and quality, but it will be able to express itself better now.

<u>The factor of luck should be removed</u>
Although the success of the original game is not highly dependent on luck, the pieces of fabric are still randomly distributed around the road map. If the order of these pieces varies from game to game, it may affect the results of the game. It was therefore decided to use the same order of pieces in each game session. This would theoretically allow all teams to play the same game.

<u>Participants need time to align tactics</u>
Playing the game with four people that are not familiar with the game, requires some time to align tactics. If the agreements made upfront are not well aligned, it will be more likely that the game will end due to process disruptions. When that happens, this is not due to a lack of empathy but rather a lack of understanding of the basic rules. When the participants will be scored on their used time, there will be an increased risk of cutting time on the alignment upfront resulting in poor test results. For this reason it was decided to give the participants 5 minutes to align their tactics before the playing time starts.

<u>Familiarity with fellow players is undesirable</u>
The second test round was played with family members that are familiar with each other. It obviously influenced the way of collaboration, which is undesirable. Besides, to simulate interpersonal communication barriers it is desirable to collaborate with new people. Therefore it was decided to include in player characteristics that players should have little familiarity with each other.

<u>Success of the team depends on explanation of the game</u>
When asked the participants what they thought influenced their results, they answered that the explanation of the game was quite determining. The rules are semi complex and the explanation of them might hint at something about good tactics. Therefore it is quite important that all participants receive the same introduction to the game.

<u>Empathy/coordination needed with one person</u>
When observing this testing round the researcher noticed that one person was coordinating the group. After playing a discussion arose on the need of empathy or coordination with all participants. If one

person steps up as leader and arranges all communication, personalities of other players are not involved. There is little that can be done about this, but it was decided to include it in the focus areas for the qualitative data collection. Those results can be included in the discussion if relevant.

Test round 3: 4 players

The third testing round was played again with 4 players. The players were fellow MSc students. The purpose of this game was to test whether the changes made after round two showed positive effects. As a result of this testing round, the following things were adjusted and/or noted.

Time was too short

The second testing round showed that infinite time was most likely a reason for the successful ending of the game. It was decided that time should be a limiting factor, so that it is included in the considerations during the game. The researcher had estimated the time required to be 20-30 minutes. At longer than 30 minutes, the team would no longer score points on this dimension. However, this turned out to be too short, the participants scored poorly because they felt too much time stress. Therefore it was decided to change the allowed time for the participants to 35 minutes per game. After 35 minutes the game is stopped.

Order of fabric pieces determining for success

The participants felt that the order of fabric pieces determined their possibilities for success. However, it is difficult to determine whether this was actually the case. Nevertheless, the researcher will try to look for a sequence of pieces that can produce proven success.

Test round 4: 4 players

The final testing round was played with 4 players. The players were fellow MSc students. The purpose of this game was to test the final version of the game before the actual session. This testing round proved that the chosen sequence of pieces worked and that the new maximum time of 35 minutes was enough. After this round of testing, it can be concluded that the game is ready for the real game session.

The adjusted game

The tests of the game resulted in final adjustments that have been summarized in Table 3. The original game and its characteristics are shown in the first column. The adjustments for the specified area are mentioned in the right column. If there are no adjustments in the right column, this means that there are no changes compared to the original version of Patchwork.

Game element (Duke)	Current version	Adjustments
Scenario	In patchwork, two players compete against each other in making a blanket. They do this by collecting patches of fabric and buttons. The one who has made the biggest piece of the blanket at the end wins.	Four players instead of two. Players must cooperate to make one blanket by putting at least 15 pieces on their individual game boards.
Events	**Programmed:** When a button is passed on the road map you receive money;	

	When a singular fabric piece is passed on the road map you can place it on the fabric map	
Cycle sequence (macro cycle)	1. Introduction to subject of the game 2. Rules of the game 3. Play of the game 4. Debriefing	
Steps of play (micro cycle)	If it is your turn: 1. You can choose to buy one of the three building fabrics in front of the pawn OR you can move your pawn in front of the other player 2. If you buy a fabric; pay -> move your pawn on the road map -> place the fabric on your game board so that it fits 3. If you move your pawn in front of the other; receive money for every step taken	If you cannot or do not want to buy a piece of fabric you can move the time pawn 2-5 places forward.
Rules	- As long as you are behind on the time map it is your turn - If you pass a button on the road map you receive money for every button on your fabric map - If you pass a singular fabric piece on the road map, you can place it on your fabric map - The first one to complete 7x7 on the fabric map receives extra points - When your pawn reaches the last box of the roadmap, the game is finished	- You play clockwise in turns - The 7x7 bonus is deleted from the game - You are allowed to communicate freely - It is not allowed to make notes with pen and paper
Roles	Everybody has the same role.	
Model	Resource allocation; explicitly presented in game materials	

Decision sequence and linkage	All players follow the steps of play. Since there are no differing roles, their decision sequences is the same.	
Indicators	- Progress on the road map - # Tiles filled on the fabric map - Available money pieces	Added: Process disruptions when boxes on the game board are filled twice
Paraphernalia	- Money pieces (1, 10, 20) - Fabric pieces - 2x Game board - Road map - 2x pawn on road map - 1x pawn between fabric pieces - 7x7 bonus	Added: 2x Game board Deleted: 1x pawn on road map 7x7 bonus

TABLE 3 GAME ELEMENTS AND ADJUSTMENTS

6.4 Research setup

To test the hypothesis a serious game was designed. The idea of the game is to have groups of people with a certain capacity for empathy play the game. It will be examined whether the groups scoring high on empathy show different results than groups with lower scores. In doing so, the attempt is to keep other factors the same and thus allow empathy to emerge as the only input variable. In this way, an attempt will be made to confirm the hypothesis. For the execution of the game session, several things have been considered. Participant choices, setup, and procedures during the session are explained in this chapter.

Participants

For this study, participants will be used from an existing course given by Hans Bakker at the TU Delft on management of engineering projects. The 24 participants have expertise in the process industry and differing working experience.

The advantage of having the participants of the course as a sample group is that they do not know each other well, but have many similar characteristics in terms of background knowledge, education level, and age. Beyond empathy, other personality characteristics can also greatly influence participants behaviours. By choosing a homogeneous group, influences of personal characteristics are somewhat equalized. Besides, gender diversity in the group is also helpful. From literature it can be concluded that woman have higher empathy levels than men (Baez et al., 2017). A mixed participant group in terms of gender therefore increases the likelihood of varying empathy levels.

A disadvantage of using the participants of the course is the lack of natural diversity. From a real-world perspective, it is easy to imagine that it is more difficult to communicate and empathize with people who have a completely different background and/or function. This is part of real infrastructure projects and a big part of the problem. According to the hypothesis, empathy might contribute more here than when, as now, empathy toward like-minded people is looked at. Because it is important that empathy be filtered as an input variable, it was decided to choose a homogeneous group anyway.

Game setup

The original game of Patchwork is played with two players. For the adjusted version it is desirable to include more players since this will simulate communicational difficulties better. However, since one of the rules is not to see each other's game boards, it becomes logistically difficult to play with more than four players. In addition, the game also becomes a lot more complex when more players are added. It requires even more communication and coordination, making the game too complicated. It is therefore decided to play with a maximum of four players per session.

As mentioned before, 24 participants will be used from the course of Hans Bakker. These people are available at the same time for a 2-hour time slot. When divided in teams of four, this would mean that six identical gaming sessions will take place simultaneously. Since the researcher is not able to be at six places at the same time, it is necessary to include extra facilitators. The facilitators will come from the researcher's network and will be properly instructed in advance. They are not informed about whether or not their team is empathic beforehand. By using the same observation forms to measure results, the influence of personal perception of the facilitator will be reduced as much as possible for the quantitative data collection. Proper instructions and game recordings will be used in order to minimize subjectivity in qualitative data collection.

The decision was made to have the participants play the game only once. This is due to the fact that learning effects occur after playing the game. Participants will be influenced by their experiences from the first time, which will cloud the results of a second time. It is no problem if the participants have experience with playing the original Patchwork game. The game has been modified to such an extent that experience with the original game is expected to have only a small or no impact on the results.

Game session procedure

Before participating in the game-session, the participants are asked to fill in the IRI test of Davis (1980) to measure their empathy scores. This will be done via an online survey tool to increase the convenience for participants. This will increase their willingness to fill out the survey, and the researcher will have the results immediately available. To waste little time during the game session, the researcher will create groups in advance based on empathy scores. To avoid ethical risk, it was decided to make two groups, selected for empathy. The 12 people with the highest scores will be in group 1 and the 12 people with the lowest scores will be in group 2. Within group 1 and 2, people are then randomly divided into groups of 4.

During the game session, all groups will be given a plenary introduction and explanation of the game. To ensure that participants demonstrate as much natural behaviour as possible during the game, the hypothesis of the study will deliberately not be mentioned yet during the introduction. The participants have been involved in course activities all day, so to get them into the game and research, the introduction will revolve around a so-called cover story. A fictional story will be devised about a real-life project that they must complete together. This is done so that the players become absorbed in the game and get some background on what they are about to do.

It is very important to explain the game plenary to ensure that everybody has received the same information prior to the game session. Additionally, the groups are provided with written instructions and an overview of the success determinants. Especially when playing the game for the first time, it is helpful that the participants can read the instructions again and are able to look them up in case of confusion. The participants are allowed to communicate freely during the game with each other. In case of emerging questions they are also allowed to ask questions to the facilitator.

After the game is finished, the post-game data collection will take place using an analogue survey. The participants will receive identical question forms on their experiences and opinion of the serious game.

It is important that they complete them individually and there is no consultation on the questions. During this moment, the facilitator will also complete the observers questions form and documentation. After finalizing the forms, there will be time to discuss the game and experiences with the facilitator and other participants. The facilitator will write down the most important things about this discussion as part of the qualitative data collection.

6.5 Quantitative data collection

This section explains the quantitative data collected in the serious game. This was done using the conceptual model given at the end of Chapter 5. The three main aspects from the hypothesis need to be operationalized in the game. This means looking for measurable variables for empathy, communication, and the integrated design process.

Measuring empathy

The fact that the literature does not yet have a unified definition of empathy is also reflected in the different measurement techniques that exist for empathy. The research of Batelaan (2021) has studied the different methods one can use through self-reporting. Four commonly used techniques were compared: the IRI test (Davis, 1980), the Empathy Quotient test (Lawrence et al., 2004), the Empathy Scale test (Hogan, 1969) and the QMEE test (Mehrabian & Epstein, 1972). The comparison is shown in Table 4.

Test	Advantages	Disadvantages
IRI test (Davis, 1980)	▪ Validated Dutch translation available ▪ Widely used ▪ Distinction between cognitive and affective empathy ▪ Short test ▪ Comprehensive in how it measures empathy	▪ Not always clear if it measures solemnly empathy or also sympathy ▪ Some items may assess someone's imagination or emotional self-control and not empathy
EQ test (Baron-Cohen & Wheelwright, 2004)	▪ Widely used ▪ Filler questions to distract the respondent from empathy	▪ Long test ▪ No distinction between cognitive and affective empathy
EM Scale test (Hogan, 1969)	*No specific advantages found*	▪ Long test ▪ No distinction between cognitive and affective empathy ▪ Not clearly a test to measure empathy, but more a measure of social skill
QMEE test (Mehrabian & Epstein, 1972)	▪ Short test ▪ Wider answer scales for more spread in the collected data	▪ It can be questioned if the scale as a whole completely measures empathy ▪ Dimensions don't clearly relate to a theoretical structure of emotional empathy

TABLE 4 EMPATHY TESTS ADVANTAGES AND DISADVANTAGES (BATELAAN, 2021)

From the analysis of Batelaan (2021) it could be concluded that the IRI test of Davis (1980) showed the most potential for use in research in the infrastructure sector. This is mainly because this test distinguishes between cognitive and affective components and it is also available in Dutch. In addition, there are many and clear explanations about how this test measures the dimensions of empathy. It was therefore chosen to use the IRI test in this study as well. It will therefore be the only one further explained.

At the time Davis (1980) designed his test, more and more was known about the distinction between the affective and cognitive sides of empathy. This distinction was just not reflected in the measurement techniques for empathy until then. That is why Davis (1980) has delved further into dimensions of empathy in the development of a new multidimensional individual difference measure of empathy. The measure not only had to be easy to administer and score, but also both the dimensions of the cognitive and affective (emotional) needed to be captured. Ultimately, his so-called IRI test distinguishes between four scales (Davis, 1983):

(1) **The fantasy scale (FS)**
This can be described as the tendency to imaginatively transpose oneself into the feelings and actions of fictional characters in books, movies or plays.

(2) **The perspective-taking scale (PT)**
This can be described as the ability to shift perspectives and adopt the point of view of other people in daily life.

(3) **The empathic concern scale (EC)**
This can be described as the tendency to experience 'other-oriented' feelings of sympathy and concern for unfortunate others.

(4) **The personal distress scale (PD)**
This can be described as the tendency to experience 'self-oriented' feelings of personal anxiety and unease in tense interpersonal settings.

Later research of Davis (1983) validates his scales by linking them to psychological measures and other measures of empathy. It appeared that the PT scale correlates positively with interpersonal functioning and self-esteem. Meaning that people that score high on the PT scale will be able to have smoother and rewarding relationships with others, resulting in better social functioning. Better scores on self-esteem is a logical consequence of this. It also scored high on Hogan's test (1969) which measures cognitive aspects of empathy in particular. The EC and FS scales have no consistent correlation with social competences but more so with emotional reactivity. They therefore both bear high similarities to the more affective test of Mehrabian & Epstein (1972). The PD scale shows the same correlations as the PT scale with interpersonal functioning and self-esteem but negatively. It also scores higher on similarity with the Hogan (1969) test, although this seems to be mainly due to the link with social competencies measured in that test. Similarity of the PD scale to Mehrabian & Epstein (1972) remains lacking, this is explained by the lack of self-oriented feelings due to empathy in that test. Thus, the dimensions distinguished by Davis (1980) have been validated on both cognitive and affective aspects of empathy.

Although Davis (1980) managed to distinguish four separate scales that all concern responsivity to others, he points out that it is time to recognize that empathy is a collection of these individually proven truths in the form of dimensions (Davis, 1983). The author stresses the multidimensional character of empathy and the four scales together reflect a collection of the reactions to others that were once seen as empathy (Davis, 1983).

Measuring communication variables
In the theoretical background, it was discovered that understanding information expectations and the presence of communication barriers are important to the success of communication during the integrated design process. Therefore, the influence on these two categories must be measurable in the serious game.

Understanding information expectations:
Understanding information expectations is difficult to measure. Thomas et al. (1998) give sample communication questions in which this dimension is addressed. A person could be asked: "How well do you understand what information your supervisor and other groups on this project expect from

you?" (Thomas et al., 1998). In this research, such questions will be asked in the post- game survey. Through a rating system of statements their understanding will be tested quantitatively. Besides, the facilitator is asked to form an opinion on understanding. To support unity and prevent personal biases, they will also quantitively score the communication. Both participants as facilitators should rate the statements on a Likert scale of 1-5.

Presence of barriers:
The presence of barriers refers to the extent to which participants suffered from interpersonal, logistical, or accessibility issues during their communications. This is measured by a survey at the end of the game asking them through statements if the previously mentioned factors hindered their communication. The observer is also given statements about the team's ability to move beyond communicative barriers. The statements should be rated on a Likert scale of 1-5.

Measuring the result of the game

Many projects in infrastructure are judged on how they score on the factors of the iron triangle (Pollack et al., 2018). The theory behind iron triangle is well established and tells that projects are successful when they are delivered within *time* and *costs* with the right *quality*. But these factors say nothing about how the process went during the project, while this is often important as well. Because this research focuses on the outcome of a process, the number of *process disruptions* is important to include.

> *"The journey is more important than the destination" – From the Alchemist* (Coelho, 1998)

The result of the game will be determined on how well the participants score on all of the success criteria. This means that each team, at the end of the game, has 4 scores that can be compared.

The dimension *cost* is measured based on the total number of coins the team has gathered at the end of the game. *Time* is measured in the real play time in minutes. The dimension of *quality* is rated on how many empty tiles the group has left at the end of the game on their combined board. Finally, points are given for the *process.* When no tiles are occupied twice, accidently or on purpose, the team scores best on this dimension.

6.6 Qualitative data collection

Since the game is played with only 6 teams it is even more important to keep a close eye on what is happening during the play sessions. For this purpose, in addition to quantitative data, qualitative data is also collected. When looking at the three variables to be measured in this study, the qualitative data collection will focus particularly on the communication processes. This is broken down into two moments, what happens during the game and what happens after the game. Both data collection moments will be elaborated in this section.

During game data collection

During the game play things happen that cannot be captured in quantitative propositions. It is up to the facilitator/observer to notice and note these events. When looking specifically at the categories of communication sayings or actions may stand out. For example, when considering the interpersonal communication barrier of playing with unfamiliar people it is typical whether people take the time to introduce themselves to each other and to which extend they do this. Notation of such events provides the researcher qualitive data on how the participants handled this communicational barrier. The facilitators will be given a list of points of attention when observing the game. The points of attention can be found in Appendix E3. In addition they are free to write down any other notable events.

Post-game data collection

After the game has finished, the participants will fill in the post-game survey first. The post-game survey can be found in Appendix E2. It is very important that they postpone the after talk and joint evaluation until after the surveys are completed. After the surveys are collected by the facilitator there is room for a post-game discussion. On the one hand, because the researcher's experience has shown that participants have a great need to chat and share their experiences, and on the other hand, because there is a lot of qualitative value in this. During this discussion the facilitator will again have some attention points and is allowed to join in the discussion. When the facilitator shares its main observations, this gets participants thinking about why they exhibited certain behaviours. Not only can important information be obtained from this for the purpose of the hypothesis, but it also provides a lot of information about other factors that may have influenced the game. This is good for the researcher to include in the results and discussion.

Finally it is worth mentioning that the researcher will ask permission to the participants to record their sessions. This also allows the researcher to listen back to the other sessions when questions arise from the surveys and observation forms from other facilitators.

6.7 Validation of the serious game

The designed serious game must be validated. The concept of validation has been applied specifically to the method of gaming by Peters et al. (1998). They base their work on an earlier work by Raser (1969) who lists four validity aspects that are important for a serious game used for research purposes: psychological reality, structural validity, process validity and predictive validity. The validity of the serious game patchwork will be proven based on these aspects.

Psychological reality requires the players to regard the simulated environment as realistic (Peters et al., 1998). Players were not asked how they found the simulated environment compared to reality. Therefore, nothing can be said about this validity criterion.

The second criterion for validity is *structural validity*. This refers to the extent to which the elements of the reference system and their relationships are reflected in the game model (Peters et al., 1998). The integrated design process (reference system) is defined as a process in which complexity occurs and integrated working is therefore necessary. The fact that several people have to make their own contribution to the joint design in the game with both an individual as well as a collective goal creates complexity. Thus this element is covered in the game model. In addition, the technical criteria of an integrated design process are reflected in the serious game. By observing the performance on time, money, quality and process, the success of the design process is measured. The structural validity is therefore high.

The third criterion is *process validity*. Process validity refers to the extent to which the process in the reference system is similar to the game model (Peters et al., 1998). This specific study is particularly concerned with communicative processes. The participants were asked at the end of the game session to what extent they found the game similar to the reality of communicating in projects. The answers varied. Explanations given for negative answers are that the game was aimed at bringing information, where in real projects information often has to be obtained. In addition, it is mentioned several times that communication in real projects is strongly influenced by different interests. In this game the different interests were represented only by separation of an individual and common goal. However, the individual goals were all the same which made the game much clearer but also easier. The game was very much focused on synchronous face-to-face communication. In reality, one also has to deal with electronic and asynchronous information, which makes communication more difficult. All in all, however, people judged the realism of the communication in the game with a 3.5 out of 5 which is a positive number. In addition, communicative barriers based on reality were implemented in the

game. The interpersonal, logistical and accessibility difficulties are similar to reality. All in all, it can be said that the game scores good enough on process validity.

The last criterion is *predictive validity*. This says something about the accuracy of the outcomes of the game and the extent to which something can be said about what really happens in the reference system (Peters et al., 1998). Because the designed serious game in this study is a highly simplified representation of reality and many other factors also play a role in the reference system, the predictive validity is estimated to be low. However, because this is a deductive research, the aim is not to predict the reference system but to test an existing theory, with which the lower predictive validity is less of a problem.

6.8 Conclusions chapter 6

The activities in chapter 6 have resulted in a presentation of a serious game to research the hypothesis presented in chapter 5. This allows for an answer to the fourth sub-question of this study:

SQ4: How can the communication within the integrated design process be simulated to research the influence of empathy?

For the simulation of the integrated design process, ten artefact specifications have been drawn. These describe what the simulation must meet, both in practical output and theoretical concepts. Based on this, it was found that the existing game Patchwork from 999 games had the most potential to serve as a simulation tool. With adjustments to implement communication, communicational barriers and need for cooperation, the game was made suitable for this research.

During the game session 24 participants will be playing the serious game in groups of 4. Prior to the game session the participants will be asked to complete the IRI empathy test to determine their empathic abilities. Based on this, teams are formed on high and low empathy scores. Because all other characteristics are as similar as possible, empathy will serve as a varying input variable. By playing the game it will be examined whether the high empathic teams perform differently during the game than the low empathic teams. With those results, the influence of empathy on the integrated design process through communication will be investigated.

Both quantitative as well as qualitative data will be gathered to analyse the behaviours that occur in the game sessions. Participant and observer surveys will be used for quantitative purposes and observations of the game and group discussions will serve as input for the qualitative data collection.

Finally, the validity of the game was examined. On structural and process validity the game scored well. The predictive validity is low because of the highly simplified version of reality. However, due to the deductive nature of this research this is not a major problem. All in all, it was concluded that the game is sufficiently valid.

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7. Research Results Serious game

In this chapter the results of the game session will be presented. First, the quantitative research results will be presented in 7.1. Secondly, the qualitative research results will be shown in 7.2. Chapter 7.3 will integrate the quantitative and qualitative results with which an answer to sub-question 5 can be formed.

7.1 Quantitative research results

This chapter will describe the quantitative results collected during the serious game. The chapter is divided in results on the participants including their empathic abilities, the communication experiences from both participant as observer, and the results of the game in final scores.

Participants

A total of 6 game sessions were played with 24 participants from the process industry as part of a multi-day course they were taking. The game sessions therefore all took place at the same time and in the same room. All participants completed a survey in advance from which their characteristics could be extracted. The completed surveys did not have any missing values.

As shown in Figure 9, the test group consisted of more males than females. This did not pose a problem for the study. Figure 10 and Figure 12 show the age and work experience of the group. This is to some extent correlated. It can be concluded that the group was relatively young. Finally, Figure 11 shows the educational level of the group. The group all had a completed at least a higher professional education.
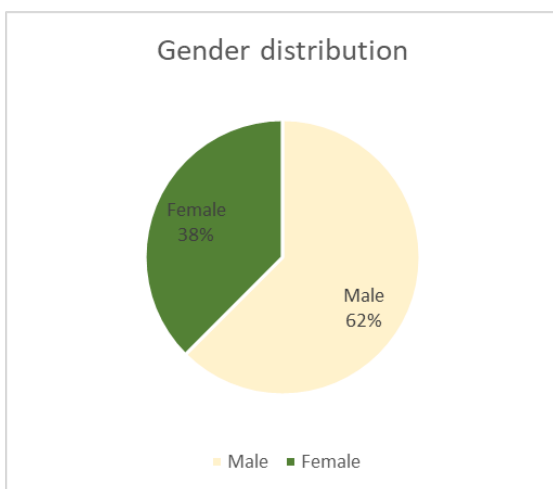
FIGURE 9 GENDER DISTRIBUTION TEST GROUP
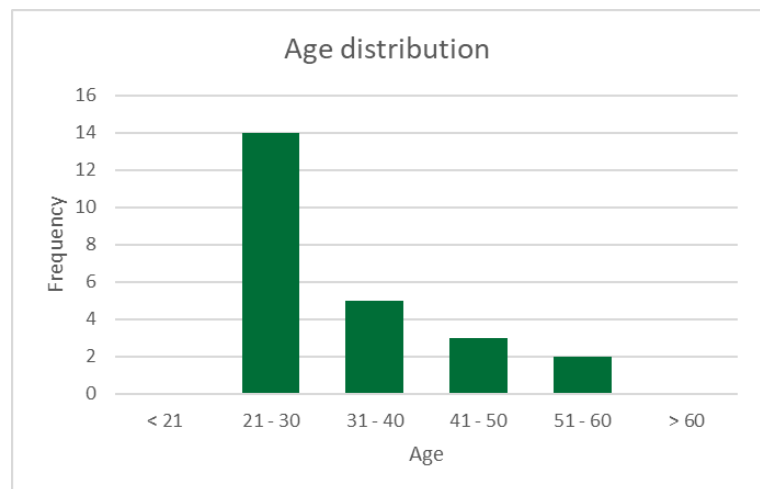
FIGURE 10 AGE DISTRIBUTION TEST GROUP
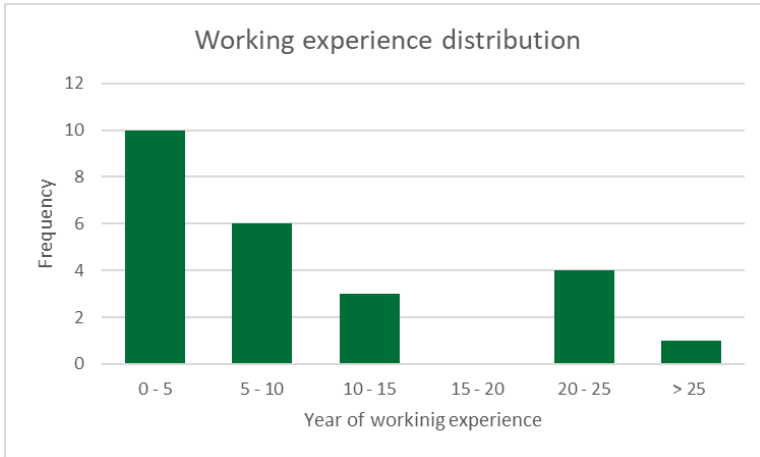
FIGURE 12 WORKING EXPERIENCES TEST GROUP
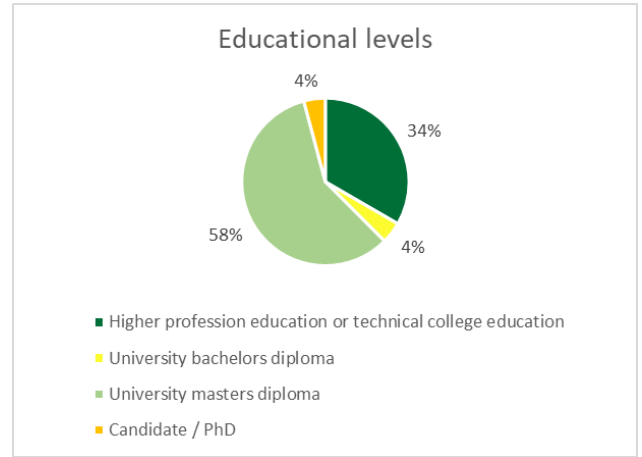
FIGURE 11 EDUCATIONAL LEVELS TEST GROUP

Participants empathy scores

In addition to general background questions, the pre-game survey was conducted primarily to determine participants' empathy scores through the IRI Davis empathy test. The IRI Davis test consists of 28 statements, which can be rated on a scale of 0 to 4. Scoring with 0 means that the statement does not describe the participant at all and scoring a 4 means that the statement describes the participant very well. Adding up these points gives a total empathy score.

Figure 13 shows the total empathy scores of the test group, broken down by men and women. Here it is clear that the women score higher on average. Empathy scores are also broken down by age and work experience. However, there was no clear correlation between these. The test group was also too small to really identify correlations in this.
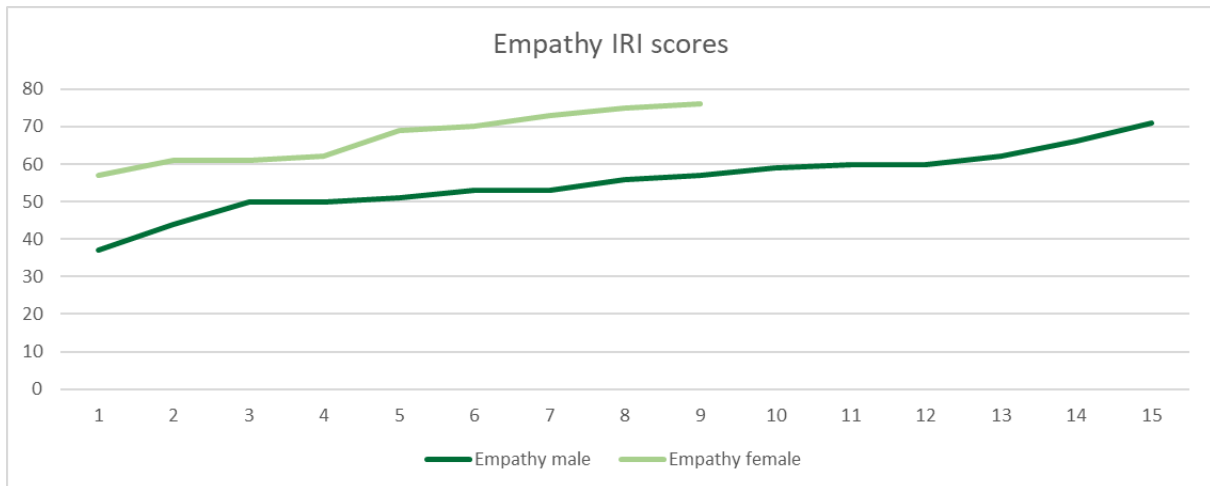
FIGURE 13 EMPATHY SCORES TEST GROUP

Based on the empathy scores the design teams were formed by the researcher. The plot in Figure 14 shows the distribution of empathy scores and the median. The lowest score measured was 37 and the highest score was 76. At the median of 60, the group was split into two creating a group with lowest empathy scores and a group with the highest empathy scores. These two groups were again split into groups of 4. This created 6 groups, 3 with lower empathy and 3 with higher empathy. Individual empathy scores of the participants in the *low* empathy teams can be found in Table 5. Individual

empathy scores of the participants in the *high* empathy teams can be found in Table 6. For each group the average scores were calculated in the highlighted columns. In this column, outlining also shows the most dominant dimension. It should be noted here that due to the lower empathy scores of the men, the low-empathy teams consisted mostly of men and the women were in the higher-empathy teams.

What is notable is that the low empathic teams predominantly achieve their highest scores on the PT scale. The PT scale is linked to the cognitive empathy skills. The higher empathy teams score also on the FS and EC scale predominantly high. The EC scale, along with the PD scale, is associated with the affective empathy skills. Absolutely the largest differences can be seen in the FS and EC scale between the low empathy and high empathy groups. The differences on the PT and PD scales are smaller. It can be concluded that the differences between the low and high empathy scores are mainly explained by the associative side of empathy. The cognitive empathy skills of both groups are closer to each other.
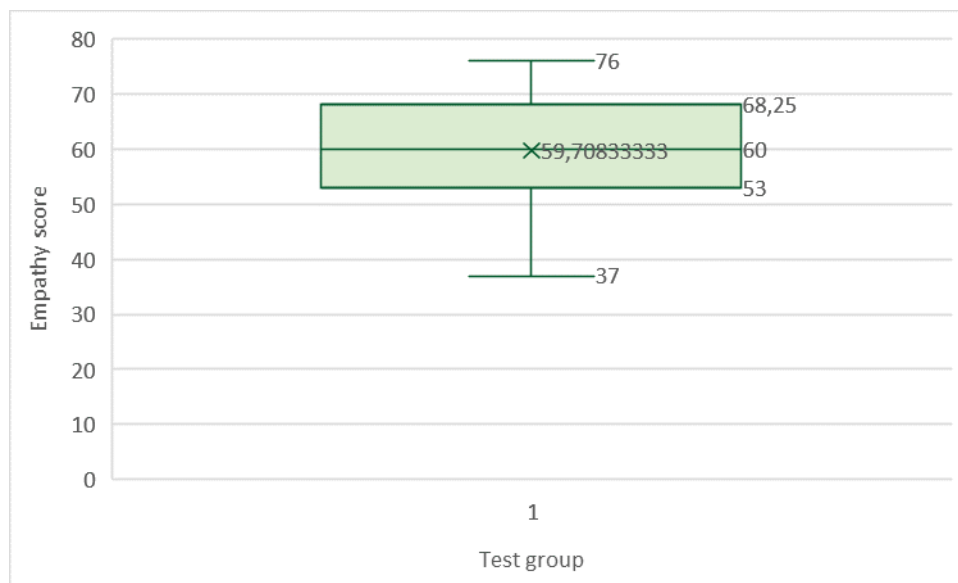
FIGURE 14 BOXPLOT EMPATHY SCORES TEST GROUP

Participant	Group 1 #1	#2	#3	#4	Avg.	Group 2 #1	#2	#3	#4	Avg.	Group 3 #1	#2	#3	#4	Avg.
Total empathy score	37	44	51	50	45,5	53	53	56	50	53	59	60	57	60	59
FS scale	4	14	14	10	10,5	14	8	12	11	11,25	13	14	10	13	12,5
PT scale	17	11	19	15	15,5	14	22	15	18	17,25	14	20	19	20	18,25
EC scale	11	9	12	12	11	12	17	17	13	14,75	15	14	16	18	15,75
PD scale	5	10	6	13	8,5	13	6	12	8	9,75	17	12	12	9	12,5

TABLE 5 EMPATHY SCORES LOW-EMPATHY GROUPS

Participant	Group 4 #1	#2	#3	#4	Avg.	Group 5 #1	#2	#3	#4	Avg.	Group 6 #1	#2	#3	#4	Avg.
Total empathy score	66	62	57	71	64	70	76	73	61	70	62	69	61	75	66,75
FS scale	21	8	20	20	17,25	12	19	22	17	17,5	16	23	14	14	16,75
PT scale	18	19	16	23	19	21	18	22	11	18	19	17	22	22	20
EC scale	15	22	13	19	17,25	24	24	21	19	22	18	16	23	23	20
PD scale	12	13	8	9	10,5	13	15	8	14	12,5	9	13	2	16	10

TABLE 6 EMPATHY SCORES HIGH-EMPATHY GROUPS

Communication

Both the participants as well as the observers were asked to form an opinion on the communication during the serious game. This paragraph will show the results of their quantitative opinions.

Participants

The participants were asked to complete a post-game survey on their experiences during the game. The survey consisted of statements to be rated on a Likert scale of 1-5. The statements involved both the communicational barriers as understanding of information expectations. It should be noted that the value of participant surveys is low. The results are not fully objective. However, the survey can serve as a supplement to the data collected by the observers.

The results of the survey are shown in Table 7. De groups are classified on the low empathy groups on the left (blue) and the high empathy groups on the right (orange). Their Likert scores are also coloured. Dark green boxes mean that participants scored communication well. Red coloured boxes represent scores that tell that the participant experienced problems with communication. There was 1 missing value in the collected data. This one was from group 3.

	Group 1				Group 2				Group 3				Group 4				Group 5				Group 6			
The fact that I did not know others (well) made the communication less	1	2	1	1	1	2	2	4	2	1	1	1	2	1	1	3	1		4	2	1	1	1	1
The fact that I did not know others (well) made the communication less	1	2	1	1	4	1	2	4	2	2	1	1	3	2	2	3	1	1	3	3	1	2	2	2
The fact that I could not see others' work made the communication less	5	3	1	2	5	4	2	5	-		2	2	4	1	1	4	2	1	4		1	4	2	5
The fact that I could not see others' work made the communication less	5	2	1	4	5	4	2	5	4	2	5	1	5	1	1	5	2	2	4		3	4	2	4
The group size made the communication less *effective*	2	3	1	2	3	3	2	4	2	2	3	1	3	5	2	2	1	1	2		1	1	2	3
The group size made the communication less *efficient*	2	2	1	3	4	3	2	4	2	2	4	1	3	5	2	3	1	1	2		1	1	2	3
The other players had a good sense of *when* I needed information from them	5	4	4	5	4	4	3	2	5	4	5	4	4	4	5	4	4	5	4	4	5	4	4	4
The other players had a good sense of *what* information I needed from them	5	4	4	4	4	4	3	2	5	4	5	4	5	4	5	4	4	5	4	5	5	4	4	4
I had trouble understanding *when* people needed information from me	1	2	2	1	2	2	3	4	1	3	1	1	2	2	1	1	2	1	3	1	1	2	1	2
I had trouble understanding *what* information people needed from me	1	2	2	1	2	2	2	4	1	3	1	1	2	2	1	1	3	1	3	1	1	2	1	2
The group had a good understanding of each other's information	5	4	4	5	3	4	4	3	4	4	5	4	4	4	4	4	5	5	3	5	5	4	4	4

TABLE 7 INDIVIDUAL SCORES POST-GAME SURVEY PARTICIPANTS

To create a better overview of the differences between the groups, the individual Likert scores were added together for each group. This results in Table 8. The colours again represent how good their communication was according to the colouring system below the table. Statements 1 through 7 were worded in such a way that low scores implied better communication. However, statements 7 through 11 were worded so that a high score implied better communication. Therefore, with dark green colour, the participants rated their communication very good, and with redder colours, their rating becomes worse.

#	Statements from survey	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
1	The fact that I did not know others (well) made the communication less *effective*	5	9	5	7	8	4
2	The fact that I did not know others (well) made the communication less *efficient*	5	11	6	10	8	7
3	The fact that I could not see others' work made the communication less *effective*	11	16	5	10	8	12
4	The fact that I could not see others' work made the communication less *efficient*	12	16	12	12	9	13
5	The group size made the communication less *effective*	8	12	8	12	5	7
6	The group size made the communication less *efficient*	8	13	9	13	6	7
7	The other players had a good sense of **when** I needed information from them	18	13	18	17	17	17
8	The other players had a good sense of **what** information I needed from them	17	13	18	18	18	17
9	I had trouble understanding **when** people needed information from me	18	13	18	18	17	18
10	I had trouble understanding **what** information people needed from me	18	14	18	18	16	18
11	The group had a good understanding of each other's information expectations	18	14	18	16	18	17

Colouring system based on combined points					
Statements 1 – 6	0-4	5-8	9-12	13-16	17-20
Statements 7 – 11	0-4	5-8	9-12	13-16	17-20

TABLE 8 GROUP SCORES POST-GAME SURVEY

Overall, the groups experienced little disruption from having to work with new people. It did not make their communication less effective. However, groups 2 and 4 did give lower scores on efficiency compared than the other groups. They indicated that their communication was less efficient due to the fact that they were playing with strangers. The logistical barrier has had more influence on communication compared to the other barriers. The fact that they could not see others work made their communication less effective and efficient. This can be seen in the higher scores on proposition 3 and 4. Especially groups 1,2, 4 and 6 experienced difficulties in this. The scores are lowest when asked about the influence of the logistic barriers on the efficiency of communication. Actually, every group indicates that not being able to see each other's work made their communication less efficient. In terms of accessibility, which was tested by disruption due to the difficulty in reaching people because of the group size in the game, experiences are mixed. Groups 2 and 4 indicated that the group size made their communication less effective and efficient. Over-all it can be said that the groups experienced the most hindrance to the efficiency of their communication because of the logistical barriers. After that, accessibility plays the biggest role.

In terms of understanding information expectations, the groups are all quite positive. They generally feel that others had a good grasp of when and what information they needed to provide. And in addition, they themselves had a good understanding of when and what information others needed from him/her. Group 2 stands out the most in this due to its lower scores. They generally had less understanding of the information expectations back and forth. It is worth mentioning that the differences are actually minimal.

For more overview per communication aspect, the scores from Table 8 are aggregated into a score per communication category. The scores of the statements that represent a particular category were added together to form the overview of Table 9. Again, the greener the box the better the communication on this aspect according to the colouring system below the table. Due to the wording of the statements, higher scores are negative for barriers and positive for understanding.

Communication aspect	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
interpersonal barrier (statements 1 - 2)	10	20	11	17	16	11
logistical barrier (statements 3 - 4)	23	32	17	22	17	25
accessibility barrier (statements 5 - 6)	16	25	17	25	11	14
understanding (statements 7 - 11)	89	67	90	87	86	87

Colouring system					
Barrier statements	0-8	9-16	17-24	25-32	33 - 40
Understanding statements	0 - 20	21 - 40	41 - 60	61 - 80	81 - 100

TABLE 9 AGGREGATED GROUP SCORES POST-GAME SURVEY PER COMMUNICATION CATEGORY

What this table shows well is that group 2 performed worse than the other groups. In addition, it is notable that group 4 and 5 experienced more interference from the interpersonal barrier. On the logistical barrier, all groups are coloured yellow or orange, which means that they experienced a lot of annoyance on this barrier. Thereby, groups 3 and 5 gave the best scores. On the accessibility barrier the scores are very different. Group 2 and 4 score high which means more hindrance, while group 1, 5 and 6 clearly had less trouble with the group size. Finally, it can be seen that on the aspect understanding information needs al groups score well. Only group 2 scored less well.

Finally, the participants were asked to score their communication in general. The results are shown in Table 10. The same colouring system was applied here, meaning that greener boxes are more positive than yellow and orange. The scores for each team are shown in Table 11. Over-all the participants were quite positive over their communications during their game. The differences are therefore again minimal. However, it stands out that group 2 is more critical of their own communications. This is in line with their scores on the earlier statements. They felt that their communication was moderately efficient and a number of players felt that their individual communication skills could have been better. Group 4 is also critical on their communication, this is in line with the previous totals. They also score lower on the other communication aspects. Groups 3 and 5 give their own communication the highest scores. However, the differences with groups 1 and 6 are minimal and they also all indicate that their communication was good, both individually and collectively.

	Group 1				Group 2				Group 3				Group 4				Group 5				Group 6			
I found the communication during the game effective	4	4	4	5	4	4	3	3	5	4	5	5	4	4	4	4	5	5	4	4	5	5	4	4
I found the communication during the game efficient	4	4	4	3	2	4	4	3	5	4	5	5	4	4		4	5	5	4	4	5	5	4	4
I am satisfied with the communication of the group during the game	5	4	4	5	4	4	4	3	5	4	5	5	4	4	5	4	5	5	5	5	5	5	4	5
I am satisfied with my own communication during the game	5	4	4	4	2	5	4	3	5	4	5	4	4	3	3	4	4	5	5	5	4	4	4	4

TABLE 10 INDIVIDUAL SCORES POST-GAME SURVEY PARTICIPANTS HIGH LEVEL COMMUNICATION

#	Statements from survey	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
12	I found the communication during the game effective	17	14	19	16	18	18
13	I found the communication during the game efficient	15	13	19	13	18	18
14	I am satisfied with the communication of the group during the game	18	15	19	17	20	19
15	I am satisfied with my own communication during the game	17	14	18	15	18	16

Colouring system based on combined points					
Statements 12 - 15	0-4	5-8	9-12	13-16	17-20

TABLE 11 GROUP SCORES POST-GAME SURVEY PARTICIPANTS HIGH LEVEL COMMUNICATION

When the results of Table 9 are compared to the results in Table 11, several things stand out. It is to be expected that much disruption as a result of the barriers and little understanding of information expectations would also lead to lower scores on over-all communication. In the case of group 2, we see this well reflected. Group 4 also fits within this expectation. The other groups reported having had limited trouble with the barriers and understood each other's information expectations well. They also scored their overall communication well. In the end, however, it can be said that all groups rated their communication quite positively and thus the differences are minimal. This indicates that the annoyance due to barriers or lack of understanding did not have a major impact.

Observers

Before the game session, the observers received a manual with instructions on their tasks. During the game, they had to assess communication using statements, each of which they substantiated qualitatively. Thus, the results below represent only the observers quantitative assessment. Table 12 shows how the observers rated the groups by proposition. These scores are grouped in Table 13 which lists the scores for each communication aspect.

#	Understanding of information expectations	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
1	People were asked if they had understood the information correctly	2	3	4	5	2	4
2	People started communicating information only when they were asked about it	4	3	4	5	4	4
3	When one could not help in the information requested, alternatives were offered	3	3	4	4	3	5
4	There was often an inventory of how far one had already achieved their individual goal	4	4	4	5	4	3
	Barrier accessibility						
5	Communication is hindered by group size	2	4	1	2	2	2
	Barrier logistics						
6	Communication is hindered by the physical barriers (partitions)	3	4	4	1	2	2
	Barrier interpersonal						
7	Communication is hindered by the fact that the group does not know each other (well)	2	4	2	1	2	2

TABLE 12 GROUP SCORES OBSERVERS ON COMMUNICATION

Communication aspect	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
interpersonal barrier (statement 7)	2	4	2	1	2	2
logistical barrier (statements 6)	3	4	4	1	2	2
accessability barrier (statements 5)	2	4	1	2	2	2
understanding (statements 1 - 4)	13	13	16	19	13	16

Colouring system					
Barriers	1	2	3	4	5
Understanding	0 - 4	5 - 8	9 - 12	13 - 16	17 - 20

TABLE 13 AGGREGATED GROUP SCORES OBSERVER PER CATEGORY

It should first be noted that the scores on the barriers are determined by only 1 proposition. As a result, the differences between them are small. Group 2 clearly scored the worst on all communication aspects. In addition, it is notable that group 4 did very well. Especially on the barrier logistics the scores are more divergent. Here groups 1-3 score worse than groups 4-6. On interpersonal and accessibility the scores are very similar. Finally, it is striking that group 4 scores particularly well on understanding information needs. Groups 1,2 and 5 score the worst here.

Game results

The game outcome was measured on four dimensions. Time, money, quality and process. Time is measured as the amount of minutes left in play time. Money is measured as the amount of buttons owned by the group at the end of the game. Quality is measured as the amount of empty boxes on the joined game board and lastly, process is measured through the amount of double filled boxes on the joined game board. It is important to note here that high numbers on time and money are therefore positive, while on quality and process they represent poor scores. The scores of the six game sessions are shown in Table 14. These results are visually presented in Figure 15.

Group No.	Time (min left)	Money (# buttons)	Quality (# empty boxes)	Process (# double filled boxes)
1.	12:00	55	19	0
2.	0:00	16	13	1
3.	04:20	44	15	0
4.	0:00	46	11	3
5.	14:59	26	10	0
6.	2:25	56	15	1

TABLE 14 SCORES OF GAME SESSIONS
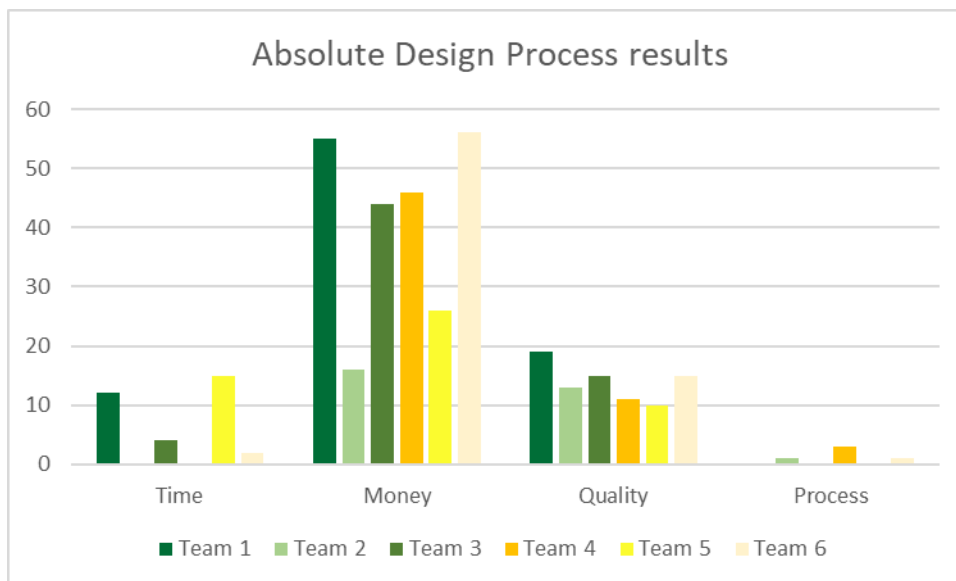
FIGURE 15 VISUAL REPRESENTATION OF GAME RESULTS

The figure shows that team 1 scores high on time and money, but a low on quality. The same can be said about team 6 with a bad score on quality and a process disruption. While team 4 scores poorly on time and money but did quite nicely on quality. So, what stands out in the results of the game session is the trade-off between costs and time versus quality and process. It is therefore interesting to look at this further.

The summed scores of time plus money and quality plus process are plotted against each other in Figure 16. It appears that teams that had a lot of time and money to spare at the end of the game generally scored worse on quality and process disruptions with higher scores. The only outlier here is team 2 with low scores on all dimensions.
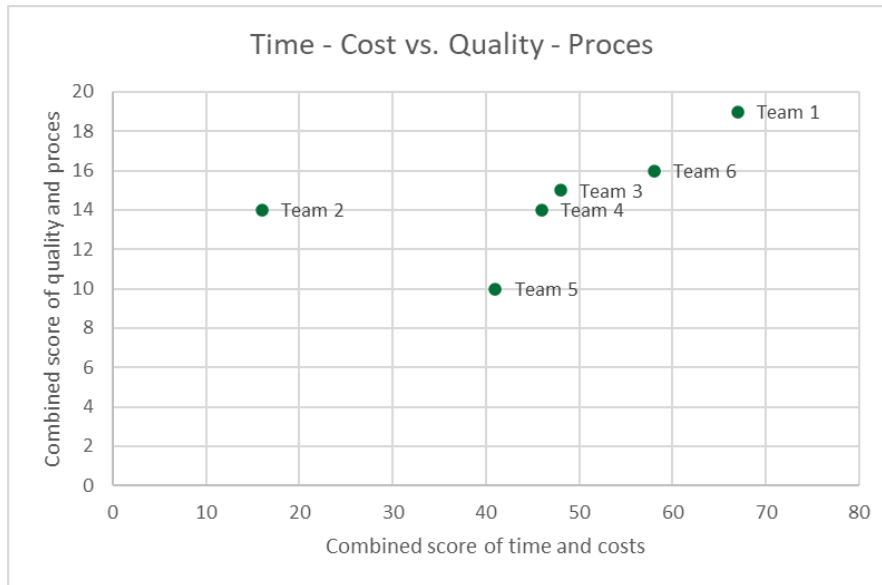
FIGURE 16 TIME, COST - QUALITY, PROCESS RESULTS

Project result has a special place in the literature because it is difficult to grasp. The criteria and their value vary from project to project. The value of each of the chosen criteria depends on stakeholders' point of view and time (Silva et al., 2016). In addition, it is questionable if project results can be expressed in one number at all and if the individual values of time, money, quality and process can be added together to come to such a number. Nevertheless, this study chose to list the totals because something stood out. Equal weighting of all dimensions was assumed here to remain as objective as possible. As concluded above, a better score on time and money is often accompanied by worse scores on quality and process errors. It is therefore often a matter of weighing up criteria in order to perform as well as possible across all dimensions. Figure 17 shows the total of time plus money minus quality and process. As can be seen, 5 of 6 teams score equivalent scores between 30 and 50. Despite different trade-offs between criteria, they ended up in the same range with some optimizing more than others. However, team 2 scored significantly lower. They performed worse than the other teams across the entire range. This is a striking result and will be discussed further in chapter 7.3.
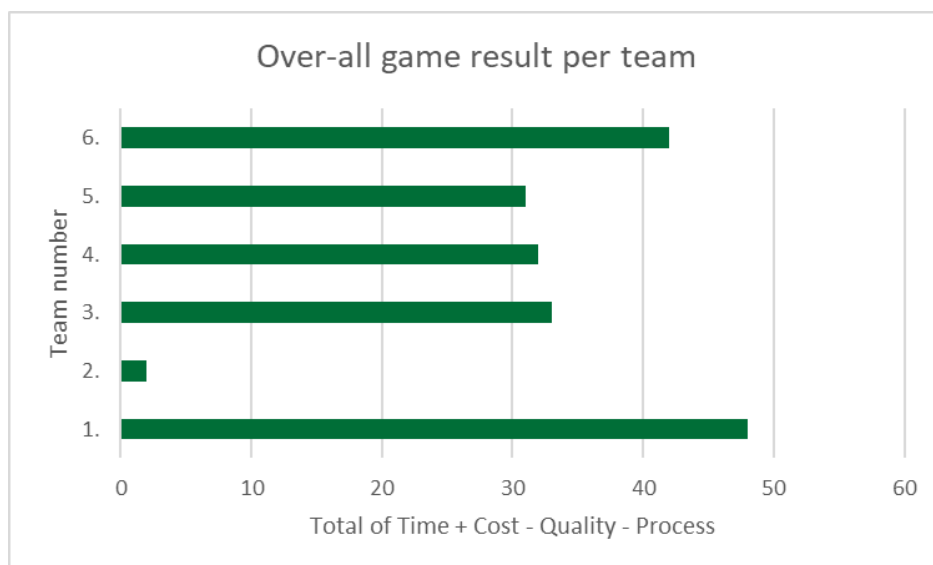
FIGURE 17 OVER-ALL GAME RESULT PER TEAM

7.2 Qualitative research results

In addition to the quantitative, much qualitative data was collected by the observers about the groups game sessions. The observers were given a manual for how they were to observe. This manual included a template of statements that they were to review and support with observations. In this way, information was gathered about general topics, empathic behaviour and the categories of communication. Key observations will be shared for each group in this chapter.

Group 1 – low empathy team

The group needed some time to get a good understanding of the rules. After some extra explanation it was clear. Apart from 1 interaction with another group they were barely distracted from the game. The group acted as one where everyone was equal and had equal input. Decisions were made as a group. They chose the tactic where the board is seen as 1 and they do not divide the boxes. Overall, there was good cooperation.

The group has good listening skills. Few visible emotions were evident and the group communicates primarily verbally. What is striking is their social behaviour. The observer indicates that they exhibit social behaviour when it leads directly to results. They helped each other well with putting things in the right place. However, they did not ask each other if everyone understood. Their social behaviour was really focused on results.

Functional social behaviour is also reflected in communication. They did not explicitly ask if one understood information correctly and an alternative was sometimes offered when one could not help in the requested information. This shows average understanding of information expectations. However, there was proactive communication. This was because the importance of sharing information was clear to everyone. But, the sharing of information was done functionally.

The group was not really hindered by the group size. Every group member was given the opportunity to speak and this was done equally. The physical barriers made communication more difficult. However, the group found a way in communicating around it. Therefore hinder was average. Finally, the interpersonal barrier did not cause any problems. The participants seemed to get along and work well together.

Group 2 – low empathy team

The players of group 2 had a good understanding of the rules and were not distracted during the game. The observer indicated that not everyone in the group had an equal say. 1 group member was more in the background while the other three were in discussion a lot. Until just before the end, everyone was particularly concerned with filling their own boards and the focus was there. Towards the end, the group goal received more attention. The group started with a good strategy discussion, however after that, the communication did not run very smoothly and they deviated from the agreements.

The group has good listening skills. They don't talk through each other much and listen well. By being considerate of each other and helping each other during their turns, they demonstrate social behaviour. Both when they don't get it right and to win the game. It was additionally noticed that they adjusted their own turn so that another player could do what was better for their board and/or the end goal.

The observer found the understanding of information needs to be average. People were not literally asked if they understood the information correctly. Often it became clear that someone did not understand something by the recipient of information. Some people gave updates on their game boards in a proactive way, but not all. They did, however, often take inventory of how far they were in their individual goal. This shows that they are looking for the needs of the other person.

It can be said that the built-in barriers were of influence during the game. The observer noticed that discussions were held in groups rather than with the whole group. As a result, not all information

got to everyone. The group size hindered communication. Physical barriers also caused problems because there was more distance between people. This made it harder for them to hear each other. Finally, there was also an effect of the barrier of new people. There was a very neat and careful approach and communication with each other. Because of this they did not point out to each other if something was not the best choice. This created interpersonal tension toward the end as time stress set in. Finally, the observer found that communication skills varied widely within the group.

Group 3 – low empathy team

The players of group 3 had some trouble understanding the rules, they asked quite some questions. Their focus was fully on the game, little distraction. Everyone has an equal share in the game and an equal say. Both during the tactics discussion and during the game everyone is involved. In addition, they are little concerned with their own board but mainly with the group goal. They used a notable technique, namely the time board is used to explain where pieces are placed. At the beginning of the session, the group has little confidence in a good outcome: "Mission impossible to fill 15 boxes per person without overlap."

During the game the group is listening well. Their social skills are also good. They have done a round of introductions and when presenting ideas, everyone is given space to express their opinions. There is good cooperation about the best time to take a piece of fabric. Towards the end, when the time constraints arose the group members used more intense voices showing emotion. However, this did not seem to bother the group.

The observer has seen quite a few observations showing that there was a good understanding of information expectations. For example, they often asked if everyone understood the information given and took the time to explain it better if someone did not understand. People did not wait to communicate until asked but there was a continuous flow of communication about the best tactics. "Who will need the single piece of fabric later?". It was shown that they understood when someone needed information by offering alternatives when they could not provide the requested information. Finally, there was a great deal of interest in individual goals.

To the barriers, the group responded differently. For example, group size did not cause any problems. The observer noted that sometimes there was some rambling but this did not detract from the outcome. The logistical barrier due to partitions did affect communication. On several occasions, the group members asked if they could not use pen and paper to facilitate communication. Finally, the interpersonal barrier did not cause any hindrance in communication. There was some noticeable tension because someone was the only one behind in meeting their individual goal, but this did not affect communication.

Group 4 – high empathy team

Group 4 had the advantage that one player had already played the game once. This player took the lead in the beginning by explaining the game. After playing 1 round, all players had a good grasp of the game. The group had very noticeably different tactics. They had not divided the board but were really going to make 1 board together. With this they were not focused on their own tableau but mainly on that of the collective. One person took the lead in the tactics. The chosen tactic worked very well, it took a little longer though. As a result, their score was disappointing. However, the observer indicated that they were very successful.

During the group 4 game, there was a lot of room for (positive) emotion. People used funny voices and showed they were enjoying themselves. They also used non-verbal behaviour when there was a rush to get into the game. However, the observer did not feel that this affected the game. The group had good listening skills and showed very social behaviour. They helped each other in choices and often asked if everyone was still happy with the tactics. It was also notable that one person said, "I see a good option for the single piece, but I trust you guys have a good option too."

The observer is really positive on the groups communication skills. In the area of understanding information expectations they scored well. People were often asked if they had understood the information correctly and also if everyone agreed with the pieces of fabric chosen. In addition, there was proactive communication. "I think you need this one, it fits well". Because they really worked together on 1 design and did not have their own corners, alternatives were considered together when the requested information could not be provided. As the game progressed a lot of attention was also paid to the individual turns. They did a round after each turn.

Because of the chosen tactic, playing with four people is more difficult, everyone has to remember everything. However, the observer indicates that this did not hinder communication. Everyone waited for their turn to talk and there was no chaos. However, sometimes double things were said. The physical barriers did not cause any problems. Also the interpersonal barrier of new people did not form an obstacle. Because they laughed and joked a lot during the game, the interaction felt familiar. In this regard, the players indicated that the new people make you focus more "purely" and not assume things. It worked positively for them. In addition, there were no tensions, even when they ran out of time. All in all, the observer is very positive about the communication.

Group 5 – high empathy team

The players of group 5 understood what the rules of the game were after extensive explanations and several rounds of play. They were very focussed and participated actively. There was clearly 1 person who communicated less than the rest. The other players were much more dominant and the group decisions were generally made by these three players. People were mostly focused on their own tableau and there was no thought that you can also put something down so that someone else can benefit. What went well was the constant communication. What went less well was that not everyone contributed equally to the final result. This group played in English, however, the language did not seem to be of influence.

The observer indicates that the group has good listening skills. There is occasional intermittent talking. Slight emotions were visible because not everyone understood the strategy right away, but these were resolved well. The group generally demonstrates social behaviour by interacting frequently and well with each other and asking about each other's individual goals. What was striking was that 1 person asked very often how the other players were doing.

In the area of understanding information expectations the observations differ. People did not actively check whether they understood the information correctly. They also did not offer alternatives in all cases when they could not provide the requested information. However, the group members were constantly communicating, and there was some thought given to what piece someone could choose during the turns. This included asking relatively quickly and often about the individual goals of the group. In doing so, they demonstrated a desire to better understand the needs of others.

Communication did not suffer from the built-in barriers. The three more dominant group mates consult a lot with each other in an orderly fashion. The group size did not hinder them in this. There were no visible tensions during the game. However, it was noticed that one groupmate behaved more calmly during the game. This may have to do with the fact that they do not know each other. However, the observer indicates that this did not affect the communication.

Group 6 – high empathy team

The players of group 6 needed about 5 minutes to get the rules of the game clear. After that, they understood what the rules were. They were rarely distracted and not concerned with the other groups in the room. 1 person had a little more difficulty understanding the game and therefore had less participation. The rest took a more proactive attitude. They were much engaged with each other and others' game boards. Over-all, the observer indicates that the amount of communication, good listening skills and thinking together was determining for the final result.

The observer indicates that the group has good listening skills and demonstrates social behaviour. By asking questions like: does everyone agree? And, "which piece of fabric would you like?" they demonstrate social behaviour. In doing so, they consulted a lot about each other's goals and were eager to reach the end together. Emotion and non-verbal behaviours did not play a major role during the game.

The observer noticed quite some understanding of information expectations. There was a lot of checking to see if one understood the information correctly. There was also continuous feedback on the consequences of the information received on the game board. It was also notable that people continuously offered alternatives when they could not help in the information requested. It was rare for people to start communicating information only as soon as they were asked; there was clear proactive behaviour by 3 of the 4.
In the area of communication barriers, the observer indicates that the group actually did not experience any disruption due to the barriers in their communication. About the barrier accessibility, the observer says that the group had a clear structure with little chaos. They did, however, occasionally ask, "who's turn is it?". Because the group could very visually describe to each other what was on their boards, the dividers (logistics) also formed little barrier. Finally, the observer indicates that the lack of noticeable tension was indicative of the fact that the new group mates were not a barrier.

7.3 Integration of Quantitative and Qualitative results

Both quantitative and qualitative data was collected during the game session. The previous sections describe these results. In order to properly answer sub-question 5, it is important to integrate these results. First, integration will take place at the group level after which integrated results will also be shown at an aggregated level. Because the data collected by the observers is objective it will be used primarily. The data collected from the participants will be used for support.

Integration on group level

For group-level integration, the quantitative and qualitative results are reviewed and merged. Communication and relevant aspects will be covered for each group.

Group 1

Group 1 is characterized by the lowest empathy scores. The Group 1 observer indicates quantitatively that the understanding of the information expectations was not very apparent. He supports this with the qualitative observation that people were not explicitly asked if they understood the information. In addition, communication was mainly functional and social behaviour was only visible when it led directly to results. The group seemed to get along well so interpersonal and accessibility issues played little role in their communication. However, the group did suffer more from the physical barriers which was shown by verbal comments about the difficulty as a result. The group achieved good project result through high scores on time, money and process. However, they achieved the worst quality.

The participants themselves confirm that they experienced the most inconvenience due to the logistical barrier and the least due to the fact that they did not know each other. They themselves did feel that they had a good understanding of the information expectations in the game.

Group 2

Group 2 has the second lowest empathy scores. In addition, they were an English-speaking group. The observer scores the group poorly on their communication. However, the observer does note that communication improved throughout the game. The group started off well during the tactics discussion. However, the players deviated from the agreements made and the communication did not run smoothly. The low scores on understanding and barriers are qualitatively supported by observations. The communication suffers from the barrier of accessibility, which can be seen because

the group consults in groups. Because of this, information is lost. The physical barrier made it difficult for them to understand each other. Finally, the fact that they knew each other poorly meant that communication was very neat and careful. As a result, they did not point it out to each other if it was not the best choice. The low score on understanding information expectations is explained by varying communication skills. People were occasionally asked if they had understood the information correctly and consulted. However, this did not happen always and with everyone. Despite achieving reasonably good quality, the group mainly left points on time, money and process. All in all, they achieved the worst result on the game.

The observer's poor scores on communication are confirmed by the participants themselves. They indicated that they were most bothered by the physical barrier and group size. They also confirm that they did not always fully understand what the information expectations were.

Group 3

With an average empathy score of 59, group three is the highest scoring low-empathy group. The observer is quite positive about the communication of group three. The high score on understanding information expectations is supported because there was a lot of focus on good understanding of the information given. When someone did not understand it well, time was taken to explain it again. In addition, there is constant communication about the best actions for everyone and many questions are asked. The poor score on annoyance due to the logistical barrier is explained by the fact that the group repeatedly asked for pen and paper to facilitate communication. Due to a slight tension at the time when someone was a little behind on their personal goal, the interpersonal barrier was rated slightly higher. Group three also did well on game result. Across all dimensions, they scored average points and did not miss out on many points anywhere.

Group 3 participants are very positive about the communication during their play. However, they experienced relatively more annoyance from the accessibility barrier. However, they did give themselves the highest score on understanding information expectations.

Group 4

Group 4 has the lowest empathy score of the higher-empathy teams with a score of 64. The observer is very positive about the communication during the game. They had a somewhat more unique tactic in which not everyone had been given their own quadrant on the board but they were really working together on 1 design. The high score on understanding information expectations are explained by regular checks. People were often asked if decisions were supported and understood. There was proactive action and anticipation of the best option for the player at the turn. The only lower score on the accessibility barrier is explained. The tactic required remembering everything about all players. As a result, information had to be repeated more often and things were said twice. Group 4's game result was poor. Due to time pressure at the end, a big mistake was made which caused them to lose a lot of points on time, process and quality.

Group 4 participants are less positive about their communication. However, they also report the greatest disruption due to group size. Next, they indicate that they were slightly bothered by the fact that they did not know each other.

Group 5

Team 5 is characterized by the highest empathy scores. The observer rated their communication quantitatively as moderately. Their understanding of the information needs of others was limited. They were primarily focused on their own game board and few alternatives were offered when they could not provide requested information. However, the qualitative observations indicate that it went quite well. There was no active check to see if people had understood the information correctly, but there

was a constant flow of communication and proactive thinking about what actions would be best for others. In addition, 1 player was very active in asking how everyone else was doing. This shows that they did understand what others needed. Although not everyone had an equal share in the game, the 3 active players worked and communicated in a structured way. This ensured that there was little inconvenience due to group size and logistics. The fact that there was 1 group member more in the background stood out for the interpersonal barrier. However, the observer indicated that this did not limit communication. The group achieved the best project result. In particular, because they achieved the highest quality without process errors in the least amount of time, their score is very high.

The participants themselves also indicated that they had a little more difficulty understanding the information needs. In addition, they indicated that they experienced the most hindrance due to the interpersonal barrier. About logistics and accessibility they are very positive, this did not hinder their communication.

Group 6
Group 6 falls under the high-empathy teams. The Group 6 observer is positive about the communication within the team. The high score on understanding information expectations is supported with comments about the many checks. The participants check if they have understood the information correctly and give each other continuous updates about their position on the board. When requested information could not be delivered, alternatives were continuously offered showing that they understood the information expectation well and wanted to address it. Because they could describe very visually and there was little chaos, the observer judged that the physical barrier and accessibility posed few problems. The interpersonal barrier also posed no problem. The group scored average on game result. Especially on time, quality and process they missed points.

Group 6 participants themselves are also mostly positive. However, they indicate that they did experience inconvenience due to the logistical barrier. In addition, their own views on understanding the information expectations are also lower than expected based on the observations.

Integration on aggregated level
For higher level integration, the three correlations from the hypothesis are assessed. First, the results regarding empathy and communicative success will be described, and then communicative success will be laid against project result. Ultimately empathy will be compared with the game results.

Empathy – Communication
In the relationship between empathy and communicative success in the game session, the following can be said. The best communicating teams according to the observers are teams 4 and 6. They score well on both dealing with barriers and understanding information expectations. These are also teams in which empathy was high both cognitive as affective components. They even had the highest scores on the cognitive dimension. The groups with the highest communication scores after this are groups 3 and 5. However, group three has a lower score on the logistical barrier and group 5 had more difficulty in understanding the information expectations according to the observer. What is striking when looking at the empathy scores of these teams is that they actually score the same on the cognitive dimension. Group 5 does have a much higher total average, but it is mainly determined by affective aspects. Group 1's communication was not necessarily bad, but they used it very functionally. From this followed less understanding of information expectations and more difficulty with the logistical barrier. This group had the lowest empathic ability both cognitive as well as affective. The group that scored by far the worst on communication was group 2. They had great difficulty communicating which manifested itself in poor scores on both communication aspects. Group 2 also had low empathy scores. From these results, it seems that communicative performance can be linked particularly to cognitive empathy competencies. With higher scores on this dimension, better communication is also observed.

When zooming in more on the aspects of communication, it is noticeable that the low-empathy groups experienced much more communicative hindrance due to the logistical barrier. The empathy groups were better able to cope with this barrier. The differences on the interpersonal and accessibility barrier are less pronounced. In terms of understanding information expectations, teams 1, 2 and 5 scored the worst, followed by groups 3 and 6, and group 4 achieved the best score. Groups 3 and 5 stand out. Group three scores quantitatively unexpectedly high for what would be expected according to the hypothesis. The qualitative observations confirm this, their communication was good. Group 5 scores quantitatively unexpectedly low for their high empathy scores. However, the behaviour described in the qualitative observations does fit with good understanding of information expectations. This makes the scores of groups 3 and 5 comparable. Thus, in line with the integration above, these scores seem to correspond to the cognitive abilities of the groups. Groups 1 and 2 had the lowest scores, followed by groups 3 and 5 and finally 4 and 6. In other words, success on understanding seems to be determined by the cognitive side of empathy. It should be said that differences were small and all teams scored satisfactorily on understanding information expectations. However, this is not surprising since the cognitive abilities of groups were also close to each other. The difference between the lower and high empathic teams is mainly determined by the affective side of empathy. It is notable that on the logistic barrier in particular, the empathic teams performed less. So it could very well be that performance on at least this barrier is related to the affective side of empathy. Because the differences on the other barriers were not as large, it is more plausible that these were also influenced by the cognitive empathy scores.

When the observers quantitative scores (from Table 13) of the two groups (low and high empathy teams) are added together, Table 15 emerges, showing that on every communication aspect examined in this study, the scores of the empathy teams were better. It is worth mentioning here that the wording of the statements ensures that a low score is good at the barriers, while at the understanding of information needs a high score is actually positive. From the explanation above, the overall picture of quantitative and qualitative result shows the same. Group 3 is an exception with a similar communicative performance to Group 5. However, their empathy scores were also the highest of the low-empathy group. Thus, the results show a slight positive relationship between empathy scores and communicative success. It should be noted that the differences between the scores are small and therefore referred to as a slight correlation.

Communication aspect	Totals Low empathy	Totals High empathy
interpersonal barrier (statement 7)	8	5
logistical barrier (statements 6)	11	5
accessability barrier (statements 5)	7	6
understanding (statements 1 - 4)	42	48

TABLE 15 TOTALS OBSERVER SCORES GAME SESSION

What is striking about the quantitative opinion of the participants themselves is that they are more divergent. From the team-level integration, it can be concluded that many of the participants scores correspond to the observers opinions. Zooming in more on the understanding of information expectations, groups 1, 4 and 6 score themselves differently than the observer. Group 1 is much more

positive where groups 4 and 6 give themselves fewer points. In the area of interpersonal barrier, groups 4 and 5 are more negative than their observer. In the area of logistics, a large difference is seen with group 3. Finally, the accessibility barrier. On this, the observers of group 3 and 4 are way more positive than the groups themselves. All in all, a big difference can be seen in team 4. They are much less positive about their communication than the observer. An important explanation for the differences between participants and observers scores is the timing of when their game results were shared. Participants were required to complete the survey after being told how they had performed. This affected the surveys. The observers, on the other hand, judged independently of the game result. This is well reflected in group 4. They had a lot of process errors which caused their game result to be less. They were also very critical of their communication. The observer on the other hand judged even before the process errors that the communication was actually quite good.

Again, the totals of both the lower-empathic and the higher-empathic teams were calculated in Table 16. From this, it can be seen that the empathic teams score better on every dimension except for the interpersonal barrier. However, in this table the bad scores of team 2 determine the totals for their group a lot. This shows well how the small sample size does not allow for correction for outliers. It is therefore questionable if these results can be used for conclusions on the relationship between empathic levels and communicative success.

Communication aspect	Totals Low empathy	Totals High empathy
interpersonal barrier (statements 1 - 2)	41	44
logistical barrier (statements 3 - 4)	72	64
accessability barrier (statements 5 - 6)	58	50
understanding (statements 7 - 11)	246	260

TABLE 16 TOTALS PARTICIPANTS SCORES GAME SESSION

Communication – Process result

The second relationship that is looked at in this study involves the communicative success and the results of the game. From the integrated quantitative and qualitative observations it can be concluded that team 4 and 6 have performed best on their communication. It was notable that group 4 chose a different tactic in which communication was even more important. This went really well until, due to a crucial mistake at the end, they lost a lot of points on process and therefore quality. Nevertheless, they scored quite well on quality. Their communicative success is mainly reflected in a high score on quality, which would have been even better if the time pressure had not caused a major process error. Group 6 dropped points particularly on time and quality. Therefore, beyond the money aspect, their good communication did not ensure the better results.

Group 5 scored very well on game result. With good scores on quality, time and process, they performed the best of all groups on these dimensions. Their communication was decent according to the observer's quantitative scores. The qualitative explanation also indicated that there was constant communication and 1 person often asked how the others were doing. However, qualitative explanation also showed that the game was mainly dominated by 3 active players. This is notable because their game success was thus not dependent on the teamwork and communication of all players. Group 1 also performed well on game result, particularly on time and money. However, the quality of their design was the worst of all teams. Qualitative observations indicated that the communication was functional and that the team suffered from the physical barrier. Their functional communication and hindrance due to the physical barrier possibly led to a bad quality.

Group 3's communication observations are mixed. They did well on the accessibility barrier, but had many problems with the physical dividers. Understanding of information needs was good again. Over-all, their communication was good on average. When we look at their game result it is also very average. A good score on time and process, but compromised on money and quality. Finally, Group 2. They were most affected by the barriers and their understanding of information expectations was also low. These poor communication scores reflect in the game outcome. There was a lack of time, little money left and a process error. Their quality was still reasonable despite this. Yet it can be concluded that their cautious, chaotic communication caused the game to end poorly.

From these results, it can be concluded that no clear linear relationship can be seen between communicative success and the over-all outcomes of the game. However, something does stand out. There is only one team that really received failing grades for their communication. That was team 2. Figure 17 in Chapter 7.1 also showed that team 2 was the only team with significantly worse game results. All other teams scored adequate to good on communication. They also all had much better game results. Therefore, it does seem like there is a positive effect of communicative success on the integrated design process outcome.

When looking at the individual game dimensions, it is worth diving into how communication is related to the quality of the game result. Groups 4 and 5 scored very well on the quality of their design. Their communication was also good. Group 1 scores very poorly on quality, which can be explained by qualitative communication observations. Group 3 has average communication and average quality of design. So far there seems to be a positive relationship between communication and quality of design. However, the observations of groups 2 and 6 fall completely out of this. Group 2's poor communication observations still provided reasonable quality, and Group 6's good communication scores are not in line with their poor quality score. All in all, the researcher finds the results of communication and design quality too weak to discern a positive relationship.

Time, money, and process results are not linked in any way to the communicative scores of groups except for Group 2. When zoomed in on the aspects of communication, no pattern can be detected either. Groups 4, 5 and 6 had the least problems with the barriers according to the observers. However, they did not have remarkably better scores on project score dimensions. Groups 3,4 and 6 score best on understanding information expectations. However, this combination is also not reflected in the project results.

As mentioned in the previous section, participants sometimes rated their communication differently than the observers. Roughly speaking, it can be said that team 1, 3 and 5 were the most positive about their communication. This does correspond to their project outcome. They all finished their game without process disruptions and with reasonable scores on the other dimensions. Just after this, group 6 follows on communicative result, with only one process disruption and reasonable scores they fit the pattern. So, based on participant experiences, it can be concluded that there is a positive relationship between communicative success and project result.
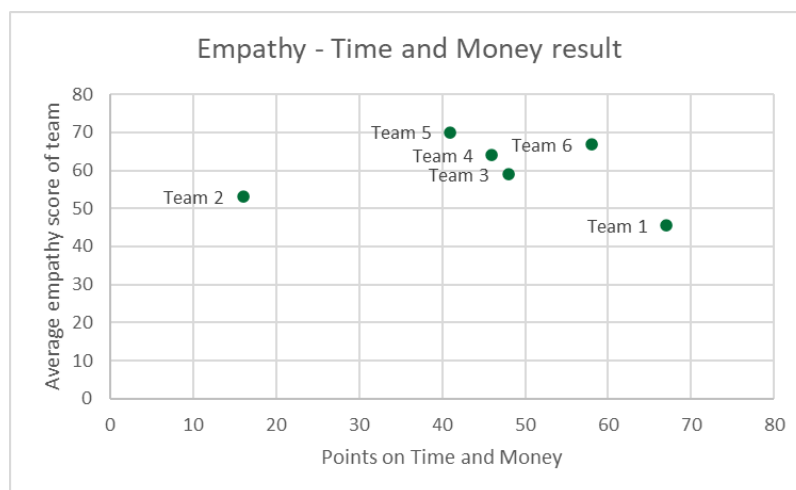
Empathy – Process result

When the line of reasoning is followed, according to the hypothesis, a relationship should be seen between empathy and game outcome. Although quantitative values of both empathy and game outcomes are available, putting those two variables together is not very easy. This is mainly caused by the disagreement in literature on project outcome. The value of each of the chosen criteria depends on stakeholders' point of view and time (Silva et al., 2016). No information was given to the teams in advance about how the criteria were weighted. Thus, they were able to use their own interpretation of this. As a result, it is not actually possible to express project result as a total in a number without prior agreement on relevant weighing factors. It was therefore chosen to first contrast the four measured dimensions separately against empathy. From this, Figure 18 follows.
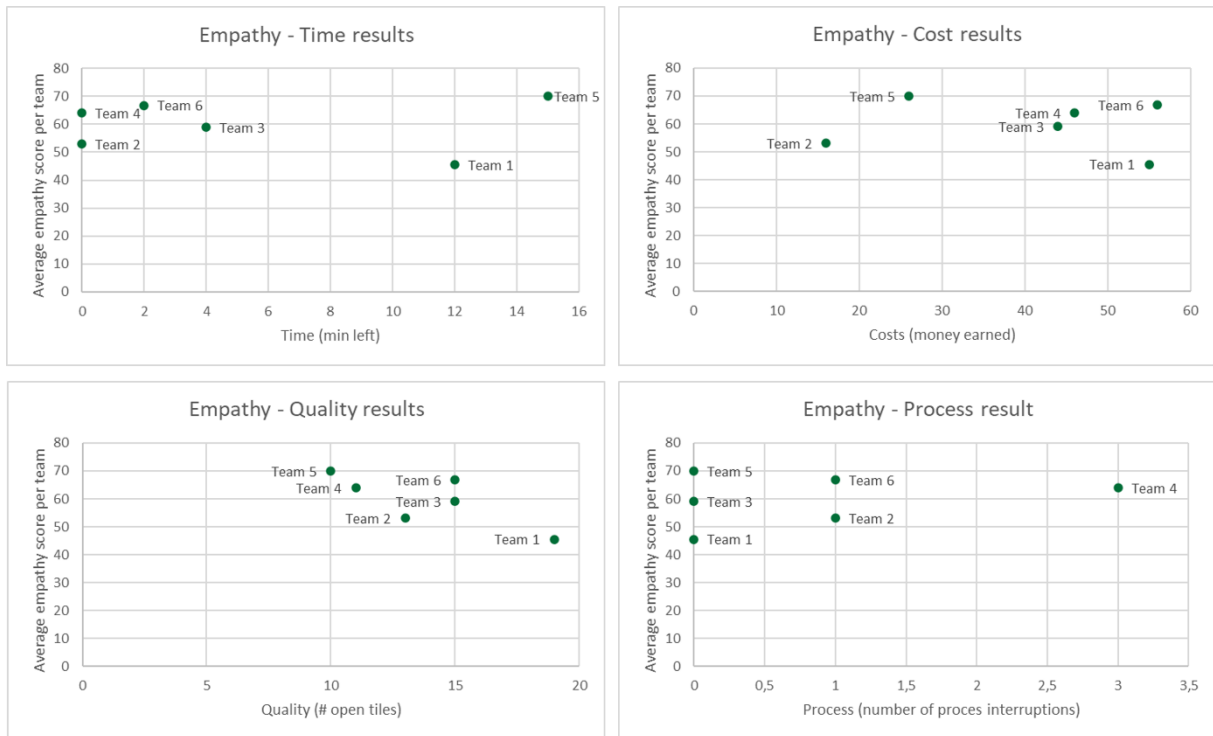
FIGURE 18 EMPATHY – INDIVIDUAL GAME RESULT DIMENSIONS

From the figure, it can be noted that on time and money, no relationship can be discerned. The high-empathy teams did not score significantly better or worse than teams with lower scores. When looking at empathy versus quality, a vague trend can be discerned where empathic teams have lower, and thus better, scores than those with lower empathy scores. However, the teams with 15 open tiles fall outside of this pattern so the researcher finds it too weak to talk about a correlation. Finally, empathy versus process. Again, there is no relationship seen between empathy scores and process interruptions during the game.

Since previous analysis already showed that there is a negative correlation between time and money and quality and process, it was chosen to take these dimensions together. By adding the values of time and money and doing the same with process and quality, Figure 19 and Figure 20 emerge.

FIGURE 19 EMPATHY VERSUS TIME AND MONEY RESULTS
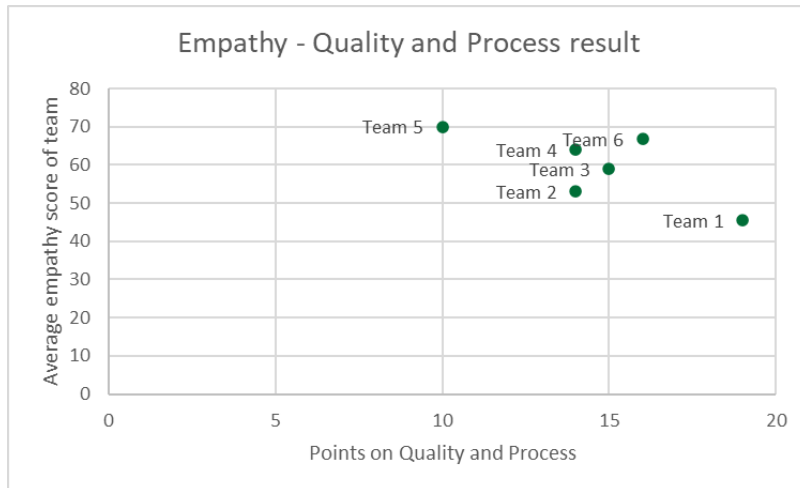
FIGURE 20 EMPATHY VERSUS QUALITY AND PROCESS RESULTS

The data points in the time and money figure show no obvious correlation. A low or high score on empathy does not seem to affect how teams handled money and available time. Empathy versus quality and process results are shown above. Although the highest and lowest empathy scores also clearly correspond to the best and worst quality scores, there is no clear correlation. The remaining four data points are close together and not aligned. It can therefore be concluded that no clear relationship can be seen between the empathy scores and the quality and process of the game result.

All in all, it can be concluded from these results that empathy has no clear relationship with game outcomes. In other words, the line of empathy through communication is not reflected in the direct results. In addition, this also says that influences of empathy on the game results through other processes than communication cannot be demonstrated in this study.

7.4 Conclusions chapter 7

The results of Chapter 7 allow for an answer to the fifth sub-question:

SQ5: What is the influence of empathy on the outcome of the integrated design process through communication in the simulated environment?

During the data collection of this study, 6 teams of 4 people from the process industry played the serious game Patchwork. Prior to the session, an empathy score was measured from each participant. Based on this, teams 1-3 were grouped on low scores and teams 4-6 formed the highly empathic teams. Based on quantitative and qualitative data collected by observers, it can be concluded that the empathic teams were more successful in their communication. This seems to be especially related to the cognitive empathy abilities of the teams. The success was measured on both the understanding of information expectations and the hindrance due to communicative barriers. The scores on understanding information expectations appear to be determined by cognitive empathy. This is while performance on the logistic barrier was better linked to affective abilities. Scores on accessibility and interpersonal barriers were less clear. Although a conjecture, it is most likely that they were also determined by cognitive empathy.

When this communicative success is plotted against the outcome of the game, there is no clear relationship to be seen. The best scoring teams on communication could not be related to the best scores on project dimensions. Although there seemed to be a weak relationship between communication and project quality, the researcher did not find it sufficient to confirm it. However, it was found that sufficient communication success is necessary for solid project outcomes. The team that scored significantly worse on project outcomes was also the only one with a failing grade for their communication. The teams with solid project results also all had satisfactory scores for their communication. So it seems that communication does matter for good project results.

The results of the simulation do not show a significant correlation between empathy and game success. Further research with larger datasets needs to conclude if this was caused by other confounding variables being dominant in game success, or all participants were already above a threshold relevant for significance of the empathy variable. It is noteworthy that also on empathy - project outcome there seems to be a slight trend between empathic ability and quality. Again, this was not sufficiently robust for conclusions but it does provide reason for future research.

PART IV: RESULTS

8. Discussion

This chapter focusses on the interpretation of the research results. First it will interpret the research results according to the hypotheses in 8.1. Next it will discuss the validity of this research in 8.2. The limitations of this study and recommendations for future research can be found in 8.3. The chapter concludes with implications and added value of the study in 8.4.

8.1 Interpretation of research results

The purpose of this research is to gain more knowledge about the relationship between empathy in teams, their communication during and the outcome of their integrated design process. For this purpose, three hypotheses have been established. This section will reflect on the results and outcomes that confirm or refute the hypotheses. First, therefore, the relationship between empathy and communication in the integrated design process will be discussed. Then, the results that say something about communication in the integrated design process and the outcomes of this process will be reflected upon. Finally, empathy will be considered alongside process outcome.

Empathy - Communication

The literature found describes a positive relationship between empathy and communication. The empirical results of the observants confirm the formed hypothesis that empathic teams communicate better in the integrated design process. Despite the differences being small, both the quantitatively and qualitatively collected data indicate that the empathic groups had a greater understanding of the information expectations of the others and experienced less hindrance on communicative barriers. When zooming in further, a few things stand out.

Group two in particular performed poorly on communication. Both the participants themselves and the observer indicated that communication was difficult. The observer noted that the group communicated too politely and reservedly. An important explanation for this may stem from cultural differences due to nationality. Group 2 consisted of people with multiple nationalities. Hofstede & Pedersen (1999) mention the strong influence of cultural differences on communication styles in simulation gaming. The article even mentions 'cultural miscommunication' and that national cultural differences can be a barrier to effective communication. It can be concluded that group 2 thus had an additional barrier in their game. However, there was another group with different nationalities in the test population and thus the same barriers, group 5. They scored well on communication and the observer did not identify any problems due to cultural differences. The theory presented in this thesis indicates that empathy can cause communicative barriers to be overcome. Group 2 scored low on empathy and group 5 had the highest empathy scores. Thus, it could well be that group 5 experienced less hindrance from the cultural barrier as a result of their empathic abilities. This would provide additional confirmation on the first part of the hypothesis that empathy positively influences the communicative success of the design team.

What stood out for Group 5 was that their game was dominated by 3 players. 1 player stayed in the background and participated less in the communication. This is notable because group 5 consisted of the people with the highest empathy scores. From the literature it is known that there is a difference between having empathy and showing it (Cameron, 2018). Suppression of empathy was not included in this study but could have had an influence. The behaviour of the passive group member could be an indication of suppression of her empathy. However, there are many other character traits that influence group dynamics. Think introversion – extroversion (Jung et al., 2012) or dominance -

submissiveness (de Long, 1970). So, while abilities and propensities of empathy give an interesting perspective, it cannot be proven that this was the cause of the observed behaviour.

Although it was expected beforehand that on all barriers the empathic teams would experience less hindrance this turned out to be less the case on the interpersonal level. The observers did indicate that they saw less disruption among the high-empathy teams, but the participants themselves scored this differently. The high-empathy teams reported experiencing as much or even more discomfort than the low-empathy teams. When looking back at the theory this can be well explained. From literature it is described that especially the cognitive side of empathy ensures good interpersonal functioning (Davis, 1983). The PT dimension of the Davis test corresponds especially with the cognitive side of empathy. Table 5 shows how the low empathic teams all get their highest scores on this dimension. Thereby, the averages differ relatively little from the PT averages of the empathic teams. Thus, this means that the cognitive empathy of the low-empathy teams was not much lower than that of the high-empathy teams. In doing so, it is thus well explainable that their interpersonal functioning was also similar. This supports the expectation that the annoyance due to interpersonal barriers is largely influenced by the cognitive side of empathy.

Although an attempt was made to isolate empathy as an independent variable for communication, it cannot be ruled out that other factors may also have influenced it. The literature review revealed that a major problem of communication in current projects has to do with different and hidden interests of people (Elsayegh & El-adaway, 2021; Hoezen et al., 2006). These interests have a great influence on communication. This is also quite conceivable as a confounding variable for this study. The participants indicated that the lack of different interests in the serious game made the game less realistic. The lack of different interests makes for lower validity, but also that they probably influenced communication less with which empathy could be better expressed. Therefore, it is not expected that different interests as a confounding factor influenced the results very much.

The game's conclusions are based primarily on the observers opinions. However, it is notable that the participants themselves sometimes had a different experience. This is especially true for teams 1, 4 and 6. Team 1 assessed themselves more positively, and 4 and 6 assessed themselves more negatively. Because the women scored higher on empathy they were in the same teams. As a result, team 1 was composed entirely of men and team 6 was composed entirely of women. From the literature it is known that gender influences self-confidence and self-reflection (Lundeberg et al., 1992). The over- and underestimation of groups 1 and 6 could therefore be explained by gender. This distorting effect is an additional reason not to rate the participant surveys of high value. Partly because of this, the choice was made to use the participant surveys only in a supplementary way and not to base conclusions on them.

Communication - Integrated Design process

Literature predicts that the success of communication has an effect on the outcome of the integrated design process. Indeed, according to the empirical results of this study, it seems that sufficient effective communication is necessary for solid project success. However, communication serves as a prerequisite and not a determining variable success of the integrated design process. There are a number of things that should be mentioned in this regard.

What stands out is team 4's high score on communication by the observer and their low score on game result. The qualitative data show that they made a crucial mistake at the end due to time stress which caused them to lose a lot of points on both quality and process. However, had this mistake not happened they would have emerged as one of the best scoring teams. This would be in line with the expectation. Team 4's poor score cannot be fully explained by the quality of their communication. This confirms that more is needed for the good outcome of the integrated design process than communication.

The best scoring team on game result is team 5. Across all the dimensions they scored well. However, the observer scores their communication quantitatively as average. This is notable because

you would expect their good game result to be explained by good communication. However, the qualitative data did show that there was constant communication and that asking often how the other person was doing ensured that there was a team spirit. This was a determining factor in their game result according to the group. This might indicate that the defined categories of communication were not the only determinants of the process outcome. The quantitative score on the categories was then correct, but the positive qualitative observations could not be scaled below them. This indicates that in addition to the connections found with understanding and barriers, there are likely more communication aspects that influence the results of the integrated design process. From the literature, we know that, according to Thomas et al. (1998), there are at least six categories that make for effective communication. From the interviews, two of those categories were actively confirmed, but the other four were not invalidated for the integrated design process. Follow-up research could focus on deepening the relationships with other communication aspects.

Team two scores poorly on communication and on game result. This is as expected. However, it should be noted that they indicated that they had difficulty understanding the rules of the game. Their low game result can therefore be partly explained by this since poor understanding of game rules can lead to, for example, wasted time and a poor score on that dimension. However, the observer's qualitative data indicate that poor communication was the determining factor in the game outcome. Therefore it is expected that the understanding of the rules of the game did not have a major disruptive effect on game results.

It is notable that no correlation is seen when observations are compared to project result, but it is seen when participants experiences are compared to project result. However, this has a logical explanation. The teams were told how they had performed before they completed the survey. The teams that knew they had done well completed their surveys more positively than the teams that knew their result was poor. Because the survey of participants is not fully objective, it had already been used only as support for the research findings. Now that it also appears that the results of this survey are strongly correlated with their project success the value of these results further diminishes.

The results show that the worst performing team received failing grades for their communication. The other teams scored significantly higher on their game results and they all had reasonably good communication scores. So it seems that there is a positive effect of communication on the project outcome. Communication is not the determining factor, but a precondition for project success. In fact, this is also what (Zulch, 2014) describes in his research. Communication is the foundation for project management from which it supports other functions that should lead to improved project outcomes. This confirms what the results in this study showed and it is an important insight for the conclusions of this study.

Empathy - Integrated Design process

The results of this study show no direct relationship between empathy and the outcomes of the integrated design process. This can be explained by the many external factors that also influence the outcomes of the design process such as the client and time and money constraints (Goodman-Deane et al., 2010). In particular, the time constraint has left a mark on the outcomes of some teams in this study according to the observers. External factors make it difficult to isolate the proportion of empathy in a study on such a scale. As a result, the effect of empathy is difficult to demonstrate. It is therefore important to examine the proportion of confounding variables relative to empathy in follow-up research with larger test groups.

Despite the absolute differences in participants empathy scores, it appeared that these were primarily determined by the affective dimension of empathy. The cognitive abilities of the participants were close to each other. Because the game result was measured on the technical aspects of real-life projects it says little about the performance on the soft side of the project. From the literature, we know that the affective side of empathy in particular shows itself through creativity and innovation in the design process (Gasparini, 2015). The designed serious game did not have such affective components in it. Therefore, they were not measured in this study while this could possibly show the

differences between the teams in this study. The lack of correlation between empathy scores and game result can be explained by this. This is an important insight and an interesting recommendation for future research.

To complement the previous insight, something stood out in Group 4. They chose a different tactic than other groups, showing creativity. This is in line with their higher affective scores as an empathic group. However, this creativity and approach took much more time which ultimately caused them to run out of time and make a crucial mistake. Without this mistake, they could have achieved an exceptional score on project quality and process. From this it seems that the creative and empathic approach is effective, provided that sufficient resources are available. A useful insight for practice as well as follow-up research.

The results showed a weak relationship between empathy and quality and process. It is too weak to really base conclusions on but a connection can certainly be recognized. This while the results on time and money were inconclusive. From the literature it appears that important factors on project quality have to do with human resource management, customer satisfaction and other types of management (Jraisat et al., 2016). This while literature on time and costs mentions many external factors like inflation, politics or weather conditions as well (Olawale & Sun, 2010). Results on time and money will therefore be more likely to be influenced by factors other than competencies. It is therefore explainable that there is a greater influence of empathy on quality than on money and time. Now that the results from this study give a first indication of this, it is good to take this into follow-up research.

8.2 Validity of research

Throughout this research multiple choices were made that led to the research conducted. The purpose of this research was to discover the relation between empathy, communication in and the success of the integrated design process of integrated infrastructure projects. For this purpose interviews were conducted with design managers and a serious game was designed and executed with 24 people from the process industry. This chapter will reflect on the validity of the research results, both internal as external.

Internal validity

Internal validity refers to the extent to which the found cause-and-effect relationship is trustworthy. From the results, a slight relationship can be seen between empathy and communication during the integrated design process. The independent variable empathy caused a movement in the dependent variable communication. However, it is difficult to exclude external influences in this study.

There are a number of factors that can impair validity. These include the effects of history, maturation, testing, instrumentation, selection bias, statistical regression and mortality (Sekaran & Bougie, 2016). History, maturation, statistical regression and mortality do not form a threat to the internal validity in this study. Testing effects could have posed a risk by having the participants to fill out a questionnaire in advance and knowing that they are the participants in a serious game that was yet to be played. However, all participants and groups received the same test and information, so testing effects were addressed and nullified. Instrumentation effects were present since all teams are observed by different observers. However, these effects were minimised by providing a manual and standardized observer forms to the observers. Selection bias occurs to some extent in the game session. A small proportion of the participants have a different origin which means they are not proficient in the Dutch language. To prevent language barriers from influencing the communication, it was decided to place the English speaking participants in 1 group as much as possible. This does imply a selection bias. However, the negative effect of language differences is estimated to be larger than the effect of selection bias with which it is a well-considered threat to the validity.

Another important part of internal validity is to reflect on the trustworthiness of the research methods used. To formulate an answer to sub-question three, three interviews were conducted with experts

from the construction industry. However, it proved difficult for them to formulate good answers to the questions about communication. They indicated that they do not often think about this and they found it difficult to name what makes communication with different parties successful. Because a degree of self-confidence was lacking in their answers, it is not possible to say with 100% certainty that the essence of the communication processes in the sector was captured. However, the choice of certain processes as a result of these interviews does not affect the found relationship between empathy and these processes. Nevertheless, this insight is very important for the industry. Knowledge about the importance of communication is growing, but apparently awareness in the industry is lagging behind.

In addition, it is good to also look at the validity of the IRI Davis test (1980). It was chosen to use this IRI Davis test because it was also available in Dutch (de Corte et al., 2007). A disadvantage of this is that it is a self-report test and thus the internal validity is lower. A self-report test requires good self-reflection and self-knowledge on the part of the participant. One might assess himself differently than how he or she actually is. With this, the scores do not reflect the real characteristics of the participant. Another risk of a self-report test is raised by one of the study participants. "These kind of survey depends on the feelings and the situation of the people at the time that they are filling the form. I believe that people have different sides in different situations" (Participant in study). This runs the risk of incorrectly measured and situational empathy scores. These risks indicate something about the reliability of this measurement method. Nevertheless, the researcher still believes that this method was the best for this study.

The validity issues associated with self-report tests also apply to the post-game survey of participants. It has already been discussed that the value of these results is low. The validity issues confirm the choice to use the survey not as leading but only as supplementary.

External validity

The extent to which the research results can be generalized to other settings or subjects is represented by the external validity. In this study the external validity is low. First, because the N in the game session was low. The game was played with six groups. This is a relatively low number to base truly grounded generalizations on. However, these six game sessions do give a first indication of a correlation.

Another threat for the external validity are the participants (van Ruijven, 2011). The risk of *sampling bias* is present. This means that the sample is not representative of the population. By using people from the process industry a deliberate choice was made to use a group of experts with working experience. With this, an attempt was made to make the group as homogeneous as possible in order to isolate empathy. However, the experience is limited to a certain industry and the group consisted for a larger part of young people. Real project teams will include people from different backgrounds in terms of experience and all ages.

Finally, a threat to the external validity is the setting (van Ruijven, 2011). The simulated environment is a simplified representation of reality. Therefore, it is good to be aware of the differences between simulation and real-life. The game attempts to simulate an integrated design process. The validity of the game has already been discussed in Chapter 6.7. It was concluded that especially the predictive validity is low. This reflects in the generalizability and thus external validity. Besides, in real life there are many other factors that influence project success such as scope changes or very current the nitrogen issues. This research has focused on only 1 factor by which prediction is not possible. The combination of lower scores on participants and setting makes external validity low.

8.3 Limitations and recommendations for further research

Although initial steps have been taken with this study in investigating empathy in the integrated design process there is also still much to investigate. First, it is recommended that this research be conducted on a larger scale. A major limitation of this study is the size of the test group. This makes it difficult to compensate for outliers, distinguish the influence of confounding variables and affects external validity. Follow-up research could therefore focus on making the test results more generalizable by examining larger test groups.

In designing the serious game Patchwork, it was chosen to include only technical criteria in the assessment of the integrated design process. However, there may be more components on which this process is assessed depending on the stakeholder or interest. For example, Silva et al. (2016) presents criteria that also focus on the long term rather than just the short term. This includes client and employee satisfaction, but also learning and development. Empathy has been proven to improve interpersonal relationships and understanding of information needs in literature as well as this research. It is therefore not inconceivable that satisfaction of actors as criteria could be strongly influenced by empathy. And, affective empathy in particular through creativity and innovation could have a greater impact on the soft side of projects. It is therefore recommended that follow-up research into the effects of empathy in the construction sector also include success criteria that focus on the soft side of projects. In addition, the interaction between design and implementation was not in the criteria of this study. The suitability of the design for implementation could also be added to the success criteria of follow-up research since this is an important requirement for the integrated design process.

The literature has shown that having empathy and showing it are not the same thing. This study did not include the difference between them. However, the empirical results do give an indication that this may have had an influence. In follow-up research on empathy in the construction sector, it is recommended to make a more in-depth study of empathic abilities and propensities. There are several studies in this area. For example the research of Cameron (2018). He describes factors that determine whether you use your empathic ability such as whether you feel comfortable with the other person. Further research could name such factors and observe them in the testing environment.

This research showed a weak relationship between communication and the quality of design also in the comparison of empathy and quality of design this relationship surfaced. In this research, this link was too weak to be made concrete. However, it does give reason to explore further. Especially since also the literature gives more clues to a relationship on this project dimension than on time and money. Follow-up research could focus on the relationship between empathy, communication and the quality of design as a result of the integrated design process.

Finally, the results in this study provide an initial indication that the positive effects of empathy require sufficient resources such as time and money to be of value. In projects there will always be choices and trade-offs to be made and also in the competences of the project team. A sheep with 5 legs does not exist. Future research could focus on potential trade-offs of empathy and also the interaction of empathy with other competences in the project team. From this, the value of empathy for practice can be further investigated.

8.4 Added value of research

With the insights gained in this study, the next step was taken in researching empathy in the construction industry. This provides contributions for both the science and the construction industry. Previous research has shown the need for full integration within the integrated design process. A way to achieve this is better communication. Through this research it has been proven that empathy can improve this communication. This allows a prerequisite for successful integrated design processes to be met. This research has also contributed to another area of research. Previous studies showed that empathy can have a positive influence on project performance of infrastructure projects, but through which process exactly this happens was not yet clear. This study shows that communication is a demonstrated aspect within the projects in which empathy is positively reflected. The improved communication can serve as a basis to also improve other processes, which ultimately can improve the overall project performance of infrastructure projects.

Next to scientific contributions this research also has practical implications. The industry can work on encouraging empathy to improve their communicative processes. Especially in projects where it is clear in advance that there will be many communication barriers present. This research has shown that empathic people will be better able to cope with these barriers. This will improve communication in

such projects. This is important because this research found that a minimal amount of communication is still necessary to achieve project results. Empathy in teams can ensure that this communication is achieved and allow the integrated design processes to be more successful. The question arises as to how the industry should then encourage empathy. Batelaan's (2021) research has written about this in the empathy framework. It describes two ways to increase empathy in the project team. On the one hand in the selection of people in the team through gender diversity, selection based on empathy scores and early involvement of empathic people in the project. On the other hand, by stimulating empathic behaviour of current people by, for example, increasing willingness to empathize or offering workshops.

In addition, the first part of this study revealed that the experts interviewed found it difficult to answer questions about communication. They indicated that they were not very involved in this and sometimes could not properly name what was really important in their communication. This is an important point for the sector. Growing scientific knowledge about communication and its relationship to project success should reach the work floor. It is important that this information and awareness also starts to live among the experts themselves. This study used serious gaming for research purposes. However, serious gaming is also often used to bring about behavioural change by creating awareness. Serious gaming could therefore also be very useful in increasing awareness of the importance of communicative processes in the integrated design process.

Finally, the first part of this study found factors that contribute to successful communication from interviews with experts. The factors are sometimes practical such as physical presence, taking time, using multiple communication channels and record-keeping. Others are somewhat more difficult to accomplish such as awareness of the other person and explaining your intentions. Now that this research shows that sufficient communication is essential for solid project results, these factors in addition to empathy can be actively used to achieve this.

9. Conclusion

In this chapter the answer to the main question will be formulated. Throughout the thesis, the sub-questions have already been answered. These answers formed the basis for subsequent steps. This chapter will therefore be particularly focused on the conclusions based on the answer to the main question.

To be able to say something about communication in the integrated design process, it is first necessary to define what is meant by communication. A literature review revealed that there are four communicative levels at which communication occurs in the integrated design process. This consists of communication within the team, between disciplines, with the client and with external stakeholders. To then define what constitutes successful communication in the integrated design process, three interviews were conducted with experts based on these communicational levels. It was concluded that understanding of information expectations and the ability to cope with communicative barriers are important on all communicative levels for communication in a fully integrated design process. The communicative barriers were further set out in logistics, accessibility and interpersonal difficulties. Empathy was defined as the ability to put yourself in the other person's emotional shoes and learn from it. With both a cognitive as an affective component people are able to understand needs, listen better, have social capabilities and thus function well interpersonally. This touches heavily on the abilities needed to be successful in communication. By stepping in and out of the other person's emotional experience with empathy one gains more knowledge with which there is more understanding of the other person's information expectations. In addition, the cognitive side of empathy allows for better interpersonal functioning and better understanding and increased knowledge of others should ensure that communicative barriers are less of a hindrance. This theory provides a hypothesis in which empathy through communication should provide for better integrated design processes. Therefore, the main research question that was answered during this study is:

"How does empathy influence the integrated design process of infrastructure projects through communication?"

With the following hypotheses to investigate:
H1: Empathy has a positive effect on communicative success during the integrated design process
H2: Communicative success has a positive effect on the results of the integrated design process
H3: Empathy has a positive effect on the results of the integrated design process

Through a serious game, a simulated environment was used to examine how empathic teams and less empathic teams communicate in an integrated design process. In the test group of process industry experts, men scored lower on empathy compared to women. A consequence of this was that the low empathy teams consisted mainly of men. In addition, it was found that the differences between the high and lower empathy teams could be explained mainly by the associative empathy skills. In this, the more empathic people scored significantly higher. Finally, it was noticeable that there was a clear trade-off between time and money and quality and process in the game results. High scores on time and money were associated with lower quality and process disruption and vice versa.

According to hypothesis 1, high-empathy teams were expected to score better on the components of communication. This hypothesis can be confirmed for this study. Particularly on understanding information expectations and dealing with logistical barriers, empathic teams proved more successful. The measured communicative success in this study appears to be determined primarily by the cognitive side of empathy. One exception was the logistical barrier. This had the most correlation with affective empathy components. Despite the differences being small, the results show a slight positive relationship between teams empathy levels and their performance on communication.

The second hypothesis predicted a positive effect of communication on the outcome of the integrated design process. When looking at individual dimensions there seemed to be a pattern in the communicative success and the quality of the design. However, the researcher found this pattern too weak to really talk about a correlation. On the other dimensions there was also no connection to be seen. Nevertheless, the results did show that sufficient communication is necessary for good process outcomes. A failing grade for communication resulted in significantly worse project outcomes. With that, it seems that communication indeed has a positive effect on the results of the integrated design process and hypothesis 2 can be confirmed. It was shown that communication is not a determining factor, but a prerequisite for project success. More is needed for a successful design process, but without good communication it becomes difficult to succeed.

Finally, the third hypothesis predicted that empathy would have a positive impact on the outcomes of the integrated design process directly. Although again a weak pattern could be seen between empathy and design quality, it was not sufficient to base conclusions on. In addition, the other outcome dimensions also had no demonstrable relationship with teams' empathy levels. Therefore, hypothesis 3 cannot be confirmed.

With all these results, a complete answer to the main question can be formed. This research shows that empathy positively influences the degree to which people understand each other's information expectations and the communicative hindrance experienced due to logistical, interpersonal, or accessibility barriers. This is particularly determined by the cognitive side of empathy. In addition, this study shows that sufficient effective communication is necessary for solid project outcomes. Communication seems to serve as a prerequisite for a successful integrated design process. Empathy in the integrated design process can thus ensure that the necessary effective communication is achieved for project success. No demonstrable effect was found in the direct relationship of empathy and the outcome of the integrated design process. The line of empathy through communication is not reflected in the direct results. Additionally, this says that influences of empathy on the game results through other processes than communication cannot be demonstrated. However, this study also cannot rule out that there was no positive effect of empathy on the outcomes of the integrated design process. Further research with larger datasets needs to conclude what the proportion is of other confounding variables being dominant in game success and how empathy relates to them.

This research is of value to both science and industry. It became clear that empathy enters the integrated design process through communicative processes. With this it takes important first steps in the research on empathy in the construction sector. In addition, it provides insights for the sector on how they can use empathy in their projects. Empathy makes it possible to better deal with barriers present in projects and in particular logistical ones. Projects with many of these barriers will benefit more from empathic project members. Besides, it can also be useful to strengthen poorly performing projects on communication with empathy. This can be done on the one hand by selecting for empathic people, but also by encouraging empathic behaviour more. Finally, this study has once again raised the issue that awareness of the importance of communication in the industry is low. Scientific insights will have to find their way into the workplace, or they will not start to have an effect on real-life projects.

The study also generated suggestions for future research. Follow-up research could first focus on strengthening the current conclusions. This can be done by increasing the size of the test group allowing confounding variables to be better identified and general validity to be increased. In addition, follow-up research could build on the results from this study. First of all by putting focus on the affective side of empathy and soft criteria in the design process. There may well be a strong connection between them. Secondly, the relationship between empathy and design quality could be further explored in response to tentative results in this study and indication from the literature. Finally, although empathy shows positive effects in this study, it seems that there are also choices associated with it. Future research could focus on potential trade-offs of empathy and also the interaction of empathy with other competences in the project team. From this, the value of empathy for practice can

be further investigated. All in all, this research has taken first important steps toward recognizing the value of empathy in construction projects and it provides much reason for follow-up research into this topic.

10.Reflection

Looking back on the research conducted, there are a few things I would like to reflect on. Should I conduct the study again, what would I do differently and what exactly am I proud of in this study. First, I would have made the interviews less broad. I had chosen to keep the definition of communication broad, however, this made answering more difficult. More delineated questions would have also made the results of higher quality. In addition, I would put more focus on validation when designing the game. Due to time constraints, the main focus was on getting the game working in the testing rounds. If there had been more focus on validation during the test rounds it would have increased the overall validity of the study. For example, by playing a test round with experts and questioning them on realism of the game, psychological reality in particular could have been increased as part of the validation of the game. Finally, during the week of the game session, I was surprised with the language preferences of the test group. It turned out that not all players were Dutch-speaking, with which language would also play a role in the game and communication. Next time I would think about this earlier and anticipate it.

On a more positive note, I would again take a lot of time to do the literature review on communication. It is a catch-all term for many aspects. The extensive reading gave me a good idea of scoping options and how best to design this research. In addition, I am very satisfied with the designed serious game. Before this research, I had never worked with serious gaming. Therefore, the fact that all the game elements worked and there were no problems during the game session was a great relief. For the time I had for the design of the game I am very happy with the version it has become.

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APPENDICES

Appendix A: The design process

Figure 21 shows the design process defined by Batelaan (2021) for the contractor Dura Vermeer. As mentioned in the introduction the process starts with the tender phase. In this phase multiple parties are involved. After the contract has been awarded and accepted the design process really starts. In this process there are 5 subprocesses that function side-by-side and are guided by project control: contract management, stakeholder management, design, execution preparation and maintenance preparation. At multiple times during the process there are gate reviews. These are meant to align the subprocesses and make sure that everybody is on the same page. All this is overseen by a higher layer of project managers.
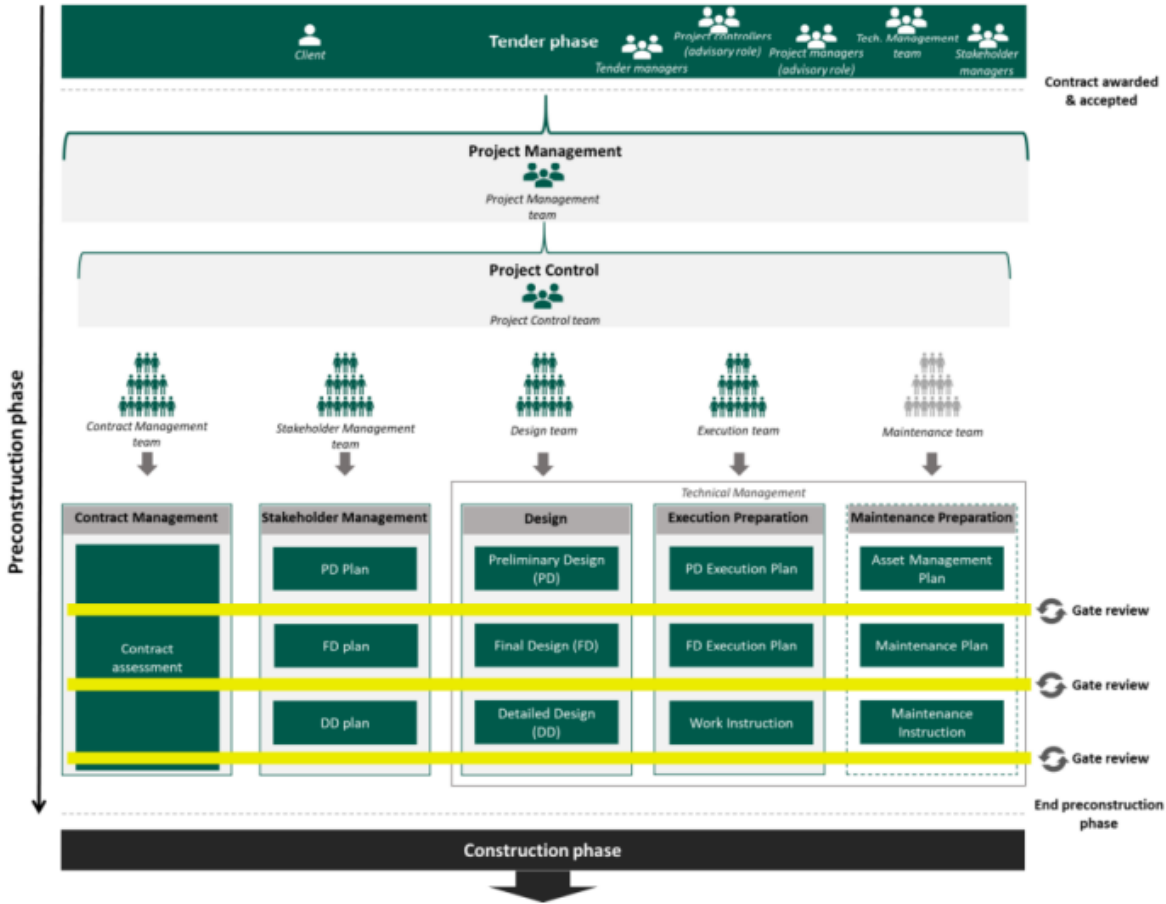

FIGURE 21 DESIGN PROCESS FOR CONTRACTOR DURA VERMEER (BATELAAN, 2021)

Appendix B: Interview setup

A standardized questionnaire was used during the interviews. The questionnaire used can be found in Table 17. As mentioned in the methodology chapter, the interview is semi-structured. If the researcher deemed it necessary, there was a deviation from the questionnaire to ask further questions.

First, the interviewee will be introduced to the study and goal of the interview. This also includes some questions on their function and position on projects. Afterwards, some questions will be asked about their current project and its status. The idea of this is that they can answer communication questions about the project so that it is placed in context. Once the reference project has been explained, questions on the communication within these projects follow. These are divided for four groups:
- The own team
- The other disciplines
- The client
- External stakeholders

After the specific communication questions, some questions on the integrated design proceed in general were asked. Also the concept of empathy was shortly introduced. Finally, they are asked about important aspects to include in the serious game. At the end of the interview, the interviewee is thanked and contact details are shared.

Introduction (5 min)	Onderwerp • Communicatie in het integrale ontwerpproces Doel • Erachter komen hoe communicatie er in een succesvol geïntegreerd ontwerpproces uit ziet Gegevensbescherming • Geïnterviewden zullen niet bij naam worden genoemd in het onderzoek. Antwoorden zullen worden geanonimiseerd. • Door deel te nemen aan dit interviews gaan de geïnterviewden er mee akkoord dat hun antwoorden gebruikt zullen worden voor onderzoek aan de TU Delft. Ook gaan de geïnterviewden ermee akkoord dat het interview wordt getranscribeerd en opgenomen. Duur • 1 uur Persoonlijke informatie vooraf: • Wat is uw specifieke functie? • Verantwoordelijkheden bij deze functie?
Algemene vragen project (10 min)	1. Op welk project zit u momenteel? 2. In wat voor fase zit dat project? 3. Hoe gaat het project? a. Was het project succesvol qua tijd geld en quality? b. Hoe kwam dat?
	Dit onderzoek gaat over communicatie tijdens het ontwerpproces. De volgende vragen zullen dus meer gericht zijn op de communicatie processen tijdens het ontwerpproces.

Communicatie in ontwerpproces (25 min)	4. Wat vindt u over het algemeen van de communicatie in het ontwerpproces van dit project? a. Waarom? *De volgende vragen zijn bedoeld om een wat beter beeld te krijgen van de communicatiestromen in het ontwerpproces. Dus wie communiceert er met wie en via welke kanalen gebeurd dat. Ik ga 4 actoren langslopen met ieder een aantal vragen. Dat zijn TDOS. Met team bedoel ik de afdelingen design, onderhoud en execution. Met disciplines bedoel ik omgevingsmanagement en contract management binnen Dura Vermeer.* 5. Kunt u iets vertellen over de communicatie tijdens project met: • **Uw eigen team (intern)** Hoe was het *formele* contact georganiseerd? Wie praat er met wie? Hoe? (Meetings/mail?) Hoevaak? Hoe was het *informele* contact op het project? Wie praat er met wie? Hoe? Veel? Wat werkte er goed in deze manier van communiceren? Hoe had de communicatie beter kunnen gaan? (Wanneer is communicatie met het team succesvol?) • **Andere teams / disciplines (intern)** Hoe was het *formele* contact georganiseerd? Wie praat er met wie? (MT?) Hoe? (Meetings/mail?) Hoevaak? Hoe was het *informele* contact op het project? Wie praat er met wie? Hoe? Veel? Wat werkte er goed in deze manier van communiceren? Hoe had de communicatie beter kunnen gaan? (Wanneer is communicatie met het team succesvol?) • **De opdrachtgever (extern)** Hoe was het *formele* contact georganiseerd? (PSU & PFU) Wie praat er met wie? Hoe? (Meetings/mail?) Hoevaak? Hoe was het *informele* contact op het project? Wie praat er met wie? Hoe?

	Veel?
	Wat werkte er goed in deze manier van communiceren?
	Hoe had de communicatie beter kunnen gaan?
	(Wanneer is communicatie met het team succesvol?)
	De stakeholders (extern)
	Hoe was het *formele* contact georganiseerd?
	Wie praat er met wie?
	Hoe? (Meetings/mail?)
	Hoe vaak?
	Hoe was het *informele* contact op het project?
	Wie praat er met wie?
	Hoe?
	Hoe vaak?
	Wat werkte er goed in deze manier van communiceren?
	Hoe had de communicatie beter kunnen gaan?
	(Wanneer is communicatie met het team succesvol?)
Communicatie algemeen in IDP + Empathie (10 min)	6. Wat zijn de grootste uitdagingen op het gebied van communicatie in het ontwerpproces?
	7. Veranderd de communicatie nog door het ontwerpproces heen?
	8. Zou meer empathie van mensen iets kunnen bijdragen aan de communicatie in het ontwerpproces?
	(vervolgvraag) Zo ja, waarom en waar zou dit dan het meeste effect hebben?
	(vervolgvraag) Zo niet, waarom niet?
	9. Is de communicatie tijdens het ontwerpproces anders dan in andere fases van projecten?
Vervolg gaming (5 min)	*Ik ga de communicatieprocessen tijdens de ontwerpfase van de projecten simuleren in een spelvorm tijdens mijn onderzoek.*
	10. Welke aspecten moeten er in ieder geval in het spel zitten om de realiteit goed weer te geven?
Closing (5 min)	Introduceer dat we aan het einde van het interview zijn aangekomen.
	Vraag of de geïnterviewde nog iets miste of iets zou willen toevoegen.
	Bedank de geïnterviewde
	Laat contactgegevens achter bij de geïnterviewde

TABLE 17 INTERVIEW SETUP

Appendix C: Quotes on success criteria and factors of communication in the IDP from interviews

This appendix shows the supported quotes on which the success criteria and factors are based in Chapter 4 of the main text. For each communication level, the listed success criteria and where present success factors are also shown including quotes. The number before the quotes indicates which interviewee used the quote.

Teams
The first communicative success factor that is pointed out is *structure*. The roles of people must be clear so that the relevant information gets to the right people. In addition, it is also important that the formal communication moments are thought out. What information needs to be recorded in which consultation and what is the purpose of the communication moments. Having a clear communication structure refers to the formal communication channels that must be well defined. A second success factor that is derived from the interviews is *understanding of interests*. When one understands the interests and views of the other, communication was successful.

Success criteria	#	Supporting quotes
Understanding of interests	1	*"When we understand each other, communication is successful. So understanding each other's interests, each other's work, each other's views. When that happens you can really form a team"*
	2	*"It always boils down to communication and whether you understand each other and whether you express yourself."*

Success factor	#	Supporting quotes
Functioning structure	1	*"I am also in the same department and hear everything. I do think it's very important that it's very flat, just you do need a clear division of roles"*
	3	*"If at any point the group gets bigger than 5 people yes then you have to have a pretty tight structure, because then again not everything is relevant to everyone."*
	2	*"I think you have to facilitate communication well. So that you make very specific what needs to be established in which consultation. Making the purpose of the consultation explicit has worked well."*
		"I believe communicative structure works well"
	3	

'

Disciplines

When asked about the success factors of communication between disciplines, many things were mentioned. Again, the most mentioned was *being understanding* towards each other. People need to understand each other's interests. If you understand what the other needs and are able to come to 1 workable solution, the communication is successful. A second factor mentioned was clarity of responsibilities and expectations. When the expectations associated with each person's responsibilities are well aligned, the likelihood of overlap and errors decreases. Good communication about expectations and responsibilities is therefore essential.

Success criteria	#	Supporting quotes
Understanding of interests and needs	2	*"Success factors are that they understand each other's interests and that they speak up about what their own interests are. That is the most important thing of all".*
	1	*"I keep coming back to understanding each other"*
	2	*"When they understand what the other person needs."*
	3	*"We have done well, I think, if we understand each other."*
	3	*"And yet again that piece of understanding what the other is doing and together arrive at 1 workable solution"*
Clarity of responsibilities	1	*"You just have certain responsibilities and if you can hold each other accountable to that and eventually meet that, then it's a success"*

Success factor	#	Supporting quotes
Time	2	*"There should also just be time to get to know each other, so you really have that informal contact there"*
	3	*"Taking time for communication is very important"*
Physical presence	2	*"Being together in a room works, because then you can also signal from the body posture or behaviour that something is not going well. If people are absent you really can't see it on a screen".*
Asking questions and explain	1	*"Success factor is when people just keep asking questions of each other, while also explaining what they are going to do with that information."*
Being aware of another	1	*"I think we have to be very conscious that we are also doing the work for each other"*

Client

The interviewees stayed mainly on factors that contribute to good communication, rather than on when communication is then truly successful. Nevertheless, two success factors can be identified. *Understanding* once again came forward as important. It was linked here to understanding each other and from there also being prepared to grant each other something. The second aspect can be captures

as having *openness and transparency*. When it is very clear to both parties what the requirements of the other are, the communication is successful.

A first retrieved success factor was awareness of the other. Being aware of the client and their world and therefore also seek each other out and keep asking questions ensures good communication. Secondly, frequent communication is mentioned as success factor. A more practical success factor of communication was being *physically* present in the same room. Face to face communication ensures that informal contact runs more smoothly and communication with the client is more frequent. Ultimately, the physical aspect is a means of achieving more informal communication. Finally, it was also mentioned that having *multiple channels* (communicative means) helped in communication.

Success criteria	#	Supporting quotes
Mutual understanding	1	*"success again has to do with understanding, and you have to show that to each other."*
	3	*"At the end of the day, you also have to give it to each other a little bit and understand where one is coming from but also the other."*
Openness and transparency	1	*"I think transparency is very important here, not having hidden interests and just knowing from each other where you stand."*
	3	*"You also just have to consult openly and transparently with the client's technical manager and not be like: let him say what we're going to do and vice versa the same applies."*
	3	*"when the communication was so open and transparent that the requirements and expectations were clear to both."*

Success factor	#	Supporting quotes
Awareness of the other	3	*"You better be aware during your project that everyone is coming from different worlds, I believe that helps"*
Frequent communication	2	*"But the most important thing really remains that you continue to find each other and that you actually speak to each other."*
Physical communication	1	*"We had agreed on physical days which also makes it easier to walk in and say: I'm struggling with this, help me. You really do notice that things go better then."*
	1	*"I experience it as a positive thing when you can easily walk in on each other and have informal contact with each other."*
	2	*"It worked to sit together in the same room"*
Having multiple communication means	2	*"It works to have something other than mail. We have vision or some other document management system, we have whatsapp, we have teams that we can chat in an informal space. It's not either-or, but it's all"*

External stakeholders
A first factor in achieving successful communication with external stakeholders is *clarity.* Communication with stakeholder is successful when it is clear so that there is no ambiguity about the agreements that are and have been made. Secondly, it is mentioned that communication should ensure that stakeholders requirements are validated. When the requirements are validated correctly, the communication is successful. Finally, one interviewee also mentioned *understanding* again. When you understand each other at the end of the communication, it is successful. From that understanding, it becomes easier to find compromise and explain why certain things go the way they do.

Success factor	#	Supporting quotes
Clarity	1	*"I think clarity is very important with external stakeholders and record keeping, so you can always refer back to agreements made with each other"*
Understanding of viewpoint	3	*"When you have a compromise where you are both dissatisfied with the result. No one can have their way completely and if you both understand that and still come out of it"*
	3	*"Understanding where we both come from and that we can also explain to them quite well what we do and why it involves only you"*

Success factor	#	Supporting quotes
Record-keeping	1	*"I think clarity is very important with external stakeholders and record keeping, so you can always refer back to agreements made with each other"*
Frequent conversation	1	*"To validate stakeholders' requirements, it is important to offer them a voice in conversations."*
	2	*"Just keep talking to each other, and you'll almost always work it out."*
Broad communication	2	*"You always have problems, and indeed it requires a lot of attention and communication with those stakeholders to talk about it properly. Not just from the environment manager, but especially from the project itself."*
Explain intentions	3	*"Understanding where we both come from and that we can also explain to them quite well what we do and why it involves only you"*

Appendix D: Quotes on communicational barriers in the IDP from interviews

This appendix shows the supported quotes on which the communicative barriers are based in Chapter 4 of the main text. In fact, these barriers are the negative influences on communicative success in the integrated design process. The number before the quotes indicates which interviewee used the quote.

Teams
First of all, it is worth mentioning is that no consistent communication problems were mentioned by the interviewees. Individually they came up with the following factors. *Distance* was mentioned as a barrier for successful communication. Working from home during the COVID pandemic resulted in the loss of much informal communication. While there is a lot of value in that. A second factor mentioned was forming a new team. In the beginning of projects people still have to get to know each other, and communication is more difficult. Added to this is the fact that the teams are often large. The size of teams was also a barrier according to interviewee (3). It is simply not possible to be in contact with everyone all the time. Finally, it was mentioned that communication in the teams was often difficult due to the different interests of the specialists. They are often more focused on content and do not like to communicate in the group and seek each other out.

Challenge	#	Supporting quotes
Distance	2	*"It didn't work well that we were communicating at a distance, you can't just ruminate after a meeting at the coffee machine. Did you mean this and did I understand correctly that this?"*
Newness	1	*"In the beginning of the project, the communication did not go as well because you are just forming a new team"*
Team size	3	*"Look those teams get big pretty quickly, and all those people, as a manager, you can't talk to all of them all the time. That is hard."*
Interests	3	*"The stereotype of the technical specialist is true to a certain extent, they just don't find it the most fun to speak in the group and really seek each other out."*
	3	*"With the technical people you see that it very quickly moves on to the content. If you have a group of structural engineers meet, they can easily talk for two hours about details, but that is not why the 10 of you have come together and that is a real pitfall."*

Disciplines
When looking at communicational challenges at the disciplinary level, three things were mentioned. The first interviewee acknowledges that the other disciplines require a lot of interaction. The success of that interaction depends heavily on the people with whom you interact. Communicative *competences* of those people were very influential in his project. Secondly, the communication is negatively influenced when people are only focussed on their selves. This challenge for communication is summarized as *egoism.* Lastly, a big challenge in the communication with other disciplines is the time at which they operate. The different disciplines are mobilised at other times in the process. for teams that are at the front of that process is difficult if they have to wait for information from teams that are not yet set up. *Different peak moments* are therefore the last challenge.

Challenge	#	Supporting quotes
Competences	1	"It takes a lot of interaction, of course, and then you're very dependent on the people who are on the project."
Egoism	2	"It goes wrong when there is only a focus of: I have to do this and this and I need that, I don't care how, I want it tomorrow"
Different peak moments	3	"The design team starts pretty early in the process. So usually you are in a phase where the design teams are already quite mobilized but the work preparation teams are not so if you are not careful you are waiting for information from people who are not there "

Client

Several challenges exist in the contact with the client. First of all, *separation* of the people representing the client and the contractor made it difficult to communicate. In addition, it is noted twice that the *different interests* create communicative challenges. Each organization has their own motivations that sometimes need to be kept hidden. Those motivations influence the communications heavily. *Capacity* problems within the clients organization caused communicative problems in one project. There were not enough people from the client involved in the project. This was at the expense of communication which reduced the accuracy and completeness of information. Lastly, a lack of informal contact caused problems. This lack came on the one hand from physical distance due to the pandemic and on the other hand from lack of familiarity with each other.

Challenge	#	Supporting quotes
Segregation of staff	2	"The people from the municipality of Amsterdam initially sat down in their own little room with 4 of them and that didn't work"
Different interests	1	"Internally, it's pretty easy to play open cards with each other, just externally it's a lot harder"
	3	"You often don't want to share everything back and forth, one you don't have to and two it's not always strategically convenient either."
Capacity	3	"A much smaller proportion of the people in the teams came from the client and that's tricky. Then you have the risk that the client starts asking questions like why is this? While they were actually just part of it on paper and that's a shame."
Distance / unfamiliarity	2	"When it was just through the mail and apparently it was still too hard to call each other it didn't work. The trust wasn't there yet such that all the lines started calling each other."

Stakeholders

Communicative challenges regarding stakeholders were often related to the different interests. External stakeholders again have different interests than those of the client. As a result, a great deal of communication was required to represent the interests of the stakeholders within the limits of the contractual agreements with the client. Their own interests, hidden or not, greatly influence the necessary communication. Finally, it was mentioned that as a contractor it is often difficult to

communicate with external stakeholders because they are not in the same system. It requires becoming part of their (experienced) world before they can be set in motion.

Challenge	#	Supporting quotes
Different interests	2	*"The barrier is mainly in the contract area. We have a contract, it contains requirements that we have to meet. And they often want more."* *"Stakeholders want to get the best out of it. Compare it to when something happens in your backyard, you would want to get the best out of it too"*
Different background	1	*"If you're not part of their system you're going to have such an incredibly hard time getting it moving."*

Appendix E: Measurement instruments serious game

During the serious game, several measurement instruments were used. First the participants were given a pre-game survey to determine their characteristics and empathy levels. The survey questions are shown in E1. After the serious game they were asked to fill in the post-game survey on their experiences and opinions which can be found in E2. Lastly, the observers were given an observation form to structure their observations in E3. Both the survey questions as well as the observation form can be found in this Appendix.

E1: Pre-game participants survey

The pre-game participants survey was important to determine the empathic abilities of the testing group. This has been done via the tool Microsoft forms. The questions that were asked in this pre-game survey can be found in Table 18.

The survey starts with the informed consent questions. These were necessary to fulfil the requirements set by the Human Research Ethics Committee (HREC). Afterwards, some personal questions were asked to retrieve characteristics of the test group. The survey ends with the IRI Davis self-report empathy test (Davis, 1980). Participants also had the option of completing the survey in Dutch. The propositions for the IRI test were taken from the study by de Corte, et al. (2007). For 28 statements, the participants were asked to rate them on a scale of 0-4. The survey ends with a question on comments or further questions.

Question		Answer options
Informed consent		
1	I have read and understood the information about the study dated 3-6-2022, or it was read to me. I have had the opportunity to ask questions about the study and my questions were answered to my satisfaction.	Yes
2	I am voluntarily participating in this study, and I understand that I may refuse to answer questions and may withdraw from the study at any time, without having to give a reason.	Yes
3	I understand that the following steps are being taken to minimize the risk of a data breach, and that my identity will be protected in the event of a data breach: - Participant questionnaires will be pseudonymized - Personal information (age, gender, education level and work experience) will be anonymized	Yes
4	I understand that personal information collected about me that may identify me, such as name, age, gender, education level, and work experience, will not be shared outside the study team.	Yes
5	I understand that personal data collected about me will be destroyed upon completion of the Master Thesis.	Yes
6	I understand that after the research the anonymized information will be used for the publication of Anniek Bertels' master thesis in the TU Delft education repository	Yes
7	I give permission for the anonymized data collected about me before, during and after the serious game to be archived in the TU Delft data repository so that it can be used for future research and education.	Yes/No

	Personal questions	
8	What is your name?	Open question
9	How fluent are you with the Dutch language?	Not at all – Only the basics – Quite well – I am a native Dutch speaker
10	How fluent are you with the English language?	Not at all – Only the basics – Quite well – I am a native Dutch speaker
11	What is your age?	< 21; $21 - 30$; $31 - 40$; $41 - 50$; $51 - 60$; > 60
12	What is your gender?	Man; Woman; Other
13	What is the highest level of education you have completed?	Lower than high school diploma; High school diploma or similar; Higher professional education or technical college education; University bachelors diploma; University masters diploma; Candidate / PhD
14	How many years of working experience do you have?	$0 - 5$; $5 - 10$; $10 - 15$; $15 - 20$; $20 - 25$; > 25
	Empathy questions	
15	I daydream and fantasize, with some regularity, about things that might happen to me	Scale $0 - 4$; $0 =$ describes me very well; $4 =$ does not describe me at all
	I often have tender, concerned feelings for people less fortunate than me.	Scale $0 - 4$; $0 =$ describes me very well; $4 =$ does not describe me at all
	I sometimes find it difficult to see things from the "other guy's" point of view.	Scale $0 - 4$; $0 =$ describes me very well; $4 =$ does not describe me at all
	Sometimes I don't feel sorry for other people when they are having problems.	Scale $0 - 4$; $0 =$ describes me very well; $4 =$ does not describe me at all
16	I really get involved with the feelings of the characters in a novel.	Scale $0 - 4$; $0 =$ describes me very well; $4 =$ does not describe me at all
	In emergency situations, I feel apprehensive and ill-at-ease.	Scale $0 - 4$; $0 =$ describes me very well; $4 =$ does not describe me at all
	I am usually objective when I watch a movie or play, and I don't often get completely caught up in it.	Scale $0 - 4$; $0 =$ describes me very well; $4 =$ does not describe me at all
	I try to look at everybody's side of a disagreement before I make a decision.	Scale $0 - 4$; $0 =$ describes me very well; $4 =$ does not describe me at all
17	When I see someone being taken advantage of, I feel kind of protective toward them.	Scale $0 - 4$; $0 =$ describes me very well; $4 =$ does not describe me at all

	I sometimes feel helpless when I am in the middle of a very emotional situation.	Scale 0 – 4; 0 = describes me very well; 4 = does not describe me at all
	I sometimes try to understand my friends better by imagining how things look from their perspective.	Scale 0 – 4; 0 = describes me very well; 4 = does not describe me at all
	Becoming extremely involved in a good book or movie is somewhat rare for me.	Scale 0 – 4; 0 = describes me very well; 4 = does not describe me at all
18	When I see someone get hurt, I tend to remain calm.	Scale 0 – 4; 0 = describes me very well; 4 = does not describe me at all
	Other people's misfortunes do not usually disturb me a great deal.	Scale 0 – 4; 0 = describes me very well; 4 = does not describe me at all
	If I'm sure I'm right about something, I don't waste much time listening to other people's arguments.	Scale 0 – 4; 0 = describes me very well; 4 = does not describe me at all
	After seeing a play or movie, I have felt as though I were one of the characters.	Scale 0 – 4; 0 = describes me very well; 4 = does not describe me at all
19	Being in a tense emotional situation scares me.	Scale 0 – 4; 0 = describes me very well; 4 = does not describe me at all
	When I see someone being treated unfairly, I sometimes don't feel very much pity for them.	Scale 0 – 4; 0 = describes me very well; 4 = does not describe me at all
	I am usually pretty effective in dealing with emergencies.	Scale 0 – 4; 0 = describes me very well; 4 = does not describe me at all
	I am often quite touched by things that I see happen.	Scale 0 – 4; 0 = describes me very well; 4 = does not describe me at all
20	I believe that there are two sides to every question and try to look at them both.	Scale 0 – 4; 0 = describes me very well; 4 = does not describe me at all
	I would describe myself as a pretty soft-hearted person.	Scale 0 – 4; 0 = describes me very well; 4 = does not describe me at all
	When I watch a good movie, I can very easily put myself in the place of a leading character.	Scale 0 – 4; 0 = describes me very well; 4 = does not describe me at all
	I tend to lose control during emergencies.	Scale 0 – 4; 0 = describes me very well; 4 = does not describe me at all
21	When I'm upset at someone, I usually try to "put myself in his shoes" for a while.	Scale 0 – 4; 0 = describes me very well; 4 = does not describe me at all
	When I am reading an interesting story or novel, I imagine how I would feel if the events in the story were happening to me.	Scale 0 – 4; 0 = describes me very well; 4 = does not describe me at all

	When I see someone who badly needs help in an emergency, I go to pieces.	Scale 0 – 4; 0 = describes me very well; 4 = does not describe me at all
	Before criticizing somebody, I try to imagine how I would feel if I were in their place.	Scale 0 – 4; 0 = describes me very well; 4 = does not describe me at all
End of survey		
22	Are there any other things you would like to share with us regarding the research / this survey?	Open question

TABLE 18 PRE-GAME SURVEY QUESTIONS

E2: Post-game participants

Post- game survey   Group nr.

You have just played the serious game Patchwork. This survey is aimed at capturing your individual experiences. Below you will find a number of statements about the game in general and the communication during the game.

You can rate the statements on a scale of 1 - 5, where:

1: Totally disagree

2: Disagree

3: Neutral

4: Agree

5: Totally agree

Some statements will ask for additional explanation depending on your given answer.

General	Totally disagree	Disagree	Neutral	Agree	Totally agree
I liked the game	1	2	3	4	5
The game location was good	1	2	3	4	5
If disagree (1-2): can you explain?					
I was distracted during the game If agree (4-5): what distracted you?	1	2	3	4	5

The introduction presentation was clear	1	2	3	4	5
The rules of the game were clear to me	1	2	3	4	5
I was motivated to do well	1	2	3	4	5
Everyone had an equal share in coordination during the game	1	2	3	4	5
During the game I took the lead	1	2	3	4	5
During the game someone else took the lead If agree (4-5): how did you experience this?	1	2	3	4	5
I focused mainly on my own tableau	1	2	3	4	5
The game felt very much like a group project	1	2	3	4	5
I felt interpersonal tensions during the game If agree (4-5): can you explain?	1	2	3	4	5

Communication

I felt like I could talk freely during the game If disagree (1-2): can you explain?	1	2	3	4	5

It was difficult to communicate equally well with all the players If agree (4-5): can you explain?	1	2	3	4	5

The fact that I did not know others (well) made the communication less effective	1	2	3	4	5
The fact that I did not know others (well) made the communication less efficient	1	2	3	4	5
The fact that I could not see others' work made the communication less effective	1	2	3	4	5
The fact that I could not see others' work made the communication less efficient	1	2	3	4	5
The group size made the communication less effective	1	2	3	4	5
The group size made the communication less efficient	1	2	3	4	5

The other players had a good sense of when I needed information from them	1	2	3	4	5
The other players had a good sense of what information I needed from them	1	2	3	4	5
I had trouble understanding when people needed information from me	1	2	3	4	5
I had trouble understanding what information people needed from me	1	2	3	4	5
The group had a good understanding of each other's information expectations	1	2	3	4	5

I found the communication during the game effective	1	2	3	4	5

I found the communication during the game efficient	1	2	3	4	5
I am satisfied with the communication of the group during the game	1	2	3	4	5
I am satisfied with my own communication during the game	1	2	3	4	5

Validation					
The game reflects the reality of communication during projects If disagree (1-2): can you explain?	1	2	3	4	5

I have played the original game Patchwork before	Yes	No

Other comments for the researcher? You can
use the back of this paper to comment

E3: Observation form

Resultaat game: ⊙ = ⏱ = ▦ = ↻ =

Begrip van de spelregels					
De spelers begrepen de spelregels Toelichting van observaties:	Sterk mee oneens	Oneens	Neutraal	Eens	Sterk mee eens

Afleiding					
De spelers waren afgeleid tijdens het spel	Nooit	Zelden	Soms	Vaak	Altijd
Toelichting van observaties:					

Coördinatie

Iedereen in de groep heeft evenveel inspraak	Sterk mee oneens	Oneens	Neutraal	Eens	Sterk mee eens
Toelichting van observaties					

Individualistisch - collectief

De spelers zijn vooral gefocust op hun eigen tableau	Sterk mee oneens	Oneens	Neutraal	Eens	Sterk mee eens
Toelichting van observaties					

Overig

Wat ging goed / wat ging minder goed?

Toelichting van observaties

EMPATHIE

Luistervaardigheden					
De groep beschikt over goede luistervaardigheden	Sterk mee oneens	Oneens	Neutraal	Eens	Sterk mee eens
Toelichting van observaties					

Emotie					
Er zijn duidelijk zichtbare emoties tijdens het spel	Sterk mee oneens	Oneens	Neutraal	Eens	Sterk mee eens
Toelichting van observaties					

Non-verbale gedragingen					
Non-verbaal gedrag speelt een rol in het spel	Sterk mee oneens	Oneens	Neutraal	Eens	Sterk mee eens
Toelichting van observaties					

Sociaal functioneren					
De groep toont sociaal gedrag	Sterk mee oneens	Oneens	Neutraal	Eens	Sterk mee eens
Toelichting van observaties					

Overig
Zag je ergens anders empathisch gedrag?
Toelichting van observaties

COMMUNICATIE

Er werd gevraagd of men de informatie goed begrepen had	Nooit	Zelden	Soms	Vaak	Altijd

Toelichting van observaties

Men ging pas informatie communiceren zodra zij ernaar gevraagd werd	Nooit	Zelden	Soms	Vaak	Altijd

Toelichting van observaties

Wanneer men niet kon helpen in de gevraagde informatie werden er alternatieven aangeboden	Nooit	Zelden	Soms	Vaak	Altijd

Toelichting van observaties

Er werd vaak geïnventariseerd hoe ver men hun individuele doel al had behaald	Nooit	Zelden	Soms	Vaak	Altijd
Toelichting van observaties					

Barriere bereikbaarheid

Communicatie wordt gehinderd door de groepsgrootte	Sterk mee oneens	Oneens	Neutraal	Eens	Sterk mee eens
Toelichting van observaties					

Barriere logistiek

Communicatie wordt gehinderd door de fysieke barrieres (tussenschotten)	Sterk mee oneens	Oneens	Neutraal	Eens	Sterk mee eens
Toelichting van observaties					

Er zijn duidelijk zichtbare onderlinge spanningen tijdens het spel	Sterk mee oneens	Oneens	Neutraal	Eens	Sterk mee eens
Toelichting van observaties	Sterk mee oneens	Oneens	Neutraal	Eens	Sterk mee eens

Communicatie wordt gehinderd door het feit dat de groep elkaar niet (goed) kent
Toelichting van observaties

Toelichting van observaties

Appendix F: Materials for game session

Playing the serious game Patchwork for research purposes requires some extra materials. This Appendix includes these documents. First the observation manual is shown in F1. The manual introduces the observers with the research and their tasks during the sessions. It is important that the manual is read completely prior to the game session. The second document F2 describes the game instructions. For clarity for the participants, an extra copy of the rules of the game was printed out for them to read. Lastly, the introduction PowerPoint was included in F3. This PowerPoint is important to give the participants all the same information before playing the game.

F1: Observation manual

In the pages below you will find the manual distributed to the observers. Because the extended rules of the game are explained in Appendix F2, they have been removed from the manual in this Appendix.

Handleiding observanten

Lieve vrienden,

Allereerst alvast heel erg bedankt dat jullie mij willen helpen met mijn afstuderen door een spelsessie te observeren. Om de spelsessie zo goed mogelijk te laten verlopen en de juiste resultaten voor het onderzoek te krijgen heb ik deze handleiding gemaakt. Hierin staat kort vermeld wat het onderzoek inhoud en hoe het spel hieraan bijdraagt. Daarna een korte toelichting van wat er van jullie verwacht wordt tijdens de sessie. Aan het einde van de handleiding vinden jullie observatie formulieren die tijdens het spel gebruikt kunnen worden. Mijn verzoek aan jullie is om deze van te voren vast door de nemen zodat je weet waarop je moet letten en de resultaten zo goed mogelijk worden genoteerd.

Succes en veel plezier!
Anniek

In deze handleiding:

Achtergrond onderzoek

Mijn onderzoek gaat over de invloed van empathie op de communicatie tijdens het integrale ontwerpproces. Dit is toegepast op infrastructuur projecten in de preconstructie fase. Dit proces bestaat uit de activiteiten die moeten leiden tot een uiteindelijk ontwerp dat kan worden uitgevoerd in de constructie (uitvoering) fase. Uit literatuur is gebleken dat fouten die leiden tot slechte project performance terug te leiden zijn naar deze preconstructie fase. Met name op het gebied van communicatie valt er veel te halen. Door middel van interviews is er uitgezocht welke aspecten van communicatie belangrijk zijn voor het integrale ontwerpproces. De twee categorieën van communicatie in dit onderzoek zijn:

1. **Begrip** van informatie verwachtingen.

Dit willen zeggen, zodra men goed begrijpt wat de informatie verwachtingen zijn van anderen zal de communicatie effectiever zijn.

2. (Aanwezigheid van) communicatieve **barrières**

Dit wil zeggen, zodra er weinig hinder wordt ervaren door communicatieve barrières zal de communicatie effectiever zijn.

De communicatieve barrières zijn verder gedefinieerd in 3 soorten:
- Logistiek
- Bereikbaarheid
- Interpersoonlijk

Indien men tijdens het integrale ontwerpproces *begrip* heeft van de informatie verwachtingen en logistiek, bereikbaarheid en interpersoonlijke zaken *geen barrière* hebben gevormd zal de communicatie effectief zijn.

Ik zal onderzoeken of empathisch vermogen van mensen (positieve) invloed kan uitoefenen op de communicatie tijdens en daarmee de kwaliteit van het ontwerpproces. Zie conceptueel model hieronder:
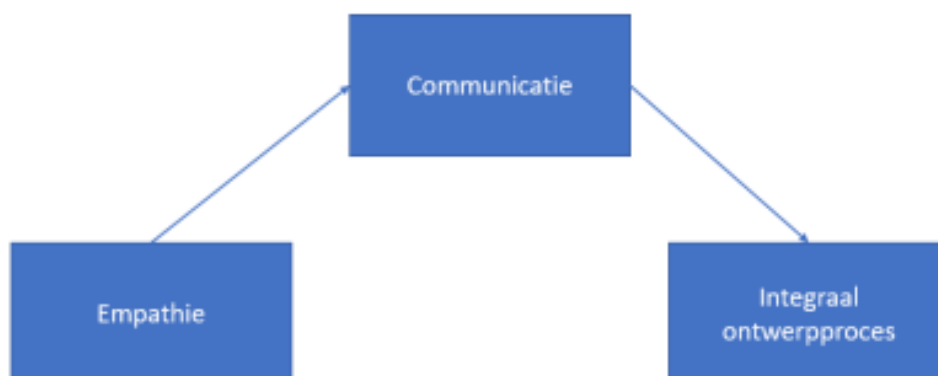
Doel serious game patchwork

De serious game patchwork is ontworpen om inzichten te krijgen in bovenstaande hypothese. Hierbij wordt het spel gebruikt als versimpelde weergave van de realiteit. Hiervoor is het bestaande spel Patchwork van 999 games aangepast voor dit onderzoek. Het spelverloop simuleert een ontwerpproces. Vier spelers zullen samen een deken moeten maken met lapjes stof. Deze lapjes kosten geld en tijd. Het doel is om zoveel mogelijk vakjes op hun deken bord gevuld te hebben zonder overlappingen.

Alle deelnemers werken aan hun eigen stuk van de deken en ieder legt ongeveer ¼ van de deken op zijn eigen bordje. Dit simuleert hoe in real-life projecten iedereen binnen het ontwerpproces zijn eigen taken heeft. Wanneer je aan het einde van het spel alle losse borden 'over elkaar heen legt' zou 1 passende deken (= eind ontwerp) moeten ontstaan. Doordat zij samen 1 deken moeten vullen zijn zij genoodzaakt goed te communiceren. Om iets te kunnen zeggen over de belangrijke aspecten van communicatie zijn de communicatieve barrière soorten als volgt in het spel geïmplementeerd.

Logistiek: deelnemers zien alleen hun eigen bord en kunnen door fysieke barrières andermans werk niet zien.
Bereikbaarheid: deelnemersaantal is opgehoogd van 2 naar 4 waarmee het lastiger wordt met iedereen te communiceren
Interpersoonlijk: de deelnemers kennen elkaar niet goed.

Het doel hiervan is om te ontdekken of deze ingebouwde barrières een probleem hebben gevormd voor de communicatie van de deelnemers en dus hoe ze ermee om zijn gegaan. Daarnaast wordt het begrip van de informatie behoeftes getest doordat zij informatie van elkaar nodig hebben om tot goed resultaat te komen.

Spelresultaat

Uiteindelijk zal de spelsessie resultaten geven op de drie aspecten van de hypothese. Empathie wordt gemeten in testscores, communicatie wordt gemeten in surveys en observatie en tot slot wordt het succes van het ontwerpproces (= resultaat game) gemeten worden op vier dimensies in het spel. Deze zijn:

- **Geld:** aantal knopen dat men over heeft aan het einde van het spel
- **Tijd:** aantal minuten dat men nodig had voor het spel
- **Kwaliteit:** aantal gevulde vakjes wanneer de borden gecombineerd worden
- **Procesverstoringen:** aantal dubbel gevulde vakjes als gevolg van miscommunicatie/fouten

Spel sessie 3 juni

Op 3 juni zal het spel gespeeld worden met 24-26 jonge experts uit de procesindustrie. De deelnemers zijn onderdeel van een cursus Management of Engineering Projects gegeven door Hans Bakker. Voorafgaand aan de spelssessie zal bij hen een empathie test afgenomen worden waarmee hun empathisch vermogen wordt getest. Op basis daarvan zullen er twee groepen worden gemaakt, een groep met de hoogste scores en een groep met de lagere empathie scores. Binnen die twee groepen worden mensen random verdeeld over groepen van 4 waarin ze het spel spelen.

De groep zal een plenaire uitleg krijgen over het onderzoek en het spel dat zij gaan spelen. Hierin worden ook de spelregels uitgelegd. Na afloop van de plenaire introductie zullen zij uiteengaan in hun groepen van 4 en plaatsnemen aan een speltafel. Zij hebben nu nog gelegenheid om vragen te stellen over het spel aan de observant. Het eerste onderdeel van het spel betreft overleg over tactiek. Iedere groep krijgt **5 minuten** om hun tactiek te bepalen. Deze tijd staat los van de tijd die gemeten wordt in het spelresultaat. Na afloop van deze 5 minuten gaat de tijd voor het spel lopen. Zij zullen het spel spelen waarbij de observanten de taak hebben belangrijke momenten/quotes/dingen te noteren.

Zodra het spel is afgelopen wordt het spelresultaat gemeten en deelt de observant direct surveys uit. Het is belangrijk dat de deelnemers weinig tot geen contact hebben tot zij deze hebben ingevuld. De surveys bevatten stellingen om de ervaringen van de deelnemers te achterhalen. Door interactie te verbieden tussen deelnemers zal hun mening zo min mogelijk beïnvloed worden door de rest. Ook de observant noteert zijn observaties. Tijdens deze discussie achteraf doet de observant mee en deelt hij zijn bevindingen. Uit deze discussie kan erg veel waardevolle informatie worden gehaald over beweegredenen en afwegingen. Het is daarom belangrijk dat de observant ook hier aantekeningen van maakt.

Zodra alle spelsessies zijn afgelopen zal ik even snel de resultaten van de groepen naast elkaar leggen en een plenaire afsluiting doen. Tijdens deze plenaire afsluiting zal de groep iets meer verteld worden over het onderzoek en de eerste resultaten. Welk team heeft het goed gedaan op welke aspecten?

Jullie verantwoordelijkheden

Jullie zullen de leiding krijgen over een groep van 4 mensen en een spel leiden.
De volgende dingen worden daarbij verwacht:

Voor de spelsessie
- Je zet het spel klaar volgens instructie p. 5
- Je start een audio opname bij aanvang van het spel

Tijdens spelsessie
- Je geeft de deelnemers 5 minuten om tactiek te bespreken en timet deze
- Je timet de speelsessie en let op de tijdslimiet van 35 minuten
- Je bent beschikbaar voor vragen over de spelregels
- Je noteert opvallende zaken op het observanten formulier
- Je markeert mee wanneer iemand een blokje op zijn tableau legt

Na spelsessie
- Je zorgt ervoor dat er geen interactie is tussen de deelnemers
- Je noteert de spelresultaten in tijd, geld, kwaliteit en proces en geeft deze informatie aan de deelnemers
- Je deelt de deelnemers survey uit
- Terwijl de deelnemers hun survey invullen vul jij het observanten formulier verder in
- Je neemt de survey in
- Je bent onderdeel van de discussie achteraf en noteert belangrijke zaken

Programma:

13:45 – 14:15 Uitleg observanten door Niek

14:15 - 14:30 Introductie + vragen deelnemers serious game (Niek)
Ondertussen: spellen klaarzetten (Observanten)

14:30 – 15:15 start spel in groepen

15:15 – 15:30 participant surveys uitdelen / invullen / innemen

15:30 – 15:45 discussie in groepen

16:00 – Korte afsluiting (Niek)

Observatie formulier

Tijdens het observeren van het spel is het belangrijk om op een aantal zaken te letten. Wat valt op voor hoe jouw team het spel speelt? Deze informatie is belangrijk voor mij om iets te kunnen zeggen over de processen tijdens het spel. Dit formulier geeft leidraad voor waar je op moet letten tijdens de sessie. Het is ingedeeld op de onderdelen algemeen, empathie en communicatie. Over elk van de stellingen wordt gevraagd om een mening op de schaal 1-5 (Sterk mee oneens – sterk mee eens) en toelichting van observaties.

Op de pagina's hierna vindt je een ingevuld observatie formulier ter voorbeeld. De punten die daarop staan zijn bedoeld als hulpmiddel, je hoeft dus niet over elk punt iets op te schrijven als er geen opvallende dingen zijn gebeurd. Mochten er daarnaast nog andere dingen zijn die je opvallen, schrijf ze vooral op!

Alle sessies worden ook met audio opgenomen zodat ik ze kan terugluisteren indien nodig.

F2: Game instructions

Rules of serious game 'Patchwork'

"Patchwork is a form of needlework that involves sewing together pieces of fabric into a larger design. In the past, it was a way to make use of left over pieces of cloth to create clothing and quilts. Today, patchwork is a form of art, in which the designers use precious fabrics to create beautiful textiles. The use of uneven pieces of fabric in particular can result in real masterpieces and is therefore being practiced by a large number of textile artists.

To create a beautiful quilt, however, requires effort and time, but the available patches just do not want to fi t together. So choose your patches carefully and keep a healthy supply of buttons to not only finish your quilt, but to make it better and more beautiful than your opponent's". (999 games, 2014).

Components

Board setup

1 Alle spelers krijgen 1 dekentableau, 1 tijdsteen en 5 knopen. Leg de resterende knopenfiches als voorraad op tafel.

2 Leg het gemeenschappelijke tijdspoor midden op tafel

3 Leg de tijdsteen op het startveld van het tijdspoor

4 Leg de lapjes stof **in deze exacte volgorde** naast elkaar en vorm daarmee een ovaal om het tijdspoor heen.

5 Zet de neutrale pion direct na het kleinste lapje stof (dat van 1x2) en vóór het volgende (met klok mee)

6 Leg de speciale lapjes (stukjes leer) op de aangegeven velden op het tijdspoor

7 De speler met de meest kleurrijke kleding begint

Rules of play

Players proceed in turns. **Clockwise**, the next player's turn is when the previous player has finished.

The player whose turn it is performs one of the following actions:

A: Advance and Receive Buttons

or

B: Take and Place a Patch

A: Advance and Receive Buttons

The player moves the time stone of his choice a minimum of 2 and a maximum of 5 steps forward. He receives 1 button for each field he moves forward in the process.

The lime green player moves her time token 4 spaces forward so that it is now in front of the yellow time token. She receives 4 buttons for that.

B: Take and Place a Patch

This action **consists of 5 steps** that must be carried out in the given order:

1. Choose a Patch

You can choose from the three patches in front of the neutral token (in clockwise order).

In this example, you can choose from the 3 marked patches. You cannot choose any other patch at the moment.

2. Move the Neutral Token

Place the neutral token next to the chosen patch.

3. Pay for the Patch

Pay the depicted number of buttons to the supply.

The label indicates the number of buttons to pay for the patch.

4. Place the Patch on Your Quilt Board

The patches on your quilt board may not overlap. You may turn the patch any way you

5. Move Your Time Token

Move your time token on the time board by a number of spaces as depicted on the label.

This patch requires you move your time token by 2 spaces.

The time board

Regardless of the action you take, you always move your time token on the time board. Some spaces of the time board are marked. Whenever you move onto or past one of those spaces, resolve the corresponding event:

■ **Special Patch:**

Take the special patch and place it on your quilt board immediately. **The special patches are the only way to "patch" single spaces of your quilt board.**

● **Button Income:** You receive a number of buttons according to the patches on your quilt board.

You will receive 2 buttons for this patch every time you receive button income.

Additional Rules

- Players may communicate freely during the game
- Players must individually all place at least 15 squares on their own tableau, if this individual goal is not met, the project will be considered failed
- If players occupy the same square on the game board on different tableaus there is a process disruption. With 3 or more process failures, the project fails.

End of the game

The game ends when:

- The time stone has reached the last square of the time track. A time stone that would cross the last space stops on the last space. If the player chooses action A, he only gets tokens for the spaces the time stone has actually advanced.
- The maximum time for the project of 35 minutes is over. Then the players must deliver the project with what they have achieved at that time.

Points

The results of the game are measured on 4 dimensions:
- Money: the number of buttons the team collected after the game is completed is added together.

- Time: the number of minutes it took the team to get to the last space on the time track.
NOTE: The time score is 35 if the game has ended because the max time to play has been reached.

- Quality: the number of empty squares on the tableau when the 4 separate tableaus are combined.

- Process Disruptions: The number of overlapping squares on the tableau when the 4 separate tableaus are combined.

NOTE: The project will have failed if:
- If the individual requirement of 15 squares per player tableau is not met
- There have been 3 or more process disruptions

Serious game 'Patchwork'

Thesis research
Anniek Bertels (MSc CME student)

TUDelft   **DURA VERMEER**

This session:

- Introduction (background, explaining Patchwork)
- Playing 'patchwork' in groups
- Filling out post- game surveys
- Group discussion
- Plenary results research

Introduction MSc Thesis

Context:

- Poor project performance
- The design process needs more integration
- Communication offers possibility to better integration

Goal:

- To gain insight in how communication during integrated design processes can be improved

Serious game Patchwork

Adjusted version of 999 games

"Patchwork is a type of sewing, where several pieces of fabric are sewn together to create a larger design"

You create a beautiful patchwork blanket on your 9x9 game board by buying pieces of fabric and puzzling them together on your board!

Your design project:

You will form a design team of 4 people

Assignment:

- Deliver 1 complete patchwork design (9x9) as a team
- Make sure each member contributes at least 15 boxes

How?

- Each team member has their own 9x9 empty board
- When it is your turn you can buy a fabric piece for your own board
- At the end, the boards are combined into 1 patchwork, assuming they fit!
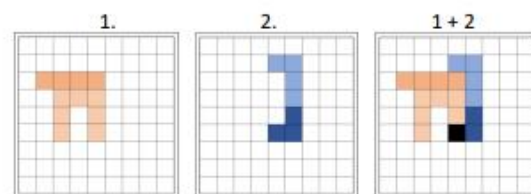
How to play:

Players proceed in turns (clockwise)

When it is your turn, choose:

A: Buy a fabric piece and put on your game board

OR

B: Move the time stone 2-5 steps and receive buttons (= money)

A: Buy a fabric piece and put on game board

1. The player chooses one of the 3 fabrics that are in front of the white pawn.
2. Pay for the fabric piece (see label)
3. Puzzle the fabric piece on your game board
4. Move the time stone on the time board (see label)
5. Move the white pawn to place of chosen fabric
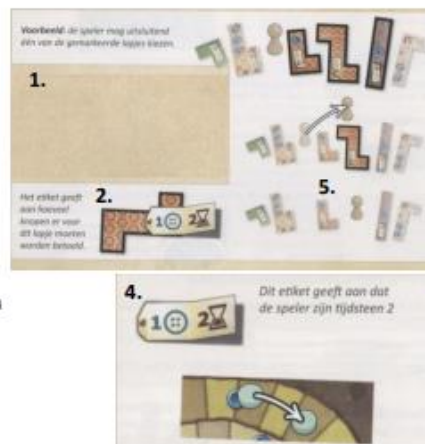
The time board

No matter which action is chosen (A or B) the time stone is moved on the time board. If it passes a special field then the following happens:

Special fabric (singular piece)
- Player takes the special fabric and is required to put it on their board
- Special fabrics are the only option to fill 'single fields'

Income
- The players receive as many buttons as the number of buttons at the fabrics on their game boards

Additional rules

- You cannot see what other people are doing -> don't cheat!
- Players are allowed to communicate freely during the game
- Every player contributes a <u>minimum</u> of 15 boxes to the final design
- Every team gets 5 minutes prior to the game to discuss tactics
- Double filled boxes count as 'process disruptions'

1.	2.	1 + 2
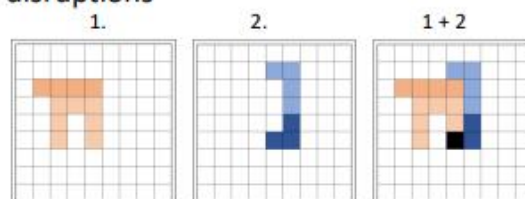
End of game

De game is finished when:
• The time stone has reached the last field on the time board
OR
• The project deadline has been reached (35 min.)

35 min.

Project result

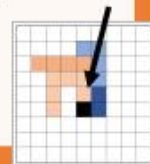| Time	Money	Quality	Process
(# minutes played) max. 35 min	(# buttons at end of game)	(# of empty boxes on the joint game board)	(# double filled boxes on the joint game board)

NOTE: the project will have failed if:
- the individual requirement of 15 fields on each players board is not reached
- there have been 3 or more process disruptions

Practical things

❖ 6 facilitators who will observe and are available for questions
❖ Communicate in language you are all most comfortable with

During game:
- 5 minutes for discussing tactics
- Max. 35 minutes of play time

After game:
- Facilitator communicates your result
- Fill out post-game survey on communication during the game (individual experiences)
- Group discussion (group experiences)

➢ Don't communicate before filling in the post-game survey!
➢ Don't communicate with other teams while they are still busy playing!

Questions?

Appendix G: Additional game materials 'Patchwork'

Although Patchwork is an existing board game that can be bought in the game store, it needs some additional materials to make it playable for the serious game purposes. Due to the increased participant count of 4 instead of 2, two additional game boards are needed. The additional board is shown in this appendix.