Health care business process redesign

a method for the structured generation of redesign scenarios

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Health Care Business Process Redesign: A method for the structured generation of redesign scenarios

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Preface

It is done, the last chapter of my Master Thesis project is written. The period in which I executed my Master Thesis has been a chapter in my life which was both enjoyable and educational. This was highly due to the fact that I have had people who supported me without any doubt in my capabilities. I would like to take this chapter to give my thanks to those that made this research, the research that it is.

First, I would like to thank Rob Vanwersch, Irene Vanderfeesten and Remco Dijkman for their feedback during this experience. I give special thanks to Rob and Irene for their enthusiasm during the process from the presentation until the finish of my Master Thesis project. I think that I could not finish it without their support and advice on my Master Thesis. I would like to give my thanks to Remco, as my third supervisor, for reading my Master Thesis and giving feedback and valuable remarks.

Second, many thanks go out to the Academic Hospital in Maastricht. The ophthalmology department provided me with a case study, without it my research would not be the same. Furthermore, I would like to thank all students, PhD's and personnel for the good time I had working in the AHM. You all made the time I spent at the hospital one I will not forget. Huge thanks go out to Frank van den Biggelaar en Rudy Nuijts who were my supervisors and who provided substantial support during my research.

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Abstract

Today's and future hospitals face an ever-changing economic and political environment in which they need to adapt their processes and technologies to cope with the demand of these economic and political aspects. However, improving and changing the processes of the hospitals is a complex task. In previous research a framework has been developed that can be used by health care practitioners to redesign their processes. This Business Process Redesign (BPR) framework for health care can assist by providing a structured method for the creation of redesign ideas. However, an actual procedure for the usage of this BPR (HC) framework is lacking. In this Master Thesis, a redesign method is developed that improves the manner in which the BPR (HC) can be applied. The developed procedure is based on the Nominal Group Technique, this method focuses on the structured generation and voting on redesign ideas. The NGT method provides different process steps that a project group can use to work on the generation of redesign ideas. During a general NGT session the generation of redesign ideas is at the centre of attention, a combination of a Multi-Level Design and BPR (HC) is used to give the project group content related rules that can be used generate redesign ideas. In the generation of the redesign ideas the MLD provides dimensions in which the BPR (HC) framework can be presented.

The redesign method was designed by integrating these three methods. Afterwards, the redesign method was evaluated by applying the redesign method in a case study. The redesign method was evaluated using three different constructs, *"Efficiency", "Effectiveness"* and the *"Perceived value".* The measured efficiency showed promising results, this has been measured by looking at the number of redesign scenarios generated. The effectiveness has been measured using several simulation models. One simulation model showed statistical improvement however the other one did not. As only one scenario is seemed as an improvement no real conclusions are taken for the effectiveness. A survey has been used to measure the perceived value. The participants who filled in the survey thought the redesign method was useful however the ease of use was still debatable. This is mostly because the description of the redesign method was too difficult and technical to understand. The redesign method can be used by hospitals for the improvement of health care processes. The MUMC+ hospital experienced this added-value at first hand, as the redesign method was used in a case study to measure the different constructs.

The research has contributed a new redesign method to the existing knowledge base. As this research also focused on the application of the redesign method, the information derived from the application can be used for future work. This future work should focus on the further evaluation of the redesign method.

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CHAPTER 1. Introduction

Organizing change in the health care sector is a difficult task, as the process structure of health care processes is ranked amongst one of the most complex structures around (Penchas, 2003). Nevertheless, today's and future hospitals face an ever-changing economic and political environment, where they must adapt their process and technologies to cope with the changing environment (Baumgart, 2007). Furthermore, insurance companies are increasing their pressure on hospitals to decrease costs but also maintain or increase their quality. All these aspect, the economic, political and increased rules, will increase hospitals likelihood to change, or adapt, their processes. However, one does not simply change the process and improve the process via that way. In this master thesis a method is created with which one can redesign health care processes and improve their overall efficiency in a systemic and structure way.

At first the reason behind the master thesis is further explained. After that the general objective and research question will be presented. In the last paragraph an overview of the master thesis is given to assure a sound reading guide.

1.1. Motivation

In present day hospitals barely use structured methods to generate redesign ideas, cases mentioning structured redesign methods for the health care are limited (Jansen-Vullers & Reijers, 2005). There are different methods with which one can redesign processes. The following kinds of methods are available: (Vanwersch et al., 2013)

- *Structured methods.* This kind of method gives support in both the procedure as well as in the procedure of redesigning. In these categories BPR (HC) from Göbel (2012) is a rule-based structured approach for redesigning processes.
- *Semi-structured methods*. Semi-structured approaches, as the name suggest, only give small guidelines to the project group focussing namely on the procedure. A Delphi procedure is one of these methods, as it only gives a guideline for organizing meetings and not interfering with the actual generation of redesign ideas.
- *Unstructured methods*. Unstructured methods leave the group with their work and do not give any guidelines on the process or how to generate redesign ideas. A simple example of such a method is simple brainstorming.

Business Process Redesign is process at which the focus is on the improvement of the internal efficiency and effectiveness of an operation. Jansen-Vullers & Reijers (2005) cited from Hammer and Champy that *"the heart of BPR is the sensible application of a number of recurring redesign practices"*. Furthermore, Jansen-Vullers & Reijers noted that BPR consists of two types of improvements. The first is the type is the radical, or 'clean sheet' approach. This radical approach states that the process should be designed from the bottom up, without considering the present state. The other type of improvement is the considering of the current state of the company as a starting point. In this case the process is improved using workshops and/or BPR methods.

Looking at literature on BPR many different methods are available, as stated above these can be categorized in three sections. In this research the focus is on the structured types of method. These methods provide procedures and content related rules for improving process. However, clear

procedures for applying methods, or frameworks, are not available. Reijers and Mansar (2004) mentioned the following: "In the literature on BPR, examples of successful BPR implementations are given. Unfortunately, the literature restricts itself to the descriptions of the 'situation before' and the situation after, giving very little information on the redesign process itself." The research of Reijers and Mansar focussed on the development of a framework, which was aimed at the provision of Best Practices, what can be considered to be change heuristics. However, as this framework provided only change heuristics the BPR field still lacked a clear procedure for applying the frameworks. Göbel (2012) stated that little research was done into the application of BPR in the health care. In the research of Göbel a framework was specifically developed for the application in the health care. The fact is that this framework is focussed solely on the provision of change heuristics. Cited from that article: *"the ease of use of the redesign heuristics needs to be improved"*.

To find in which way medical institutions can improve their processes, literature provided different structured redesign frameworks. For example the TRIZ framework (Altshuller, 1984), a BPR framework (Reijers & Mansar, 2004) and, based on both TRIZ and the BPR framework, the BPR (HC) framework (Göbel, 2012) was created. The BPR framework originates from research done by Reijers & Mansar (2004). The focus of that BPR framework was on the administrative domain. In the framework, 29 change heuristics were listed. Furthermore, researchers from the former USSR have developed the TRIZ framework (Altshuller, 1984). Building on the TRIZ framework Chai, Zhang and Tan (2005) developed a service design based TRIZ framework. In this service based framework, the focus is on addressing weaknesses in service design. Chai, Zhang and Tan, describe 40 change heuristics. In the research from Göbel, a panel group and a moderator developed the BPR (HC) framework based on the BPR and the TRIZ framework mentioned before. A total of 45 change heuristics are provided in this framework. The change heuristics documented in the BPR (HC) framework are given in Appendix I. In these three researches the different frameworks were developed as guidelines to improve the cross-functional business processes of an organization, which are processes that range over several business functions. In those frameworks change heuristics are defined to improve processes. The term, change heuristic, is defined as principles that are applied locally on a specific element, of any process, and may help to improve the performance of the overall process as seen in Göbel (2012). These are for example the parallelization of activities or increasing the number of employees.

In a literature review, conducted as a preparation of this master thesis the implicit usage of the BPR (HC) framework was assessed (Van Balkom, 2013). The literature review concluded that the change heuristics originating from the BPR (HC) framework are widely used and applied by researchers, in an implicit manner. In further analysis it revealed that the BPR (HC) framework was nearly complete and could be used to improve medical processes. Nevertheless, as discussed in the master thesis of Göbel (2012), and the literature review, several limitations exist with the application of the BPR (HC) framework. It seems that at certain points the research on the BPR (HC) framework is limited, for example only in one instance the *effectiveness* and *ease of use* is tested. The first limitation considered is the *effectiveness* of the framework. In the case, of Göbels` research, the *effectiveness* was tested by applying several change heuristics in a case study. By looking at the results of this application the effectiveness of the method was measured. The second aspect considers the *ease of use*, of the BPR (HC) framework, for healthcare practitioners. Ease of use in that case was defined as the perceived value of health care practitioners on the ease of use of the BPR (CH) framework,

measured by performing a survey. The efficiency of the BPR (HC) framework was not considered a performance measure. The efficiency of the framework can be seen as the number of accepted ideas divided by the number of generated ideas. The two aspects, *effectiveness* and *ease of use*, were analysed in further detail, which leads to the conclusion that a clear health care process redesign procedure has never been established.

The first point, concerning one of the limitations of the BPR (HC) framework, considers the usage of the BPR (HC) framework. The implicit usage of the BPR (HC) framework has been established in multiple instances, resulting in positive results (Göbel, 2012 and Van Balkom, 2013). The researches focussed on the mapping of the change heuristics, documented in the BPR (HC) framework, to actual redesign scenarios found in literature. Nevertheless, the explicit usage deserves more attention, i.e. the actual effectiveness of the documented change heuristics. Göbel stated this limitation in the evaluation of the BPR (HC) as a thought for future research. The second limitation considers the ease of use of the BPR (HC) framework. This research was initiated to provide hospitals with a structured redesign method for generating redesign ideas using the BPR (HC) framework. As that framework is not yet easily applicable a structured redesign method is needed, as was noted during the survey executed during the research of Göbel.

It was made clear that health care practitioners indeed find it challenging to use the BPR (HC) framework (Göbel, 2012). It was noted that without proper training the health care practitioners found it complex to apply the BPR (HC) framework. A small number of change heuristics were applied in the research of Göbel, however knowing that this is only one instance the effectiveness of the BPR (HC) framework is debatable (Göbel, 2012). Knowing all aspects of the BPR sector and limitations of the BPR (HC) framework it was chosen to incorporate three methods into one to solve the limitations stated above and provide health care practitioners with a structured manner to redesign process.

1. The Nominal Group Technique is used as the general procedure for the redesign method. This technique provides health care practitioners with a structured process that can be used to generate redesign ideas. When the redesign ideas are generated the NGT provides steps which can be used to come to a consensus on what ideas are the best ones.
2. The BPR (HC) framework is used to give content related rules to generate redesign ideas.
3. The Multi-Level design will be used to define different sub-levels in the BPR (HC) framework and thus creating a more user friendly framework.

A combination of these three methods provides health care practitioners with a structured method for doing a redesign project in their own system. In this master thesis the redesign method is used to redesign a Health Care process. During the application the effectiveness of the redesign method can be checked and in such a way solving one of the limitations on the BPR (HC) framework as stated in the research done by Göbel (2012). The other limitation, ease of use, is solved by creating a more substantial procedure by incorporating the NGT and MLD methods. However, the choice for these two methods is not yet clarified, this will be done in the following two sections.

1.1.1. The choice for the Nominal Group Technique

To clarify the choice for the Nominal group Technique it is compared with other methods that perform the generation of redesign ideas the same as the NGT, to ensure the right choice has been made for the NGT. Ideas generated in a NGT sessions are weighted and discussed in this way combining both qualitative and quantitative information. By quantifying the information the best ideas are retrieved from all included ideas. Furthermore, this added value can be used in future situations, for example to present the reason for implementing a certain idea to management. The actual comparison is given in Chapter 2.2.1 as in that chapter the different steps in a NGT method are discussed.

Assumable, the NGT method will increase the usability of the BPR (HC) framework by providing a structured manner in which to find the most important ideas. In such a way it solves a limitation of the BPR (HC) framework, i.e. providing a procedure for the application of the framework. With the NGT method explained the MLD can be explained.

1.1.2. The choice for the Multi-Level Design

The third method used, besides the NGT and BPR (HC), is the Multi-Level design. The MLD is used to define dimensions in which the BPR (HC) framework can be presented, as the Multi-Level Design focuses on designing systems in phases it can be used for just that. In these phases, the focus goes from the concept, to the system and at last the encounter with the client (Patricio et al., 2011). Kozlowski and Klein (2000) argue that all organizations are multilevel systems, which means that organizational systems are divided into organization as a whole, the group and an individual level. Each of these levels has their own disciplines, theories and approaches for doing their work. As the health care sector can be considered as highly complex (Penchas, 2003) it seems presumable that redesigning subsystems is more beneficial over redesigning the system as a whole. Looking at the application in Health Care, the whole system is a department and all of the external aspects. The subsystems are the different processes and locations within the department.

Summarizing, the MLD gives a manner in which information can be presented in several subsections instead as a whole, which is a more easy way to use the BPR (HC) framework. Furthermore, using the flexibility of the MLD method allocating the change heuristics to a specific level becomes easier. Thus it can be used to overcome one of the limitations presented before, the limited ease of use documented in Göbel (2012). As with the NGT a comparison with other methods is discussed in paragraph 2.2.2.

1.2. Objective

With the context, and motivation, of the thesis discussed the objective of the thesis can now be given. As the literature review of the author showed promising results for the usage of the BPR (HC) framework it is assumable that a combined method of the NGT, MLD and the BPR (HC) framework will provide substantial support for health care practitioners in redesign projects. This research focuses at providing an answer for the following research questions:

General Objective:
"To develop and evaluate a business process redesign method, with the BPR (HC) framework, NGT and MLD as cornerstones, which can easily and effectively be applied in the Health Care sector."

Research Question 1:
"How can the NGT, MLD and the BPR (HC) framework be integrated into one combined method?"

Research Question 2:
"What is the perceived and actual value of the newly created combined method in a case study?

1.3. Research design

Before discussing the report structure a general overview of this research is described. In Hevner et al. (2004) a general overview is created of the IS research framework. The research done using this framework is a typical design-based research in which three stages can be defined:

1. ***Analyse***: the first step consist of the creation of background on the subjects at hand. In this research the background provides material from previous research. These materials are comprised of foundations and methodologies. In this case the Nominal Grouping Technique (NGT), the Multi-Level Design (MLD) and the BPR (HC) framework, mentioned before, are taken to form a new redesign method.
2. ***Design***: The first research question is based on the design phase. This is the integration of the NGT, MLD and BPR (HC) methods into one. The design is based on information generated during the analysis phase, combining this with own creativity of the author
3. ***Evaluate***: The second research questions is based on the evaluation phase. When it is clear how the design of the redesign method looks the next step is the application and evaluation of the redesign method. In this case the evaluation is done in three manners. The actual value is measured by looking at both efficiency and effectiveness. The efficiency of the redesign method is checked by applying the method in a case and measuring the number of accepted redesign ideas and the number of generated ideas. The effectiveness is checked by implementing several redesign ideas in a simulation study. The perceived value of the method is checked by doing a survey with health care practitioners who worked with the method. All these factors are obtained via the application of the method in a case study.

The case study, mentioned above, is aimed at redesigning the cataract surgery process. This process was already analysed in Martens (2012), in that project the author analysed the process and found different bottlenecks and problem areas. In this study, the focus will be on redesigning the process using the redesign method. Nevertheless, the problems defined by Martens will also be addressed. By using the created redesign method in this project, the actual value of the created method is assessed by looking at efficiency of the redesign method and the effectiveness of the redesign method using simulation. The perceived value of the created method will also be assessed by using a survey.

1.4. Report structure

The remainder of this report is structured as followed. Compiling all information in Chapter 2 creates an actual knowledge base. This knowledge focuses on the presentation of detailed representations of the different methods that are used to form the redesign method. Chapter 3 discusses the redesign method as a whole. Finally, in chapter 4, the evaluation of the method will be discussed. A thorough discussion on the method and the conclusion with which the research will be closed are given in chapter 5 and 6. This is also visually represented in Figure 1.

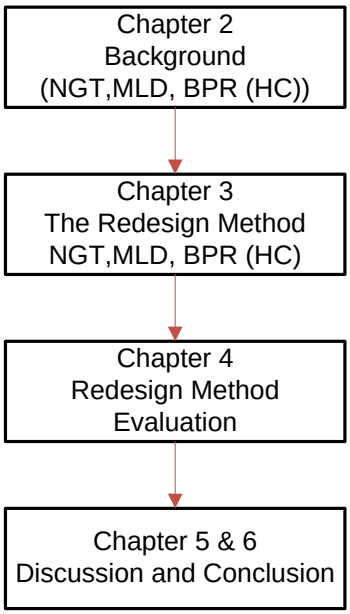

Figure 1: Research Design

CHAPTER 2. Background

In this chapter background information is provided on several topics that are used extensively in this master thesis. Business Process Redesign (BPR) is the first topic that is discussed in paragraph 2.1, this discussion is closely followed by the description of the BPR (HC) framework (§2.1.1.) followed by the Nominal Group Technique and the Multi-Level Design as the last topics discussed in paragraph 2.2.1 and 2.2.2

2.1. Business Process Redesign

Business Process Redesign is a structured approach that gives project groups the tools to analyse, improve, control and manage processes with the aim of improving the quality. In total BPR is only a small part of Business Process Management, in which a much broader scope than previous approaches has been taken. BPM primarily focusses on the customer and the improvement of inter-functional interaction. Figure 2 depicts the BPM life cycle, in which the planning and design is executed by using BPR methods.

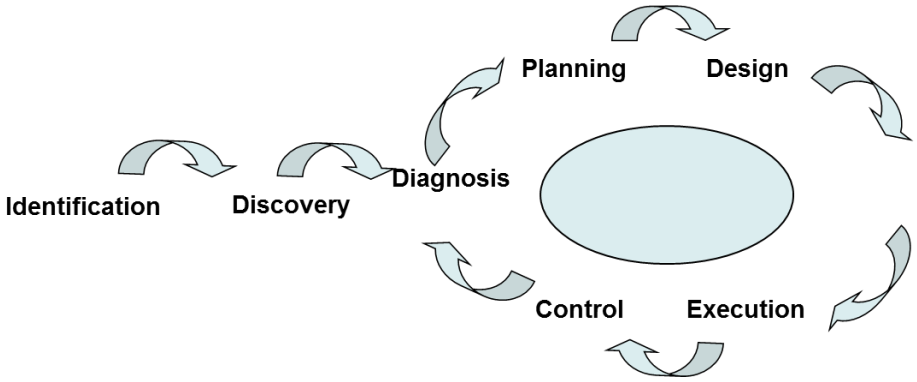

Figure 2: The BPM life cycle

The application of a BPR framework focuses on the structured handling of specific problems. These problems are translated to general problems for which general rules of thumbs exist with which the problems can be solved. Earlier, (§1.1) the term change heuristic was used which is exactly the same as a rule of thumbs in this case. In Figure 3 the general approach for rule-based techniques is given. The BPR (HC) framework focuses on applying these general rules of thumb to the health care sector. The BPR (HC) framework was especially developed for the health care sector, as previous research showed not many frameworks are specifically build for the health care domain.

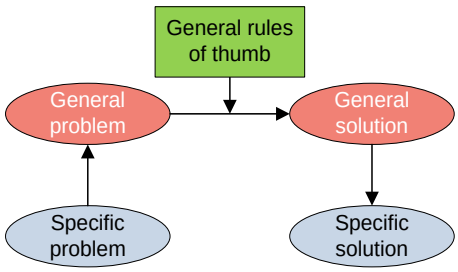

Figure 3: General approach rule-based techniques taken from Vanwersch (2013)

2.1.1. The Business Process Redesign (HC) framework

The literature review, executed by the author and mentioned before, focussed explicitly on the value created by the BPR (HC) framework. The research done by Göbel (2012) defined the BPR (HC) framework as a combination of a BPR and TRIZ framework, as discussed before. In that research Göbel focussed on finding change heuristics that can be applied in health care processes, in the end in total 45 change heuristics were defined. An overview of these change heuristics is depicted in Appendix I.

The former BPR framework (Reijers & Mansar, 2004) produced a number of change heuristics that can be split up in different sectors (for example customer, environment and physical layout). The BPR (HC) framework integrated that BPR framework and the TRIZ framework (Altshuller, 1984). By integrating these two redesign frameworks a number of new sectors were added, non-human resources and physical layout. These sections are also depicted in Figure 4.

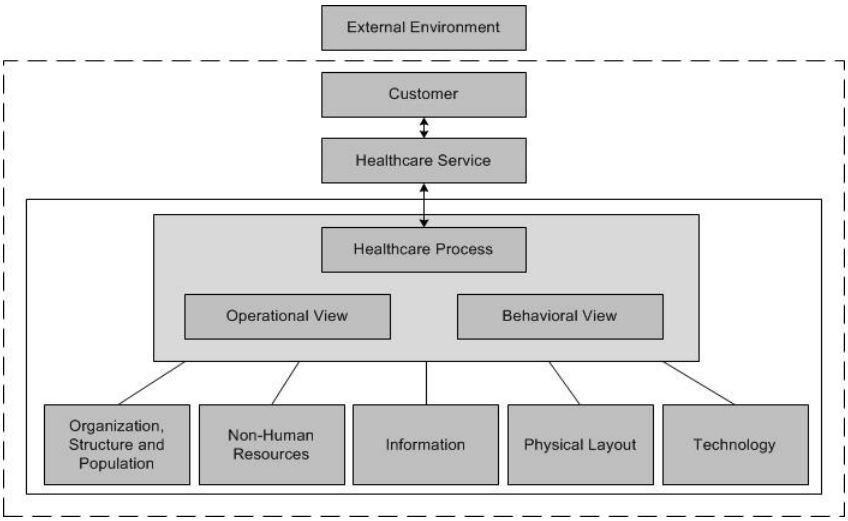

Figure 4: BPR (HC) sections taken from Göbel (2012).

The author focussed his literature review (Van Balkom, 2013) solely on the assessment of the implicit value of the BPR (HC) framework. The change heuristics were coded to redesign scenarios found in literature. In this manner the most important change heuristics were found and the implicit value was assessed. Concluding one can say that the implicit value of the BPR (HC) framework is high. Without knowing many researchers already use change heuristics defined in this framework.

The research of Göbel used a form of brainstorming to support the application of the BPR (HC) framework. Nevertheless, healthcare practitioners seem to find this support lacking (Göbel, 2012). This thesis will add additional support to the BPR (HC) framework by looking into the application of the BPR (HC) framework in combination with the NGT and MLD methods.

2.2. Background on NGT and MLD

The background information of NGT and MLD is retrieved from articles found using a structured literature review. This literature review was executed during this Master Thesis, thus this is a different literature review as was discussed before. That literature review focussed solely on the BPR (HC) framework and was executed as preparation for this Master Thesis. A detailed description and results from the literature review are given in Appendix II.

2.2.1. The Nominal Group Technique

The NGT primarily relies on gathering information from all group members where it tries to give everyone enough time to give their opinion. According to O'neil and Jackson (1983) the NGT allows and encourages people to contribute more to the output of the group. The reason for using the Nominal Group Technique becomes apparent in a study performed by Lloyd-Jones, Fowell and Bligh (1999). The authors argue that the usage of the NGT minimizes the group dynamics. These group dynamics are seen during brainstorm sessions where peer pressure influences/biases ones opinion. For example, in a brainstorm session one loudmouth is controlling the discussions. Whereas, in a NGT session, participants think of redesign ideas silently thus eliminating the loudmouth controlling the session. This occurs because people are asked to present ideas one by one, again silently.

Before describing the NGT method a discussion is held on why the NGT is the best method for this case. For example, the Delphi method is another method that can provide support with group working. Van de Ven and Delbecq (1974) argued that the NGT and the Delphi method offer at least the same results in effectiveness. Also, Teijlingen et al (2006) argued that the Delphi Method concentrates on measuring consensus as the NGT focuses on reaching, or developing, consensus on a specific topic it seems assumable that the NGT is the better one to create a better ease of use for redesign projects that use the BPR (HC) framework.

Another group method is the Focus Group. Claxton et al (1980) argued that the focus group is in principle the same as the NGT. Nevertheless, the NGT has some advantages over standard focus groups. For example, the NGT gives quantitative information about proposed suggestions whereas the focus group method only provides qualitative information about provided suggestions. Other examples can be seen in the article of Claxton et al. (1980), the author named several other reasons why the choice for NGT is sound. Summarizing, the NGT gives the project a structured approach for generating and finding the best ideas about a specific topic, as it also focuses on reaching a consensus it can be used to increase the procedure for redesigning processes.

Knowing NGT is the best procedure for this method a literature review is used to find 13 articles in which the NGT method was described in full detail. These articles were used to create an overview of all different procedural options (what steps can be performed in what order). Further additional recommendations, with respect to the application of the technique, were also retrieved and summarized during the literature review.

In the 13 articles included several different procedures were presented for the usage of the Nominal Group Technique. Based on these different procedures, a general flowchart was build showing the different possibilities to apply the NGT. Figure 5 depicts this general flow chart. The thicker lines represent routes which are taken most often. Furthermore, the thicker circles are the activities that belong to the route that is taken most of the times. After the Figure has been given, all steps will be briefly discussed to ensure that the integration of the NGT is clear. In every circle a specific step is given and between brackets the number of articles that have taken that specific step.

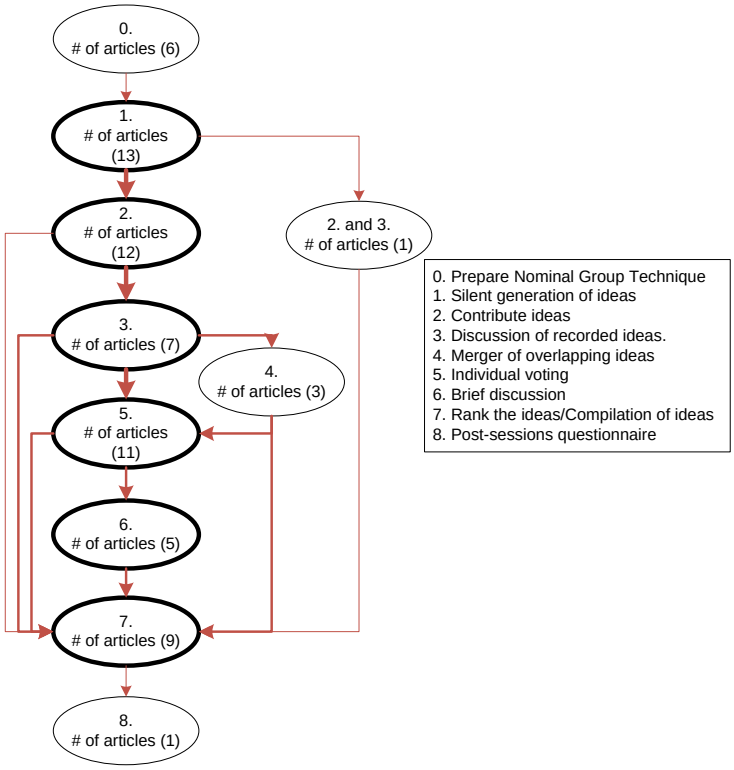

Figure 5: Integrated procedure for NGT

Step 0. In this first activity the focus will be on the preparation of the NGT sessions. This consists of, for example, the group selection, a presentation about the procedure and deciding at which aspect the focus will be.

Step 1. The next step is during the actual NGT session itself. After the content of the sessions is discussed the next step is the silent, and individual, generation of ideas on the subject. That is done to ensure that no participant holds back any ideas that they may have.

Step 2. When the ideas are generated they are presented, by the participants, in a round-robin fashion. The leader will restrain oneself from contributing ideas and will be responsible for recording the presented ideas.

Step 3. After the ideas are recorded there may be inconsistencies between how participants interpreted the ideas, which is why at step 3 there could be small discussions on the ideas to clarify them. Redesign scenarios can come in many forms and specifications that is why brief discussions could be allowed to further explain certain redesign scenarios. It seems assumable that group members could use this extra information when voting on a particular redesign scenario, as is suggested by articles included in the knowledge base.

Step 4. Several ideas could represent same thoughts or consider the same processes. That is why step 4 concentrates on merging ideas that have an overlap with one another. Merging ideas can resolve into better ideas. When the ideas are merged a final list is created.

Step 5. When it is clear what the final list is the next step is individually voting on the ideas incorporated on the list.

Step 6. After it is clear what ideas are most popular, the list can be ranked and presented to the participants of the NGT group.

Step 7. This part of the NGT session consists of a final discussion on the ideas ranked. That is, because there might be some ideas that are worth discussion because of the impact they might have on the organization.

Step 8. The final step of the NGT consists of a post-session questionnaire. This questionnaire can focus on any factor. For example, the evaluation of the method used or the overall quality of the NGT sessions.

With the general NGT procedure discussed there are still some other aspects that were mentioned in the articles, for example the role of the leader, voting mechanisms and others. These aspects were taken from the summaries in Appendix IV. As information is integrated from several articles a direct reference is not given. General and detailed summaries are given in the Appendix.

Role of the Leader

The role of the leader of a NGT session is a very important factor that needs to be clearly defined. There are very different roles the leader can have, for example participant and leader, or only leader or other. In this redesign method the leader will be just that, the leader. The leader is confined to only lead the discussions and not contribute with information. Moreover, the leader is focussed on the process and guidance of participants in the NGT process.

Voting Mechanism

In the knowledge base several articles focused on providing a mechanism for the voting on ideas. However, a clear definition cannot be based on the knowledge base. As an example the following voting mechanisms are used, a 5-point likert scale, priority ranking (1 to 5) or participants' choice for five redesign ideas. The clear definition is not provided because there are different methods presented, or no method at all, for the voting. In this case the author provided a mechanism for the voting.

Location of the sessions

The location is a very important aspect, which is why enough thought should go into finding the correct location where the meeting should take place. The room should be one in which there is whiteboard or some other object on which one could write the suggested ideas. Also the room should have enough capacity that one could present the procedure and content of the session in an easy way.

Group Structure

When looking at the actual group that is going to participate in the process it should be done carefully. The group should consist of not only manager, doctors, doctors in training and secretary. This way a diverse group of participants is ensured, moreover it ensures the thorough investigation of all levels of the company. Participants of with relatively high process knowledge and participants with relatively low process knowledge should be included. By this means there are also people who look critically at the process as they have less knowledge on the process. Some articles discussed the number of people included for the session. The number of participants varied from as much as 4 till 12 participants.

Discussion during sessions

During the sessions there are some moments at which participants are inclined to go in discussion with one another. This should only be allowed if the ideas suggested are not clear enough defined or if discussion is needed on the actual content of the idea. As this breaks group dynamics discussion should be kept at a minimum until the time comes the ideas can be discussed as seen in Figure 5.

2.2.2. Multi-Level Design

The Multi-Level Design focuses on designing a system in phases. Kozlowski and Klein (2000) argue that all organizations are multilevel systems, which entails the division into organization as a whole, the group and an individual level. Each of these levels has their own disciplines, theories and approaches for doing their work. The usage of Multi-level design becomes clear as there is no specific order in which the sections have to be used. Other level designs are for example Breadth- and Depth-first. In this design either the company is looked at in the breadth first or first in depth dependent on the method one is using. (Klöckner, Wirschum and Jameson, 2004). Breath first can be considered as looking at the company from a widest point of view to a more specific view on the process. Depth first is looking to the method with specific view to a wider view. Looking at these other techniques as Breadth- or Depth-first it is concluded that the flexibility of the multi-level design seems to add more value and the BPR (HC) framework becomes more easy to use.

Knowing that the BPR (HC) framework is created by using several sections in which change heuristics are defined, the choice for MLD seems apparent. By dividing the different sections in different clusters (for example organizational sections and external sections) and after that in different levels (for example an organizational level) a more structured way of presenting the framework is created. In a previous usage of the BPR (HC) framework, it was presented as a whole. It seems assumable that of these 45 change heuristics, only a small portion would be properly applied. By dividing the BPR (HC) into several subsections a health care practitioner, someone with less knowledge of process redesign, is presented a manageable set of change heuristics which one can use. Looking in literature there are several other manners with which this could be achieved, as discussed in before, however the MLD gives the most flexible manner of application. Summarizing, the MLD gives a manner in which information can be presented in several subsections instead as a whole, which is a more easy way to use the BPR (HC) framework. Thus it can be used to overcome one of the limitations presented before, the limited ease of use documented in Göbel (2012).

During the literature review on MLD it became apparent that the research into this method is lacking. There were only 2 articles found that provided sound and good knowledge on the Multi-Level Design method. Integrating these two approaches is presumable to be impossible, as the differences are too great. It is decided to discuss both articles separately and not, as was in the previous paragraph, present one integrated approach. A detailed summary of the two articles is given in Appendix IV.

Looking at the first article, by Gittel and Weiss (2004), it focussed on inter- and intra-organizational processes. The authors provide a new method for evaluating multi-level operations. They state that a company should be evaluated by looking at both inter- and intraorganizational process, i.e. routines, information systems, team meetings, boundary spanners. These processes should be coordinated which leads to a network. With a better coordination the efficiency and quality will increase.

Whereas, the other article (provided by Patricio et al. (2011) focuses on creating and defining what adds value to the customer and look at how it can be improved. The authors follow 4 steps in which the value for the customer will be defined and the value for the customer can be increased. There is

a slight difference in these steps but only between 3 and 4, which is the design of the system and the design of the encounter.

1. *Study the customer experience*

In this first step, the focus is on the current situation. Through observations and investigations the current situation is investigated. It further details the customer experience and the view for which value the customer wants. This can be seen as how the company is viewed by others.

2. *Design the service concept*

The service concept is defined as the positioning of the company in the value experience of the customer, including service offered and the partnerships established. This step focuses on the firms' value however it also defines the value in a broader context. In this step the focus is on what we offer as a company.

3. *Design the service system*

The focus shifts from finding what value customers wants to the design of the actual service experience itself. This is done based on the results from step 2, at which the value wished is discovered. This third step focuses on the definition of how the company can offer the value.

4. *Design the service encounter*

The last step of the MLD is the design of the service encounters. These are defined as the moments of interaction between customer and company; for example, internet or a physical store. This level defines the interaction setting, process and the role of the participant.

Looking at both articles they state that a company should be designed looking at internal and external processes. In the internal processes there is a distinction made by Patricio et al. (2011), which focuses on the differences between what should be done and how this should be done. One aspect that both articles have in agreement with each other is the definition of different dimension and/or perspectives in a company. These aspects are used in the development of the redesign method.

CHAPTER 3. The redesign method

Having built a knowledge base the next step is developing the redesign method with that background knowledge. The first part describes the methodology with which the method is created. In the second part the actual design of the method is at the centre of attention.

3.1. Development methodology

As there are many forms in which the methods can be used this aspect needs to be discussed. When both the NGT and MLD are clearly defined they are combined with the information obtained about the BPR (HC) framework. With the combination of all this information, a basis for the new method is created. However, this information alone is not enough to form the method. The author uses his own knowledge, creativity and insights in the methods to create one new, integrated redesign method.

The Nominal Group Technique will form the basis for the actual redesign method. As this is a technique with which one can generate ideas in a structured manner it therefore it can be used as the starting base for the redesign method. As earlier could be seen a predefined step in the NGT process is the “silent individual generation of ideas”. In this step the MLD and BPR (HC) methods will be used to provide support for the structure generation of redesign scenarios. The MLD provides dimensions to structure the generation of the ideas. The BPR (HC) framework on its turn provides content related rules for inspiration. When the redesign ideas are generated the NGT session is continued.

3.1.1. The nominal group technique

The integrated procedure provided a crucial insight in the working of the Nominal Group Technique. As all steps were already defined, and discussed, in Chapter 2, here the choice of which variant will be used is discussed. As there are many different routes that can be taken in the NGT process it must be made clear how and why the NGT session is used in its present form.

The following steps contain no information about that specific step but a small discussion is given to provide the reader with a reason of inclusion or exclusion of the steps that are included. In Table 1 the NGT method is presented in different steps with the reason for inclusion given.

NGT-step	*Reason for Inclusion*
0. Prepare Nominal Group Technique	The preparations are important, as the group selection, presentation etc. have significant influence on the working of the performance of the redesign method. Thus these aspects are the reason for including this step.
1. Silent Generation of ideas	During this step the redesign ideas are generated. However, the generation of ideas will be performed using the content related rules of the BPR (HC) and the dimensions of the MLD framework.
2. Contribute ideas	In this second step the ideas are presented in a round robin fashion. This is a decision taken by the author, with which the division of time is fairly distributed over participants. It seems assumable that without presenting the ideas, the step would not work and the whole process would not work.
3. Discussion of recorded ideas	To tackle the large variety of ideas a small discussion could be held. It seems assumable that the participants could use the extra information on the provided ideas (i.e. redesign scenarios). As the discussion is only needed when extra information is needed this step could be skipped.
4. Merger of overlapping ideas	It is possible that certain ideas focus on the same process or thoughts. That is why, during this step, similar ideas can be merged. This can increase the insight in the ideas and lead to better, more comprehensive, ideas. This is done by the participants or session-leader.
5. Individual Voting	When it is clear which ideas are merged, the next step is silent, individually, voting on the ideas on the list. It is desirable as one should account for the fact that only a minimum number of ideas can be implemented.
6. Rank ideas	The final ranking is done to ensure a good overview of all included and merged ideas. By ranking the ideas, the most important ideas become apparent. That is the idea given the most points by the participants.
7. Discuss ideas	This step consists of one last discussion on the most important ideas on the final list. This discussion can focus on the ideas that are at the top of the list, hereby focusing on the details of that idea.

Table 1: NGT procedure as used with reasoning

Now that the procedure for the redesign method is clear, the next step is discussing the method used for generating the ideas, i.e. redesign scenarios (step 1 from the NGT procedure). This method consists of the combination of BPR (HC) and the multi-level design The BPR (HC) framework provides content related rules (change heuristics). MDL provides the different dimensions which can be used to present the BPR (HC) framework in different levels.

3.1.2. Combination of the BPR (HC) method and Multi-Level Design

The explanation of the two methods, BPR (HC) and MLD, is done in one chapter as both methods are used in the same step (seen in the previous paragraph). The BPR (HC) framework is presented in chapter 2, with all different elements that come with that method. For example customer, organization structure or physical layout. The BPR (HC) method focuses on the delivery of content related rules with which the participants can redesign the process, i.e. the change heuristics. By integrating these factors with the information gained from the knowledge base a structured procedure is created that can be used to actually generate redesign ideas. In Table 2, the combination of both MLD and BPR (HC) is shown. Using information gained from knowledge base a distinction will be made between three different types of change heuristics. In Appendix V the division of change heuristics is given, i.e. the combination of MLD and BPR (HC).

MLD dimension	***Reasoning***	***BPR (HC)***
Level 1: *The service concept*	The first type of change heuristics focuses on everything outside of the company. This step focuses on what do other companies do and what does the customer want. For example, involving other parties or customers in the process to further improve the processes. This is the first step in the multi-level design as discussed by Patricio et al. (2011).	- *Customer* - *External environment*
Level 2: *Main process Design*	The second step focuses on the decision of what to do. These change heuristics focus on for example the question if process steps should be added or removed to ensure that certain processes are improved.	- *Business process operation*
Level 3: *Detailed process design*	The last step consist of the question how one should execute the processes. For example, what resources to use or the addition of certain information sources to ensure the improvement of the process.	- *Business process behaviour* - *Business process operation* - *Information* - *Non-human resources* - *Organization population* - *Organization structure* - *Physical layout* - *Technology*

Table 2: Combination of BPR (HC) and MLD

However, as one may notice the last step of the multi-level design is left out, the creation of the service (see paragraph 2.2.2.). During the creation of the BPR (HC) framework it was checked for aspects that could be incorporated in that level. However, this seems to split up the factors in such a way that it seems illogical. Factors from step 3 should be split up and be incorporated in this last step. The author decided to leave out the last step as including it would lead to confusing division in the BPR (HC) framework. This MLD/BPR (HC) framework is used, in combination with the NGT, as the redesign method. Knowing how both the methods (NGT and MLD/BPR (HC)) can, and are, applied the next step is presenting the redesign method as a whole.

3.2. The Redesign Method

Knowing how each method (NGT, MDL and BPR (HC) are defined the three methods can be integrated into one. As discussed before NGT provides the procedure for doing a redesign project in which step 1 is the generation of actual redesign ideas. In Figure 6 the full redesign method is given that depicts the full working and procedure of the redesign method.

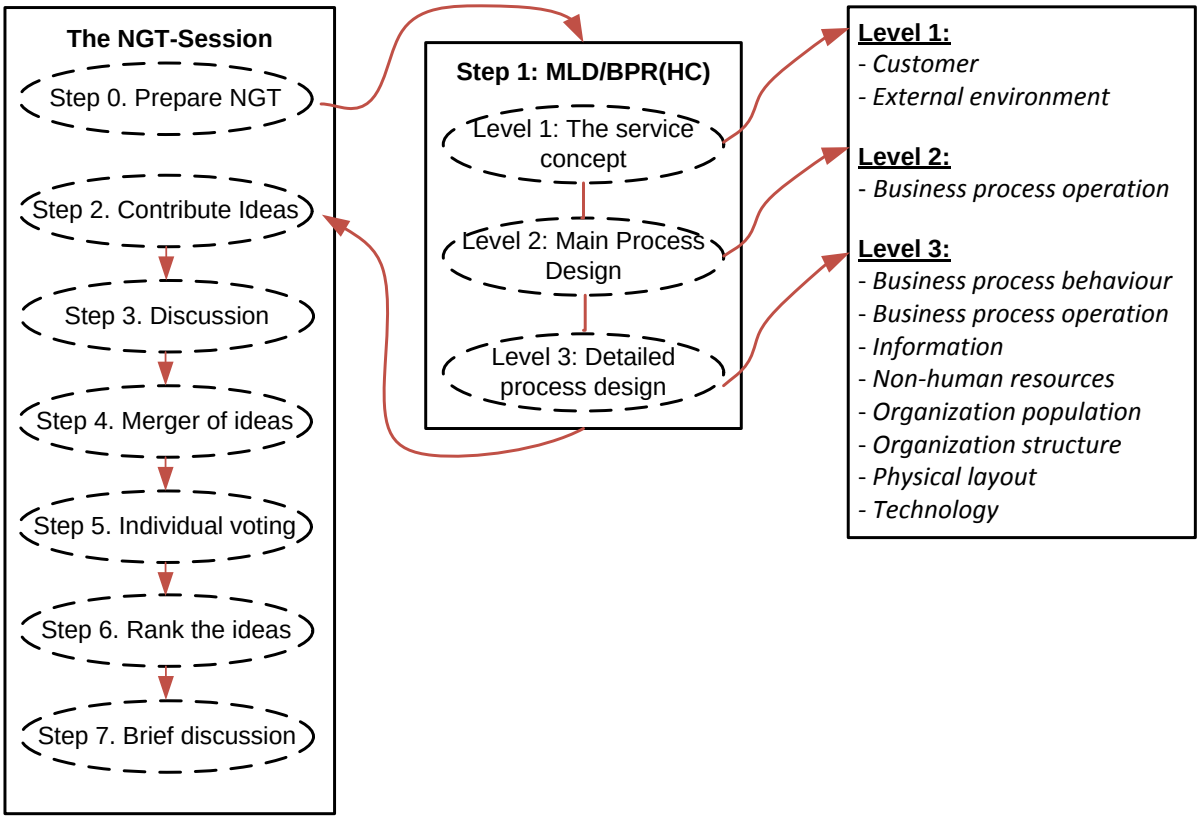

Figure 6: The redesign method

The NGT method is used as the procedure for generating redesign ideas. The first step, *(step 0)*, is the section in which the NGT session is prepared. This is one of the most important steps in the session, as in this step consists of the configuration of the group with which the redesign method is executed. Furthermore, a leader is chosen that will lead the sessions. This one should focus on the guidance of the process and not include his, or her, own opinion in the generation of the redesign ideas. The next step is the generation of the actual redesign scenarios.

As the first step *(step 1)* consists of the actual generation of redesign ideas, the side-step to MLD/BPR (HC) is taken. Using this method a structured way is presented with which the participants can generate redesign ideas. The BPR (HC) method is used to provide the participants with content related rules which are used to generate the redesign ideas. The multi-level design in its turn provides dimensions with which the BPR (HC) is presented.

When redesign ideas are generated the next step, *(step 2)*, considers the contribution of the redesign ideas in a round-robin fashion. When all redesign ideas are contributed a small discussion is held *(step 3)*. These small discussions are executed to generate more information on the redesign

scenarios or explain complex redesign ideas. After the discussion redesign scenarios, which overlap, are merged into one *(step 4).* The participants can vote on the list with the merged redesign scenarios. The voting procedure is rather straightforward. The first 7 items are chosen by the participants and are included in the final list *(step 5).*

Finally, when all voting results have been added up a final list of redesign scenarios is generated. This list is used as information for the next step *(step 6).* This step consists the ranking of the results from the voting. This ranking is performed to ensure a good overview for the participants and ensure a list for the next step *(step 7).* This step consists of a discussion on the ranked results.

Finally, having the redesign method created is a good step for this research. However, the creation is not the only part of this research. The next step is the application of the redesign method in a case study. This application focuses on the usage of the redesign method in a case study in a medical environment.

CHAPTER 4. Redesign method evaluation

After finishing the development of the redesign method the following question remains, *what is the perceived and actual value of the newly created redesign method in a case study?* In this chapter the evaluation of the redesign method is described. This chapter is divided in the discussion of the case study (§4.1), discussion of the application of the redesign method (§4.2) and an overview of the results (§4.3).

4.1. The case study

The first paragraph (§4.1.1) describes the company at which the research is executed. After this the ophthalmology department is described (§4.1.2). In the third part the process in the case study is explained (§4.1.3).After this is made clear, the context of the case study itself will be given in de second paragraph (§4.1.4).

4.1.1. The Maastricht UMC+

The MUMC+ is a hospital with a total of 5.222 employees and about 715 beds available for the care of patients. Furthermore, there are around 29.200 admissions per. Besides the care for patients, the hospital is also responsible for the education of new staff-members. This is done at the university that is located next to the hospital itself. Moreover, because of the fact that the MUMC+ is an academic hospital, the hospital is always looking to improve, not only the care, but also the processes with which the patients are treated in the hospital. (Information taken from www.MUMC.nl)

4.1.2. The ophthalmology department

Besides being an important stakeholder for this research, it also has benefits for supplying the case study. First off all, the MUMC+ benefits from the insights that are provided by doing the research itself. By carefully looking at the process, factors that are influencing the process are both discovered and described. As this was already done in previous research (Martens, 2013) this research complements that research and gives an overall better overview of bottlenecks. These factors can be changed which will improve the process that is researched. Furthermore, the MUMC+ receives benefits from the application of the redesign method to one of their processes. This is because of the changes that are made to the system. The MUMC+ can take action to change the process and increase the throughput of that system or lower waiting times. The ophthalmology department is set up since 20122 in which the Eye-tower was created. In this department the cataract is one of the most common conditions.Cataract is a condition that takes around 1500 operations per year, at this moment this is also rising and is the most operation.

4.1.3. Cataract surgery process

When looking at the case study the most important aspect is the process under investigation. In the study done by Martens (2012) the process of the “Ophthalmology” department was already defined. To give an overview the general process is discussed in the following section. The total process is also depicted in Figure 7 and 8.

When a patient has visual acuity complaints the patient can consult a general practitioner (GP) or optician. The GP or optician can refer the patient to the MUMC+. The patient is then directed to the

cataract centre either directly or via the general consults. When a general consult is required the patients are again directed to the cataract centre just as the patients who did not receive the general consult. After the cataract consult there are two options that the patient can take: a patient has another disease than those related to the eye and leaves the process or if the patient does not want an operation to cure the VA complaints. These routes of the patients are not considered in this research because these patients do not enter the actual treatment process.

The patients who require an operation continue with the process by having an appointment at office hours on Monday in the afternoon at the cataract centre. The patients receive an anaesthesia form that has to be filled in before continuing to their appointment. While the patients fill in the forms the physician in training prepares the office hours. During the office hours in the cataract centre the patients are going through some measurements. First, the patient is taken for an AR-measurement. After that, the patient enters the waiting room again and waits for the second and third measurement. These are the IOL and Pentacam measurements; measurements that can be executed in any order. When all measurements are done the physician consults the patient on their condition and the choices they have. When the patient has made a decision he/she can make the appointments for the OR and the post-operative controls. If the patient has not yet decided which lens he/she wants the patient calls the cataract centre when the appointments can be made.

Before the actual operation can take place a couple of administrative steps need to be performed. These are not important for this research which is why they are not named. At the day of the operation the process starts when the patient signs him/herself in at the daycentre. After this the patient can be prepared for the operation (in the day centre and after he/she is brought up to the operational level he/she is prepared in the holding). After the preparations the anaesthetist will perform his/her work where after the operation will take place. When the operation is done, the patient is transported back to the day centre and can leave the process. After the day of the operation the patient must come back to have several post-operative checks. During such a check the auto-refractor is re-measured as pre-consult measurement. After this measurement the patient is consulted by the doctor. In the case that a patient needs an operation on both eyes, after the first operation on one eye, two controls take place. After these controls the second surgery is done on the other eye. After one last control the patient can leave the process.

4.1.4. Assignment context

The case study provides the information about the way of working of the redesign method, as well as the practical environment in which it can be tested. The redesign method provides the MUMC+ with insight in the way of working of the process and provides ways in which the process in the ophthalmology department can be improved. Before this research was initiated, the process owners noticed that the department experienced problems with patients having long waiting times as well as high throughput times in the ophthalmology department. Why and how these problems arose was not clear. A previous study by Martens (2012) provided insight into these problems and solutions on how to solve them. However, clear improvement ideas were not generated in that research. This is the reason the MUMC+ was contacted to provide a case study for the application of the redesign method because with the application of the redesign method the required improvement options would be generated.

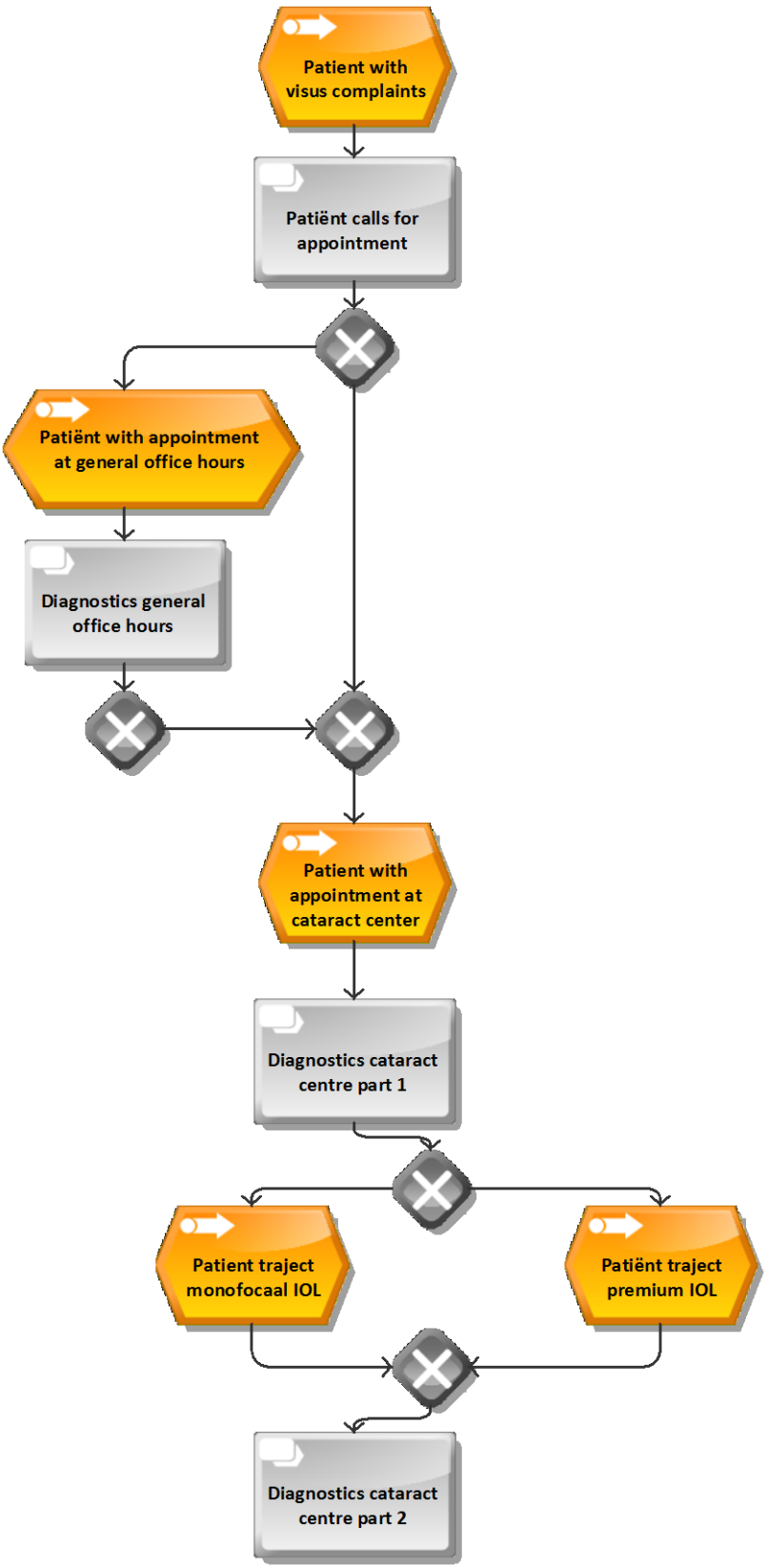

Figure 7: Cataract patient process part 1 taken from Martens (2012)

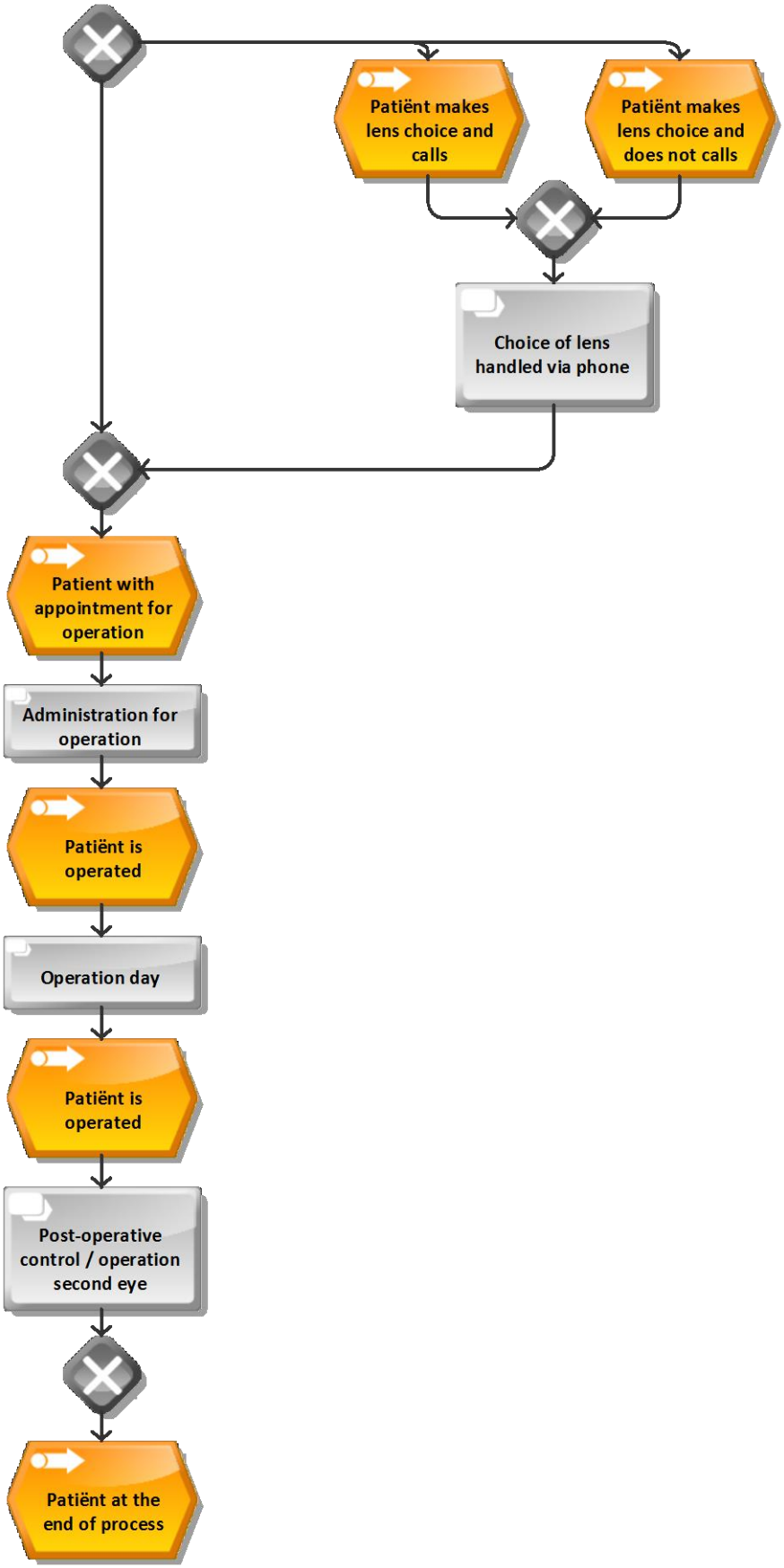

Figure 8: Cataract patient process part 2 taken from Martens (2012)

4.2. Application of the redesign method

The redesign method was applied in a case study, discussed in the previous paragraph (§4.1). This paragraph focuses on the used procedure and the results of the application of the redesign method. The redesign method was applied during a workshop in the MUMC+ in which health care practitioners were asked to use the redesign method. The different sessions are depicted in Figure 9.

In this chapter the procedure for the application is discussed. As a preparation for the actual application of the method a group of MUMC+ employees was composed. This group consisted of 7 participants ranging from nursing staff to physician till supporting staff. This group worked with the redesign method on the case study and tried to generate redesign scenarios. The different employees were chosen in such a way that a cross-functional group was created. This means that not only management stakeholders are included, but also nurses, doctors and planning-personnel.

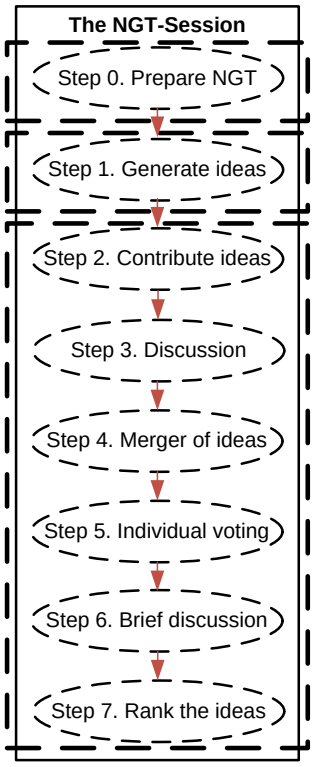

Figure 9: NGT procedure used during the sessions

Because of time constraints it was decided that the session with the workgroup could be separated into three separate sessions. The first session focussed on the explanation of the procedure, which is discussed here, as well as the working of the redesign method. The procedure is explained to increase the commitment of the workgroup. The working of the redesign method was discussed in full detail meaning that the redesign method was clearly depicted and in every step the goal was explained.

The second session consists of the generation of redesign ideas by the participants. The participants have used the method to think of and create, redesign possibilities for the cataract process. At the start of the third session the participants are ready with their generated ideas ready, can be performed at an effective rate.

The third session consisted of the actual application of the redesign method. The time, in this third session, is used to present and discuss possible redesign scenarios which were generated during the time between the first and third sessions. This has resulted in a list in which the most profitable scenarios are located on the top of the list. The third session started with a small introduction into the procedure of that session and the introduction of the different redesign scenarios. After this information was given all redesign scenarios were discussed. In these discussions participants could come up with new redesign ideas or discard generated ideas because of lacking support. The traceability of these redesign scenarios is low, during the discussion all redesign ideas were noted without relating the ideas to the participants. This full list of redesign ideas is given in Appendix VI.

The full list of 52 redesign scenarios was presented for the participants who than could vote on those ideas. It was decided to provide the participants with the full list to ensure the freedom for choosing the ideas they found most important. The voting is rather straightforward, the first 7 ideas are chosen by the participants. The voting results are presented in Appendix VII.

4.2.1. Evaluation of the redesign method

Knowing how the redesign method is applied, the created redesign method is evaluated by measuring five different factors, which are divided into two sections. These sections are given in Table 3. The first section, *actual value*, is measured by looking at the efficiency and effectiveness. The *efficiency* is measured using the results from the application of the redesign method. The measurement consists of the division of the number of accepted ideas by process owners divided by the number of redesign ideas (minus the duplicates). The *effectiveness* is checked by applying redesign ideas in a simulation model. This effectiveness is measure by looking at the content of redesign ideas and the effect it has on the performance of the process, measured by looking at specific performance indicators. The perceived value is divided in three constructs, *"Ease of Use", "Perceived Usefulness"* and the *"Intention to Use".* These constructs are measured using the results of a conducted survey.

Measures -->	**Actual Value(§4.3.1) & (§4.3.2)**	**Perceived Value (§4.3.3)**
	Efficiency	Ease of use
	Effectiveness	Perceived usefulness
		Intention to use

Table 3: Measures for assessing the method

As stated before the perceived value of a method is measured using three variables. According to Moody (2003) and Davis (1989) these are *"Ease of Use", "Perceive Usefulness" and the "Intention to Use".* The three factors are described as followed, cited from Moody (2003):

- *"Perceived ease of use":* the degree to which a person believes that using a particular system would enhance his or her job performance.
- *"Perceived usefulness":* a person's subjective probability that using a particular system would enhance his or her job performance.
- *"Intention to use":* the extent to which the prospective user intents to use the target system.

In previous research, such factors were measured using a survey. For example in Göbel (2012) a survey is used to assess the perceived value of the BPR (HC) framework. That same BPR (HC) framework was used in this research to create a new redesign method. In this research, a questionnaire with a likert scale is performed to assess the opinion of the health care practitioners. The questions stated in the questionnaire were based on several constructs. In Davis (1989) and Moody (2003) these constructs were already used to define questions. Depicted in Table 4 are the 12 constructs of Davis (*"Technology Acceptance Model",* 1989) and Moody (*"Method Evaluation Model",* 2003) which can assess a method. These constructs are tested and validated and can be easily used to test the perceived value of the created redesign method.

Perceived Usefulness	**Perceived Ease Of Use**
1. Work More Quickly	1. Easy to Learn
2. Job Performance	2. Controllable
3. Increase Productivity	3. Clear & Understandable
4. Effectiveness	4. Flexible
5. Makes Job Easier	5. Easy to Become Skilful
6. Useful	6. Easy to Use

Table 4: Overview of *"Usefulness"* and *"Ease of Use"* constructs

The factor "intention to use" is not defined by the different constructs. However, Moody (2003) has defined several questions which can be used to define the "intention of use" of a method. The same questions have been used in Göbel (2012) to find the intention of use for the BPR (HC) framework.

4.3. Results of the evaluation

The first section measures the actual value. This is split between measuring the efficiency (§4.3.1) and effectiveness (§4.3.2) of the redesign method. The second section (§4.3.3), perceived value, focuses at assessing the perceived value by measuring the "Ease of Use", "Perceive Usefulness" and the "Intention to Use" as defined by Davis (1989) and Moody (2003).

4.3.1. Actual Value; efficiency

The first factor in analysing the actual value of the redesign method is the measurement of the efficiency. In the previous paragraph the application of the redesign method was discussed (§4.2). After the group had worked on redesigning the process, a set of redesign scenarios was generated.

In this section these results, the list of redesign ideas, is used to define the efficiency of the redesign method. Its efficiency is measured by the percentage of accepted redesign ideas. This is done in the simple way of calculating the *Output* divided by *Input* times a 100%. The input, in this case, is the number of redesign scenarios created during the workshops. The redesign scenarios will be checked by the process owners and discussed with other process experts. The output is the number of redesign scenarios they have accepted. By dividing these two numbers one gets the efficiency of the method.

During the application of the redesign method 52 redesign scenarios were created by the participants in the workshop at the MUMC+. This list of generated redesign scenarios is given in Table 13 in Appendix VI. A summary of the workshop can be seen in Figure 10, with in Appendix VIII the detailed results.

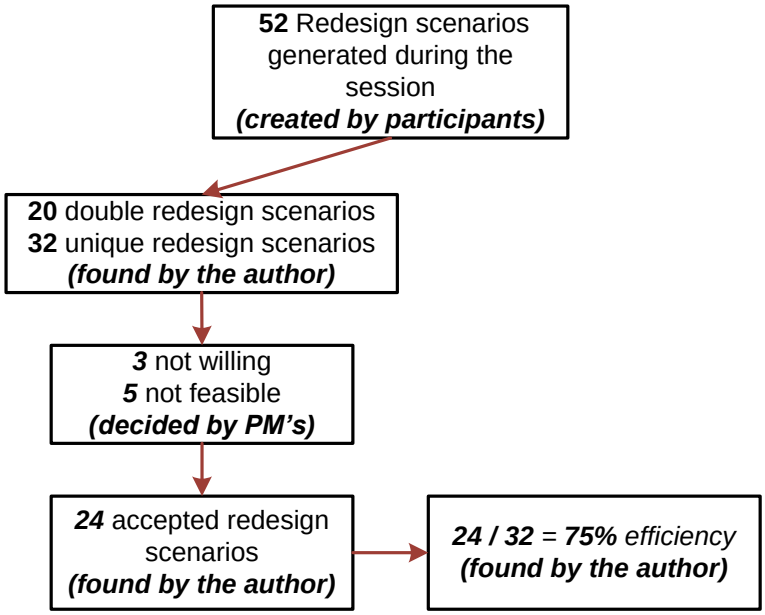

Figure 10: Overview workshop results

After analysing the results there were 20 duplicate redesign scenarios which were merged with other redesign scenarios from the list (one step from the redesign method). For example, the redesign idea to increase the number of AR-measurement devices was found in two separate instances. Because many ideas were generated in duplicate instances, only 32 redesign ideas were incorporated in the list which was discussed with the process managers (PM). The PM's have been asked to judge the scenarios on two aspects. The first is the fact whether the scenario can be

implemented, labelled *feasibility*. The second one is whether the MUMC+ would be willing to implement the redesign scenarios, labelled *willingness*. The process managers consider the redesign ideas and think of the redesign ideas being financially worthwhile, if the redesign idea does not break any legal rules or if it is practical feasibly. These ideas were judged by the PM's on the two aspects named before. In collaboration with the subject experts it was decided that 24 redesign scenarios were accepted, which is because 3 redesign scenarios were seen as scenarios that could not be implemented. Besides those scenarios, 5 others were seen as ideas that the MUMC+ were not willing to implement.

As one can see the efficiency of the redesign method is highly influenced by the number of duplicates in the set of redesign scenarios. This can be explained by looking at the change heuristics in-depth. Several change heuristics can be used to redesign the same aspect in a given process. Moreover, the duplicates can be explained by looking at the participants who joined in the group. The participants all perceive the change heuristics slightly different and may record ideas in a specific change heuristics different. This would create duplicate ideas in slightly different change heuristics. However, one of the steps in the redesign method is the merger of these ideas into one and thus excluding many redesign ideas. This merger is done partly by the session leader and the participants. In the end an efficiency of 75% was achieved. This is indeed a good start for the first application of a newly created method. Nevertheless, information about the level of efficiency that a method should achieve is not found so really concluding that an efficiency level of 75% is good cannot be done.

4.3.2. Actual Value; effectiveness

The second factor focuses on the measurement of the effectiveness of the redesign method. The effectiveness of the redesign method is measured by measuring the effectiveness of the implementation of two redesign scenarios, i.e. by predicting the process performance improvements of the redesign idea. There are only two redesign ideas checked because of time constraints in the research. The redesign ideas have been chosen by the process managers. These two redesign ideas were chosen out of the full list of ideas, this was done to ensure the process managers have the freedom to choose. The choice was made clear by looking at the practical usability for their process. The PM's did not make a ranking on practical usability, but only looked at the ideas in which they same the most practical relevance. The experiment on the application of two of the redesign scenarios was done in a model of the system. A simulation was used to predict the impact of the redesign scenarios on process performance.

As was prescribed by literature a sound methodology is needed for the checking of the effectiveness. Knowing that simulation is used to check the redesign ideas, the next step is defining a sound simulation methodology. For example, Jansen-Vullers & Reijers (2005) and Law & Kelton (2000) created two different structured simulation approaches. In this research the method proposed by Law & Kelton (2000) is used. In Appendix IX, Figure 18 the overall simulation method is presented. Besides this graphical interpretation, the method will be discussed in full detail in that Appendix.
The following redesign scenarios used to check the effectiveness. In this case it was decided to implement one redesign idea in the policlinic and one during the process of the operation. These redesign scenario both have a direct influence on the process. In the following section the redesign

ideas are given and different scenarios will be described. The two redesign ideas can be found in Appendix VI.

- ***Redesign Idea:*** *Perform the pentacam only on indication of the outcome of the IOL-master.*
  During the visit of the patient in the policlinic the patient goes through three measurements, as described before (§4.1.3). Two of these are the pentacam and IOL-master measurements. During the application of the redesign method it was noted that the outcome of the IOL-master could be used to decide whether a pentacam measurement is needed or not. In this case only a percentage of patients need a pentacam measurement. For the simulation 4 different scenarios are used which are based on different percentages, as there was not information on the exact percentage different scenarios are tested. The percentage of patients can be influenced by the doctors as they order the pentacam for the patients. At the moment all patients get a pentacam measurement, as this may not needed this has an influence on the throughput time of the patient. As there is not an exact percentage in which patients need a pentacam measurement the 4 different scenarios are measured.
    - 25% of the patients not having a pentacam.
    - 50% of the patients not having a pentacam.
    - 75% of the patients not having a pentacam.
    - 100% of the patients not having a pentacam.
- ***Redesign Idea:*** *Take out the anaesthetist and let the holding-nurse perform the anaesthetic*
  During the process of the operation of the patient there is the part where the patient is anesthetized. This can be done in two ways, there is the operational procedure where the anaesthetist does the procedure. The second way considers the anaesthetist only drops some liquid in the eye before the operation. Moreover, this second step can be done by the holding nurse, thus removing the anaesthetist and the activity he/she does. For this simulation there are also 4 different scenarios that were simulated. In this case the anaesthesia is chosen by the doctor who operates and the patient who is operated on. It can be influenced by the doctor as he/she can prescribe as certain type. At this moment the percentage of patients who got drop-anaesthesia is not known which is why the 4 scenarios are measured.
    - 25% of the patients having drop-anaesthesia.
    - 50% of the patients having drop-anaesthesia.
    - 75% of the patients having drop-anaesthesia.
    - 100% of the patients having drop-anaesthesia.

The throughput time of the patient will be taken as the main performance measure at which the scenarios will be checked against. Both in the polyclinic, as in the operation levels, the throughput times of the patients were measured. Knowing the current throughput times of the patients, the different scenarios can be implemented, simulated and compared which is why the throughput time is the performance measure measured from the simulation model. Furthermore, this section also includes a qualitative measurement on the application of the redesign ideas. These qualitative measurements look at the increased flexibility of included resources and the time gained by executing the process in other ways.

Policlinic

All simulations are based on 42 productions runs of different data. An overview of the different averages and confidence intervals given is presented in Figure 11. The confidence interval is calculated with a 95% interval. The redesign scenario focussed on the patients entering the model for the pre-operative consult, as these are the only patients who receive pentacam measurement. The patients only enter the simulation model during the afternoon. When looking at the confidence intervals there seems to be an overlap between the scenarios. Looking at the Old Situation and situation with 25%, 50% and 75% one can say with 95% certainty that there is no difference between the implementation of these 3 scenarios. The last scenario, 100% no pentacam, can be said to be an actual improvement. As the confidence interval has no overlap with the old situation one can say with 95% that the 100% scenario is an improvement with the old situation.

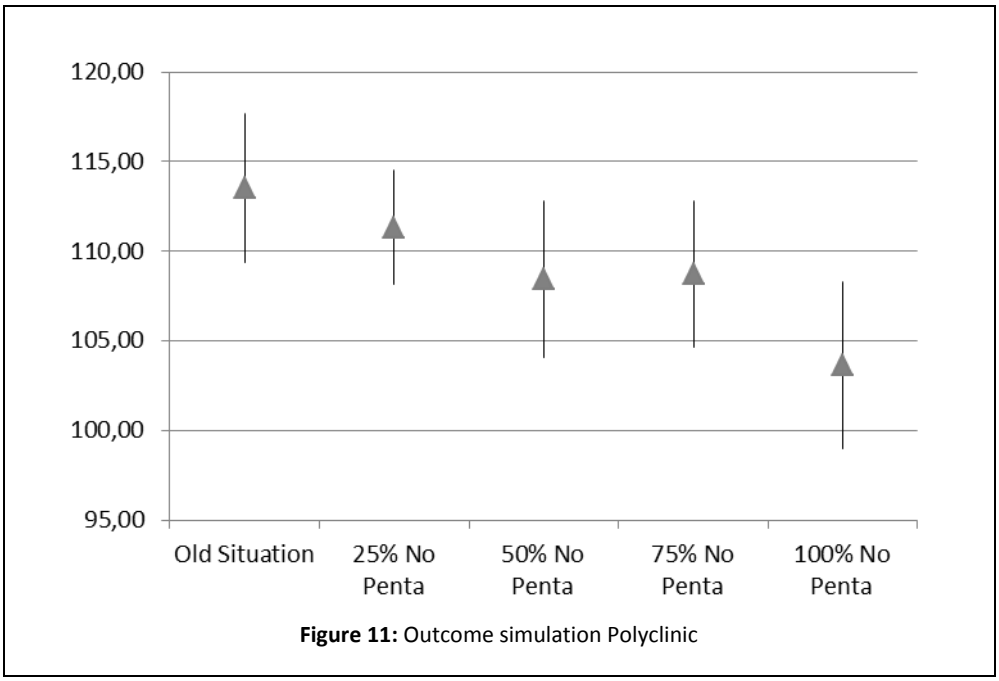

Figure 11: Outcome simulation Polyclinic

Analysing the redesign scenario into further detail other improvement become apparent that cannot be quantified. The pentacam measurement is performed because patients may take a special lens. When the IOL-master indicates a pentacam is not needed, the special lens option cannot be chosen. This will decrease the time it takes for the consult with the doctor to take place which is because the doctor does not have to analyse the results of the pentacam measurement. The results of the simulation were discussed with the process managers. In this discussion the results were analysed with the focus on expectancy, i.e. do the results follow the results shown. They thought the results showed no particular strange things and followed expectations.

Furthermore, only one employee is needed for the IOL-master measurement. The other employee can do the IOL-master if a patient needs a pentacam, in other situations that employee can be assigned to other tasks, hereby improving the flexibility of the overall number of employees. In general 30 patients are planned during the afternoon. Knowing that the pentacam measurement costs about 05:30 minutes an employee is on average 2 hours and 45 minutes is gained for that employee. Presumable, this increases the flexibility of that employee.

Operation Level

Again this information is generated using 42 productions runs of the simulation program. An overview of the averages and confidence intervals is presented in Figure 12. The OR model focuses on all patients that come in during a specific day, so no specific difference between morning and afternoon. Looking at the confidence intervals no real conclusion can be made on the improvements that are possible achieved. As all confidence intervals are overlapping no real conclusions can be based on this information.

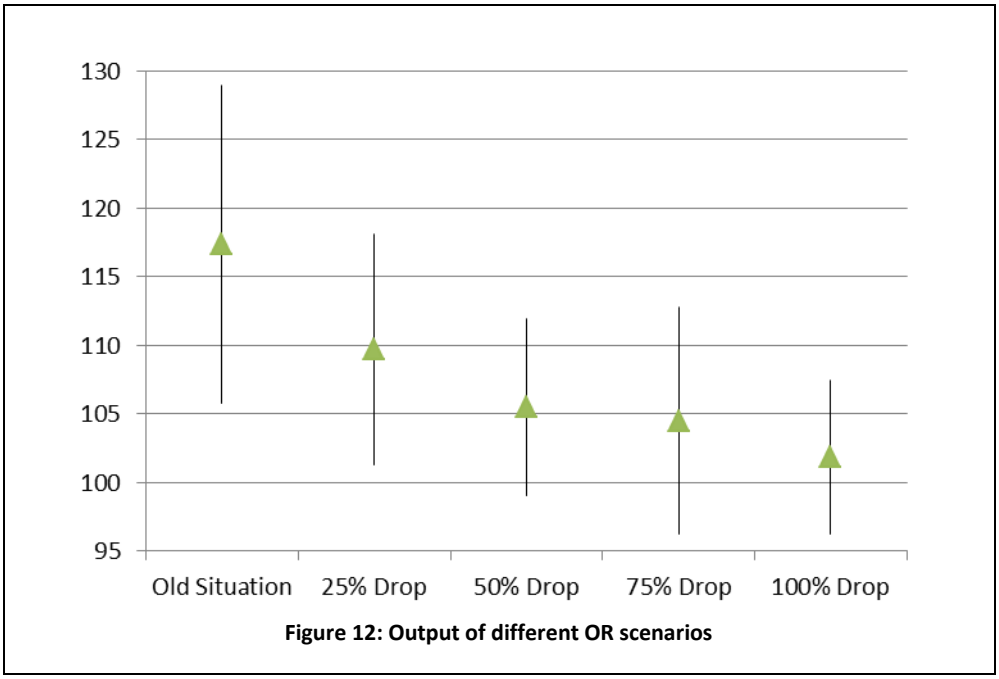

Figure 12: Output of different OR scenarios

By excluding the anaesthetist the overall throughput time of the process decreases. Other advantages are the flexibility increase of the anaesthetist. By taking tasks away from that position the anaesthetist can focus on increasing the quality of his other tasks. An anaesthesia costs around 07:17 minutes with around 9 patients coming per day this relieves the anaesthetist from about an hour of work. This increases the flexibility of the anaesthetist, as he/she may be needed for other processes. The anaesthesia via liquid droppings costs around a half a minute and may take two or three times. It increases the amount of work of the holding nurse however as it may increase with a minute this is negligible. Again, the results were discussed with the process managers. In this case the results were hard to discuss as the knowledge of the process managers was limited on the operational processes. However the effect of the operational implementations was seen as 'normal'. In this case one should keep the political factors in mind, as the anaesthetists need to be convinced in doing the process in another manner.

In the end no real conclusions can be taken from the results of the measurement on effectiveness. The polyclinic model showed only one scenario that improved the model. As there were some other improvements when implementing the redesign idea the effectiveness is somewhat proved. However, when looking at the OR simulation model no conclusion can be made. The improvements described when implementing the redesign idea showed some improvements but no real quantified data was gained. Overall, the effectiveness was not really proved to be high.

4.3.3. Perceived Value

Using the constructs described in §4.2 a survey was created for measuring the perceived value of the redesign method. Building upon the data gathered from Moody (2003) and Davis (1989) the survey in Table 5 was created. All questions are based on questions already stated by Moody (2003) and Davis (1989). In the article from Moody (2003) not all constructs were used in the creation of the survey. The articles of Moody and Davis were extensively used in other researches in which they used the information for creating a survey to measure the perceived value. This makes validating them unnecessary. The resource of every question is explained in Appendix XI. However, the questions are not the only part. In the survey a likert scale is used to check the participants' opinion on questions. This likert scale uses the following five options, *(Complete disagreement, Disagreement, Neutral, Agreement and Complete Disagreement).*

Besides the questions using likert scales there were open questions stated. These questions focused on the positive and negative aspects of the different aspects of the redesign method. These aspects concern the NGT, MLD and BPR (HC) methods used in the redesign method. Furthermore, the participants were asked to give their opinion on future usage.

	Perceived Ease of Use
1.	I found the procedure for applying the redesign method complex and difficult to follow.
2.	Overall, if found it difficult to apply the redesign method.
3.	I found the redesign method easy to learn.
4.	I found it difficult to apply the redesign method at this cataract process.
5.	I found the rules of the redesign method clear and easy to understand.
6.	I am confident that I am now competent to apply this redesign method in other process redesign cases in practice.
	Perceived Usefulness
7.	I believe that the redesign method would reduce the time to find good redesign ideas.
8.	The redesign method would make it easier for to users to come up with good redesign ideas.
9.	Overall, I found the redesign method useful.
10.	Using the redesign method would increase the quality of my redesign ideas.
11.	Overall, I think this method does not provide an effective solution to come up with good redesign scenarios.
12.	I think this redesign method enables to generate more redesign ideas than without it.
	Intention of Use
13.	I would not use the redesign method to come up with redesign ideas for other process improvement cases in practice.
14.	I intend to use this redesign method in the future to come up with redesign ideas instead of using instinct or own experiences.

Table 5: Post-session survey

Overall, there were 6, out of the 7, participants that filled in the survey. That gives a response rate of approximately 85%, which is more than enough to continue with the analysis of the results. Averages have been shown around 55.6% which gives enough confidence (Baruch, 1999) to continue working with this data.

For every participant the score they gave is depicted in table 6. The scores have been adapted for the negative questions that were stated in Table 5. For example, Q2 ("Overall, I found it difficult to apply the redesign method"). If this question is answered with a -2 this means that the redesign method was easy to apply. So it should be a 2 which implies a positive result. Par 1 represents the score of participant 1 and so on until par 6. For every section, "Ease of Use", "Perceive Usefulness" and the "Intention to Use", the median values (M) and standard deviations (D) are presented per participant. The scores range from -2 till 2, whereby "-2" presents completely disagreement. "0" indicates a neutral position from the participants, "2" presents a complete agreement with the factors.

	Par 1	**Par 2**	**Par 3**	**Par 4**	**Par 5**	**Par 6**	**Median**	**Deviation**
Perceived Ease of Use								
Q1.	*-1*	*1*	*1*	*0*	*1*	*-1*	***0,5***	***1,0***
Q2.	*-1*	*1*	*1*	*0*	*-1*	*-1*	***-0,5***	***1,0***
Q3.	*-1*	*-1*	*0*	*0*	*0*	*1*	***0,0***	***0,8***
Q4.	*-1*	*0*	*-1*	*-1*	*1*	*-2*	***-1,0***	***1,0***
Q5.	*-1*	*-1*	*1*	*-1*	*0*	*1*	***-0,5***	***1,0***
Q6.	*-2*	*-1*	*1*	*0*	*1*	*1*	***0,5***	***1,3***
Perceived Usefulness								
Q7.	*1*	*0*	*-1*	*1*	*0*	*2*	***0,5***	***1,0***
Q8.	*0*	*1*	*0*	*0*	*1*	*1*	***0,5***	***0,5***
Q9.	*0*	*1*	*0*	*1*	*1*	*1*	***1,0***	***0,5***
Q10.	*0*	*1*	*1*	*0*	*1*	*2*	***1,0***	***0,8***
Q11.	*0*	*-1*	*-1*	*-1*	*-1*	*-2*	***-1,0***	***0,6***
Q12.	*-1*	*1*	*1*	*1*	*1*	*2*	***1,0***	***1,0***
Intention to Use								
Q13.	*0*	*-1*	*1*	*0*	*-1*	*-2*	***-0,5***	***1,0***
Q14.	*0*	*0*	*-2*	*0*	*0*	*1*	***0,0***	***1,0***

Table 6: Post-session survey results

Perceived Ease of use

Overall the participants found the procedure for applying the method complex. Two participants however found it partly easy to understand *(Par 1 and 6)*. Looking at question two *(Q2)* the participants did not find it difficult to apply the method itself. Concluding from this one can say that the procedure for applying the method was complex, however, the redesign method itself was easy to understand. Overall, the participants found the redesign method easy to apply for the first time *(Q3 & 4)*. Analysing the last two questions it is seen that there is a discrepancy between the results. The participants found the rules not that clearly defined, nevertheless, the participants find themselves partly confident to apply the method in other redesign cases *(Q6).*

Perceived Usefulness

Overall, the participants found the redesign method useful for coming up with new redesign ideas and finding ways of improving the process. Only one participant reacted neutral to the fact if the redesign method was useful or not *(Par 1)*. Other participants found the redesign method party useful to highly useful. As can be seen all question besides one are answered positively (partly agreement). Looking at question 11 however a partly disagreement is seen. This is due to the fact that the question is stated negatively. The question states the following *"I think this method does not*

provide an effective solution to come up with good redesign scenarios." Looking at the negative outcome the participants are convinced that the redesign method does give that an effective solution to generate redesign scenarios.

Intention of use

Both earlier discussed constructs have an influence on the intention to use the redesign method, which is probably why it is situated near the perceived ease of use. The intention of use, in this case is highly influenced by the perceived usefulness. During the sessions in which the redesign method was applied the participants noted that they were indeed confident of the usefulness however they thought that the redesign method would only work on the larger processes and the procedure for using the method was too technical. These aspects are discussed in the next section which described the open questions stated in the survey.

The participants' discussion

The open questions stated in the survey are given in Appendix XII, in this Appendix results from the open questions are also given. The first session, the explanation of the method, went without any problems. During the second session the participants noticed the redesign method was somewhat too technical. For example, the term "Change Heuristic" was used. This is a term that was explained in the procedure and during the first session. However, the participants still had problems with the understanding of the term "Change Heuristic". For example, one participant stated that *"one point of attention is the large amount of change heuristics and jargon in the redesign method".*

The redesign method increased the manner in which participants could participate in the workshops. In previous research O'neil and Jackson (1983) argued that NGT influences the manner at which participants are included in the workshops. The redesign method worked as it was intended, it included every participant in a manner at which they have equal say. One participant stated *"the method includes even people that do not interfere with normal discussions"*. By using the method the participants are found in different functional layers of the company. Furthermore, it creates acceptance in the participant group and the democratic manner in which the sessions is executed creates a sound surface for implementing the redesign scenarios.

Further opinion was given on the division of the change heuristics in subsections, i.e. the combination of MLD and BPR (HC). The participants found the division an effective manner to present the change heuristics. However, some participants found the last level a bit too big. The third level, alone, presents 34 change heuristics. The participants were intimidated by the huge number of change heuristics in the last level. The participants noted that several change heuristics focused on the same type of improvement, which is an aspect that was considered as a negative aspect of the BPR (HC) framework, one participant stated *"a lot of change heuristics are focussed on the same process".*

Overall, the participants found the redesign method useful for the generation of redesign ideas in larger projects, (*"In greater project it is useful", "Better and more ideas are created")*. There were some minor issues during the preparation and application of the redesign method, i.e. the understanding of the procedure of applying the method. The participants are of opinion that the method is useful for the larger projects and agreed with the fact the method provided a more structured approach for redesigning processes.

CHAPTER 5. Discussion and limitations

In this chapter the redesign method is central in the discussion, this discussion consist of the advantages and disadvantages of the redesign method. The first section, §5.1, discusses the research performed during this Master Thesis. In the second section (§5.2) the limitations of the study are discussed.

5.1. Discussion

In the objective the following general objective was stated, this objective was derived from literature on the BPR (HC) framework on other aspects noted in literature.

"To create and evaluate a business process redesign method, with the BPR (HC) framework, NGT and MLD as cornerstones, which can easily and effectively be applied in the Health Care sector."

In general, the redesign method is created in a structured manner with enough knowledge of all underlying methods used. Because of the knowledge gained during the preparation of this Master Thesis the background for the BPR (HC) framework was created. However, the background of NGT and MLD was not yet compiled. A structured literature review is used to form a knowledge base on these methods. In retrospect a second pair of eyes should be incorporated to ensure the right knowledge is included in the creation of the redesign method.

From a scientific point of view the procedure, which was written for the application of the redesign method, was very structured. This is based on the decision to describe every different aspect, the procedure, the method and the different terms used in the method as thoroughly as possible. These terms are for example the term change heuristic or Business Process Redesign. From a practical point of view it was noticed that the procedure was too difficult and hard to understand. This was seen in the survey, as was stated by a participant *"The user friendly is influenced by the jargon".* Even though every aspect is explained one should always hold the practical implication in high regards. As there are many different views to look at the application of the redesign method it is noted that there is a delicate balance between the scientific and practical details.

The redesign method lived up to the expectations of all stakeholders. Splitting up the BPR (HC) framework limited the number of change heuristics which made sure the participants found themselves not overwhelmed with the number of change heuristics. By using the multi-level design a structured manner to split up the framework in different sections was achieved. One participant stated in the survey that the dimensions from the MLD provided the BPR (HC) with *"an effective manner to present the content related rules".* The manner in which the redesign method provided support on the generation of redesign ideas was perceived as a positive effect by participants. One participant noted the following, *"The content related rules are a structured manner for the generation of redesign ideas"*.

The evaluation focussed on the measurement of three factors. These are the *"Efficiency", "Effectiveness"* and the *"Perceived Value"* of the redesign method.

The efficiency is checked by looking at the number of redesign scenarios generated during the session and the number redesign scenarios accepted. The results showed an efficiency of *75,00%,* which is presumable good. However, due to time constrains no other research was found that could substantiate this claim. The efficiency is highly dependent on the number of duplicate redesign scenarios (about 40 % of the 52 redesign ideas were lost, §4.3.1). Furthermore, the efficiency is dependent on the strictness on which process managers judge the redesign ideas. It is noticed that only 8 redesign ideas were excluded, which seems low as there were 32 redesign ideas included for that discussion. The strictness that was used in the judgment of the redesign ideas is, presumably, low. Thus the number of excluded redesign ideas was low as well. When looking at the redesign method it can be seen that similar ideas are merged into one idea. The merging of ideas is performed consequently which leaded to a lower number of redesign ideas, however they are higher of quality.

The effectiveness of the redesign method has been checked by use of a simulation that evaluates two redesign ideas. The simulation itself went without any problems and the process for measuring the effectiveness was structured and is executed using careful attention for detail. However, the results were less convincing. As the different confidence intervals were overlapping not all redesign scenarios provided the convincing results. Only in one scenario the results showed promising results. Knowing all these factors the effectiveness is not convincingly proved. After analysing the results into further detail it becomes apparent a t-test should be added to statistically prove differences in the effectiveness.

The perceived value was checked by holding a survey in the participant who applied the redesign method. The survey showed promising results for the redesign method, however there will still disadvantages to the survey and the results itself. The survey was held under only 6 participants which limits the reliability of the results. Furthermore the results itself were highly influence with the complexity of the description of the redesign method. As was shown earlier the participants found the redesign method complex to apply. One participant stated “it is difficult to understand the method really good”.

Overall, by including NGT (as a procedure) and MLD (as a provision of dimensions) the ease of use of the BPR (HC) method is highly increased. First of all, the NGT session provides a simple, but structured, manner for health care practitioners to lead the redesign projects. This was noticed by all stakeholders. Second of all, on its turn MLD provides the dimensions in which BPR (HC) can be presented, in this way presenting a more comprehensible framework. This way one limitation of the redesign method is solved.

One specific aspect needs to be considered when looking at the effectiveness of the redesign method. This redesign method was created for two reasons, to increase the ease of use of the BPR (HC) framework and to prove the effectiveness of the effect. However, proving the effectiveness is one case, but how does it perform in retrospect to other methods? Other research is executed at the moment that will provide and answer to this question.

5.2. Limitations

Based on the methodology of this research, several limitations arise that are discussed in this section. In §5.2.1 the limitations on the literature review are discussed, §5.2.2 discusses the limitations on the redesign method. In the third paragraph the limitations on both the efficiency and effectiveness is discussed §5.2.3). The last paragraph (§5.2.4) discusses the limitations on the perceived value.

5.2.1. Background

The background is created by the usage of a structured methodology, on the methodology no limitations exist. However, here is one limitation on the creation of the background information. This limitation considers the limited results during the search for Multi-Level design articles. During the search for proficient MLD articles it became apparent that there were not enough articles that focus on that subject. There are still a lot of aspects that can be considered to make it more transparent. Furthermore, the researcher must focus on proving the multi-level design in other manners.

5.2.2. The redesign method

The development of the method was based on two aspects. One was the base models of the NGT, MLD and BPR (HC) methods, the other one was the insight of the author. The author decided on the different parts of the NGT to use. However, this is based on information found in the background. Other researchers may have taken other decisions based on different information. Looking back on the creation of the NGT method it may have been deemed wise to combine different step knowing that certain steps are not easily separated. In the application of the redesign method the generation and discussion on the redesign ideas was done during the same step. Future research should include the thorough inspection of the decisions taken in the creation of the redesign method.

Furthermore, the development of sections in the BPR (HC) framework is a point of discussion. The different sections of the BPR (HC) contain 6 change heuristics. The last section contains 34 change heuristics compared to a significant lower number in the other sections of the framework. However the last section consists of 34 change heuristics. This is quite a high number of change heuristics even from a scientific point of view, let alone a practical point of view. Dividing the last section into two subsections could affect the generation of more redesign scenarios. As the last section needed a large amount of time the participants noted that dividing that level into more detailed sections could make them focus on the change heuristics in more detail. Knowing this aspect it should be noted that more research can be done into the division of this section to provide the participants with a more understandable section.

5.2.1. Actual value

The actual value of the redesign method is based on the efficiency and the effectiveness of the redesign method. The efficiency is based on the number of redesign scenarios generated using the redesign method. However, there are so many duplicate ideas (20) this could limit credibility of the results. Because these duplicates are merged with the other idea which that ideas resembles the limitation is somewhat reduced. Nevertheless, it should be noted that the number of duplicates should be lower as this limits unnecessary discussion. The retrieval of duplicates was considerably clear. The different duplicate redesign ideas could be tracked throughout the list and the duplicates were noted and merged into one.

The effectiveness is based on the two simulation models created. The creation of the simulation model has been based on Law and Kelton (2002), who provide a methodology in their book that has been used in multiple other researches. Furthermore, these simulation models are created using real life information and observations of the cataract centres. During the validation it was noticed that there are still some differences between the simulated and real model, these differences could lead to biased results in the effectiveness. While there is a substantial amount of time invested in the validation of the two models there could still be certain situations in which the model is not working correct.

A company, which expertise is simulation, was contacted to validate the model. By both this scientific and practical validation, the results on the effectiveness are more reliable. In future situations health care practitioners can actually implement redesign ideas and measure the results because of the high reliability.

Limitations could also be seen in the choice for different redesign ideas and the performance indicator chosen for the implementation in the simulation study. The redesign ideas were chosen using the expertise of the process managers. However, as there were many other redesign ideas the choice for a specific can be debated. Maybe if one had chosen another redesign idea this could mean another outcome for the effectiveness. Furthermore, the performance indicator, “general throughput time” was chosen. One can also debate that the choice for a different performance indicator can influence the outcome of effectiveness. For example, waiting time at a specific moment could be used and the influence the redesign ideas would have on the waiting time.

5.2.2. Perceived value

The perceived value of the redesign method is based on the survey held amongst the participants. This survey is held amongst 6 participants, which means that the perceived value is only based on the opinion of this number of participants. This number seems low, at least looking at the statistical relevance. That means the redesign method, and thus the survey must be held again, but at that moment a larger amount of participants must be included. In paragraph 2.2.1 the number of participants in a NGT session was discussed, as seen there one must keep in mind that NGT sessions should never consist of more than 10 participants. Thus, the survey could be executed in several other redesign projects using the redesign method. This would be done to ensure a better overview of the three constructs, *effectiveness, efficiency and ease of use.*

Besides the low number of participants in the survey there is another limitation when looking in-depth at the perceived value. Not all participants were extremely positive during the usage of the redesign method. The procedure, that describes the method, was somewhat too complex for the health care practitioners. This has an influence on the actual result of the survey. Because the procedure of the redesign method was too complex, as perceived by the health care practitioners, this could influence their opinion. In future situations the group must be somewhat larger, and the procedure should be written in such a way that every participant who works with it can easily apply the method. When the procedure is improved this will most likely improve the perceived value of the redesign method.

5.3. Future research

Knowing the extensive research done, by the author, there are still directions for future research. The first and foremost important aspect is focussed on the extension of research into the multi-level design. This method is still in its younger years, as has been noticed during the creation of the knowledge base. Future research should focus on the creation of a reliable multi-level design, based on further research into this method.

Concerning the overall development of the redesign method there is further research that must be initiated. This research must focus on the analysis of the decisions taken during the creation of the redesign method. The redesign method can be further validated by the application in other hospitals or other medical processes. Future work looks at the redesign method and analyse it in group context.

As the evaluation of the redesign method is performed in only one case the future direction is obvious. The redesign method should be applied in many other redesign projects, thus extending the evaluation of the redesign method. Including other health care practitioners in the usage of the redesign method increases the credibility of the measurement of the perceived value. Other health care practitioners may be ahead of other and have more experience with redesigning processes. This maturity of redesigning processes leads to more detailed evaluation of the redesign method. Furthermore, by applying the redesign method in other cases the credibility of the effectiveness is increased. In this research the effectiveness has been checked, but without any clear conclusions on the results the effectiveness must be checked further. In future cases the effectiveness can be checked by using other methods, for example simply looking at the applicability, general impression of quality or the total quality of the redesign scenario.

Looking at general, and current, aspects of the redesign method several aspects come into mind. The term change heuristics was mentioned by several participants as being complex and hard to understand. In future research one could find a more comprehensive and understandable for different types of employees. Furthermore, at this moment the redesign method should be adapted in such a way it discourages the creation of duplicate ideas.

CHAPTER 6. Conclusion and directions for Future research

In this research it has been made clear that health care practitioners struggle with the usage of methods to redesign process. It was noted that the BPR (HC) framework was not ease to use to redesign processes. In Göbel (2012) it was stated that health care practitioners still lack a clear procedure for using redesign idea. Knowing a clear procedure for applying the redesign guidelines was never defined, it created a limitation for the BPR (HC) framework. In this research the focus is on the integration and creation of a structured redesign method (i.e. the BPR framework by Reijers & Mansar, the TRIZ framework by Altzhuller and the BPR (HC) framework by Göbel).

This research focused on the integration of three methods (NGT, MLD and BPR (HC)) to create an overall structured, but user-friendly redesign method. The NGT and MLD methods were defined and based on grounded decisions it was chosen to use them in a specific manner. The actual integration included many decisions which were used with the view on the application and integration of the redesign method. Eventually, the three different methods were combined using insights obtained during the creation of the background information. In the end a structured redesign method was created in which the NGT, MLD and the BPR (HC) framework were integrated.

The evaluation of the redesign method started with the application of the redesign method. In this research a case study is found in the MUMC+ hospital. In this case study the redesign method is used to redesign the cataract-processes. A cross-functional team has been composed that works with the redesign method. After the team executed the redesign method an evaluation has been done in three-fold. The first aspect focussed on the efficiency of the redesign method. The efficiency was measured using the number of accepted number of redesign scenarios divided by the number of redesign scenarios without duplicates. The *efficiency* result is 75%.

The *effectiveness* has been tested by the usage of two simulation models, which are used for the implementation of one redesign scenario. Using a sound methodology the simulation models have been created, verified and validated. The process managers validated the models with gave enough confidence to continue with these models. The first model showed promising results and showing one scenario which had statistical improvement. The second model showed no significant improvements.

The *perceived value* of the redesign method can be split up in three different constructs that have been tested using a survey. These three constructs are the Perceived Usefulness, Perceived Ease of Use and the Intention to Use. The results of the survey showed that, in general, the participants had a positive feeling about the Perceived Usefulness of the redesign method. All participants found the ease of use of the redesign method low, however this is most likely because of the complexity of the procedure for using the redesign method. Next, the Intention to Use was considerably low, this is mainly influenced by the Ease of Use which was already low. The survey showed that opinions were very diverse, some people saw the potential of the redesign method others did not.

At this moment the redesign method is a useful and interesting manner to redesign processes. The overall goal of this research was to create and evaluate a redesign method, which was achieved by creating a structured background for the creation and the structured evaluation of the redesign method. Looking at the different measured constructs it may not be statistically proved but the redesign method helps health care practitioners with the procedure for redesigning processes and helping them with the overall generation of redesign ideas. This was noticed during the application of the redesign method in verbal communication with the participants. Overall, the redesign method was received with a positive feeling and participants were satisfied with the working of the redesign method.

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CHAPTER 8. Appendices

8.1. Appendix I; BPR (HC) change heuristics

The first column defines the change heuristics. The second column defines the part at which the change heuristic can be applied or in which sector of the company it is applied. The origin of the change heuristic is defined in column 4. First, the yellow lines in the excel file are from the TRIZ framework, (Tan, Chai, & Zhang, 2005). All other lines are from the BPR framework from (Reijers & Mansar, 2004). In the last column the definition of the change heuristic is given.

Proposition name	Definition in new catego	New / original	New definition
Control relocation	Customer	Original	Relocate control steps in the process to others
Contact reduction	Customer	Original	Combine information exchanges
Integration	Customer	Original	Consider the integration with a process of client or suplier
Order types	Business process operation	Original	
Task elimination	Business process operation	Original	Delete tasks that do not add value from a client's viewpoint
Order-based work	Business process operation	Original	
Triage	Business process operation	Original	Consider the division of a general task into alternative tasks
Task composition	Business process operation	Original	Combine small tasks into composite tasks or vice versa
Prior counteraction	Business process operation	New	Add tasks to prevent happening of a undesirable situation or to reduce its impact
Prior action	Business process operation	New	Perform tasks, before they need to be executed, or add tasks to smooth the execution of remaining tasks in the process
Periodic action	Business process operation	New	Consider making an action periodic or changing the periodicity of an already recurrent action
Shortcut	Business process operation	New	Introduce process short-cut possibilities
Resequencing	Business process behavior	Original	Move tasks to more appropriate places
Knock-out	Business process behavior	Original	Execute those checks first that have the most favorable ratio of expected knockout probability versus the expected effort
Parallelism	Business process behavior	Original	Introduce concurrency within a business process
Exception	Business process behavior	Original	Isolate exceptional cases from the normal flow
Order assignment	Organization structure	Original	Let workers perform as many steps as possible for single cases
Flexible assignment (HR)	Organization structure	Original	Assign human resources in such a way that maximal flexibility is preserved for the near future
Centralization	Organization structure	Original	Treat geographically dispersed human resources as if they are centralized
Split responsabilities	Organization structure	Original	Avoid assignment of task responsiblities to people from different functional units
Customer teams	Organization structure	Original	Consider assigning teams out of different departmental workers that take care of specific sorts of cases
Numerical involvement	Organization structure	Original	Minimize the number of departments, groups and persons involved in a process
Case manager	Organization structure	Original	Make one person responsbile for the handeling of a case
Resource adjustment (HR)	Organization population	New	Consider changing the number of human resources
Specialist-generalist (HR)	Organization population	Original	Consider to make human resources more specialized or more generalist
Empower	Organization population	Original	Give workers most of the decision-making authority and reduce middle management
Substitution (HR)	Organization population	New	Replace expensive human resources with less expensive ones
Control addition	Information	Original	Check the inputs and outputs of a process
Buffering (I)	Information	Original	Subscribe to updates instead of copmlete info. Exchanges.
Feedback	Information	New	Consider introducing feedback
Task automation	Technology	Original	Introduce technology to automate tasks
Integral technology	Technology	Original	Try to elevate physical constraints in a process by applying new technology
Trusted party	External environment	Original	Replace a decision task by the decision of an external party
Outsourcing	External environment	Original	Relocate work to a third party that is more efficient
Interfacing	External environment	Original	Consider a standardized interface with clients and partners
Reconstruction	Physical Layout	New	Consider reconstructing the physical layout
Flexible layout	Physical Layout	New	Make the physical layout flexible
Physical shortcut	Physical Layout	New	Introduce physical short-cut possibilities
Sustainable use	Non-human resources	New	Consider reusing, dissolving or evaporating non-human resources
Resource adjustment (NHR)	Non-human resources	New	Consider changing the number of involved non-human resources
Flexible assignment (NHR)	Non-human resources	New	Assign non-human resources in such a way that maximal flexibility is preserved for the near future
Specialist-generalist (NHR)	Non-human resources	New	Consider to make non-human resources more specialized or more generalist
Buffering (NHR)	Non-human resources	New	Consider to buffer non-human resources
Copying	Non-human resources	New	Consider to use inexpensive copies of non-human resources instead of expensive original ones
Substitution (NHR)	Non-human resources	New	Replace expensive non-human resources with less expensive ones

Table 7: The BPR (HC) Framework

8.2. Appendix II; Literature review method including results

In this section (§8.2) the results of the literature review will be presented. As the literature search and the relevance screening are done parallel the results will be presented at the same time (§8.2.1). The next paragraph (§8.2.2) will present the results of the quality screening.

8.2.1. Literature search and relevance screening

During the literature search, all titles and abstract were screened using the criterion set. When both these parts of the literature review have been conducted, there are 25 articles included per subject. The literature search is done separately. Therefore, 50 articles are included, in total, after the relevance screening. An overview of included articles is given in Appendix III. After the full copy screening only 2 MLD and 21 articles were included. The results are summarized in Figure 13.

Before continuing the discussion of the literature search and the relevance screening one topic needs to be discussed. The lack of research done on the field of multi-level design is becoming apparent as the search for literature and the full copy screening got along. During the full copy screening all articles besides two were excluded. These are the articles of Patricio et al (2011) and Gittel & Weiss (2004). These articles focus on the Multilevel Service Design and will be included for the quality screening. This is the reason why the MLD part will not be discussed in the explanation of the manner in which the search and screening were done.

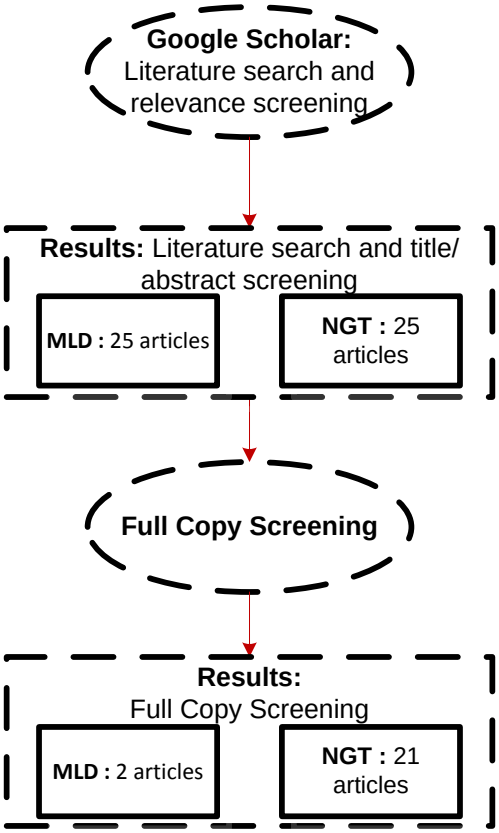

Figure 13: Results literature search and screening

Literature Search and Title/Abstract Screening

For the screening of the articles there are certain criteria set on which the articles can be judged. To get a clear overview of these criteria they will be explained in the following part. For every criterion a specific rule is given, with every rule it is given if it is an inclusion (I) or exclusion (E) criterion. These criterions have been set up by the author in collaboration with the TU/e supervisors.

Usefulness

This criterion focuses on the usefulness of the articles. The criterion is divided in two sections, every section focuses upon one aspect of the article. As the literature review focuses on information about the two methods, there should be an exact reference to that method in the title and abstract. If there is not an exact reference there is a high chance that the article is not focussing on the method.

- ***The article should focus on the Nominal Grouping Technique (NGT) (I), or***
- ***The article should focus on the Multi-Level Design (MLD) (I).***

The second part focuses on the fact that the article should give a clear overview of the method. As consideration, the article should be constructed as a literature review or an overview study, as in these articles the subject is, normally, fully described. That is why, to combine the three methods, these kinds of studies are needed. If the article only uses the method and does not give a general description of the method used in that article it will be excluded. The last criterion focuses on the explicit usage of the methods. When other articles use the method they will, assumable, explain how they used the method.

- ***The article should be a literature review on the NGT or MLD (I), or***
- ***The article should be another overview study on the NGT or MLD (I), or***
- ***The article should use a specific form of NTG/MLD(I)***

To give an understanding of how the literature search and the title and abstract screening were done an example is given. The first step in doing the literature search was accessing Google Scholar, as a source of articles. During the literature search the following article was found, *"Improving the quality of group judgement: Social judgment analysis and the nominal group technique"* written by Rohrbaugh (1981). Seen in the title, it is indeed focusing on the application of the nominal group technique (*criterion usefulness)*. The next check is on the abstract of the article, in which the following sentence is present: *"Social Judgment Analysis and the Nominal Group Technique. These two methods are compared in a controlled experimental setting with regard to their potential both to significantly reduce group disagreement and to provide accurate judgments."* This sentence gives the author enough confidence that the article is indeed focusing on the nominal group technique (*criterion usefulness)*.

During the search and screening another aspect was checked, which is the full copy availability. Only articles with a full copy available are included. So, if even abstract screening is good the article is excluded if the full copy cannot be found. For example, the article of McMurray (1994): "*Three Decision-making Aids: Brainstorming, Nominal Group, and Delphi Technique"*. As can be read in the title and abstract the article is indeed about the Nominal Group Technique, but the full copy cannot be retrieved, so it is excluded.

Full Copy Screening

Now it is known which articles are included the next part explains the results of the full copy screening. For this part the same criterion set for the title and abstract screening will be used. After the full copy screening was conducted there were 21 included (therefore 4 articles were excluded) for the Nominal Group Technique.

To give an understanding of how the full copy screening was done several examples will be described that became apparent during the full copy screening. For the NGT, two examples will be given, one in which an article is included and one in which an article is excluded. One of the first examples can be seen in the article of Paulus and Yang (2000), *"Idea Generation in Groups: A Basis for creativity in organizations"*. In that article a good description of the Nominal Group Technique is given. Furthermore, the article focuses on giving an overview on NGT and other methods. Paulus and Yang demonstrate a *"brain writing"* paradigm wherein they explain the Nominal Group Technique.

In Jung (2001) the author developed an experiment in which the nominal group was compared with the real group method. As this becomes clear in the abstract, the article is included in the first part of the literature review. However, it became apparent that the article only focused on researching the effectiveness of the Nominal Group Technique and does include a description of the NGT procedure.

8.2.2. Quality screening

For the screening of the Title/Abstracts and the full copy a set of criterion was defined. However, as the focus here is on the screening of the quality a new set of criterion has been devised. These criterions focus on the quality of the information provided in the selected articles from earlier screenings. The following two criterions have been set for the quality screening.

- ***The article should give a good description, of at least ¼ of page, of the method used (I)***
  The goal of the first research question is, to define a new method that combines the three methods given before (NGT, MLD and the BPR (HC) framework). To do this a detailed description of the three methods is needed. The detailed description of the three methods is needed to ensure that the most important parts of the methods are taken into account.

Before extracting data from the articles the articles need to be screened on the quality of the information included in the articles. The results of the quality screening are included in Figure 14. In this Figure one can see that there are only 2 articles included for the Multi-Level Design and 13 for the Nominal Group Technique.

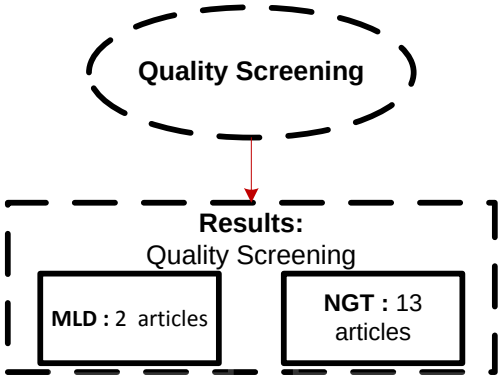

Figure 14: Results quality screening

Because of lacking research in MLD these articles will only be checked against one criterion, *"there must be a description of the MLD method present."* The articles proposed for the data extraction (Patricio et al., 2011, and Gittel & Weiss, 2004) are checked and are seen as sound articles for the data extraction. This opinion is also supported by the TU/e supervisors.

By providing a number of examples, the procedure for conducting the quality screening will be provided. Seen in Jones and Hunter (1995) the article is comprised of a description of at least ¼ of a page. Another example can be seen in Paulus and Yang (2000). The authors give a small description of the Nominal Group Technique, as it is shorter than ¼ of a page it will be excluded.

8.2.3. Data extraction and integration

In the first part, of this paragraph, the results of the literature review are summarized where after the results are integrated into one clear representation of that method. The results of the literature review are summarized in Figure 15.

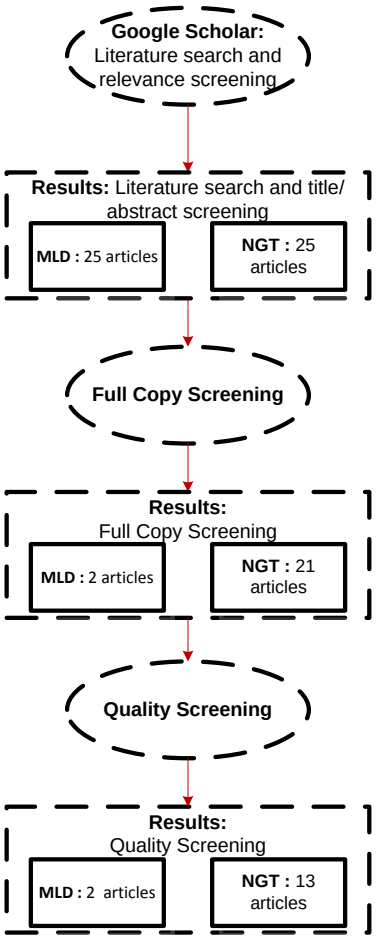

Figure 15: Overview Literature Review

The extraction of the data is done by extracting specific pieces of information from the MLD and NGT articles included after the quality screening. More precisely, the data that was extracted regards the objective, procedures (i.e. detailed steps of the technique) and other recommendations regarding the applications of the technique. For each of the selected 2 MLD and 13 NGT papers, a summary of the objective, the procedure and additional recommendations are included in Appendix IV.

8.3. Appendix III; Article database

ID	Author	Year of publication	Title
1	J. Jones D. Hunter	1995	Consensus methods for medical and health services research
2	I. Summers D.E White	1976	Creativity Techniques: Toward improvement of the Decision Process
3	R.A. Powell H.M. Single	1996	Focus Groups
4	H. Trickey I. Harvey G. Wilcock D. Sharp	1998	Formal consenss and consultation: a qualitative method for development of a guideline for dementia
5	P.B. Paulus H.C. Yang	2000	Idea Generation in Groups: A Basis for creativity in organizations
6	J. Rohrbaugh	1981	Improving the Quality of Group Judgment: Social Judgment Analysis and the Nominal Group Technique
7	No Authors Known		Nominal Group Technique (1)
8	No Authors Known		Nominal Group Technique (2)
9	C.L. Asmus K. James	2010	Nominal Group Technique, Social loafing, and Group Creative Project quality
10	P. Delp A. Thesen J. Motiwalla N. Seshardi	1977	Nominal Group Technique
11	M.J. O'neil L. Jackson	2006	Nominal Group Technique: A process or initiating curriculum development in higher education
12	A. MacPhail	2010	Nominal Group Technique: A useful method for working with young people
13	P.L. Roth L.L.F. Schleifer F.S. Switzer	1995	Nominal Group Technique - An aid in implementing TQM
14	C. Boddy	2012	The Nominal Group Technique: an aid to Brainstorming ideas in research.
15	R.B Dunham	1998	Nominal Group Technique: A Users` guide
16	P.P. Lago M.G. Beruvides J.Y. Jian A.M. Canto A. Sandoval R. Taraban	2007	Structuring group decision making in a web-based environment by using the nominal group technique
17	J.W. Satzinger M.J. Garfield M. Nagasundaram	1999	The Creative Process: The Effects of Group Memory on Individual Idea Generation
18	C. Okoli S.D. Pawlowski	2004	The Delphi method as a research tool: An example, design considerations and applications
19	A.H. van de Ven A.L. Delbecq	1974	The Effectiveness of Nominal, Delphi, and Interacting Group Decision Making Processes
20	J.D. Claxton J.R. Brent Ritchie J. Zaichkowsky	1980	The Nominal Group Technique: Its Potential for Consumer Research Author
21	P. Lomax P. McLeman	2006	The uses and abuses of nominal group technique in polytechnic course evaluation
22	D.L. Jung	2001	Transformational and Transactional leadership and Their Effects on creativity in Groups
23	S.D. Scott	1986	Using the Nominal Group Technique Effectively
24	T. R. Henrich T.J. Greene	1991	Using the Nominal Group Technique to elicit roadblocks to an MRP II implementation
25	T. Lancaster R. Hart S. Gardner	2002	Literature and medicine: evaluating a special study module using the nominal group technique

Table 8: Article database NGT

ID	Author	Year	Title
1	P.M. Harper R. Gani	2000	A multi-step and multi-level appraoch for computer aided molecular design
2	R.E. Bank A.H. Sherman	1980	An Adaptive, Multi-Level Method for Elliptic Boundary Value Problems
3	J.H. Gittel L. Weiss	2004	Coordination Networks Within and Across Organizations: A Multi-level Framework
4	H.L. Lee C. Billington	?	Designing products and processes for postponement
5	J. Gray D. Jesson N. Sime	1990	Estimating Differences in the Examination Performances of secondary Schools in Six LEAs: A Multi-Level Approach to School Effectiveness
6	D.M. Rousseau	1985	Issues of level in organizational research: Multi-level and cross-level perspective
7	K.J. Klein F. Dansereau R.J. Hall	1994	Levels issues in theory development, data collection, and analysis
8	F.J. Yammarino F. Dansereau	2008	Multi-level nature of and multi-level approaches to leadership
9	S.W.J. Kozlowski K.J. Klein	2000	A multilevel approach to theory and research in organizations: Contextual, temporal, and emergent processes.
10	R. House D.M. Rousseau M. Thomas-Hunt	1995	The Meso Paradigm: A framework for the integration of micro and macro organizational behavior.
11	L. Hooghe G. Marks	2003	Unraveling the Central State, but How? Types of Multi-level Governance
12	C. Charbit	2011	Governance of Public Policies in Decentralised Contexts
13	J. Braithwaite J. Westbrook M. Pawsey D. Greenfield J. Naylor R. Iedema B. Runciman S. Redman C. Jorm M. Robinson S. Nathan R. Gibbert	2006	A prospective, multi-method, multi-disciplinary, multi-level, collaborative, social-organisational design for researching health sector accreditation
14	W. Darr G. Johns	2004	Political decision-making climates: Theoretical processes and multi-level antecedents
15	B. Leavy D. Jacobson	1999	Innovation - The case for multi-level research
16	M. Sonnenberg B. Koene J. Paauwe	2011	Balancing HRM: the psychological contract of employees
17	J. Kirchner C.N. Edlund K. Henderson L. Daily L.E. Parker J.C. Fortney	2010	Using a Multi-Level Approach To Implement a Primary Care Mental Health (PCMH) Program
18	H. Bendya B. McKelvey	2006	Using coevolutionary and complexity theories to improve IS alignment: a multi-level approach
19	M.A. Dixon R.A. Noe D.L. Pastore	2008	Human Resource Management Systems and Organizational Effectiveness in Non-Profit sport organizations_A multilevel approach
20	E.B. Ferlie S.M. Shortell	2001	Improving the Quality of Health Care in the United Kingdom and the United States: A Framework for Change
21	G.L. Pearce	2007	The Future of Leadership development: The Importance of Identity, Multi-Level Approaches, Self-Leadership, Physical Fitness, Shared Leadership, Networking, Creativity, Emotions, Spirituality and On-Boarding Processes
22	M. Dotoli M.P. Fanti C. Meloni M.C. Zhou	2004	A multi-level approach for network design of integrated supply chains
23	M.R. Kuhn M. Otter L. Raulin	2008	A Multi Level Approach for Aircraft Electrical Systems Design
24	K. Korabik D.S. Lero	2004	A Cross-cultural Research Project on the Work-Family Interface: Preliminary Findings
25	L. Patricio R.P. Fisk J. Falcão e Cunha L. Constantine	2011	Multilevel Service Design: From Customer Value Constellation to Service Experience Blueprinting

Table 9: Article database MLD

8.4. Appendix IV; Detailed summary knowledge base

ID for enumeration	Author	Year	Title
1	J. Jones D. Hunter	1995	*"Consensus methods for medical and health services research"*
2	J. Rohrbaugh	1981	*"Improving the Quality of Group Judgment: Social Judgment Analysis and the Nominal Group Technique"*
3	J.D. Claxton J.R. Brent Ritchie J. Zaichkowsky	1980	*"The Nominal Group Technique: Its Potential for Consumer Research Author"*
4	A. MacPhail	2010	*"Nominal Group Technique: A useful method for working with young people"*
5	S. Sink	1986	*"Using the Nominal Group Technique Effectively"*
6	M.J. O'neil L. Jackson	2006	*"Nominal Group Technique: A process or initiating curriculum development in higher education"*
7	P. Lomax P. McLeman	2006	*"The uses and abuses of nominal group technique in polytechnic course evaluation"*
8	I. Summers D.E White	1976	*"Creativity Techniques: Toward improvement of the Decision Process"*
9	P.L. Roth L.L.F. Schleifer F.S. Switzer	1995	*"Nominal Group Technique - An aid in implementing TQM"*
10	P.P. Lago M.G. Beruvides J.Y. Jian A.M. Canto A. Sandoval R. Taraban	2007	*"Structuring group decision making in a web-based environment by using the nominal group technique"*
11	T. R. Henrich T.J. Greene	1991	*"Using the Nominal Group Technique to elicit roadblocks to an MRP II implementation"*
12	C.L. Asmus K. James	2010	*"Nominal Group Technique, Social loafing, and Group Creative Project quality"*
13	C. Boddy	2012	*"The Nominal Group Technique: an aid to Brainstorming ideas in research"*

Table 10: Overview included NGT articles

Author	Year of publication	Title
J.H. Gittel L. Weiss	2004	*"Coordination Networks Within and Across Organizations: A Multi-level Framework"*
L. Patricio R.P. Fisk J. Falcão e Cunha L. Constantine	2011	*"Multilevel Service Design: From Customer Value Constellation to Service Experience Blueprinting"*

Table 11: Overview included MLD articles

8.4.1. General summaries

In this first part the focus is on the general summaries made from the included articles. Furthermore, in every summary the steps are assigned to the integrated NGT steps showed in chapter 4.2.1.

1. ***"Consensus methods for medical and health services research"***

This article describes the nominal group technique as a highly structured meeting to gather information from relevant experts about a given issue. The NGT consists of two rounds in which panellists rate, discuss and then rerate a series of items and/or questions. In the 1960 the method was developed in the United States and has been applied in typical problems in socials services, education and industry. Nominal Group Technique has not been applied to Health Care processes but is used for the examination of clinical interventions. The authors structure the NGT as followed:

1. Participants spend several minutes writing down their views
2. Contribute one idea to record it on a flip chart
3. Similar suggestions are grouped, where it is deemed appropriate and a group discussion is used to clarify and evaluate each idea.
4. Privately rank each idea and present and summarize these results.
5. The overall results will be discussed and reranked.
6. The final results are reranked and results will be presented.

The method could be adapted to only provide participants with a single meeting or in other ways the NGT can be adapted. The leader of the NGT-group can also add a participant observer collecting qualitative data on the participants group. Nevertheless, the nominal group technique is different from focus groups as the NGT only focuses on the definition of one aspect or focuses on one single goal.

2. ***"Improving the Quality of Group Judgment: Social Judgment Analysis and the Nominal Group Technique"***

In this article the author (Rohrbaugh, 1981) uses the model as was developed by Delbec and Van Der Ven. the Nominal Group Technique gained popularity by the usage in different conferences, science studies and social work studies. It has been widely applied in health, social service, education, industry, and government organizations. The article recognizes that the following six steps can be seen in the Nominal Group Technique:

1. Silent generation of ideas.
2. Round-robin feedback from group members recording their different ideas.
3. Discussion of each recorded idea.
4. Individual voting on the different recorded idea.
5. Brief discussion on results.
6. Final individual voting through rank-ordering.

By providing the group with a precise structure NGT is intended to reduce process losses. The usage of NGT was tested for its accuracy of group judgments and that test was supportive of the use of NGT. Other authors/articles were cited that gave contradictory evidence about the usefulness of NGT. Rohrbaugh states, as a last point, that the Nominal Group Technique has been given only minimum evaluative tests.

3. *"The Nominal Group Technique: Its Potential for Consumer Research Author"*

Claxton et al define the NGT as a process which is normally implemented in six stages. A moderator will make an initial statement on the topic area to be discussed. Participants are then directed to reflect the topic on individual basis. Depending on the complexity of the problem the sessions could take longer. The next step is a consolidation of all ideas proposed by the participants. The ideas are ranked to establish the relative importance of every idea. Different iteration could be done to ensure that the value of each idea has been established in fullest detail.

The NGT provides two specific outputs for the project participants. Claxton et al. name for example the list of ideas that are relevant to the topic in question. Secondly, the NGT provides quantified individual and measures of the relative desirability of the ideas raised in the session.

Comparison with focus groups.

Claxton et al. defines that the NGT is perhaps closest to what others define as exploratory research. The major strengths of exploratory methods are the ability to find specific issues that cause problems in a particular research. Nevertheless, several restrictions can be seen when using standard focus groups, instead of the Nominal Group Technique. First, the output of a focus group is highly unstructured, never knowing the precise classification of the ideas. Second, the focus group does not account for the intimidation of participants, for example; participants may be outspoken by others. Third, to ensure that those factors are minimized and the full potential is achieved a highly skilled session leader is needed. Finally, it is needed to bring participants to a meeting room this inhibits the usage of a probability sampling procedure.

When is NGT applicable?

Claxton et al. defined situations in which the NGT are most widely used. The first aspect is thinking up ideas in a creative sense. Second, NGT provides employee with time and motivation to articulate ideas that they thought up in other days. The third aspect is providing a preliminary evaluation for ideas. The latter of these two are cases in which the NGT is the more valuable than, for example, focus groups.

4. *"Nominal Group Technique: A useful method for working with young people"*

The NGT is an interview technique in which participants work in one room with one another, however, they work independent to generate ideas. The NGT can be used to receive input from all different group members available, not just from a few members vocally. NGT has been vastly used as an evaluative tool in medicine, health care nursing and other. All these articles discussed findings that were achieved by using NGT, other only focused on the methodology of NGT.

What is Nominal Group Technique?

NGT is used to receive input from all group members and the potential dominance of the interview by more vocal members is avoided. Before starting a NGT meeting a number of steps have to be performed. For example, the inclusion of clearly identified information require from the group, selecting and preparing the meeting area and providing the necessary equipment. NGT relies on independent idea generation, after that pooling the individual judgments of the group members allowing for discussion and incorporating mathematical voting procedures. There is some debate

between different authors about the role of the NGT group leader. That is, if the group leader should contribute to the idea generating or only an idea receiver.

Using NGT can have a number of advantages. First, NGT balances participation between group members. MacPhail names different other research that stress the impact that one specific person can have in a group, inhibiting responses from other members of the group. The NGT is used to represent the view of everyone putting forward their own statements. The data does not need validation as the members of the group have weighted. Furthermore, shifting responses from one response to another are easy to record. Third, because the NGT is a series of steps the NGT could be defined as a procedure for doing, relatively, the same projects.

5. ***"Using the Nominal Group Technique Effectively"***

The NGT has come along at a most fortunate time in the evolution of management thought, technique and practices. Experience is proving that the quality, effectiveness, and efficiency of specific group processes play a significant role in the overall success of programs and techniques. Managers spend as much as 80% of their times in meetings, this has a great impact on managerial productivity. Unfortunately, group processes too often leave the participants exhausted and discouraged because of the endless debating. Another problem is the fact that the problem that the group must address is not clearly defined. In this management era where everyone is involved in the decision making and problem solving, methods like the NGT have been well accepted. The NGT has proved to be extremely effective because it is:

1. Easy to learn
2. Applicable to a wide variety of areas and situations
3. Easy to integrate into programs and projects of larger scope
4. Highly satisfying to participant
5. Quite successful at inspiring a commitment to action.

How to execute the Nominal Group Technique?

According to Sink (1986) the following 5 steps can be seen to apply the Nominal Group Technique:

1. *"Individual Silent Generation"*
2. *"Individual round-robin feedback from group members"*
3. *"Group clarification of each recorded idea"*
4. *"Individual voting and ranking"*
5. *"Discussion of group consensus results and focus on potential next step"*

In the remainder of the article every step is discussed in fullest detail. This information will be used to bring about the Nominal Group Technique. Further information about the NGT will not be stated here as it will only be used to use the NGT in the case study.

6. ***"Nominal Group Technique: A process or initiating curriculum development in higher education"***

O'Neill and Jackson argue that the NGT is a structured procedure for facilitating group-based decision making. The verbal interaction between group members is restricted as far as possible, at least to a leader-individual interaction. The group leader is the one that can discuss all options and other aspects during the meeting. NGT originally arose in management science as a form that is superior to normal brainstorming. It encourages participant's to talk and contribute to the groups output. The authors suggests that the NGT improves the structure of communication of groups, that

in it form leads to better productivity of the group meetings as a whole. The NGT allows a ranking of ideas through a weighted process, for example a likert type of scaling. Therefore, it combines both qualitative and quantitative information about the ideas under research. The authors have found, during their research, the following manner of doing a NGT:

1. *Outline of the NGT (Assumptions and Method*
2. *Presentation of the task, question or issue*
3. *Silent (possible individual) nominations*
4. *Master list construction (round-robin listing)*
5. *Item clarification*
6. *Merger of overlapping or congruent items*
7. *Evaluation of items*
8. *Discussion/subsequent action*

7. *"The uses and abuses of nominal group technique in polytechnic course evaluation"*

Lomax and McLeman (2006) investigated into the NGT and defined several aspects concerning the usage of the NGT. The method is one that combines advantages both qualitative and quantitative methods. NGT may be used to identify opinion on any specified issue or topic. A group of individuals will be identified with one group leader. Each participant will be asked to give a response to a given statement, topic or any other. The participants are asked to give their ideas, without the discussion of any other member. That way the participants are not biased by any other. The group leader collects the ideas and lists them onto a blackboard/flipchart. This cycle is repeated until no ideas can be presented anymore. Participants then consider the master list and decide which five items are most important, giving 5 points to the most important, four points to the second and so on. Then the leader collects all points and enters them to the ideas posted on the master list.

Uses of NGT

NGT has been applied in the development of programs or on management issues. The authors state that different uses include assessments, problem identification, goal definition and development and also others. Furthermore, the authors list uses in other contexts, such as social training and guidance. Lomax and McLeman used the NGT in several project using several different group members, such as students or teachers. If the participants, being part of the group are not representative for the group one cannot speak of a valid evaluation method. When starting a new NGT project it is important that the members are, at least, given a global overview of the method. Furthermore, the leader should not participate in the discussion on different ideas. That is because the leader is already informed in the exact goal of the meeting and other factors also influence the leader and its opinion.

In conclusion it can be said that NGT possesses attributes that provide companies with an economic and speedy way of identifying problems at that moment. The participants' autonomy was sustained by using NGT, however this may conflict with creating a group viewpoint. That is because the group is still interacting with one another and that may cause certain participants to be biased.

8. *"Creativity Techniques: Toward improvement of the Decision Process"*

This article describes the Nominal Group Technique as one that utilizes a component not contained by other group techniques. That component is the fact that the group does not vocally interact, so the group can be labelled as being nominal. The nominal group technique can be implemented as follows; without vocally interacting write down your ideas, after that the lists can be centred on organization dimensions. The lists are read in round-robin fashion. Each person reads their items and adds them to a final list and the highest priority items are identified by a voting system.
The article cited that there are many advantages that come with the usage of the Nominal Group Technique.

1. Non-interacting groups do not inhibit the performance of members
2. Non-interacting groups do not tend to focus on a single train of thought.
3. Because others are fully focuses on their task other people will also focus more on their tasks.
4. The process avoids early evaluation of the ideas.
5. It tries to engage participants to give even there most risk full ideas.
6. Use of personnel and organizational categories encourages the stating of social-emotional dimensions.

When the groups are interacting it has one potential to stimulate thinking that is absent from the first step of the non-interacting nominal group process. The desirable delay of evaluation is obtained by postponing the vocal input within the NGT.

9. *"Nominal Group Technique - An aid in implementing TQM"*

TQM is a technique that enhances the effectiveness by focusing on the continuing improvement of business processes. Many of the principles that go with implementing TQM are done in groups, it is there were NGT becomes important.

Many approaches exists with which one can approach group working, NGT combines some of the best characteristics The NGT tends to generate more ideas of higher quality than normal interacting groups and the Delphi method results in slightly lower quality ideas. Participants in the NGT groups are more confident that their ideas will work once a consensus is reached. That aspect is very important as the groups with high levels of confidence tent to be more engaged in taking action on implementing their ideas. Finally, the participants included in the NGT process are more satisfied with the meeting process.

After the identification of NGT, as being superior to other methods, it is used to implement the TQM. During the NGT process one should focus on the following steps:

- *Independently Generate ideas.*
- *Record Ideas in a round-robin format.*
- *Discuss Ideas*
- *Reach a decision*
- *Announce results*

However, the NGT process does not have to end at that point. The leader of the group may decide to take an iterative approach. The leader may hold some vote to let the group decide to eliminate unpopular ideas. A last point from Roth et al. state that the NGT can also be used to develop time tables, develop action plans, and generate and select items for customer surveys.

10. *"Structuring group decision making in a web-based environment by using the nominal group technique"*

Lago et al. provide a substantial view on the NGT, using an online of face-to-face method. The authors state that NGT provides an environment in which the creativity is stimulated as it allows silent generation of ideas. NGT equalizes participation and stimulates the generation of ideas by sharing the ideas with a group. When groups use brainstorming for the generation of ideas it will divide the participants' attentions. The NGT stimulates the participants to think about the ideas in more detail and encourages creativity. However, the lack of physical presence, as is optional with NGT, does not allow for body language to influence the ideas. Furthermore, the lack of physical presence contributes to an increase of number of unique ideas and also reduces participants' inhibition. However, all these advantage does not mean that the effectiveness is enhanced. The NGT is a sequential process as the participants present their contributions to the group in a sequential manner. NGT has proven to do the following:

- Increase creativity
- Promote equality of participation
- Reduce the effect of dominant personalities
- Promote consensus

The NGT process

1. Participants fill in a pre-sessions survey to assess their experience.
2. Idea generation
3. Round Robin idea provision.
4. Clarification of the ideas
5. Voting on the ideas
6. Final Discussion
7. Participants fill in a post-sessions questionnaire.

Discussion

The main conclusion of the study was that the face-to-face NGT (traditional manner) outperformed the new web-based method of using NGT. However, only small differences became apparent when looking out the outcomes of both methods. The online environment was seen as 40% less efficient than the normal face-to-face version. In relation to efficiency, the participants felt that the online process too more time than it should. Furthermore, it was observed that the online group took significantly more time to reach consensus than the traditional groups. As overall conclusion it could be said that the online environment is, in general, less effective than the offline environment is. Based on the results found in this article one could state that to use NGT as an efficient tool, the design problems should be addressed and incorporated in the design.

11. *"Using the Nominal Group Technique to elicit roadblocks to an MRP II implementation"*

The NGT was first discusses in Delbecq and Van de Ven (1986). NGT uses a variety of settings is often associated with group planning, this is done to ensure group ownership of the resulting decision. The NGT is structured in such a way that it is easy to learn and can be applied effectively with relatively little experience. In normal group meetings it is difficult to find everyone's` opinion because the group meetings are dominated by one person. While a NGT is not suited for all groups and all meetings, it does provide an organized way to obtain the group's expertise.

Using the Nominal Group Technique

The steps in the NGT are as follows:

1. Introduction of the task statement.
2. Individual, silent generation of ideas.
3. Round robin listing of ideas.
4. Clarification of ideas.
5. Consolidation of ideas.
6. Voting and ranking of ideas.

Conclusions

The NGT improves the communication between members of an implementation team as well between that team and the managing party. The NGT is very efficient as there can be useful information in less than three hours. The validity is guaranteed because it comes from the whole group and they are ranked in importance of the various ideas. NGT can generate further discussions and can be the focus a dialogue on how to improve the implementation.

12. *"Nominal Group Technique, Social loafing, and Group Creative Project quality"*

Asmus and James (2010) specified NGT as a technique for structuring creative group processes, it seems that NGT is more effective. The NGT was originally developed by Delbecq and Van de Ven (1971) to facilitate the generation of ideas while increasing the quality of the participation. NGT involves four stages:

1. Generate ideas individually
2. Outline the generated ideas to the group
3. Through discussion choose an idea or combination of ideas.
4. Execute the plan that was developed and set it in motion.

When encountering more complex project, additional rounds of idea generation could be added. Other authors have added arguments that NGT is an effective strategy for group enhanced on performance of tasks requiring idea generation. Moreover, others supported the effectiveness of NGT for promoting group creative performance. Whether NGT yield better performance than other methods has been at the focus in many NGT research. Some authors argued that NGT improves groups creative output over basic brainstorming, because NGT reduces the blocking of ideas by blocking the talking in the generation of ideas.

Another mechanism with which the NGT might be more effective is the fact that they let people work individual. As the individual will put in less effort in a collective goal than in an individual it seems logical that the NGT is more effective, this effect has been seen in different studies named in the article. In the situations when working in a group there are different methods with which one can improve grouping dynamics. Nevertheless, the fact that individuals do less in groups is at any stage bad for the overall group output. The fact that member lose effort in a major type of process loss has been observed in unstructured creativity groups. In addition, other studies have shown that some group members reducing their effort results in reducing other group members level of effort. That effect can produce a chain reaction resulting in a poor group performance. The NGT was developed to reduce this effect of poor group performance. The NGT gives each individual participant an equal chance to provide input into the idea generation. The NGT was designed to

eliminate group effects that had negative influence on group outcome, so it should also reduce the "less effort" effect. Different authors did already research into this effect and found promising results.

This article focuses on looking at the effect of NGT on the effect of individuals losing effort, and also what the effect of this "less effort" is on the NGT creating ideas. The NGT decreased the fact that participants reduce the effort they put into the project. So, the idea that the authors created more a sense of what the NGT has as effect on the group dynamics is achieved.

13. *"The Nominal Group Technique: an aid to Brainstorming ideas in research"*

The NGT is an upgrade to the Brainstorming group research, because in the first stage of the group process the ideas are generated in silence. The participants are nominally in a group however they work individually on a given task, which gives the name NGT. Papers suggest that brainstorming is more enjoyable for the members but is not as productive as the participants tend to believe and the group can generate more and better ideas when silently generated ideas. During the silent working on generating ideas people can produce more creative ideas. Brainstorming inhibits creative thinking compared to the silent techniques as used in the NGT. A further advantage of the individual working is the fact that the extrovert participants are less dominant in the group exercise. It also identifies areas of interest where earlier projects did not focus on. Other authors speculate that brainstorming remains popular because the ideas are generated in group setting, and that may lead to quicker evaluation of the ideas and get them accepted faster. However, other research showed that working individually generated many more ideas than groups do.

The optimal combination of group processes for solving a problem was first, the usage of NGT and after that structured feedback and interactive discussion and lastly another NGT session for voting for final judgment. The first step from NGT is to write down own ideas without reference to one another. After that the ideas are presented and are openly displayed for all members to look at. A rating or ranking of each of the ideas is made and each idea is assigned a value according to the importance of the ideas. After that group participants then manipulate the ideas on the board, as a group, to relevant criteria. Then they vote for ideas on selected criteria, this causes a great deal of interaction within the group, with quickly breaking down feelings of inhibition within the group. The whole process of the NGT shakes the adult mind and thereby stimulating creativity. The highest valued ideas are further developed. An advantage of this approach is the fact that the results are more structured than in other techniques. Because of the lists on the whiteboards or with sticky notes the process is structured and the group leader does not have to remember all outcomes of each process. At last different advantages of the NGT are reported to be that the groups do not focus on a single thought. The competitiveness of group participants, while silently writing ideas, is a way to improve participants' involvement.

Concluding one can say that the NGT, by using the silence generation, the use of NGT has beneficial roles to play in management and market research. In practical terms, the discussion of ideas and manipulation of exercise is reported to cause more physical movement and interaction within the group. The participant in the group are involved in discussing ideas and voting for ideas, this breaks down inhibitions and creates a good group mentality.

1. *"Coordination Networks Within and Across Organizations: A Multi-level Framework"*

The design of organizations is, from origin, a multi-level approach. The original work on organizations is addressed to the design for integrating activities across the firm. Early work on this integration considers cross-functional routines/protocols, information systems or other. Integration can also be achieved through the use of mechanism of control. It is interesting to see what mechanisms have been found effective in linking units within organizations and which are also effective for linking activities across organizations.

The next aspect that is of interest is Network Theory; this is relevant because it is based on the relationship between interacting units. These relations are the fundamental component of network theories. The network perspective offers a way in which one can understand coordination, which is fundamentally about connections among actors. Other authors pointed that network analysis has been recognized as a multi-level approach. These authors discussed the trend of organizational theory towards a multi-level analysis. The potential of multi-level theory/networks has been assessed in limited extent.

The authors proposed the following multi-level approach:

Proposition 1: Intra-organizational design (e.g. routines, information systems, team meetings, boundary spanners) can improve quality and efficiency performance by strengthening intra-organizational coordination networks.

Proposition 2: Inter-organizational design (e.g. routines, information systems, team meetings, boundary spanners) can improve quality and efficiency performance by strengthening inter-organizational coordination networks.

Furthermore, if the same organization design features used for internal coordination are also used for external coordination, we expect that coordination will be strengthened even further, resulting in greater quality and efficiency than when dissimilar mechanisms are used.

Proposition 3: The *similarity* of intra and inter-organizational design (e.g. routines, information systems, team meetings, boundary spanners) improves quality and efficiency performance by strengthening the interface between intra and inter-organizational networks.

See Figure 16 for a graphical illustration of these propositions.

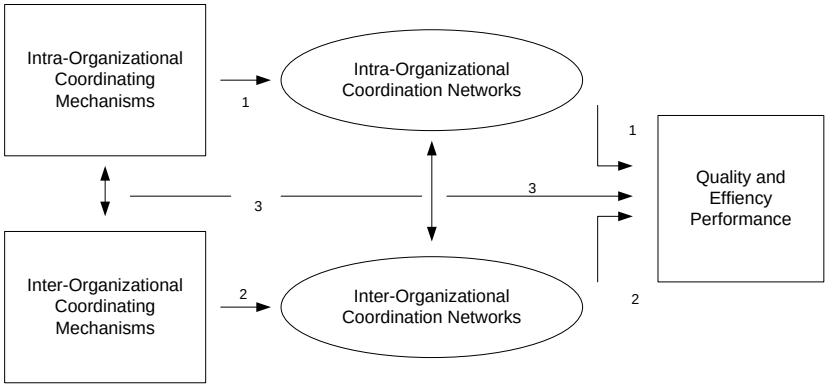

Figure 16: MLD according to Gittel and Weiss (2004) (General Summary)

2. *"Multilevel Service Design: From Customer Value Constellation to Service Experience Blueprinting"*

This research builds on other authors' perceptions on creating new service design methods. According to that perception, criteria for evaluating new design methods should be process detail, invention, relevance, and extensibility. The MSD method combines different contributions of different fields and design. The service offered through the different levels of customer experience. It recognizes that organizations cannot design customer experiences, but service system can specialized for customer experience.

According to other authors the design process starts with observation and investigation of the current situation. The next step considers the modelling, which forms the bridge between the problem and the solution. This is achieved by interpreting a systematizing the understanding of the existing situation and explore new potential solutions. Finally, by using an iterative process, the most ideal solutions are materialized into prototypes and ultimately finished. The MSD follows 4 steps:

1. Studying the customer experience
2. Designing the service concept
3. Designing the firm's service system
4. Designing the service encounter

A multi-level service design requires a multidisciplinary team, in which the manager of the business area and actors from marketing, IS and operations are included. The models from the MSD help teams analyse and discuss the existing solution, furthermore problems are revealed that interfere with the customer experience and other potential areas for innovation. The next subsections present the steps, concepts, and models of MSD in detail.

Step 1: Studying the Customer Experience

This first step is an in-depth study of the experience of the customer at different levels. MSD uses different qualitative methods to enrich and detail the understanding of the customer experience at different levels. The stage involves the data collection techniques such as observation, focus groups or walkthroughs. The quality study in MSD enables mapping the overall customer activity and service tasks. These are related to the different levels of the customer experience. Furthermore it enables a better understanding of the desired experience at the different levels. An additional quantitative method can be done to evaluate further feature or to make global assessment of the experience.

Step 2: Designing the Service Concept

Step 2 defines the service concept as: "Benefits that the service is expected to offer to the customer. The MSD defines the service concept as the positioning in the customer value constellation including the service offered and the partnerships established. So, MSD focuses on the firms' value however it defines the value as a broader context in the value network in which the firm acts.

Understanding the Value Constellation Experience (VCE).

The design of the service concepts start with the understanding of the value constellation experience. This is created through the interaction between the customer and all organizations that enable a given customer activity, such as buying a house. The in-depth studies, performed in step 1,

enable the decomposition of different activates that form the value constellation experience and the identification of the most important experience factors. Although the research on experience has adopted a holistic approach, it has only addressed the customer experience at the firm level. MSD has broader view, which is crucial for understanding customer experience beyond the view of the firm. This broader view is used to identify additional components that are necessary to enhance the value constellation experience. This helps companies understand how the customers use their services and opens new possibilities for possible innovation.

Designing the service concept through the Customer Value Constellation (CVC).
In MSD, this model developed is de customer value constellation. This enables the design of the service concept. It represents the set of service offerings and interrelationships that enable customers to create their value constellation experience for a given activity. The CVC is build using the value constellation per activity and combines it with existing offerings from the company. The CVC holds into account that value is not only created within the company but also outside within the network in which the company is embedded. The company can then use the CVC to analyse the current services offered and possible enhance the offering by using information gained from the creation of the CVC.

Step 3: Designing the Firm's Service System
In this step the focus is on enhancing the service experience according to the results defined in step 2. The concepts of service system is a configuration of people, technologies and possible other resources.

Understanding the service experience.
The interaction between customer and a company's service system creates the service experience. This service experience accomplished a given service activity. Moreover, it is seen as the result of the customer journey and is, traditionally addressed by customer experience research. In MSD, the in-depth studies enable the decomposition of certain activities to all the moments of contact between customer and company. This information is important because the company gets knowledge about the different service encounters that create the customer journey, the paths and interface which are used by customers. This analysis highlights potential opportunities for improvements in the firm's service system.

Designing the service system through the Service System Architecture (SSA) and the Service System Navigation (SSN).
Building on the service experience, the company can design the service system that enables the customer to follow multiple patterns through the service provided. The design consists of three components. First, for every task, the system should off a mix of interfaces that enables customer to choose their preferred journey. Second, the service system should accommodate the customer with a smooth journey through the service experience. Third, instead of replicating each task in every service, the system should enhance different service while contributing to the efficient allocation of resources.

The MSD uses two models for the design process at a system level; these are the SSA and SSN. The SSA is used to define the structure of the system, with providing an integrated view of the offers and

support processes across different tasks. Moreover it builds upon the understanding of the service experience, as this was experience was earlier defined. This analysis defines a mix of alternative service interfaces and processes that support tasks in the service experience. The integrated view that the SSA provides identifies breakdowns in the existing system or new possible solutions. The SSA provides a static view, as on the other hand SSN offers a dynamic view. Based on the analysis made in the SSA, the SSN maps the alternative paths customers may take across service encounters. One of these paths represents a possible journey of the customer. The SSN provides information on which the service interfaces can be better identified and designed, which provides customer with a better way to cross the services. Thus, by offering an interface mix and providing alternative routes, the SSA and SSN accommodate the creative nature of services. Furthermore, these two analyses provide a structural and navigational view of the system and guide each service encounter.

Step 4: Designing the Service Encounter

The last step of the MSD is the design of the service encounters. These are defined as the moments of interaction between customer and company; for example, internet or a physical store. These are also called touch points in the service design field. This level defines the interaction setting, process and the role of the participant.

Understanding the Service Encounter Experience (SEE).

The encounter is created through interactions at a given service interface for a given task. In MSD, in-depth information from customers enables the mapping of the process customers use to create their experience for each service encounter. It is also important to understand factors that enable a desired service encounter experience, such as ease of use or usefulness of a service interface.

Designing the service encounter with the Service Experience Blueprint (SEB) diagram.

The MSD method uses a specific diagram to design each specific encounter. The diagram used is based upon the detailed understanding of the service encounter experience. Furthermore, it maps the actions of different participants in the encounter. It depicts lines of interaction, fail points and waiting points.

An interface link presents a point in the encounter where the customer should be rerouted to another interface. Again, the diagram is used to map the existing service but is also used to explore alternative that may improve the encounter. MSD offers a holistic view with the multilevel perspective, from service concept to the multi-interface system level. The MSD provides the companies with different levels for each different decision maker. For example, business managers are more interested in the SSA and the SSN. With the set of models defined by the MSD the project members can understand the impact the decisions they make have on the operation.

8.4.2. Detailed summaries

The focus in the following summaries is shifted towards the more critical information that is presented in the articles.

1. ***"Consensus methods for medical and health services research"***

Author(s):

J. Jones

D. Hunter

NGT procedure as used in the article

1. *Participants spend several minutes writing down their views. (step 1)*
2. *Contribute one idea to record it on a flip chart. (step 2)*
3. *Similar suggestions are grouped, where it is deemed appropriate and a group discussion is used to clarify and evaluate each idea. (Step 3 and 4)*
4. *Privately rank each idea and present and summarize these results. (step 5)*
5. *The overall results will be discussed. (Step 6)*
6. *The final results are reranked and results will be presented. (Step 7)*

Goal of the article

In this case the goal of the article was the comparison of the Nominal Group technique with the Delphi method, to see which one performed better.

Significant aspects

The authors suggested that an additional observer could be included that collects qualitative data on the participants group.

2. ***"Improving the Quality of Group Judgment: Social Judgment Analysis and the Nominal Group Technique"***

Author(s):

J. Rohrbaugh

NGT procedure as used in the article

1. *Silent generation of ideas. (step 1)*
2. *Round-robin feedback from group members recording their different ideas. (step 2)*
3. *Discussion of each recorded idea. (step 3)*
4. *Individual voting on the different recorded idea. (step 5)*
5. *Brief discussion on results. (step 6)*
6. *Final individual voting through rank-ordering. (step 7)*

Goal of the article

In this article the main focus in on providing a comparison between the Nominal Group Technique and the Social Judgment Analysis.

Significant aspects

The article did not present any important aspect on the NGT that should have been extracted for the correct usage of the method.

3. ***"The Nominal Group Technique: Its Potential for Consumer Research Author"***

Author(s):

J.D. Claxton

J.R. Brent Ritchie

J. Zaichkowsky

NGT procedure as used in the article

1. *A moderator will make an initial statement on the topic area to be discussed. (step 0)*
2. *Individual reflection on the topic at hand. (step 1)*
3. *Present ideas and explain in group context. (step 2)*
4. *Consolidation of the presented ideas (step 2)*
5. *Ranking of the presented ideas (step 5)*
6. *Compilation of the results obtained. (step 7)*

Goal of the article

The authors present an overview on the Nominal Group Technique, how it can be used and what the usage is for consumer research.

Significant aspects

The authors define situation in which the NGT can be applied. They name three situation in which the NGT can provide valuable support. First, a situation in which on needs to create ideas in creative sense. Second, NGT provides employees with time and motivation to generate and talk about ideas they once thought of. The last aspect is the situation in providing preliminary evaluation for ideas.

4. ***"Nominal Group Technique: A useful method for working with young people"***

Author(s):

A. MacPhail

NGT procedure as used in the article

1. *Select and prepare necessary information for the group. (step 0)*
2. *Independent idea generation. (step 1)*
3. *Pooling of individual judgments of the participants allowing for discussion and including a mathematical voting mechanism. (step 2 and 3)*
4. *Rank the ideas. (step 7)*

Goal of the article

Conclusion on the appropriateness of using the Nominal Group Technique when researching into younger people's opinion.

Significant aspects

One aspect hat is not ready mentioned by others is the inclusion of the Nominal Group Leader in the discussion; yes or no. The leader will have a prejudice about some of the ideas and might see them as unreal, this is because the leader will have a broader knowledge on the subject and the Nominal Group Process.

5. ***"Using the Nominal Group Technique Effectively"***

Author(s):

S. Sink

NGT procedure as used in the article

1. *Individual Silent Generation (step 1)*
2. *Individual round-robin feedback from group members. (step 2)*
3. *Group clarification of each recorded idea. (step 3)*
4. *Individual voting and ranking. (step 5)*
5. *Discussion of group consensus results. (step 6)*
6. *Focus on potential next step. (step 7)*

Goal of the article

Providing an insight in the workings of the Nominal Group Technique and providing a way to use the technique more effective.

Significant aspects

Every phase is discussed in full detail, this is of great importance when designing the method. This information will be included during the design of the method but will not be summarized in this part.

6. ***"Nominal Group Technique: A process for initiating curriculum development in higher education"***

Author(s):

M.J. O'neil

L. Jackson

NGT procedure as used in the article

1. *Outline of the NGT (Assumptions and Method). (step 0)*
2. *Presentation of the task, question or issue. (step 0)*
3. *Silent (possible individual) nominations (step 1)*
4. *Master list construction (round-robin listing) (step 2)*
5. *Item clarification (step 3)*
6. *Merger of overlapping or congruent items (step 4)*
7. *Evaluation of items (step 5)*
8. *Discussion/subsequent action (step 6)*

Goal of using the NGT

Explanation of the workings of the Nominal Group Technique and using it in the forming of a curriculum for higher education.

Significant aspects

The authors present some simple rules for the leader of the nominal group sessions:

- Do not reinterpret a person's idea
- Use the participants own wording
- Do not interject your own ideas – the leader does no participate
- The NGT is not a debate, do not let participants challenge each other
- Allow people to think, let them have enough time
- Do not look for patterns in the results

7. *"The uses and abuses of nominal group technique in polytechnic course evaluation"*

Author(s):

P. Lomax

P. McLeman

NGT procedure as used in the article

1. *A group of individuals is identified. (step 0)*
2. *Each participant is asked to give ideas without discussion. (step 1)*
3. *Collect ideas and list them onto a blackboard/flipchart. (step 2)*
4. *Repeat cycle until now ideas are present (step 2)*
5. *Participants consider the master list and decide which five items are most important. (step 5)*
6. *Points are given to the top 5 and enter the items on the last master list. (step 5)*

Goal of using the NGT

The authors show the usage of the Nominal Group Technique for the course evaluation.

Significant aspects

It is important that the group members are given a global overview of the nominal group technique as it will be used. This is important for the group members to know before beginning. Furthermore, the leader should not participate in the discussion of ideas, the leader is not a participant only an observer/moderator.

8. *"Creativity Techniques: Toward improvement of the Decision Process"*

Author(s):

I. Summers

D.E White

NGT procedure as used in the article

1. *Without vocally interacting write down ideas. (step 1)*
2. *The ideas are read in round-robin fashion. (step 2)*
3. *All ideas are added to a final list and highest priority items are identified by a voting system. (step 7)*

Goal of using the NGT

Creating an overview of several creativity techniques to improve the decision process.

Significant aspects

There are several aspects that the author name that are important. The participants are fully focused on their task and that will cause other people to focus more on their tasks. Furthermore, the NGT process avoids early evaluation of the ideas. It tries to engage participants to give even their most risk full ideas. At last, the author states that the non-interacting groups do not tend to focus on a single strain of thought.

9. ***"Nominal Group Technique - An aid in implementing TQM"***

Author(s):

P.L. Roth

L.L.F. Schleifer

F.S. Switzer

NGT procedure as used in the article

1. *Independently Generate ideas. (step 1)*
2. *Record Ideas in a round-robin format. (step 2)*
3. *Discuss Ideas. (step 3)*
4. *Reach a decision. (step 5)*
5. *Announce results. (step 7)*

Goal of using the NGT

The article proposes a way of using the Nominal Group Technique process for the implementation of Total Quality Management.

Significant aspects

The authors have stated that the Nominal Group Technique represents a way of generating more ideas of higher quality than other methods are possible can. Furthermore, the participants of the NGT are more confident that the ideas will work once a consensus is reached.

10. ***"Structuring group decision making in a web-based environment by using the nominal group technique"***

Author(s):

P.P. Lago

M.G. Beruvides

J.Y. Jian

A.M. Canto

A. Sandoval

R. Taraban

NGT procedure as used in the article

1. *Participants fill in a pre-sessions survey to assess their experience. (step 0)*
2. *Idea generation. (step 1)*
3. *Round Robin idea provision. (step 2)*
4. *Clarification of the ideas. (step 3)*
5. *Voting on the ideas. (step 5)*
6. *Final Discussion. (step 6)*
7. *Participants fill in a post-sessions questionnaire. (step 7)*

Goal of using the NGT

The authors have stated a difference between face-to-face and web-based usage of the nominal group technique.

Significant aspects

The most important aspect mentioned in the article is the fact that a traditional manner of doing the nominal group technique is outperforming the new web-based method of using the NGT. Moreover, the NGT increases creativity, promote equality and promote consensus.

11. *"Using the Nominal Group Technique to elicit roadblocks to an MRP II implementation"*

Author(s):

T. R. Henrich

T.J. Greene

NGT procedure as used in the article

1. *Introduction of the task statement. (step 0)*
2. *Individual, silent generation of ideas. (step 1)*
3. *Round robin listing of ideas. (step 2)*
4. *Clarification of ideas. (step 3)*
5. *Consolidation of ideas. (step 4)*
6. *Voting and ranking of ideas. (step 5)*

Goal of using the NGT

The goal of the article is the same as the title, it shows the way the Nominal Group Technique can be used to elicit roadblocks to an MPR II implementation.

Significant aspects

The authors present the method as a way of improving the communication between members of an implementation team as well between that team and the managing party that controls the process.

12. *"Nominal Group Technique, Social loafing, and Group Creative Project quality"*

Author(s):

C.L. Asmus

K. James

NGT procedure as used in the article

1. *Generate ideas individually. (step 1)*
2. *Outline the generated ideas to the group. (step 2)*
3. *Through discussion choose an idea or combination of ideas. (step 5)*
4. *Execute the plan that was developed and set it in motion. (step 7)*

Goal of using the NGT

The goal of the article is presenting the influence of the Nominal Group Technique on social loafing and the impact it has on the creative project quality.

Significant aspects

The authors state that one of the important aspects is the adding of additional round of idea generation if the project is of a complex nature. The NGT decreases the fact of social loafing so it is interesting to use for redesign projects.

13. *"The Nominal Group Technique: an aid to Brainstorming ideas in research"*

Author(s):

C. Boddy

NGT procedure as used in the article

1. *Write down ideas without reference to one another. (step 1)*
2. *Present ideas and openly display them for members. (step 2)*
3. *The ideas are ranked and each idea is assigned a value. (step 5)*
4. *Vote for ideas by using selected criteria. (step 5)*
5. *The highest valued ideas are further developed. (step 6)*

Goal of using the NGT

The authors present and discuss the Nominal Group Technique for the possibility of using it in types of market research or management research where it is desirable to generate as many ideas as possible.

Significant aspects

The authors suggest that the Nominal Group Technique is superior to brainstorming. As brainstorming is a more enjoyable technique it is less productive as participants tend to believe and groups can generate more ideas when silently generating ideas.

1. ***"Coordination Networks Within and Across Organizations: A Multi-level Framework"***

MLD procedure as used in the article

The procedure for a multi-level design or as the authors state a multi-level approach is given in Figure 17. The procedure depends on mechanisms that create coordination within and between companies in a given network.

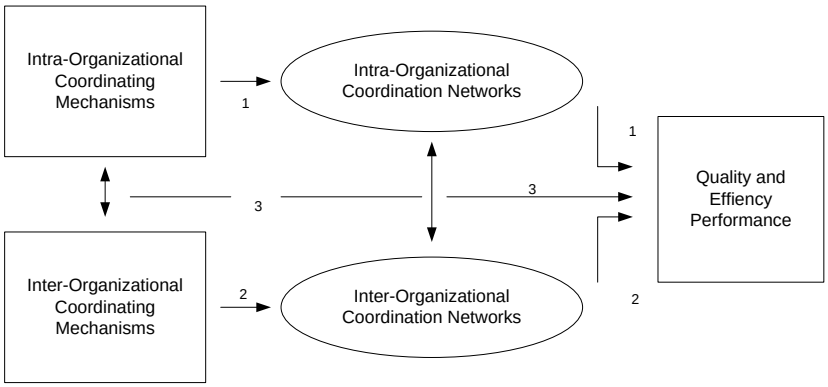

Figure 17: MLD according to Gittel and Weiss (2004) (Detailed Summary)

Goal of using the MLD

The goal of the authors was to create a multi-level framework with which one could coordinate the networks within and across organizations.

Significant aspects

The different numbers in Figure 17 are effects that certain decisions or mechanisms have on the networks/companies. The following 3 effects can be seen in the Figure.

1. Routines, information systems, team meetings, boundary spanners can improve quality and efficiency performance by strengthening intra-organizational coordination networks.
2. Routines, information systems, team meetings, boundary spanners can improve quality and efficiency performance by strengthening inter-organizational coordination networks.

   Furthermore, if the same organization design features used for internal coordination are also used for external coordination, we expect that coordination will be strengthened even further, resulting in greater quality and efficiency than when dissimilar mechanisms are used.
3. Routines, information systems, team meetings, boundary spanners can improve quality and efficiency performance by strengthening the interface between intra- and inter-organizational networks.

2. ***"Multilevel Service Design: From Customer Value Constellation to Service Experience Blueprinting"***

MLD procedure as used in the article

5. Study the customer experience
    a. Observation and investigation of the current situation.
6. Design the service concept
    a. Benefits that the service is expected to offer to the customer. The MSD defines the service concept as the positioning in the customer value constellation including the service offered and the partnerships established. So, MSD focuses on the firms' value however it defines the value as a broader context in the value network in which the firm acts.
7. Design the service system
    a. In this step the focus is on enhancing the service experience according to the results defined in step 2.
8. Design the service encounter
    a. The last step of the MSD is the design of the service encounters. These are defined as the moments of interaction between customer and company; for example, internet or a physical store. These are also called touch points in the service design field. This level defines the interaction setting, process and the role of the participant.

Goal of using the MLD

The authors provide the reader with an overview of a multi-level design that can help companies while creating more value for their customers.

Significant aspects

The MSD provides information for every part of the company. With the set of models, made in every part, the MSD provides the members with an understanding of what impact their decisions have on the operational activities.

8.5. Appendix V; Division of change heuristics

Level	Heuristic	Category	Definition
1	Contact reduction	Customer	Combine information exchanges
1	Control relocation	Customer	Relocate control steps in the process to others
1	Integration	Customer	Consider the integration with a process of client or supplier
1	Interfacing	External environment	Consider a standardized interface with clients and partners
1	Outsourcing	External environment	Relocate work to a third party that is more efficient
1	Trusted party	External environment	Replace a decision task by the decision of an external party

Level	Heuristic	Category	Definition
2	Order types	Business process operation	Decide if tasks are oriented towards same patient groups and if needed distinct between business processes.
2	Prior action	Business process operation	Perform tasks, before they need to be executed, or add tasks to smooth the execution of remaining tasks in the process
2	Prior counteraction	Business process operation	Add tasks to prevent happening of a undesirable situation or to reduce its impact
2	Shortcut	Business process operation	Introduce process short-cut possibilities
2	Task elimination	Business process operation	Delete tasks that do not add value from a client's viewpoint
2	Triage	Business process operation	Consider the division of a general task into alternative tasks

Level	Heuristic	Category	Definition
3	Exception	Business process behaviour	Isolate exceptional cases from the normal flow
3	Knock-out	Business process behaviour	Execute those checks first that have the most favourable ratio of expected knockout probability versus the expected effort
3	Parallelism	Business process behaviour	Introduce concurrency within a business process
3	Resequencing	Business process behaviour	Move tasks to more appropriate places
3	Order-based work	Business process operation	Consider stopping to work batched wise and only do activities periodically.
3	Periodic action	Business process operation	Consider making an action periodic or changing the periodicity of an already recurrent action
3	Task composition	Business process operation	Combine small tasks into composite tasks or vice versa

Level	Heuristic	Category	Definition
3	Buffering	Information	Subscribe to updates instead of complete info. Exchanges.
3	Control addition	Information	Check the inputs and outputs of a process
3	Feedback	Information	Consider introducing feedback
3	Buffering	Non-human resources	Consider to buffer non-human resources
3	Copying	Non-human resources	Consider to use inexpensive copies of non-human resources instead of expensive original ones
3	Flexible assignment	Non-human resources	Assign human resources in such a way that maximal flexibility is preserved for the near future
3	Resource adjustment	Non-human resources	Consider changing the number of human resources
3	Specialist-generalist	Non-human resources	Consider to make human resources more specialized or more generalist
3	Substitution	Non-human resources	Replace expensive human resources with less expensive ones
3	Sustainable use	Non-human resources	Consider reusing, dissolving or evaporating non-human resources
3	Empower	Organization population	Give workers most of the decision-making authority and reduce middle management
3	Resource adjustment	Organization population	Consider changing the number of involved non-human resources
3	Specialist-generalist	Organization population	Consider to make non-human resources more specialized or more generalist
3	Substitution	Organization population	Replace expensive non-human resources with less expensive ones
3	Case manager	Organization structure	Make one person responsible for the handling of a case
3	Centralization	Organization structure	Treat geographically dispersed human resources as if they are centralized

Level	Heuristic	Category	Definition
3	Customer teams	Organization structure	Consider assigning teams out of different departmental workers that take care of specific sorts of cases
3	Flexible assignment	Organization structure	Assign non-human resources in such a way that maximal flexibility is preserved for the near future
3	Numerical involvement	Organization structure	Minimize the number of departments, groups and persons involved in a process
3	Order assignment	Organization structure	Let workers perform as many steps as possible for single cases
3	Split responsibilities	Organization structure	Avoid assignment of task responsibilities to people from different functional units
3	Flexible layout	Physical Layout	Make the physical layout flexible
3	Physical shortcut	Physical Layout	Introduce physical short-cut possibilities
3	Reconstruction	Physical Layout	Consider reconstructing the physical layout
3	Integral technology	Technology	Try to elevate physical constraints in a process by applying new technology
3	Task automation	Technology	Introduce technology to automate tasks

Table 12: Overview BPR (HC) heuristics with division using MLD

8.6. Appendix VI; Full list of redesign ideas

Idea
Adding additional information on the website
Post-operative consult by doctor only for complex patients
All pre-measurements by one employee
Execute glass-measurement and AR-measurement at the same time
Add and additional AR-scanner and computer during cataract centre. Because refraction uses the AR-scanner this is more efficient
Let complex patient be consulted by staff member
Provide cheaper lenses for premium patients
Adding additional login columns
Provide patients with real-time information with regard to the procedures and pre-consult.
Introduce clinical assistant hereby processing information in a better manner
Introduce clinical assistant hereby processing information in a better manner
Introduce clinical assistant
Introduce a better folder that can be used to inform patients
Let patients make their own appointments
Execute pentacam on indication of the IOL measurement
Execute pentacam on indication of the patients wish to get a premium lens
Learn TOA's to execute optometrists measurements
Explain the procedure beforehand
Learn TOA's to execute optometrists measurements
Make sure to change the responsible doctor after the operation.
Let patients make their own appointments
Adding additional login columns
All equipment in one chamber
Take out the anaesthetist and let the holding-nurse perform the anaesthetic
Control visits are prepared by the optometrist instead of the doctor. Educate the optometrist for doing the control visits.
Educate optometrist, toa's and doctor assistants to do pre-measurements
Execute pentacam on indication of the IOL measurement
Add and additional AR-scanner and computer during cataract centre. Because refraction uses the AR-scanner this is more efficient
Take a picture of the eye during consultation for the doctor who does the operation
Provide cheaper lenses for premium patients
Introduce clinical assistant

Idea
Control visits are prepared by the optometrist instead of the doctor. Educate the optometrist for doing the control visits.
In the schedule and capacity one must account for the tasks different employees have. This means that different patient needs extra additional information on the measurements.
Distinct between complex and non-complex patients.
Let meetings be executed plenary.
Information folders can be provided by other companies
Inform patients on the process
Provide the process with additional employees
Patients get their operation dates immediately after the consult. Also, if they cannot be planned after consult patients can plan their operation dates via internet
Patients have to provide their medical information via a standard format
Supervision is present during the cataract centre, all the time
Teach TOA's the measurements of optometrist
Make sure to get patients to the right waiting room
Make sure to change the responsible doctor after the operation.
Not every supervisor seems to know the right information about torisch lenses. Outsource to a third party
Let patients be seen by the exact same doctor all the time
Let patients decide on the question if they want a premium lens or not
Let patients check their condition post-operational
If information is already in the system don't repeat the measurements
Let patients go directly to level 2
Prepare consults before the actual arrival of the patient in which case the measurements that need to be done can be decided upon.
When measurements are done in earlier stages this does not have to be done during cataract consult.

Table 13: Full list of redesign ideas

8.7. Appendix VII; Voting results

Idea							Average
Provide patients with real-time information with regard to the procedures and pre consults.	2 + 2 + 2 + 3	6	6	6	5		5,75
When measurements are done in earlier stages this does not have to be done during cataract consult.	2 + 3	6	5				5,5
Educate optometrist, toa's and doctor assistants to do pre-measurements	3 + 5 + 1 + 3 + 1	5	3	7	5	7	5,4
Introduce clinical assistant	1 + 6 + 1	7	2	7			5,33
Adding additional login columns	3 + 1 + 5 + 6	5	7	3			5
Let meetings be executed plenary.	4 + 3 + 4 + 3	4	5	4	5		4,5
Make sure to change the responsible doctor after the operation.	4	4					4
Control visits are prepared by the optometrist instead of the doctor. Educate the optometrist for doing the control visits.	4	4					4
Provide cheaper lenses for premium patients	4	4					4
Distinct between complex and non-complex patients.	4	4					4
Execute pentacam on indication of the IOL measurement	6 + 2 + 6 + 7 + 1	2	6	2	1	7	3,6
Distinct between premium and non-premium patients.	7 + 2 + 5	1	6	3			3,33
Inform patients on the process	5	3					3
Take a picture of the eye during consultation for the doctor who does the operation	5	3					3
Prepare consults before the actual arrival of the patient in which case the measurements that need to be done can be decided upon.	7 + 5	1	3				2
Add and additional AR-scanner and computer during cataract centre. Because refraction uses the AR-scanner this is more efficient	5	2					2
Supervision is present during the cataract centre, all the time	6 + 7	2	1				1,5
Let complex patient be consulted by staff member	1	1					1
Let patients make their own appointments	7	1					1

Table 14: Voting results

8.8. Appendix VIII; Redesign ideas including results

Idea	Decision (Nee 1 = Not willing) (Nee 2 = Not feasible)
Adding additional information on the website	Double
Post-operative consult by doctor only for complex patients	Double
All pre-measurements by one employee	Double
Execute glass-measurement and AR-measurement at the same time	Double
Add and additional AR-scanner and computer during cataract centre. Because refraction uses the AR-scanner this is more efficient	Double
Let complex patient be consulted by staff member	Double
Provide cheaper lenses for premium patients	Double
Adding additional login columns	Double
Provide patients with real-time information with regard to the procedures and pre-consult.	Double
Introduce clinical assistant hereby processing information in a better manner	Double
Introduce clinical assistant hereby processing information in a better manner	Double
Introduce clinical assistant	Double
Introduce a better folder that can be used to inform patients	Double
Let patients make their own appointments	Double
Execute pentacam on indication of the IOL measurement	Double
Execute pentacam on indication of the patients wish to get a premium lens	Double
Learn TOA's to execute optometrists measurements	Double
Explain the procedure beforehand	Double
Learn TOA's to execute optometrists measurements	Double
Make sure to change the responsible doctor after the operation.	Double
Let patients make their own appointments	Yes
Adding additional login columns	Yes
All equipment in one chamber	Yes
Take out the anaesthetist and let the holding-nurse perform the anaesthetic	Yes
Control visits are prepared by the optometrist instead of the doctor. Educate the optometrist for doing the control visits.	Yes
Educate optometrist, toa's and doctor assistants to do pre-measurements	Yes
Execute pentacam on indication of the IOL measurement	Yes
Add and additional AR-scanner and computer during cataract centre. Because refraction uses the AR-scanner this is more efficient	Yes
Take a picture of the eye during consultation for the doctor who does the operation	Yes
Provide cheaper lenses for premium patients	Yes
Introduce clinical assistant	Yes

Idea	**Decision (Nee 1 = Not willing) (Nee 2 = Not feasible)**
Control visits are prepared by the optometrist instead of the doctor. Educate the optometrist for doing the control visits.	Yes
In the schedule and capacity one must account for the tasks different employees have. This means that different patient needs extra additional information on the measurements.	Yes
Distinct between complex and non-complex patients.	Yes
Let meetings be executed plenary.	Yes
Information folders can be provided by other companies	Yes
Inform patients on the process	Yes
Provide the process with additional employees	Yes
Patients get their operation dates immediately after the consult. Also, if they cannot be planned after consult patients can plan their operation dates via internet	Yes
Patients have to provide their medical information via a standard format	Yes
Supervision is present during the cataract centre, all the time	Yes
Teach TOA's the measurements of optometrist	Yes
Make sure to get patients to the right waiting room	Yes
Make sure to change the responsible doctor after the operation.	Yes
Not every supervisor seems to know the right information about torisch lenses. Outsource to a third party	Nee 1
Let patients be seen by the exact same doctor all the time	Nee 1
Let patients decide on the question if they want a premium lens or not	Nee 1
Let patients check their condition post-operational	Nee 2
If information is already in the system don't repeat the measurements	Nee 2
Let patients go directly to level 2	Nee 2
Prepare consults before the actual arrival of the patient in which case the measurements that need to be done can be decided upon.	Nee 2
When measurements are done in earlier stages this does not have to be done during cataract consult.	Nee 2

Table 15: Detailed decisions on redesign ideas

8.9. Appendix IX; Overview simulation methodology

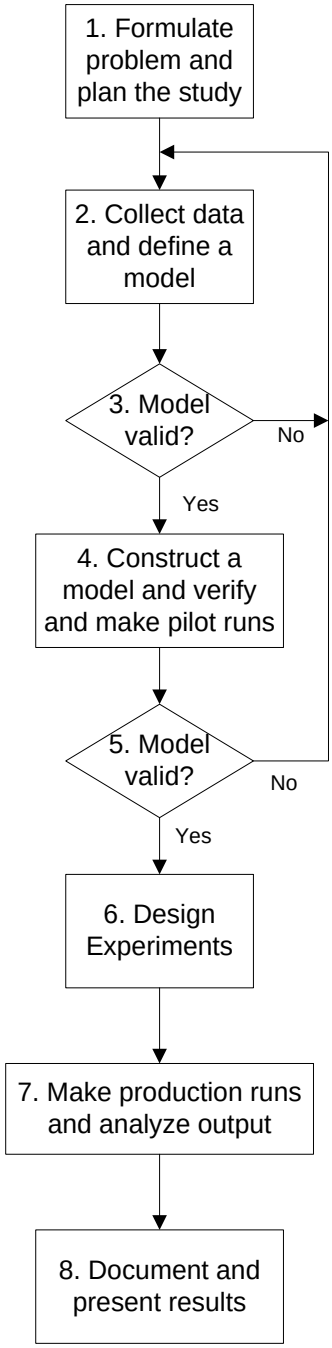

Figure 18: Simulation Methodology

Formulate the problem and plan the study

During the kick-off meeting with the MUMC+ process owners it became apparent that the process throughput time in the policlinic was too long, considering the process and waiting time of the patient. Additionally, the operational levels were considered as focus points during earlier projects in the MUMC and because of future plans it deserved further attention. Thus the overall objective for the simulation of the policlinic was considered as:

"To improve the throughput time of a general patient during a policlinic/operational visit"

For this objective a performance measure was chosen to account for the changes that were inevitable when applying changes to a simulation model. Moreover, this performance measure will be used to validate the model with the process it was built by. The throughput time of a general patient will be taken as the performance measure. In the policlinic there is an explicit difference between morning patient (post-operative patients) and patients who arrive after noon (pre-operative patients) that is why there will be two separate throughput times

"The throughput time is the time from which the patient enters the department till the time the patient leaves the department."

The scope of the model is not to only focus on those aspects that are most important for the project; cataract patients involved in the policlinic and the operational process. Besides that, the process is set to only focus on processes that involve the patient and processes set in the hospital. For example, the planning of new appointments is not taken into account for the utilization of the resources.

During this first meeting the discussion shifted towards the simulation program that will be used during the evaluation of the redesign method. As the author himself did earlier research with Flexsim HC that program had the preference. One of the aspects that were deemed most important, by the MUMC+ supervisors, was the fact that the simulation software should provide 3-D simulation. The program Flexsim HC has been developed by system programmers and health care practitioners for health care processes, and provides 3-D simulation, which is why Flexsim HC is chosen. Furthermore, Flexsim HC has the option to include not only patient processes but also laboratory work etc. With other projects done with Flexsim HC at TU/e and the additional options of the software, it became clear that Flexsim HC was the right choice.

The period over which this project was done is from the first of February till the first of august, at which moment the results will be presented.

Collect data and define a model of current process

For the two parts of the project there will be an assumptions document made. In this document different aspects from the reality have been described. This document will contain information as described in the methodology. As this document is only relevant for the creation of the simulation model the information from this document is only give in the Appendix. For the two parts, policlinic and the operation level, different assumptions documents will be made. In Appendix X the assumptions documents for respectively the polyclinic and the operational levels are given.

Construct a computer program, verify and validate the model

- **Policlinic**

Construction

The construction of the model started by adding the system layout and looks of the model, i.e. making it look like the real world. In this manner the MUMC+ gets the feeling that the simulation model starts living. In Appendix X, in Figure 20 the simulation model is depicted. In this model one can see the entrance, desk and other rooms where examination take place. After the layout has been created the next step is created the activities and paths the patients take. This is done inside of Flexsim HC and considers many steps that will not be explained here as they are too technical. After looking at small activities, larger and larger activities are added. When all paths of the patient are added there are a total of 12 paths.

Cataract centre Pre-Operative	Cataract centre Post-Operative	Cataract centre PTM
Cataract centre 1 Pre-Operative	Cataract centre 1 Post-Operative	Cataract centre 1 PTM
Cataract centre 2 Pre-Operative	Cataract centre 2 Post-Operative	Cataract centre 2 PTM
Cataract centre 3 Pre-Operative	Cataract centre 3 Post-Operative	Cataract centre 3 PTM

Table 16: Different patient paths

Verification

The manner in which the techniques are used is discussed in the following enumeration.

Technique 1. The simulation model was built in several different modules. First, testing al pre-operative patient, after that the post-operative patients and after that the Premium/Toric/Multifocal patients.

Technique 2. During the creation of the simulation several SME's were involved to ensure the process was implemented in the correct manner. Furthermore, colleague student Marvin Jacobs was asked for his opinion as he is focusing his research on the same process, it may be assumed that he has sufficient knowledge of the process.

Technique 3. Different process times were adapted in the simulation model. As the technique suggests this should result in assumable scenarios. That is what happened, when adapting a process time the throughput time became longer/shorter depending on what was done with the process time.

Technique 4. In the simulation model many time stamps are recorded, these stamps record time at which activities are finished. Via this way an event log is created in which the patient track is successfully defined. Using the table shown in Appendix X (Table 24) an event log is created which is the same as the process model of the patient themselves.

Technique 5. As the model itself can be analysed a simplified version is not needed. The simulation model is compared with the real model, at which the throughput time is already known.

Technique 6. The program Flexsim HC makes use of 3-d simulation and advanced animations. During the running of simulation one could see different patient run through the model and different doctors seeing patients. The simulation model is checked and all animations seem to run correct. A Figure of the simulation model can be seen in Appendix X.

Technique 7. In this Appendix the different process times are given, these times are generated over 42 different runs. The table in Appendix X (Table 22 & 23) presents the comparison between the real situation and the simulation model. The difference seems to be minimal and thus gives enough confidence for continuing with the simulation model. However, the waiting times seems to depict an increased difference, this explains the difference in throughput time which is depicted in Table 17.

Technique 8. This last technique focuses on the type of simulation program used. As the Flexsim Simulation Software is a renowned company focusing on simulation it seems assumable that the products they produce are of high standard and quality. That gives enough confidence to assume no subtle errors in Flexsim HC.

Validation

The first step in the validation is comparing the simulation model with the performance measure from the actual existing system. During the measurement days the general throughput time of the morning and afternoon are taken for all patients. Doing so, the performance measure can be compared with the outcomes of the simulation model.

	Simulation	Real Model	Difference	Acceptable
Morning Average	0:54:28	1:03:00	0:08:32	√
Afternoon Average	1:53:31	1:48:44	0:04:47	√

Table 17: Comparison throughput time Polyclinic

The term acceptable is defined by the author, the TU/e supervisors and the SME's from the MUMC+. Together this group discussed the difference between real model and the simulation and saw a small difference. However, it seems that even the averages did not concern the SME's as they perceived the averages as acceptable. Furthermore, by including the SME an overall sound decision has been taken into the validation of the simulation model.

There are in total 4 process times that should be accounted for in a sensitivity analysis, which are the process times for the AR, IOL and Pentacam measurement. Also first and second consult have been included in the sensitivity analysis. During technique 3, of the verification, a small analysis on the impact of changing the process times was done. By this way a sensitivity analysis was already done. All process times have a significant impact on the throughput time, i.e. the performance measure, of the model. Furthermore, the consults with the patient have the highest impact on the process, as these are the highest processing times in the model. That is because all patients have to go through the consult changing that time has a high influence.

- **Operation Level**

Construction

As with the model of the polyclinic model the construction of the OK complex started with the addition of the system layout and the looks of the model. In this manner the physical world is

recreated in the simulation model. In Appendix X the simulation model as it is at the moment is depicted. There is a general overview given in Figure 22 and in Figure 23, which depict the day centre. After the layout has been created different patient tracks will be added. As these tracks are less complicated as the ones used in the model of the polyclinic, only 1 different track for the patients is created. The creation of the patient tracks is done in Flexsim HC and considers many steps that are too technical to be explained. The creation will begin with the smaller tasks and continues creating larger activities. With the path of the patient created the verification of the model can start.

Verification

The application of these techniques is described in the following enumeration.

Technique 1. The model is constructed in 3 sub-sections. First, the day centre was created in which different structures such as a waiting room, operation chairs and operating nurses were added. Second, the operating rooms were created. This level also includes de holding in which the patients are prepared. After these 2 sub-sections were created they were integrated into a whole that could be used for the simulation.

Technique 2. The creation of the simulation included several SME's, which could help to ensure the process, of the patient, was implemented in the correct manner. Furthermore, Marvin Jacobs (colleague student) was asked for his opinion, as he is focusing his research on the same process it seems assumable he has profound knowledge on the subject.

Technique 3. During the verification of the OR-model different process times were adapted in the simulation model. The technique suggests that the changes in the simulation model should result in assumable scenarios. As was with the previous model, here adapting different process times results in shorter/longer throughput times depending on what was done with the process time.

Technique 4. During the simulation many times were recorded, these stamps record time at which activities are started and/or finished. In Appendix X an event log is depicted in which the process can be seen with which the patient is treated. This trace follows the process in full detail.

Technique 5. This technique suggests that the model should be run at simplified assumptions. However, this model can be simplified anymore. The process is rather straightforward and the process does not contain many choices. The simulation model can easily be compared with the real world situation.

Technique 6. Flexsim HC makes use of advanced animations. During the creation of the model much time was spent in correctly representing real world aspects. In the model there are not any indications that a bug still remains in the simulation model. Several other animations were checked and neither of them contained faults.

Technique 7. In Appendix X different process times are given. These are generated over 42 different runs of the OR model. The tables in Appendix X (Table 24 and 25) represent the comparisons of the process times and waiting times of the OR model. Between the process times there seems to be not difference at all. However, when looking at Table 27 there is a huge difference in the time that the patients need to wait before being operated, and at which time they have to wait in the holding. As this point the patients are much sooner in the holding than in the real model.

Technique 8. This last technique focuses on the type of simulation program used. As the Flexsim Simulation Software is a renowned company focusing on simulation it seems assumable that

the products they produce are of high standard and quality. That gives enough confidence to assume no subtle errors in Flexsim HC.

Validation

The first step in the validation is comparing the simulation model with the performance measure from the actual existing system. During the measurement days the general throughput time of the morning and afternoon are taken for all patients. Doing so, the performance measure can be compared with the outcomes of the simulation model.

	Real Life	Simulation Model	Difference	Acceptable
Average Throughput Time	1:52:00	1:57:00	0:05:00	√

Table 18: Comparison throughput time OR

The term acceptable was earlier defined in the thesis as the opinion and agreement between author, the TU/e supervisors and the SME's from the MUMC+. The group discussed the difference between the real model and the created simulation model and saw the 5 minutes as a small difference. All parties were in agreement that the difference was acceptable.

In total there are 6 process times that should be accounted for in the sensitivity analysis that are the process times for the Preparation of the Patient, Adding Eye Drops, Prep the patient in holding, Administer anaesthesia, Prep the patient and operating on the patient. For all process times the influence was checked during technique 3, of the verification. The highest influence can be seen in the operating time on the patient. As that is the highest one it has the highest influence on the total throughput time of the patient.

Design experiments

The design of experiments is represented by the application of the redesign method. The following redesign scenarios have been chosen to be implemented in the redesign scenarios. This choice has been discussed with MUMC+ supervisors to ensure the result is satisfactory for both this research and the MUMC+. These redesigns have a direct influence on the process, which was given in paragraph 4.1.3, more information is described in that paragraph.

- In the policlinic it was decided that the pentacam measurement could be left out if the IOL-master registered a specific value. Where in previous cases the IOL-master and the pentacam should be performed, in this case only a small percentage of the patients need a pentacam measurement. In the simulation model 4 different scenarios were simulated.
    - 25% of the patients not having a pentacam.
    - 50% of the patients not having a pentacam.
    - 75% of the patients not having a pentacam.
    - 100% of the patients not having a pentacam.
- During the process of the operation of the patient there is the part where the patient is anesthetized. This can be done in two ways, there is the operational procedure where the anaesthetist does the procedure. The second way considers the anaesthetist only drops some liquid in the eye before the operation. However, this second step can be done by the holding nurse, thus removing the anaesthetist and the activity he/she does. In this model there are also 4 different scenarios that were simulated.
    - 25% of the patients having drop-anaesthesia.
    - 50% of the patients having drop-anaesthesia.

- 75% of the patients having drop-anaesthesia.
- 100% of the patients having drop-anaesthesia.

This means that there will be 4 separate results depicting the actual influence these decisions have on the system. The run- and warm up length are defined by the original models. As both systems are finite, i.e. systems that run only one day, it can be considered that no specific run –and warm up length needs to be defined.

8.10. Appendix X; Assumptions documents

Assumptions document polyclinic

For this assumptions document, the Appendix is divided into different sections. First, the system layout will be given. This will be the building platform for other information that must be included. After the system layout has been discussed the second part consists of a description of the procedure with which the resources work. The last information that is added is detailed information about the system or the manner in which they are defined.

System layout

In Figure 19 the layout of level 2, in the ophthalmology tower, is depicted. This Figure is also used as a layout in Flexsim HC as a building block for the simulation. Included with this system layout the process layout will be gathered from Martens (2012) a research focussed on defining the process of the cataract patient. Combining both these information sources creates a well-covered system layout. At last, different sections have been defined inside the system where important parts of the process will take place. The following four have been defined:

1. The entrance
2. Pre-consult research chamber
3. Second research chamber
4. Consult rooms for doctors
5. Waiting room

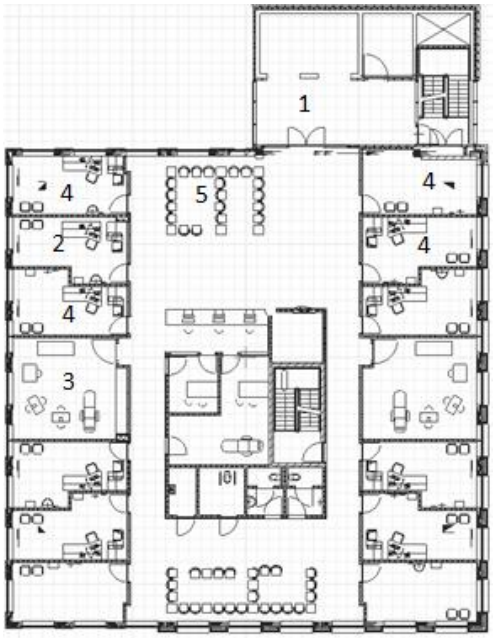

Figure 19: Plan of level 2, cataract centre

Operating procedures

Using information obtained from earlier research (Martens, 2012) the operating procedures during a policlinic visit were defined. However, as Law en Kelton (2000) mentioned one single source of information is never enough. That is why several measurement days have been planned at which the author and several others measured certain process times. During these days better insights in the operating procedures have been established. Moreover, by asking doctors, assistants and others about their way of working increases the validity that a sound operating procedure is present for in cooperation into the simulation model.

Model parameters

The model parameters were established using the measurement days mentioned in the previous paragraph. During these days parameters such as process times, resources and others were defined. An example of a measurement document used on such a day is presented in table 21.

Bekende gegevens							
Time:	Patient Name	Birth Name	Date Of Birth	Patient Number	Sex	Doctor:	Planningstype:
8:20	Patient A		2-8-1952	51053561	V	STAARCENTRUM	PRE-OP
08:30	Patient B		3-8-1952	01199796	V	STAARCENTRUM 1	PRE-OP
08:30	Patient C		4-8-1952	01475976	M	STAARCENTRUM 3	EC
08:40	Patient D		5-8-1952	81049207	M	STAARCENTRUM 3	EC
08:50	Patient E		6-8-1952	61158664	V	STAARCENTRUM	EC
08:50	Patient F		7-8-1952	21026484	V	STAARCENTRUM 2	EC
09:00	Patient G		8-8-1952	81753804	M	STAARCENTRUM 1	EC
09:00	Patient H		9-8-1952	71163101	V	STAARCENTRUM 2	EC
09:00	Patient I		10-8-1952	71264796	V	STAARCENTRUM 3	EC
09:10	Patient J		11-8-1952	91049768	M	STAARCENTRUM	EC
09:10	Patient K		12-8-1952	01249058	M	STAARCENTRUM 2	EC

Table 19: Measurement scheme Polyclinic processes

Input probability

Law and Kelton provided information on obtaining input probabilities from data with which it is not certain with distribution it follows. This program was used to confirm or asses the distribution of the process times. Moreover, using the data obtained during the measurement days the routing fractions for different tracks have been defined. For example for,

1. Which room the patient enters, which is defined in table 21. As the doctors are assigned to a specific room that gives the room the patient enters as the consult will take place. With the previous locations defined by using information obtained during the measurement days an overall complete picture is compiled.
2. The type of lens the patient had implanted. In the section *"planningstype"* 4 types of patients can be seen. Pre-operative controls, End-Controls, Weekly-Controls and Premium/Multifocal patients. With pre-operative patient, it is not yet known what type of patient it is. End-controls and weekly-controls are patients with normal types of lenses implanted. The premium/multifocal patients have special lenses implanted.
3. The doctor the patient is seen by, this is defined in the column doctor. As can be seen there are a total of 4 doctors present in polyclinic. Besides those 4 doctors one supervisor is present and 2 eye-measurement specialists.
4. The explicit different routing each patient takes. This is checked via the event trace of the polyclinic, which is shown in this Appendix.
5. The planning-time is defined in the first column, as there was a misunderstanding between the measurement personnel and the doctors about that time. That is the measurement personnel knows that the patient enters the system at that time however the doctors think that the planning time is the time they need to be at the doctor.

All this information is used to define routing fractions and process times. However, this information will not be mentioned as this is only used in the actual design en creation of the simulation model. In the paragraph 5.3.3 the validation and verification will be further discussed.

Figure 20: Simulation Model Policlinic

	Real Life	Simulation Model	Difference
AR-Meter	0:04:00	0:04:31	0:00:31
IOL-Master	0:05:54	0:05:54	0:00:00
Pentacam	0:05:31	0:06:06	0:00:35
Doctors Consult	0:12:33	0:13:52	0:01:19

Table 20: Comparison Polyclinic Process times

	Real Life	Simulation Model	Difference
Wait For Fr	0:14:07	0:10:09	0:03:58
Wait For SR	0:09:42	0:00:55	0:08:47
Wait For Consult	0:23:32	0:15:11	0:08:21
Wait For Consult 2	0:11:58	0:10:28	0:01:30

Table 21: Comparison Polyclinic Waiting Times

	EntryTime	EnterWait	StartFR	FinishFR	EnterWait	StartSR	FinishSR	StartSR2	FinishSR2	EnterWait	StartConsult	FinishConsult	EnterWait	StartConsult2	FinishConsult2	Exit
PreOp_Consult_Staar0_ID1	41,62	43,28	45,77	54,48	55,05	55,05	60,51	60,62	67,62	68,26	68,98	95,68	96,18	111,91	130,72	131,74
PO_Consult_Staar3_ID2	56,51	58,17	59,16	62,07	62,64	0	0	0	0	0	63,36	67,13	0	0	0	67,71
PO_Consult_Staar2_ID3	68,04	69,7	70,69	75,36	75,93	0	0	0	0	0	76,67	82,13	0	0	0	82,85
PreOp_Consult_Staar1_ID4	75,18	76,84	77,83	86,85	87,42	87,42	91,97	92,08	97,92	98,57	99,42	123,56	0	0	0	124,48
PO_Consult_Staar3_ID5	77,98	79,63	80,76	84,74	85,36	0	0	0	0	0	86,12	92,03	0	0	0	92,62
PO_Consult_Staar2_ID26	167,77	169,42	170,51	173,11	173,72	0	0	0	0	0	185,5	189,19	189,76	224,4	225,66	226,37
PreOp_Consult_Staar2_ID88	508,63	510,28	566,41	575,33	575,93	575,93	585,02	585,11	589,59	590,22	605,76	616,12	616,69	658,97	676,65	677,7
PreOp_Consult_Staar3_ID89	510,23	511,89	576,51	584,66	585,26	585,26	594,32	600,25	606,76	607,43	608,28	644,34	0	0	0	645,34
PreOp_Consult_Staar1_ID90	517,72	519,38	585,87	592,25	592,86	592,86	600,22	600,35	613,88	614,56	620,45	630,14	630,74	646,57	666,29	667,21
PreOp_Consult_Staar2_ID91	520,79	522,44	593,43	599,47	600,07	607,44	612,58	613,92	621,41	622,06	645,9	658,07	0	0	0	659,12
Eventline	**1**	**2**	**3**		**4**	**5**				**6**	**7**		**8**	**9**		**10**

Table 22: Event-log polyclinic

Assumptions document operational level

For this assumptions document, the Appendix is divided into different sections. First, the system layout will be given. This will be the building platform for other information that must be included. After the system layout has been discussed the second part consists of a description of the procedure with which the resources work. The last information that is added is detailed information about the system or the manner in which they are defined.

System layout

Figure 21 depicts the layout of both level 3 and 4 of the ophthalmology tower. These figures are used in the simulation program as a building block for the simulation itself. When including a process layout gathered from Martens (2012) a first attempted can be made for the simulation program. By combining both these information sources creates a sound representation of the system layout. Different sections have been defined inside the layouts depicting important parts of the process that will take place.

1. Entrance on level 3, the day centre
2. Areas in which patients can wait for their operations
3. The four operating rooms available for the ophthalmology department on level 4.
4. Entrance on level 4, surgery level.

Figure 21: Layout Level 3 + 4 of the ophthalmology tower

Operating procedures

In 2012 a researcher already defined all steps involved with operating a cataract patient. Nevertheless, second sources of information are addresses as one single source is never enough (Law and Kelton 2000). During several measurement days, the author and several other researchers measured the process times, routing fractions and other aspects of the process. Furthermore, the resources assigned to the operational process were asked about their way of working and the standard protocols during their work. Combining all these sources an overall sound process is defined, including all procedures etcetera.

Model parameters

The model parameters were established using the measurement days mentioned in the previous paragraph. During these days parameters such as process times, resources and others were defined. An example of a measurement document used on such a day is presented in Table 23.

Kloklijst

Process Part:	Day Center
Measured by:	A. of B
Date:	woensdag 22 mei 2013

Bekende gegevens						Times to measure										
						Entry Time	Prepare Patient		Add Eye Drops		Patient in OR chair		Reentry Time	Patient out OR chair		Exit
Time:	Patient Name:	Date of Birth:	Patient No:	Sex:	Operator:		Start	Finish	Start	Finish	Start	Finish		Start	Finish	
7:45	Patient A	1-1-1952	66666666	V	Doctor A											
8:00	Patient B	2-1-1952	66666666	M	Doctor A											
8:25	Patient C	3-1-1952	66666666	V	Doctor A											
8:50	Patient D	4-1-1952	66666666	M	Doctor A											
9:15	Patient E	5-1-1952	66666666	M	Doctor A											
9:40	Patient F	6-1-1952	66666666	M	Doctor A											
10:10	Patient G	7-1-1952	66666666	M	Doctor A											
10:35	Patient H	8-1-1952	66666666	V	Doctor A											
7:45	Patient I	9-1-1952	66666666	M	Doctor B											
10:00	Patient J	10-1-1952	66666666	M	Doctor B											

Table 23: Measurement scheme Operational Processes

Input probability

The same method as in paragraph 9.10.4 is used to assess the process times as a distribution for the simulation model (Law and Kelton, 2000). The process times will not be given here as they are only intended to use in the simulation model itself. Furthermore, through the measuring of the process certain routing fractions have been discovered. For example,

1. Add Eye Drops. The patient will drop certain liquids in his eye as a preparation for the surgery. When the patient arrives at the hospital the day centre personal checks the dilatation of the eyes of the patients. If the dilatation is not enough the patient will need more drops of liquids in his/her eyes.
2. Further in the process there are no points at which the process differs for patient. All patients will get exactly the same treatment. The only aspect that could change for all patient is the OR room in which they are operated. It is only sometimes that there are 2 operating rooms used at the same time for cataract patients.
3. Again the planned time a patient enters the system is defined in the first column of table 25. As was in the previous paragraph the arrival time is differently assumed by different resources.

This information is used to define the routes the patients may take and the process times that go with that route.

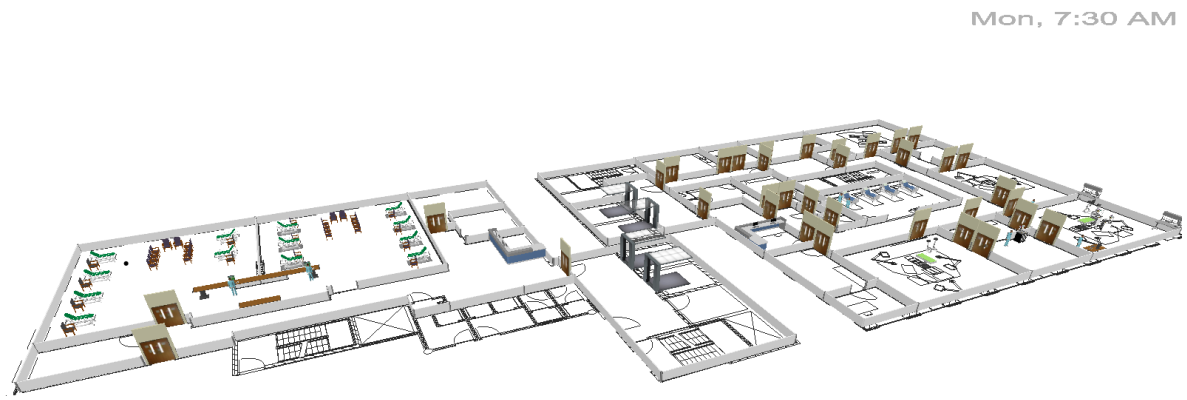

Figure 22: General overview OK-Levels

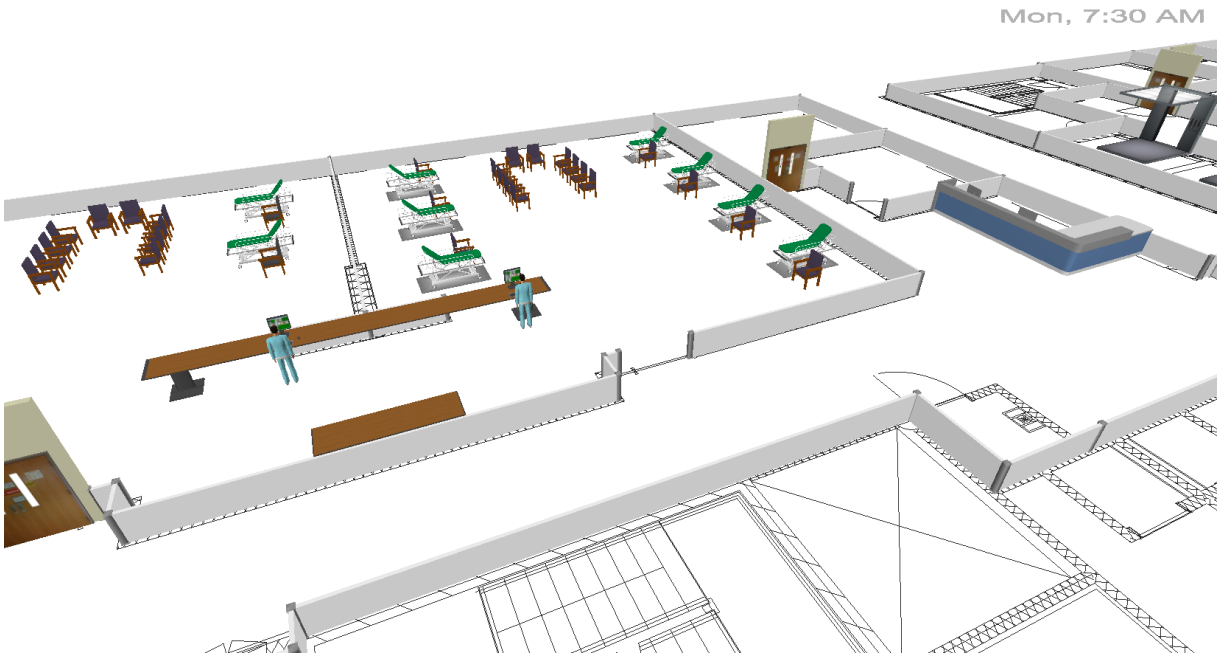

Figure 23: Day Centre OK-Levels

	Real Model	Simulation Model	Difference
Check SL	0:07:00	0:07:09	0:00:09
Check Eye	0:03:00	0:00:55	0:02:05
Check Prep	0:02:49	0:02:49	0:00:00
Check An	0:07:17	0:07:39	0:00:22
Check OP	0:26:17	0:23:07	0:03:10
Check Clean	0:04:00	0:03:57	0:00:03

Table 24: Comparison OK process times

	Real Life	Simulation Model	Difference
Wait For Prep	0:02:33	0:03:09	0:00:36
Wait For Holding	0:18:40	0:18:48	0:00:08
Wait For Op In Holding	0:10:13	0:33:19	0:23:06

Table 25: Comparison OK waiting times

	EntryTime	BeginSL	EndSL	BeginEye	EndEye	Dummy	BeginPrep	EndPrep	BeginAn	EndAn	BeginOP	EndOP	BeginClean	EndClean	ReturnDC	ExitTime
Operational_1_ID1	58,98	60,69	72,44	72,44	77,03	78,29	80,03	82,52	82,52	86,33	92,94	113,48	113,48	117,15	116,85	118,42
Operational_2_ID2	75,31	78,61	85,74	0	0	85,8	87,39	89,48	89,48	101,29	122,86	139,1	139,1	142,1	142,5	159,96
Operational_3_ID3	94,43	96,25	99,83	0	0	101,25	116,06	117,36	117,36	125,86	149,7	173,11	173,11	179,05	176,58	196,71
Operational_4_ID4	97,42	101,78	112,37	0	0	112,44	141,77	147,4	147,4	150,06	187,18	211,42	211,42	213,11	215,04	237,02
Operational_5_ID5	145,21	146,91	149,95	0	0	150,01	175,48	177,2	177,2	185,51	220,95	268,77	268,77	271,23	272,11	276
Operational_6_ID6	180,09	181,86	189,72	189,72	194,54	194,57	216,28	223,36	223,36	229,86	278,19	293,35	293,35	297,28	296,77	301,99
Operational_7_ID7	204,11	205,88	210,05	210,05	214,68	296,88	326,41	328,72	328,72	336,5	355,44	369,13	369,13	373,48	372,55	394,04
Operational_1_ID8	220,36	222,07	230,65	0	0	230,72	271,13	273,14	273,14	283,27	303,75	323,95	323,95	327,96	327,31	345,54
Operational_2_ID9	250,29	252,05	258,37	0	0	258,44	295,8	297,94	297,94	306,5	330,33	345,44	345,44	348,27	348,86	367,63

Table 26: Event-log for OK patients

8.11. Appendix XI; Question survey resources

Perceived ease of use

1. I found the procedure for applying the redesign method complex and difficult to follow.
    - Moody (1997) → *I found the procedure for applying the method complex and difficult to follow (PEOU1)*
    - Davis (1989) → *I would find CHART-MASTER easy to use*
2. Overall, if found it difficult to apply the redesign method.
    - Moody (1997) → Overall, I found the method difficult to use (PEOU2)
3. I found the redesign method easy to learn.
    - Moody (1997) → *I found the method easy to learn (PEOU3)*
    - Davis (1989) → Easy to learn (ease of learning) → *Learning to operate CHART-MASTER would be easy for me*
4. I found it difficult to apply the redesign method at this cataract process.
    - Moody (1997) → *I found it difficult to apply the method to the example data model (PEOU3)*
    - Davis (1989) → Flexible → *I would find CHART-MASTER to be flexible to interact with*
5. I found the rules of the redesign method clear and easy to understand.
    - Moody (1997) → *I found the rules of the method clear and easy to understand*
    - Davis (1989) → Clear and understandable → *My interaction with CHART-MASTER would be clear and understandable*
6. I am confident that I am now competent to apply this redesign method in other process redesign cases in practice.
    - Moody (1997) → *I am confident that I am now competent to apply this method in practice (PEOU6)*
    - Davis (1989) → Easy to become skilful → *It would be easy for me to become skilful at using CHART-MASTER.*

Perceived usefulness

7. I believe that the redesign method would reduce the time to find good redesign ideas.
    - Moody (1997) → *I believe that this method would reduce the effort required to document large data models (PU1)*
    - Davis (1989) → Work more quickly (quickly) → *Using CHART-MASTER in my job would enable me to accomplish tasks more quickly*
8. The redesign method would make it easier for to users to come up with good redesign ideas.
    - Moody (1997) → *This method would make it easier for users to verify whether data models are correct (PU4)*
    - Davis (1989) → Makes job easier (make it easier) → *Using CHART-MASTER would make it easier to do my job.*
9. Overall, I found the redesign method useful.
    - Moody (1997) → *Overall, I found the method to be useful (PU4)*
    - Davis (1989) → Useful → *I would find CHART-MASTER useful in my job*
10. Using the redesign method would increase the quality of my redesign ideas.
    - Moody (1997) → (*Using this method would make it more difficult to maintain large data models (PU5)*)

- Davis (1989) → Job performance → *Using CHART-MASTER would improve my job performance.*

11. Overall, I think this method does not provide an effective solution to come up with good redesign scenarios.
    - Moody (1997) → *Overall, I think this method does not provide an effective solution to the problem of representing large data models (PU6)*
    - Davis (1989) → Effectiveness → *Using CHART-MASTER would enhance my effectiveness on the job.*
12. I think this redesign method enables to generate more redesign ideas than without it.
    - Moody (1997) → (*Using this method would make it more difficult to maintain large data models (PU5))*
    - Davis (1989) → Increase productivity (productivity) → *Using CHART-MASTER in my job would increase my productivity*

Intention to Use

13. I would not use the redesign method to come up with redesign ideas for other process improvement cases in practice.
    - Moody (1997) → *I would definitely not use this method to document large Entity Relationship models (ITU1)*
14. I intend to use this redesign method in the future to come up with redesign ideas instead of using instinct or own experiences.
    - Moody (1997) → *I intend to use this method in preference to the standard Entity Relationship Model if I have to work with large data models in the future (ITU1)*

8.12. Appendix XII; Results open questions.

1	Describe in your own words the advantages and disadvantages (in terms of efficiency and effectiveness) for the usage of the 5-step plan for sessions.	**Advantage:** The first advantage of the 5-step plan is that the commitment of the different functions, and the democratic structure of the process, commitment creates for the implementation of the changes. **Disadvantage:** The 5-step plan does not guaranty a successful implementation of the redesign ideas.
2	Specify whether you like to use this 5-step plan in future process improvement projects and why?	It is a fine method for the creation of structure in the first phases of a redesign project and most certainly is useful for future projects.
3	Describe in your own words the advantages and disadvantages (in terms of efficiency and effectiveness) for the usage of the content related rules.	**Advantage:** The content related rules are a structured manner for the generation of redesign ideas. **Disadvantage:** However, the content related rules do not always lead to practical redesign ideas.
4	Specify whether you like to use these content related rules in future process improvement projects and why?	See answer 2, the question states the same.
5	Describe in your own words the advantages and disadvantages (in terms of efficiency and effectiveness) of the dimensions used for the content related rules?	**Advantage:** An effective manner in which processes can be simplified. **Disadvantage:** Because the different dimensions can be intertwined leading to an incorrect application for practical reasons.to reality, thus leading to inefficiency.
6	Specify whether you like to use these dimensions for future process improvement projects and why?	Dependent on the structure of the content related rules and enough intertwinement with reality the content related rules can be used in future process improvement processes.

1	Describe in your own words the advantages and disadvantages (in terms of efficiency and effectiveness) for the usage of the 5-step plan for sessions.	**Advantage:** In this manner all aspects of the process have had attention. **Disadvantage:** Difficult to understand the method really good.
2	Specify whether you like to use this 5-step plan in future process improvement projects and why?	MUMC+ works via the lean principle which leads to inconsistency between this method and the lean method.
3	Describe in your own words the advantages and disadvantages (in terms of efficiency and effectiveness) for the usage of the content related rules.	See point 1.
4	Specify whether you like to use these content related rules in future process improvement projects and why?	See point 2.
5	Describe in your own words the advantages and disadvantages (in terms of efficiency and effectiveness) of the dimensions used for the content related rules?	**Advantage:** An effective manner to present the content related rules. **Disadvantage:**
6	Specify whether you like to use these dimensions for future process improvement projects and why?	See point 2.

1	Describe in your own words the advantages and disadvantages (in terms of efficiency and effectiveness) for the usage of the 5-step plan for sessions.	**Advantage:** People who, usually don't discuss that well are inclined to intervene with the discussions. The creation of better and more better ideas in a wider spectrum is ensured. **Disadvantage:** The method takes relatively much preparation time.
2	Specify whether you like to use this 5-step plan in future process improvement projects and why?	The method works well in the bigger projects. At little projects the method is less applicable. The user friendly is influenced by the jargon and huge quantity of heuristics.
3	Describe in your own words the advantages and disadvantages (in terms of efficiency and effectiveness) for the usage of the content related rules.	See above.
4	Specify whether you like to use these content related rules in future process improvement projects and why?	See above.
5	Describe in your own words the advantages and disadvantages (in terms of efficiency and effectiveness) of the dimensions used for the content related rules?	**Advantage:** All aspects of the process are considered. **Disadvantage:** Many change heuristics consider the same process steps.
6	Specify whether you like to use these dimensions for future process improvement projects and why?	It is much to deal with, maybe a less detailed version can be used.