Enhancing Flexibility in Project Scope with the help of Value Engineering

Akash Singh
4904737

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Enhancing Flexibility in Project Scope with the help of Value Engineering

By

Akash Singh

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Author:

Name: Akash Singh
Student number: 4904737

Graduation Committee:

Committee Chair:	Prof. Dr. H.L.M Bakker, TU Delft
First supervisor:	Dr.Ir.A. Jalali Sohi, TU Delft
Second supervisor:	Dr.Ir. LSW Koops, TU Delft
Company Supervisor:	Mr.Ir. Anand Ramdien, RWS

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Preface

Hereby, I am pleased to present to you my graduation thesis, which marks the completion of my journey as a M.Sc. graduate student at Delft University of Technology in the track of Construction Management & Engineering. This Master's has further enhanced my passion and interest towards the field of construction and project management. The graduation research phase of my Master's especially paved the way towards my pursuit of thorough understanding of the working as well as the complexities associated in the field of construction management.

During my internship at RWS, I not only theoretically learnt about flexibility in a project's scope, but also had a chance to practically see its importance through the eyes of experienced practitioners. In addition, I also gained in-depth knowledge of the important tool of value engineering. I am truly thankful to all my mentors, subordinates and professors. I want to mention the few persons who went out of their way to support me.

The first person that I would like to thank is my company supervisor, Mr. Anand Ramdien for giving me this opportunity. I am very grateful to him for his constant support and faith that he had on me. The second person I want to thank is Dr. Jalali Sohi, for giving me the opportunity to work on his creation. Dr. Jalali Sohi has always inspired me and will continue to do so. I am grateful for his clear and constructive feedback along with his expertise in the field. In addition, I want to thank my second supervisor, Dr. Koops for always being so kind and understanding. In addition, I want to thank Prof. Dr. H.L.M Bakker for taking out the time to serve as the chair of my committee.

Furthermore, I want to acknowledge all the interviewees and respondents of my research surveys for their time and effort. I would not be able to do this without them. I am also very grateful to work with all the wonderful employees at RWS for taking out the time to meet with me online and help me brainstorm my findings. I also want to thank all my subordinates. I especially want to mention Sankeerth, he was also doing an internship for his M.Sc. thesis and whenever I would interact with him, we would have very productive discussions.

Lastly, on a more personal note, I would like to thank my family, who have supported me throughout my years of education, both morally and financially. I am glad to have the unconditional love and support of my four younger sisters. A big thank you to my friends, Hansika and Anurag for their encouragement, patience and constant care.

I hope you enjoy reading this thesis as much as I enjoyed writing it.

Akash Singh
4904737

Executive summary

Project management is predominately used by the organization to accomplish their goals and deliver their projects successfully. The dynamic nature of a project's life cycle, along with the complexities associated with it, call for an increase in the flexibility of the possible project management approaches. Flexibility is the ability to adjust and adapt to situations in an unrestrictive and moldable manner. Looking at the ever-changing nature of the project, it is important to move away from the traditional project management process towards a more integrated and collaborative approach.

A project consists of many stakeholders who are influenced by the implementation of the scope of the project. The stakeholders tend to have their own expectations and interests from a project, however, many times it is not practically possible to execute the requirements and ideas of each of the stakeholders. There should be a fine balance to address the issues of stakeholders without compromising the project scope. As this part for maneuvering is tightly framed, this tends to be a problem, especially in complex and longer duration projects. Thus, the scope of a project should be flexible enough to have the ability to adjust and adapt to any feasible alternative solutions. However, it is difficult to add the developments as space in scope is no longer available. The rigid implementation procedure for the development of scope does not leave much room for changes in the project scope. This leads to our problem statement:

"The project scope at the front-end phase of the project is tightly framed which limits the adjustment or implementation of change in the project scope"

The research aims towards enhancing the flexibility in project scope. The starting point of studied research was the enablers for flexible scope from the research of Jalai Sohi (2018). The research began with identifying 13 enablers along with the strategies for enhancing flexibility in project scope. During the literature review, it was observed that many authors have emphasized on the need for implementation of soft factors in a project to enhance flexibility in project scope. It was observed that six out of the 13 enablers and strategies were focused on the soft skills of stakeholders. The enabler and strategies focusing on the soft factors include trust, involvement of the stakeholder, communication, collaboration, commitment and managerial review. Observing the importance of soft skills among the stakeholder, a third enabler was developed that was "interaction among the stakeholders". Out of 13 enablers, 3 enablers were chosen for further investigation that were: broad task definition, embrace change and interaction among the stakeholders. The aim was to investigate the implementation the ether enablers for enhancing flexibility in project scope. The barriers for implementation of the enablers were identified from the literature. The barriers were categorized in four categories costing of 'Limited awareness', 'Stakeholder driven barriers', 'Organizational behavior' & 'Contractual barriers' which led to the development of the framework from literature.

The second aspect of the research was Value Engineering (VE). VE is a creative, organized effort, which analyzes the requirements of a project for the purpose of achieving the essential functions at the lowest life cycle cost. During the literature study, six steps involved in VE were thoroughly studied and it was observed during the literature review that VE is just not limited to a cost cutting techniques. VE aims towards enhancing the value of the project. It was further observed that many authors have discussed the importance and benefits of performing VE in different industries but still there is lack of significant evidences showing the potential benefits of performing VE in a construction project. Therefore, a list of potential benefits of performing VE in a construction project was formulated based on the literature. In total 21 benefits were identified.

To check the reliability of our data gathered during the literature review, a survey was conducted with 25 practitioners of the industry for ranking the benefits and the barriers identified from the literature. The

responses were analyzed to evaluate the Relative importance index (RII) score. Overall, each benefit had a RII score more than 0.6 which reflects that the benefits were recognized and experienced by most of the respondents.

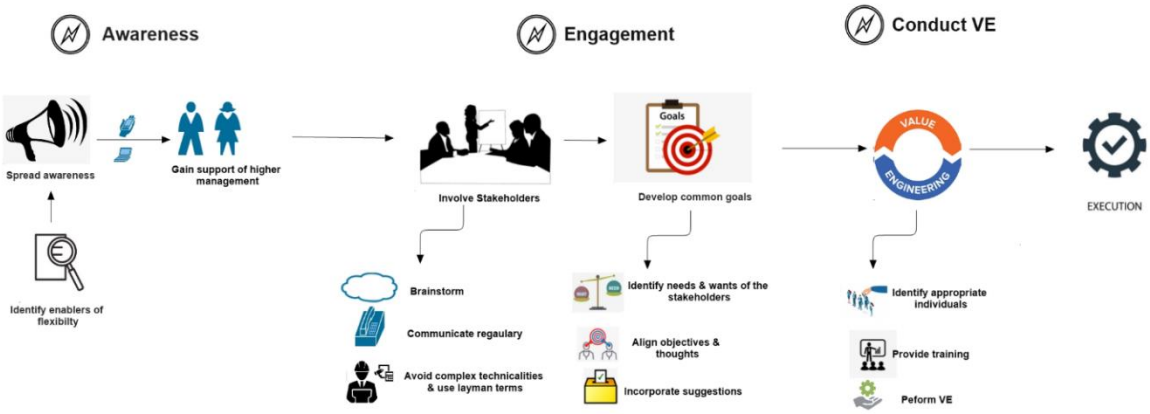
The next phase of the research was the case analysis. Two cases were investigated in total. In the first case, the client was not aware about the enablers initially. The scope was developed with limited involvement of the stakeholders. Once the original scope was developed, the stakeholders did not accept the scope. There was a need for redefining the scope together with the stakeholders. That is the time VE was introduced in the project. As opposed to the first case, the second case took a proactive approach as VE was performed at the beginning of the project. The project manager was already aware about the importance of enablers and the methodologies for implementing the enablers because of past experiences in the projects. The scope was developed with the consensus of the stakeholders from the beginning of the project. During the detail analysis of the two cases, the most common barrier that was observed in the cases was 'lack of trust'.

As mentioned earlier, VE was introduced in the two cases in different situation and therefore some interesting facts during the cross-case analysis were observed. The total number of barriers experienced by the practitioners in the first case until the VE was performed was 13. On the other hand, the total number of barriers experienced by the practitioners in the second case where VE was performed from the beginning experienced 4 barriers in total. There can be a possibility that VE might helped to resolve some of the barriers experienced by the practitioners in the case where VE was introduced in the project as a proactive approach. Overall, it was observed that VE played a supporting role in enhancing the flexibility of project scope. As only two cases were investigated and therefore, the results may differ by investigating more cases.

From the case analysis, the root causes for most of the barriers was observed to be lack of awareness about the enablers and the methodologies for implementing the enablers. In addition, there was lack of engagement of the stakeholders during the development of the scope. Furthermore, in both the projects, VE played a supporting role for implementing all the three enablers.

In the next, suggestions were formulated based on the case analysis and the literature for resolving the barriers. In addition, a framework was developed based on the observations of the case analysis which reflects the step by step implementation of the suggestions for resolving the barriers. The suggestive framework was the combination of ''spreading awareness about the enablers', 'engagement of the stakeholders' and 'conduct VE' for resolve the barriers. An expert analysis was performed to understand the applicability of the suggestions formulated for resolving the barriers. Following this, the conclusion was made based on the results and recommendations were suggested.

Framework to enhance flexibility in the project scope.



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1. INTRODUCTION

The changing needs and the dynamic nature of the construction projects demands the incorporation of flexible approaches. Flexible project management approaches have been successfully implemented in the software, production, and manufacturing industry. Hence, it is an opportunity for the construction industry to facilitate flexible practice in the projects. Incorporating flexibility in the project scope is core of this research.

This chapter will provide an introduction to the research topic and the problem statement in the scientific world as well as in the practice. The research objective and questions will be formulated accordingly. The research design will be discussed in detail.

1.1. Research context

Project management is predominately used by the organization to accomplish their goals and deliver their projects successfully (Grant & Pennypacker, 2006). According to PMI (2016), project is unique as it is not a routine operation, but a specific set of operations designed to accomplish a specific goal.

The traditional project management process assumes the projects to be static (Shahu, Pundir & Ganapathy, 2012). Whereas, in modern scenario, project management is no longer about managing the project in a sequence of phases. It is about incorporating the voice of the end users, prioritizing efforts, and trade-offs and much more (Maylor, 2010). The traditional method of project management seems to be insufficient in dealing with the uncertainties and complexities in a project (Shenhar, 2014). The projects are experiencing cost overruns and delays (Hussain, 2012). Growing complexities and increasing uncertainties are one of the major causes for the cost overruns and delays (Olsson, 2006). The presence of the dynamic environment, increasing complexity and uncertainty demands attention towards the dynamic management approaches (Hertogh and Westerveld, 2010). It is vital for the project's success to have the right knowledge and skills for dealing with the dynamic environment of the project (Millhollan, 2008).

The unpredictable and dynamic changes in the project environment leads to change in project scope (Sun & Meng, 2009). There is a high possibility that a client or the stakeholders expect or demand changes in the project scope (Mochal, 2004). There are multiple factors that can lead to changes in scope including internal and external factors. The internal factors consist of changing requirements of the stakeholders and organization whereas the external factors includes market conditions, government regulation and many more (Nahod, 2012). Changes in scope are challenging for the organizations (Beer & Norhia, 2000). It is important for the project managers to emphasizes on the scope management procedures to manage the scope in an efficient way (Olawale & sun 2013). The practitioners across the globe find it difficult to manage the scope issues with the efficient strategies (Kermanshah, 2019).

Many authors have recognized the growing need for flexible approaches in the recent time (Alder, 2014; Jalali Sohi, 2018; Olsson, 2006; Eriksson et al., 2017; Canale, 1998). Flexibility is the capability to adjust the project to prospective consequences of uncertain circumstances within the context of the project (Husby, 1999). However, there is limited literature showing the role of flexibility in the construction process (Shahu, Pundir & Ganapathy, 2012) and the application of flexible approaches (Jalali Sohi, 2018) in the construction industry.

Many project management methodologies like scrum and PRINCE 2 are used in the construction industry for achieving flexibility in the project. Similar way, Value Engineering (VE) is a project management tool which

aims to achieve the essential functions of a product, service or project with the lowest cost (Zhang, Mao& AbouRizk, 2009). Many times, VE is confused with a cost cutting technique in the construction industry (Ilayaraja & Eqyaabal, 2015). VE is just not limited to the cost cutting techniques. It focusses on enhancing the value of the project, rather the cost, in relation to the function of the project (Olawumi & Arijeloye, 2016). Implementing VE at the right moment in a project increases the value of the project by focusing on the functional requirements of the project by generating multiple alternatives (Siterman, 2009). However, there is lack of awareness in the construction industry about the VE and how it is performed in the construction industry (Olawuyi, 2009; Bowen,2010). Hence, it creates an opportunity to conduct a research on VE and investigate if VE can help to enhance flexibility in project scope.

As mentioned earlier, the changing needs and the dynamic nature in the construction projects demands incorporation of flexible approaches. Flexible project management approaches have been successfully implemented in the software, production and manufacturing industry and hence it an opportunity for construction industry to facilitate the practice in the projects. Incorporating flexibility in the project scope is the core of this research.

1.2 Research gap

The growing complexities and dynamic environment during the project's life cycle demand an increase in flexibility in the project management approaches (Hertogh and Westerveld, 2010). Flexibility is necessary to face the changes and uncertainty in the project (Kreiner, 1995). Many researchers have realized the importance of flexibility in the project and have introduced different perspectives on the concept of flexibility (Spiller et al., 2015; Wang et al., 2008; Eriksson et al., 2017). Koppenjan et al. (2011) have emphasized the potential and need for implementing flexible project management practices in the construction industry. Wang et al. (2008) introduced two management strategies to stimulate flexibility in a project. Verganti (1999) also identified two approaches to become flexible in a project. Olsson (2006) categorized flexibility into external and internal flexibility. He further developed a framework for analyzing flexibility.

The software, production and manufacturing industry have successfully implemented flexible approaches in their project (Jetter & Albar, 2015). However, the research paper showing the role of flexibility in the construction industry are still limited (Shahu, Pundir & Ganapathy, 2012). Jalali Sohi (2018) made efforts to manage flexible project management approaches and identified the enablers for flexibility. In his research, he developed a flexibility framework. The identified enablers were categorized into five categories: What, How, Who, When, and Where. A total of 26 enablers for flexibility were identified. The category “what” signifies the ability to be flexible in terms of project goals and scope. As our research focuses on the flexibility in project scope, the category of “what” will be focused in this research. However, the implementation of the enablers was not tested in his research and hence it creates an opportunity to investigate the applicability of the enablers for flexible scope.

The research of Jalali Sohi (2018) is the starting point for this research as it created a gap for the implementation of the enablers for flexible scope for enhancing flexibility in project scope.

1.3. Gap in practice

The research was conducted in the Rijkswaterstaat (RWS) which is a part of the Ministry of Infrastructure and Water Management's executive organization. The organization works towards the safety, livability, and accessibility of the citizens in the Netherlands (Lintsen, 2002). RWS acts as a client for the infrastructure projects within the Netherlands. The collaborating parties expect some flexibility in the project scope to add or eliminate the developments and opportunities that come across during the project (Diepstraten, 2020). With the increasing dynamic environment in the projects, there is a possibility for change in scope and project

requirements which makes it important for the client to have room for changes (Drury & O'Dwyer, 2012).

The degree of freedom to maneuver is high at the initial stage of the project as the cost for change is low as shown in figure 1-1 (Olsson & Magnussen, 2007). As the cost for change is low at the front-end phase, the scope of the project should be flexible enough to incorporate the change. Change in scope is always challenging for the organization (Beer & Norhia, 2000). It is important to communicate the vison for changes at every possible level of organization. Everyone should understand what is being done and why (Bittner & Spence, 2006).

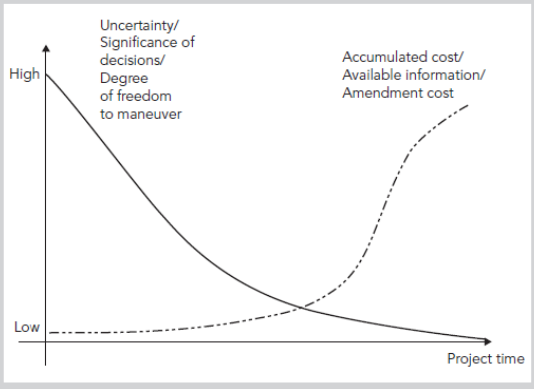

Figure 1-1. Degree of freedom to change with respect to project time (Olsson & Magnussen, 2007)

According to the practitioners, the room for maneuver in the project procedures and the scope is tightly framed and hence it creates an opportunity for research to enhance flexibility in the project scope.

1.4. Problem statement

Change in scope is a natural part of the project (Alder, 2014). The parties involved in the project expects some flexibility in the project scope to add or eliminate their interest in the project scope. After the review over the current scenario in the previous sections, it was observed that the procedures for the development of scope is tightly framed which can limit the possibility for adjustment or implementation of changes in project scope. Also, the front-end phase of the project was observed as the prime time for enhancing flexibility as the cost for change is at the lowest. This brings us to our problem statement that is:

“The project scope at the front-end phase of the project is tightly framed which limits the adjustment or implementation of change in the project scope”

1.5. Research objective

Based on the research gap and the problem statement, the objective for the research is formulated as:

“**Enhancing the flexibility in the project scope by the application of the enablers for flexible scope with the help of Value Engineering”.**

1.6. Research questions

To the achieve the main research objective, main research question is formulated as:
How flexibility in project scope can be enhanced with the help of VE in the construction industry?

To achieve the main research question, sub research questions are formulated which are as follow:

1) What are the enablers and strategies for becoming flexible on the scope?
2) Is flexibility limited to hard factors?

3) How are the enablers implemented in the industry?
4) What are the benefits of performing VE in a construction project?
5) What are the barriers for implementing enablers for flexible scope management in a project?

1.7. Research scope

This research focuses on the government as they are responsible for planning policy for infrastructure (Rijkwaterstaat, 2010). The public planning process is divided into three categories in the Netherlands that are: the planning process at the national, regional, and local levels (Reimer et al., 2014). The research will be focused on the Dutch national infrastructure planning process. The process is also called MIRT (Ministrie van Infrastructuur en Milieu, 2016). Olsson (2004) concluded that project owners, users, and project management teams have a positive attitude towards project flexibility. During the development of scope or changes in scope, the project owner is expected to consider the stakeholder's interests and power during the scope's development. Thus, the research will be investigated from the project owner's / client's perspective. The project owners are also called the client. In this case, the potential stakeholders will be the province, municipalities, shipping association, environmental association, bicycle association, citizens, and many more. Development of scope or changes in scope requires interaction among the client, project team, stakeholders, and users, which is an important aspect of the whole process. So, it is important to understand how the stakeholders are involved and interact in the development of scope and during the changes in scope (Olsson, 2004).

The important delineation of this research is that flexibility in scope will be investigated in the project's front-end development phase. The reason behind the delineation is that the project will be transferred to the contractor. Flexibility in scope can still be an issue once the project is transferred, but the interest will change according to the contract type. The research is strictly focused on enhancing the flexibility of scope in the project's front-end phase. According to the MIRT, it is the exploration and planning stage of the project. Secondly, the research is limited to national infrastructure projects.

Country: The Netherlands
Organization: Rijkswaterstaat
Type of project: Infrastructure project
Perspective for the research: Project owners/Client
The phase of the project: Front-end phase

1.8 Research methodology

The section describes the research approach to answer the main research question. The research methodology is shown in the figure 1-2.

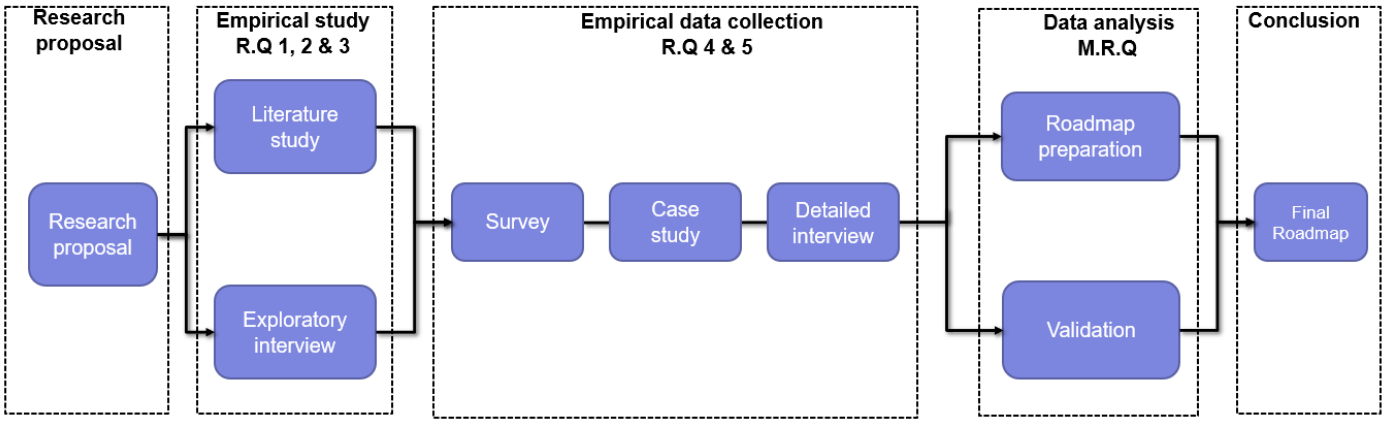

Figure 1-2 Research methodology

"MRQ" = Main research question "RQ"= Sub research question

Empirical study

1. **Literature study**: The literature study is divided into two parts. The first part will help to answer the sub research question 1 and 2. In this step, the concept of flexibility in project scope will be understood which will give a good base for the upcoming steps in the research. The flexibility will be followed by identifying the enablers and strategies for enhancing flexibility in project scope. Further, the influence of soft factors among the stakeholders for enhancing flexibility in project scope will be observed. In addition, a list of barriers for implementing the enablers will be formulated which will theoretically address the sub research question 5.

   The second part of literature will review the second keyword of the research that is "Value engineering". The methodology will be discussed in detail and a list of benefits for performing VE in a construction project will be formulated from the literature.

2. **Exploratory interview**: The first step of the practical study will be the exploratory interviews with industry practitioners. The intent will be to understand the practitioner's perspective on the barriers to become flexible on the scope. This will help to observe if the barriers mentioned by the practitioners are comparable to the one identified in the literature.

Empirical data collection

1. **Survey**: The survey will be conducted parallel to the case study analysis. The benefits of performing VE will be identified in the literature review. A survey will be conducted to check if practitioners experience the benefits of performing VE in their project. In addition, the barriers for implementing the enablers will be the second part of the same survey. The barriers and the benefits will be ranked on the basis of the survey results.

2. **Case study**: The case study methodology will be conducted. Two case studies will be investigated in the project where VE was performed in the FED phase of the project. The aim is to understand the application of the enablers. Furthermore, the occurrence of the barriers for implementing the enablers will be understood. In addition, it will also be verified if VE played a role in resolving the barriers than hinder implementation of the enablers.

3. **Detailed interview**: During the case study methodology, detailed interviews will be performed with the practitioners to understand their perspective on the selected project in the case study for this research. The intent will be to investigate the enablers' presence and how they were implemented in the project. Further, what were the barriers experienced by the practitioners to implementing the enablers. Lastly, it will be essential to understand why VE was performed in the project and what role did VE played in developing the scope.

Data Analysis

1. **Roadmap preparation**: After performing the last step, the aim is to resolve the barriers identfied during the case analysis. Suggestions will be propsed based on the results of case nalyssi and the literature for resolving the barriers. Based on the suggestions, a suggestive model (framework) will be devloped.

2. **Expert Validation**: A session consisting of experts will be conducted to validate the effectiveness of the proposed suggestions for resolving the barrirers.

1.9. Research structure

The figure 1-3 depicts the step by step approach towards developing the final framework.

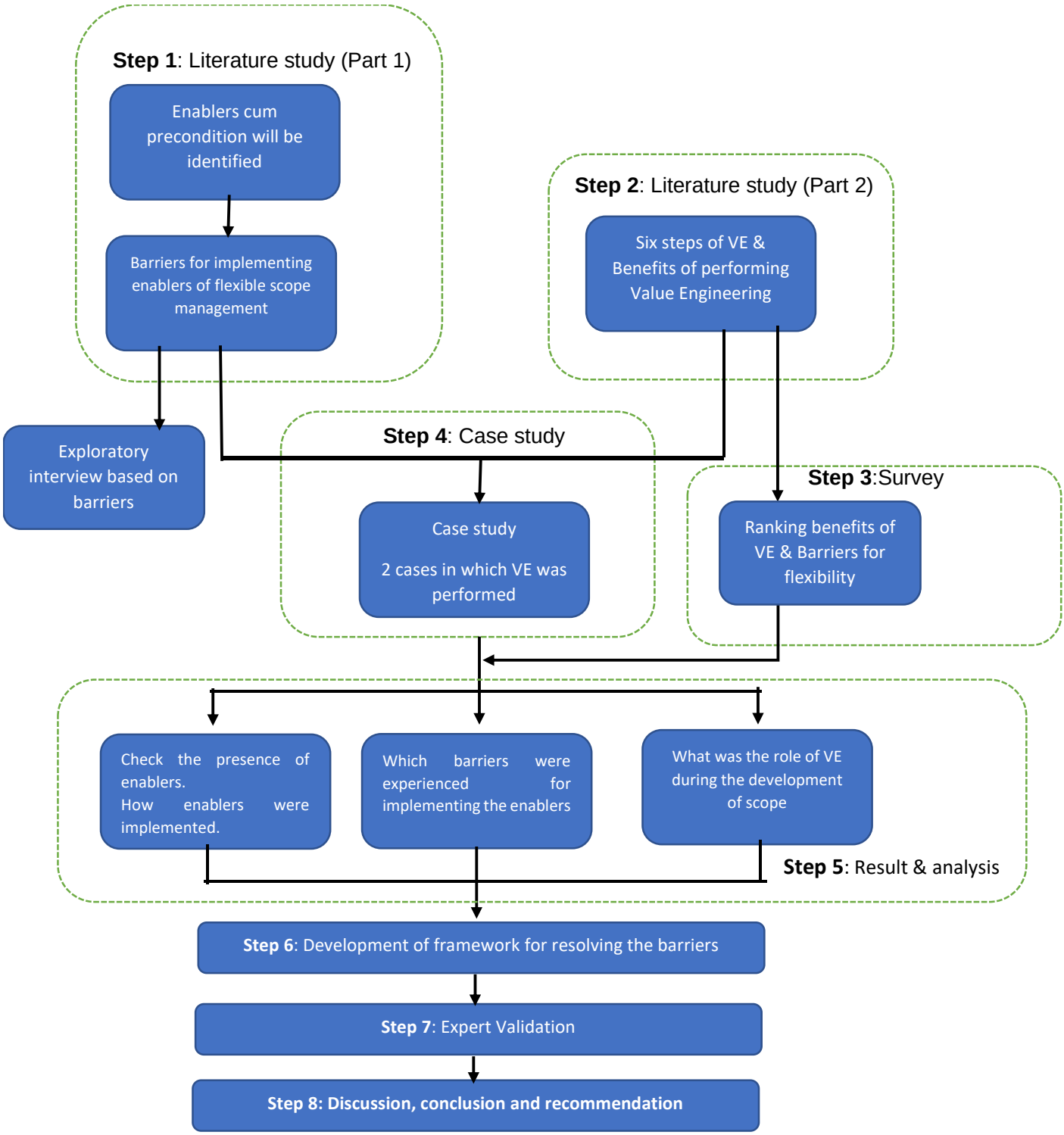

Figure 1-3 Structure of the research

2. LITERATURE STUDY

In the previous chapter, an introductory idea about the research was presented to help get the readers get familiar with the topic and the design of the research. The forthcoming parts of the thesis will capture the main aspects of the research. The first milestone of the research, necessary to get started was the literature review. The literature review was conducted to comprehend the current scenario on the flexibility in the project scope and VE in the construction industry. It was important to lay the foundation through the literature review before starting with the empirical research. The systematic literature review helped to understand pre-existing research and findings in the scientific world.

During the literature review, the main aim was to gather the data from the existing research in the field of flexibility and understand the point of view of the other author regarding the field. The sections below give an abstract idea about the structure of this chapter.

Section 2.1: Introduction: Flexibility in project scope

Section2.2: What is flexibility and why do we need it?

- Perspective of different authors on flexibility
- Why is it necessary to have flexibility in project scope?

Section 2.2.1: The phenomena of “flexibility” for the front-end phase: Why is it necessary?

- Which phase of the project is most suitable for flexibility in project scope?
- Perception of the different stakeholders involved in the project towards the flexibility

Section 2.2.2: Enablers for enhancing flexibility in project scope

- Identification of enablers and strategies for enhancing flexibility in project scope

Section 2.2.3: Influence of enablers related to soft factors on flexibility in project scope flexibility in scope

- Understanding the influence of soft factors for enhancing flexibility
- Identification of the enablers related to soft factors

Section 2.3: The three enablers for flexible scope

- Identifying how the enablers can be applied in according to the literature
- Identification of the barriers for the implementation of enablers for flexible scope management

Section 2.4: Categorization of the barriers

- Categorization of the enablers based on four clusters

Section 2.5: What is Value engineering

- Introduction to VE

Section 2.5.1: Six steps of VE

- The six steps of VE will discussed in detail.

Section 2.5.2: Benefits if VE

- Identification of the benefits for performing VE in a construction project.

2.1 Introduction: Flexibility in project scope

Due to the different characteristic, the construction industry is different from the other sectors (Dubois & Gadde, 2002). The construction sector is an expandable and complex as it develops with time and involves many actors. These characteristic leads to complexities within a project (Kazi, 2005; Razek et al., 2008). Multiple actors have multiple requirement and expectations from the project which demands for changes in scope. Managing the scope in a project is usually recognized as a challenge for the project owners (Adler, 2014). However, changes in scope need not be always seen as a threat to the project which is in contradiction to (Beer & Norhia, 2000; Nelson, 2011; Farok & Garcia, 2016) and in support of (Jalali Sohi, 2018; Olsson, 2006). Change in scope demands for enhancing flexibility in project scope which will be discussed in the next section.

2.2 What is flexibility and why do we need it?

Different authors have developed different definitions and perspective of flexibility. Some of the definitions and perspective are mentioned below.

1) Project flexibility stands for capability to adapt to new, different, or changing requirements (Olsson, 2006).
2) Flexibility is the ability to adjust and keep the options open (Erikson, Larsson & Pesämaa, 2017).
3) The capability to adjust the project to prospective consequences of uncertain circumstances within the context of the project (Husby, 1999).
4) Flexibility is the ability to respond effectively and efficiently to the changing circumstances (Schmenner & Tatikonda, 2005).
5) Flexibility in project is related to “room for maneuvering” (Eikeland, 2001; Midler 1995)
6) Flexibility can be described as a way of making irreversible decisions more reversible or postponing irreversible decisions until more information is available (Olsson & Magnussen, 2007).

The six definitions mentioned above are acquired from six different authors and can be summarized in two aspects. The two aspects are the ability to adjust according to the changing circumstances and being open towards the options until sufficient information is available. This brings out two perspective of flexibility; the first one being “adjust” and the second one being “keeping the options open”. The first perspective “adjust” means incorporating the changes which can appear due to the uncertain and changing environment (Aaker & Mascarenhas, 1984), whereas , the second perspective is about keeping the options open and not committing to the solutions too early (Perminova & Wikstrom 2019; Olsson, 2005).

“The above section helped to understand the context of flexibility from the perspective of different authors. The two perspective of flexibility that are “adjust” and “keeping the options open” will be the base for our further research”

Most projects are started based on the preconceived and rigid idea of a technical solution (Olsson & Samset, 2006). The initial idea or the solution that remains unchallenged often turns out to be the selected or the chosen solution. The traditional approach attempts to have full predictability at the initial stage of the project (Hass, 2007; Thomsett, 2002). The traditional approach tends to jump at the tried and tested solutions, rather than exploring innovative alternatives (Olsson & Samset, 2006).

Various reports in the field of project management shows that we do not have predictability and control over all the variables. Thus, the need of the hour is encouraging flexibility in the process to overcome any possible situation that may occur (Olsson & Samset, 2006; Eriksson et al., 2017; Sun & Meng, 2009). Looking at the dynamic nature of the project it is important to move away from the traditional sequential and fragment

process towards a more integrated, collaborative approach (Forgues & Giraud, 2009) as well as a more flexible approach.

"The scope in the traditional project management approach might be based on the preconceived idea which remains unchallenged due to the attempt to have full predictability at the FED phase of the project. It was observed that predictability and control over all the variables in project management is limited and hence there is a need for applying flexible project management approaches"

2.2.1 The phenomena of "flexibility" for the front-end phase: Why is it necessary?

In this section, the most suitable phase of the project life cycle for implementing flexibility in the project scope will be discussed. This will help in narrowing down the research to a specific phase. Furthermore, the roles and contributions of the stakeholders towards increasing flexibility will also be discussed. In addition, the opinion of different stakeholders about flexibility will be discussed.

Flexibility can be incorporated into the different phases of a project. However, based on the existing literature, front-end phase is the most appropriate stage to enhance flexibility. This is because of the lower costs associated with implementing possible changes in this phase. (Morris & Hough, 1991; Miller and Lessard 2000; Olsson, 2006). In addition, flexibility in the front-end phase is also the least controversial as it covers the activities prior to the final decision to go ahead with the project (Olsson 2006). It is not a good idea to make changes once the decision is taken and specifications have been established (Morris & Hough, 1991). In additions Miller and Lesard (2000) suggested that the flexibility should be limited to the front-end phase of the project.

Different stakeholders have different perspectives about the flexibility (Olsson, 2006). Olsson (2006) observed the opinion of the different stakeholders on flexibility with respect to different stages of the project as shown in table 2-1. He reported that the project owners and the project management team are likely to have a positive opinion towards the flexibility in the project scope. The users are expected to have a mixed opinion towards flexibility at the front-end phase of the project.

Table 2-1 Stakeholder perspective on flexibility in project phases (Adopted from Olsson, 2006)

Phases	Front-end	Planning	Execution
Project owner	+	+	+
Users	+/-	+	+
Project management	+	+/-	-
Contractor	N/A	-	-

"+" = Positive opinion on project flexibility, "-" = Negative opinion, "+/-" = Mixed opinion

"Flexibility in the front-end phase is observed to be most suitable as the cost of implementing the change is lowest at the front end phase of the project. It was observed that project owners and the users have a positive attitude towards flexibility at the front end phase of the project"

2.2.2 Enablers for enhancing flexibility in project scope

The prior two sections highlighted the meaning of flexibility along with the most suitable phase of the project for the flexibility in project scope. In this section, the research conducted by various authors for enhancing flexibility in a project will be discussed. The aim will be to identify the enablers which can be implemented for enhancing flexibility in project scope.

Olsson categorized (Olsson, 2006) flexibility into external and internal flexibility. The former refers to the adjustments in the project scope, whereas the latter stands for flexibility within the defined scope; how requirements shall be met. The author (Olsson, 2006) also developed a framework for analyzing flexibility in the front-end phase of the project as shown in figure 2-1. The framework reflects that identifying the drivers for flexibility and appropriate implementation of the enablers in the front end phase of the project can help to enhance flexibility in a project (Olsson & Samset, 2006).

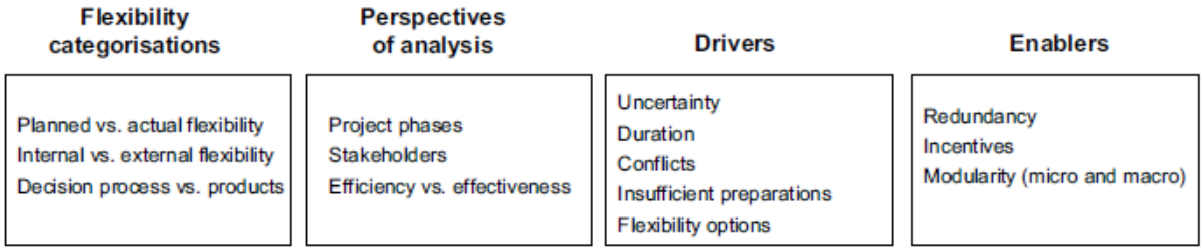

Figure 2-1. Framework for analyzing project flexibility (Adapted from Olsson, 2006).

Jalali Sohi (2018) identified 26 enablers for incorporating flexibility in project management. He categorized the 26 enablers in five categories consisting of "what", "when", "how", "who" and "where". The category of 'what' is about the enablers for enhancing the flexibility in project scope. Three enablers for flexible scope were identified consisting of "broad task definition", "embrace change" and "functional based contracts". The three enablers are discussed in detail in the section 2.3.

Wang Jiang & Klein (2008) also conducted a research in the field of flexibility. He observed two management controls for enhancing flexibility in projects related to software as shown in figure 2-2. The first one is change control and it helps to facilitate flexibility by controlling the unstable scope and run-away requirements. Focusing on the functional task and denying the irrelevant request allows the project manager to prevent overloading which can help the project team to identify the core requirements and their potential change. Second one is the managerial review. In managerial review, the flexibility of the systems should be monitored and evaluated. To achieve that, the reviews of the team should be audited at regular intervals. The two factors can add flexibility and lead to boosting the project performance (Wang et al., 2008).

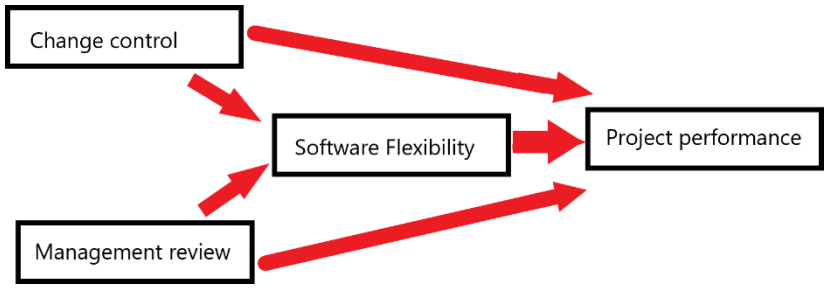

Figure 2-2 Management controls for flexibility in software (Adapted from Wang et al., 2008)

Apart from Wang et al., (2008), another interesting perspective was presented by Spiller et al., (2015). He discussed flexibility from the perspective of phased design. In phased design, step by step implementation occurs by first satisfying the current demand capacity and functionality and then expanding as demand grows. In phased design, the flexibility is achieved by keeping the options open until new information or technological advances are available. The guiding principle for all the design is that the first phase must be able to function independently from any potential additions later. It was observed that phased design is in the line of late locking. According to Olsson (2006), late locking is a strategy where decisions and commitments in the projects are made sequentially over episodes.

Bittner & Spence (2006) observed that planning the scope in small iterations gives the project manager opportunity to move the scope from one iteration to another or make changes in the scope. Verganti (1999) identified two opposite approaches to incorporate flexibility in the product development. The first one being anticipation, involved analyzing the future requirements as early as possible during the front-end phase. The second strategy identified was reaction, which reflected the ability to implement changes at the later stage of the project.

"It was observed that the literature specifically focused on enablers for enhancing flexibility in project scope was limited and hence the enablers and strategies were identified from the domain of project management rather than specific to project scope. Based on the definition and the context in the respective research article of the enablers and strategies, a list of five enablers and two strategies was chosen which might have influence on enhancing flexibility in project scope. The list of the enablers and strategies was mentioned in table 2-2 (hard factors). In addition, it was observed that soft skills among the stakeholders can play a vital role in enhancing flexibility in project scope. Hence, in the upcoming section, the influence of soft skills among the stakeholders on flexibility in project scope will be discussed in detail"

2.2.3 Influence of enablers related to soft factors on flexibility in project scope

Snuhadi (2014) distinguished between soft and hard factors in a project. Soft factors are associated with the behavioral aspects among the stakeholders in a project. On the other hand, hard factors are related to technical and mechanical aspects which directly lead to improvement in the performance of the project. He further added that soft factors can help to enhance the effective use of hard factors.

During the literature review in the last section, it was observed that many authors have emphasized on the need for implementation of soft factors in a project to enhance flexibility in project scope (Bittner & Spence, 2006; Eriksson et al., 2017; Atkinson et al. 2006; Elich, 2012). Hence, during this research, it was decided to identify and discuss the enablers for flexible scope which are related to soft factors in a project and how they can influence flexibly in project scope.

Change in scope can be implemented by different approaches. The two basic approaches are project and process management (De Bruijn et al., 2010). Project management approach is characterized by "predict and control" (Veeneman, 2012). It emphasizes on controlling the phases of the project instead of the environment (stakeholders) of the project. On the other hand, process management refers to a managerial style that is oriented towards the activation of stakeholders, managing interaction, and creating variety of content (Edelenbos & Klijn, 2009).

A project is a collaborative effort. Multiple stakeholders are involved in a project which may possess different interest. According to process management, most efficient solutions are developed by negotiating and sharing of knowledge with the various stakeholders (Veeneman, 2012). Decision making in a complex project can be confounding because of the network of stakeholders involved in the project. Interaction among the network of the stakeholders should be used to manage the change in needs of the stakeholders and simultaneously cope with the changes (Hetogh & Westerveld, 2010). On the other hand, project management approach should consider project from social and political context while dealing with the dynamic circumstances of the project. The social interaction and human actions, the framing and reframing of project, stakeholder relations should be focused on dealing with the dynamic nature of the project (Winter, Smith, Morris & Cicmil, 2006).

Olsson (Olsson 2006) distinguished between effectiveness and efficiency. The long-term effects of the project are measured in terms of effectiveness. Eikeland described (Eikeland 2001) effectiveness relates to how the

output of a project contributes to the added value for the owners and users. He also stated that efficiency is the ability of a project to produce immediate outcome. It is all about producing the output with the agreed scope, quality, cost, and time. Elich explained (Elich 2012) effectiveness only depends on the process-oriented management and not on the project-oriented approach. The author concluded that scope changes should be managed mostly by the process-oriented approach. A process-oriented approach aims to move and make improvements when multiple stakeholders are involved in a project. Negotiation and discussion become an important aspect for the success of the project. Inadequate management can lead to conflicts and issues among the stakeholders (Tillmann et al., 2011), in the case of implementing large change events during the life cycle of the project, as the actors are not in the position to negotiate. Long term cooperation among the stakeholders requires flexibility on the common interest, instead of simply assigning the risk to the other parties. It is important to be flexible on the attitude of the stakeholders and that is how we can expect them to negotiate (Nystén-Haarala, 2010).

It is important to bring the stakeholders on the table together and discuss the issues. With effective communication one can come up with a negotiated and efficient solution which will not lead to any issue or friction among the actors (Elich, 2012). Empirical study by Tzortzopoulos et al., (2003) reflects that a lack of alignment within the stakeholders leads to the conflict and changing list of requirements. Stakeholders are not confident about what results the collaboration will produce. Stakeholders in such a situation anticipate the uncertainty of the benefits and the actual cost of such a collaboration. Stakeholders should use the soft terms like 'good will' and 'commitments' among themselves (Nystén-Haarala, 2010). Stakeholders have the tendency of unawareness instead of ignorance when it comes to deal with changes in a project. Thus, a proactive approach is required to deal with the changes. (Demirel et al.,2017).

A change procedure is responsible to assist in dealing with the changes during the contract tenure (Rijkswaterstaat, 2014). The change procedure reflects a reactive approach to manage the project changes. As mentioned earlier, a difference in the interests of the stakeholders can lead to a conflict. The change procedure situation demands for a proactive approach but studies showing the proactive approach for implementing the change is limited (Cruz & Marques, 2013). It is important to communicate the vison for changes at every possible level of organization. Everyone should understand what is being done and why (Bittner & Spence, 2006). Kotter (1996) observed that the communicating the vision is one of the most important factors in failing to implement the change efforts (John P. Kotter, 1996). Hence, success of the project is dependent not only on the hard factors but also on the soft factors like high level of trust, involvement and collaborative relationship among the stakeholders (Elich, 2012).

In addition, Eriksson et al., (2017) mentioned that flexibility in the project is focused on three central practices as explained below:

1. Collaboration among the key stakeholders and actors: Mega construction projects are highly complex. Complex projects consist of inter-organizational and highly interrelated tasks of diverse actors. It is important to coordinate and involve them in the project as they will be required to collaborate during problem-solving situations and decision making. This marks the first characteristic of enabling flexibility.

2. Explorative learning: This is the second characteristic for enabling flexibility. This includes identifying and testing new creative solutions. Explorative learning is related to innovation and the development of alternative solutions.

3. Adaption of solutions to fit changes in scope due to unexpected or changed circumstances: This is the third characteristic for enabling flexibility. Adaptation involves managing change and unforeseen

problems. Looking at the dynamic environment, reactive adaptation is important to deal with the new situation and satisfy the requirements of the stakeholders.

The hypothesized relationship among the three characteristics are:

Collaboration facilitates explorative learning: Internal organizational collaboration is essential for explorative learning and innovation. It is difficult to come up with efficient and creative solutions individually. Cross-fertilization and recombination of knowledge and expertise from different disciplines lead to development of creative solutions. Thus, it is important to encourage regular collaboration between the key stakeholders to create a novel solution. The decision to adopt any new technology should be a collective decision of the stakeholders, as all the key stakeholders will withstand the impact on this change. Such joint decisions require collaboration. However, in a contradictory situation where the project is plagued by individualistic or opportunistic behavior, it will be difficult to expect the contractors to come up with innovative solutions and clients will be less interested in implementing those solutions in the project. Thus, it is very important to have trust to develop and implement creative solutions.

Explorative learning enhances adaption: Changing circumstances can lead to rendering the original plan and thus we are required to have reactive adaptation. Every stakeholders' ability to understand the broader consequences of the change evolves with time and thus it is important to keep them involved in the project regularly. Thus, stakeholders are required to conduct proactive explorative learning to have the capability to adopt new technology or change as soon as possible. Hence, it is important to generate alternative solutions when adapting to changing situations.

"Infrastructure projects consist of multiple actors with different interest and they are dependent on each other for realization of their goals. Implementing the change in scope can be complicated in complex project where multiple stallholders with different interests are involved. In such a situation, the client can bring the stakeholders together on the table and discuss the problem openly. This will give the stakeholders better understanding of the problem and more importantly they will be in a better position to understand the perspective of other stakeholders. It was observed that flexibility in project scope is depended on the enablers based on soft skills among the stakeholders like level of trust, commitment, communication, involvement and collaborative relationship among the stakeholders"

On further investigation of the enablers based on the soft factors, it was observed that implementation of each of the enablers based on soft skills is interdependent. Karlsen et al., (2008) developed a model for building trust in project-stakeholders relation. In his model, it was observed that communication and commitment among the stakeholders leads to development of trust. Similarly, Tschannen-Moran (2001) concluded that the level of collaboration is directly related to the level of trust among the actors. Observing the influence of the different enablers on each other, it was decided to find a common link among the enablers.

Interaction in construction industry involves a process in which organizations and individuals through their action affect each other in terms of communication, collaboration and trust (Forsman et al., 2011). Atkinson et al. (2006) mentions that the early interactions are vital for success of the project. He further mentions that the degree of involvement of the stakeholders in terms of interaction among the stakeholders will affect the flexibility and uncertainty in a project. Ives and Olson (1984) mentioned that user involvement is important for the project success. They further formulated six different types of involvement which is based on the interaction in a project.

It can be observed in the last paragraph that authors have previously mentioned the relationship between the "interaction among the stakeholders" and "communication", "collaboration", "trust", "commitment" & "involvement". Interaction among the stakeholders can be observed as the common link among the enablers based on the soft factors. This leads to introduction of the new enabler "interaction among stakeholders". The definition of Interaction among the stakeholders is the "**tendency of the actors to influence each other by their actions in terms of communication, trust, collaboration, commitment and involvement**". The five enablers based on soft factors will be discussed under the enabler "interaction among stakeholders". The detailed discussion about the enabler with respect to the soft factors is discussed in section 2.3.3.

In the last two sections enablers and strategies based on the soft factors and hard factors were observed. To enhance the flexibility in the project scope, it is important to implement the enablers in the project. Hence, a table is developed with enablers and strategies for enhancing the flexibility in project scope as shown in table 2-2.

Table 2-2 List of enablers based on hard and soft factors for enhancing flexibility in project scope

		Enabler	Significance of the enabler	Author
Hard factors	1	Broad task definition	Defining the scope of the project into a broad task instead of highly detailed work packages.	Jalali Sohi et al., (2019)
	2	Embrace change	The significance of this enabler is to accept and implement the change.	Jalali Sohi et al., (2019)
	3	Functional based contracts	The main functions of the projects should be focused on the function rather than the detailed specifications.	Jalali Sohi et al., (2019)
	4	Iterative planning	Planning the scope in small iteration gives the project manager opportunity to move the scope from one iteration to other or make changes to the scope.	Bittner & Spence, (2006), John P. Kotter, (1996)
	5	Phased deign cum late locking	Not taking decisions until it is necessary to be taken	Perminova & Wikstrom (2019), Olsson (2005)
	6	Explorative learning **(Strategy)**	Identifying and testing new creative solutions. Explorative learning is related to innovation and the development of alternative solutions.	Eriksson et al., (2017)
	7	Adaption of solutions **(Strategy)**	Adaption of solutions to fit changes in scope due to unexpected or changed circumstance	Eriksson et al., (2017)
Soft factors	8	Good will & Commitment		Nystén-Haarala, 2010
	9	Involvement of the stakeholders		Elich, (2012)
	10	Communication among the stakeholders		Bittner & Spence, 2006
	11	Trust		Elich,2012, Jalali Sohi et al., (2019)
	12	Managerial review		Wang et al., (2008)
	13	Collaboration among the key stakeholders and actors		Eriksson et al., (2017), Elich (2012)

Three enablers were selected from the list of 13 enablers as shown in table 2-2. Broad task definition and embrace change were the first two enablers selected for further investigation in this research. There were several reasons for choosing these two specific enablers from the 13 enablers. One of the main reasons for choosing these two enablers was the parent work of this research by Jalali Sohi (2018) who identified these enablers. This research aims to further study the application of the enablers identified in the category of 'what' in the research of Jalali Sohi. Three enablers consisting of "broad task definition", "embrace change" & "functional based contract "were identified in his research for enhancing the flexibility in scope. The three enablers were always on the priority for further research. The third enabler "functional based contract" was not investigated further as this research is focused on the front-end phase of the project "Functional based contract" might be in contradict with the scope of our research. In addition, it was observed during the literature review of enabler "broad task definition" that functional thinking can be used as medium to look at the project from a broader view instead of narrow solutions as discussed in section 2.3.1. There was a possibility of overlap in the enabler "broad task definition" and "functional based contract" and hence, functional based contract was not investigated further. The third enabler that was selected for further investigation was "interaction among the stakeholders". As discussed earlier, enablers related to soft factors might play a vital role for enhancing the flexibility in project scope. Hence, it will be a good idea to investigate the enabler "interaction among the stakeholders" further to understand the influence on flexibility during the case analysis.

Some enablers and strategies were not investigated further in the research. These enablers are "functional based contract", "iterative planning" and "late locking". The strategies are "explorative learning" and "adaption of solutions". These enablers and the strategies will create an opportunity for future research. In the next section, the three enablers will be discussed in detail and the barriers for implementation of the enablers will be identified.

2.3 The three enablers for flexile scope

In this section, the three enablers chosen from the last section will be discussed in detail. The Three enablers are broad task definition, embrace change and interaction among the stakeholders. The reason behind selecting these three specific enablers from the list of 13 was mentioned in the last section.

2.3.1 Broad task definition

The significance of the enabler "broad task definition" is to define the scope of the project in terms of a broad task instead of highly detailed work packages (Jalali Sohi, 2019). The clients usually tend to think about the product to be built rather than the problem which it aims to tackle (de Ridder & ter Huerbe, 2007). The clients tend to be more focused on the product specification and not on the functional requirements, wishes and needs of the actors involved in the project (Hoeze, 2006). This leads to shift in focus towards the concept of functional specification. Functional specification is a document which consist of requirements that an object must meet (Viola, 2012). In layman terms, functional specification defines the desired result by focusing on what is to be achieved rather than how it is to be done. This practice helps to look at the project from broader picture instead of developing highly detailed work packages.

The project can be analyzed from "what" problem or "how" problem. The "what" problem stands for "what should be done" and on the other hand, the "how" problem elaborates "how it should be done?" (Kaufman & Woodhead, 2006). The functional analysis tends to make the designer and development team think solution free instead of answering the "how" question at the initial stage of the project without exploring multiple alternatives for the project (ter Huerne et al, 2006). The "how" questions lead to limiting the solution space for the market. It is important to understand the applicability of the functional specification according to the project (Ridder & Huerne, 2007). The functional analysis can be performed by one party, but it is

advised to perform this analysis with all the parties including the project team, client, stakeholders, user experts and consultants (Kaufman & Woodhead, 2006). Different actors of the team bring different experiences and expertise which enhances the quality of functions developed during the analysis. System Engineering (SE) (Viola et al., 2012) and VE methodologies (Parker, 1998) are used in the construction industry to look at the project from the broader view by conducting functional analysis. Both the methodologies share an overlap in terms of thinking in terms of functions. The SE approach is explained in detailed in the appendix 1 while VE approach is explained in the section 2.5.

The practitioners face barriers for the implementation of this enabler. Understanding the needs of the users is one of the most important aspects for performing functional analysis (Veenvliet, 2004). “The user does not know what they want” reflects that customer needs are not sufficiently known and thus it will be difficult to develop functions (Orr, 2004). Ineffective communication among the team members or misunderstanding between the users and stakeholders can lead to misinterpretation of the functions (Dallas, 2000). de Haan, Degenkamp, Schotanus & Mulder, (2017) distinguished the factors that influence the implementation of functional specification in terms of soft factors and hard factors. The soft factors consist of the behavioral factors while, the hard factors consist of regulatory factors. In his research, it was identified that soft factors have a positive influence on the implementation of the functional specification. Stakeholders should be trained for the hard purchasing techniques, but at the same time, it is also important to invest in the soft factors as well. One example of investing in soft factors are promoting increased dialogues among the stakeholders. This will help to create more solution space for the solutions.

Barriers for implementing functional contracts was identified by de Haan et al., (2017). The barriers are as followed:

a. **Solution oriented thinking by the project owners:** Technical experts are inclined towards having a solution-oriented mindset instead of looking at the project from a functional perspective. Experts may have the tendency of directly going to the solution instead of understanding the core of the problem. Tried and tested solutions are encouraged, and functional perspectives are ignored which leads to limiting the flexibility in the solution space.

b. **Risk averse behavior:** The clients have the pressure of not committing mistakes and thus they prefer to stick towards the traditional solution. They have a fear that if they go to market with the functional requirement, they will not get what they want.

c. **Knowledge of specific products at the client:** In some cases, it is noticed that the client has more expertise than the contractor and thus, it limits the application of functional specification. The greater the expertise of the clients, the more they tends towards technically specified solutions instead of giving opportunity to the market for coming up with more valuable solutions.

d. **Available preparation time**: The client may have the perception that a functionally specified solution requires more time and investment. According to them, traditional and proven solutions require less time.

e. **Policy, standards, interfaces, norms, guidelines, laws and regulations**: The standards and regulation set by the client and government like appearance, quality and uniformity can limit the solution space for coming up with different or innovative solutions.

f. **Limited awareness of the enabler and the methodology**: VE and SE are used as a

methodology for looking at the project from a functional perspective. Many researchers have emphasized on the lack of awareness in the construction industry about the methodologies which can limit the implementation of the functional thinking in a project (Olawuyi, 2009; Bowen;2010).

g. **Limited training or coaching for interpreting the functions**: Developing and interpreting the functions require a specific technique to be developed and understood (Younker, 2003). Practitioners who do not have the experience or knowledge about the functions may not be confident in implementing functional thinking in their projects.

Nine barriers for implementation of the enabler "Broad task definition" are identified and are mentioned below:

1. Poor communication and misinterpretation between the stakeholders
2. User's needs are unknown
3. Solution oriented thinking by the project owners
4. Risk averse behavior
5. Knowledge of specific products at the client
6. Available preparation time
7. Policy, standards, interfaces, norms, guidelines, laws and regulations
8. Limited awareness of the enabler and the methodology
9. Limited training or coaching for interpreting the functions

The identified barriers will be further investigated during the case analysis.

2.3.2 Embrace change

The significance of this enabler is to accept and implement the change (Jalali sohi, 2019). The project plan consists of the processes that are required to monitor, verify, and control the project scope throughout the lifecycle of the project (PMI, 2008, p.103). The project plan also contains details of the change management process and the scope change plan that should be implemented during the change in scope. (PMI, 2008, p. 126). Avoiding the implementation of a change that can possibly add value to the project may cause dissatisfaction among the stakeholders (Cohn, 2006). Changes in the scope can be categorized into three categories consisting of the change order, construction change directive (CCD) and reworks (Hao et al., 2008). The change order refers to the changes that occurs due to any unanticipated times such as changes from the client, technological changes and others. The CCD is issued by the client requesting for change in contact scope when there has been no agreement on scope. The last change in called the rework. Rework signifies the redoing of a process or an activity that was incorrectly implemented in the first place and usually arises during the quality inspections. In this research we will focus on the first type of change in scope which is change order. The construction industry follows a systematic plan or model called the scope change model to implement the changes in scope. Hao et al., (2008) have developed a change process model consisting of five stages in a sequence of identify, evaluate, approve, implement, and review. The process model is based on the synthesis of the multiple change process model. The process model is described in a figure mentioned in appendix 2.

Traditionally, it is difficult to deviate or implement changes in the original plan. Olsson (2004) describe change in scope as one of the most important cause for disagreement among the stakeholders. Thus, disagreements among the stakeholder can be interpreted as one of the causes for the changes in scope. Resistance to implement the change is one of the key aspects for implementing the change. A quantitative study was

conducted to identify the sources of resistance to change (Val & Fuentes, 2003). They categorized the sources in five different categories. The top five sources of resistance were:

a. Dealing with the existence of deep-rooted values
b. Different interests among the stakeholders
c. Communication barriers
d. Organizational silence
e. Capabilities gap.

The dynamic nature of the project requires regular communication between the teams, stakeholders and the customer to achieve intermediate decisions that will help to support during the dynamic time. Connor (1993) also identified five common causes of change in resistance that were:

a. Lack of belief
b. Different descriptions of the need for change
c. No agreement about the goals for change
d. Lack of belief that goal is attainable
e. No confidence in the manger for implementing the change.

Although many authors have categorized the causes for resistance to change (Vennström & Eriksson, 2010; Val & Fuentes, 2003; Connor,1993), we prefer to develop categories based on the common barriers identified in the literature. The factors which may influence the implementation of change or resistance to change are as follows:

1. **Self-interest**: Stakeholders may have the tendency to resist the change as new circumstances might influence their self-interest. Stakeholders may try to take advantage of the situation and maximize their self-interest. Salaman (2000) argued that the organizational employees have the tendency to actively evade and divert control as they seek to maximize their personal interest which might not get realized with the change. Furthermore, they try to defend their own area of control and autonomy. This reflects that the stakeholders who will face changes in terms of their personal benefits may resist towards implementing the change.

2. **Lack of trust**: Stakeholders may have the tendency to resist the change when they are not aware or informed regarding the need and outcome of the change (Daft, 2000). Limited knowledge about the change may lead to suspicious behavior among the stakeholders. It is advisable to involve the stakeholders during the process of negotiations. This can encourage development of trust among the stakeholders which may enhance the flow of information. Trust encourages the exchange of information among each other and determines if the stakeholders are willing to allow others to influence the decision-making process (Carnevale & Wechsler, 1992). Negotiation among the stakeholders can lead to development of efficient solutions. Trust is important to make the stakeholders negotiate in a positive manner else it may lead to aggressive dialogs. This may hamper the implementation of change in the project.

3. **Disparity in perception and evaluation**: Stakeholders may have the tendency to assess the cost and benefit of change in scope differently and it can lead to conflict and tension among the stakeholders. Verenych et al., (2019) concludes that implementation of the change is carried out smoothly if the stakeholders understand the project processes and characteristics of the project and product. Different perception may lead to different outcomes and which will eventually lead to resistance in implementation of change in scope.

4. **Limited involvement of stakeholders**: Stakeholders may try to resist the change when they don't have adequate information about the needs, purpose and outcomes of the changes and thus it is advisable to involve them in the decision making process.

2.3.3 Interaction among the stakeholders

An infrastructure project consists of a number of stakeholders with different goals, interests and resources who are dependent on each other for realization of their goals (De Bruijn & Ten Heuvelhof, 2008). Every stakeholder that can be influenced by the implementation of the project is interested in the decision among process of the project. Lack of support from the key stakeholders, can lead to failures in decision making process (Okoro, 2016). The negative attitude from the stakeholders can obstruct the implementation processes in the construction project (Olander & Landin, 2005). De wit (2019) concluded that limited stakeholders are involved during the development of the scope. More actors lead to exploring different perspective instead of thinking from same conventional patterns (Edelenbos & Klijn, 2005). Actors bring specific knowledge that can help in developing efficient alternative solutions. In the waterfall model of project management, the involvement of the stakeholders is limited to validating the end result. Looking at the dynamic nature of the project, it is vital that stakeholders remain aware of the progress that is made throughout the development of lifecycle. This means that it is important to involve stakeholders during the development of the scope rather than getting their final opinion on the end result. (Inayat et al., 2015). Olsson (2004) describe change in scope as one of the most important cause for disagreement among the stakeholders and cost overruns.

Early interaction among the stakeholders is important for the project success. Inability to communicate and understand the needs and expectations of the stakeholders leads to conflicts and difficulties in the later stage of the project (Atkinson et al., 2006). The literature reflects the importance of the stakeholders for becoming flexible on scope. Thus, it is important to investigate how stakeholders are involved during the development of scope or during the changes in scope. In the section 2.2.4, it was also noted that flexibility in project scope is just not limited to the hard factors. Soft factors among the stakeholders play an important role for enhancing the flexibility. Trust, communication, involvement of the stakeholders, commitment and collaboration were identified as one of the important enablers cum preconditions for becoming flexible on scope. Releasing the importance of stakeholders for becoming flexible on scope, it was decided to further investigate the soft factors in detail. The third enabler for enhancing the flexibility in project scope was developed which is called "interaction among the stakeholders". Interaction in construction industry involves a process in which organizations and individuals through their action affect each other in terms of communication, collaboration, commitment and trust (Forsman et al., 2011).
Interaction among the stakeholders: Tendency of the actors to influence each other by their actions in terms of communication, trust, collaboration, and involvement.

The first aspect of the enabler "interaction among the stakeholders" is communication among the stakeholders. Communication is directly linked to interaction. It is difficult to learn and understand the perspective of other stakeholders without communicating directly or indirectly with them (Ihlen, 2013). Direct meeting can be in form of stakeholder meeting and indirect meeting can be in the form of communication through news and media. It is important to understand which kind of interaction is most suitable in a dynamic environment to communicate in an efficient manner.

The second aspect of enabler "interaction among the stakeholders" is trust. Trust is one of the most important aspects of interaction. Trust among the stakeholders plays an important role in the project success. Trust is a valuable asset as it helps to create loyalty which gives the project owners the benefit of doubt in a situation when they expect the stakeholders to understand and believe them (Beslin & Reddin,

2004). It is important to be aware of how trust is built in relations and which factors influence the process of building trust. Karlsen et al., (2008) developed a model for trust building in a project-stakeholders relation. Nine factors were identified which will help to build trust and create a positive atmosphere in reaching the milestones of the project. Communication skills, behaving reliable, showing commitment, being sincere, benevolent and competent, having and acting with integrity, working towards reaching project milestones and establishing common goals are the factors which influence the trust building process among the stakeholders (Karlsen et al., 2008).

The third aspect of the enabler "interaction among the stakeholders" is user involvement or the stakeholder involvement. User involvement plays a vital role in the success of system development (Tait & Vessey, 1998). Many authors have concluded that user involvement and system success have a direct relationship (Swanson, 1974). It is important to involve the relevant stakeholders during the decision-making process to gain support ad generate sense of urgency as the stakeholders are dependent on each other (de Bruijn & Ten Heuvelhof, 2008). Interaction among the stakeholders can be different according to the need of the project and thus it is important to understand the dynamics of different type of interaction.

Ives & Olson (1984) categorized interaction in six categories in terms of user involvement that are:

1) No involvement: Users are unwilling or not invited to participate
2) Symbolic involvement: User input is requested but ignored
3) Involvement by advice: User advice is solicited through interviews or questionnaire
4) Involvement by weak control: Users have "sign off" responsibility at each stage
5) Involvement by doing: A user as design team member
6) Involvement by strong control: User may pay directly for new development out of their own budgets or the user's overall organizational performance evaluation is dependent on the outcome of the development effort

The last aspect of the enabler "interaction among the stakeholders" is collaboration. Collaboration among the stakeholder in the layman language is working together to accomplish a common goal. Collaboration is something that is difficult to achieve in a short time. It is a process which is influenced by the dynamics among the stakeholders. Tschannen-Moran (2001) concluded that the level of collaboration is directly related to the level of trust among the actors. This reflects that collaboration is influenced by the level of collaboration among the parties.

For implementing the enabler "interaction among the stakeholders", a process which can be followed is stakeholder engagement plan. Stakeholder engagement is process which consists mainly of two levels that are participation and involvement. Participation means engaging the stakeholders at the higher level by working together in a project. Involvement of the stakeholders means exchange of information to keep the stakeholders aware about the project and other parties involved in the project (Mok, Shen, & Yang, 2014). Many authors have developed stakeholder engagement framework which can be followed by the project managers for implementing the enabler 'interaction among the stakeholders' (Holmes and More, 2007; Rajablu, Marthandan, and Yusoff, 2014: Yang and Shen, 2014)

During the case analysis, all the four soft factors above mentioned will be investigated in detail under the enabler "interaction amongst the stakeholders".

"In the last section, the three enablers were discussed in detail and the barriers for the implementation of the enablers were identified"

2.4 Categorization of the barriers

In the last section, barriers for implementation of the enablers were identified. There was a possibility that the barriers for the implementation of one enabler might influence the implementation of the other enabler and hence, a common list of barriers was formulated based on the literature discussed under section 2.3. The list of the barriers was divided into four categories according to the root cause of each barrier. The categories consist of organizational behavior, stakeholder driven barriers, limited awareness and contractual barriers. The categories are explained in detail below. The barriers are distinguished in four categories as shown in table 2-3.

Organizational behavior: This category shows how individuals and groups act within the organization where they work (Bauer & Erdogan, 2012). To become flexible, it is advisable for the organization to be flexible in their way of thinking. The organization may have the tendency to stick to their traditional way of working instead of implementing a change in the project. Thus, it is important to identify the list of barriers that occur due to the organization behavior.

Stakeholder driven barriers: Stakeholders play a vital role in becoming flexible on the scope as discussed in section 2.2.4. Trust, communication and involvement of the stakeholders were identified as a few of the preconditions necessary to become flexible on scope. Thus, it is advisable to understand the dynamics of the stakeholders in a project and how they influence the implementation of flexibility in a construction project. A list of barriers will be developed that occur due to stakeholders.

Limited awareness: It was observed that the existence of the enablers and the methodology for implementing the enablers are not renowned in the construction industry. Thus, a list of barriers that occur due to limited awareness in the construction industry is developed

Contractual barriers: Contracts play a vital role in implementing flexibility in a project. The type of contracts reflects the extent to which flexibility can be incorporated in a project. The fixed price contracts restrict the implementation of the changes in scope (Inayat et al., 2015). The strict structure of the contract does not leave any room for the contractors or the other parties to come up with solutions with more value. Thus, it is important to develop a list of barriers that occur due the structure of contracts.

The table below shows the categorization of the barriers based on the categories discussed above.

Table 2-3 Categorization of barriers (Framework from theory)

Organizational behavior	Stakeholder driven barriers	Limited awareness	Contractual barriers
Solution oriented thinking	Stakeholder needs are unknown	Limited awareness of the enablers	Policy, standards, interface, norms, guidelines, laws and regulations
Limited involvement of the business owner after allotting the budget	Poor communication among the stakeholders	Limited training or coaching for interpreting the functions	Contractual limitation
Limited transparency in decision making	Self-interest of the stakeholders	Available preparation time	

Risk averse behavior of the project managers and client	Difference in perception among the stakeholders		
	Lack of trust among the stakeholders		
	Limited involvement of the stakeholders		

"Until now in the literature review, the first key word "flexibility in project scope" was discussed. The literature started with understanding the concept of flexibility in project scope. Further, the enablers for flexible scope were identified. The enablers related to hard and soft factors were identified. In total 13 enablers were identified. Out of 13 enablers, 3 enablers were selected for further research. The barriers for implementing the three enablers were identified. The barriers were categorized into four category which lead to the formation of our theoretical framework"

In the next section, the second key word of the research "VE" will be discussed. The section starts with a discussion about the VE. Further, the six steps of VE are discussed. In addition, a table is formulated with the benefits of performing VE in the construction industry.

2.5 What is Value Engineering?

Value Analysis (VA) is a study which can be applied on projects which aims for improving the performance and eliminate the extra costs in a project (Ilayaraja & Eqyaabal, 2015). VA was conceived for the first time in 1940s by Lawrence Miles and Harry Erlicher while working at General Electric. During world war II, there was shortage of component parts, skilled labor and raw materials. Lewis and Erlicher searched for acceptable substitutes. They noticed that these substitutions often reduced costs, improved the product, or both. What started out as an accident of necessity was turned into a systematic process (Tang & Bittner, 2014). They called their technique "value analysis". Group of practitioners formed a learning society by the name "Society of American Value Engineers" (SAVE) in 1959 at Washington, DC.

VA is classified into two approaches namely hard system approach or "VE" and the soft system approach or "value management" (VM). VE is a creative, organized effort, which analyzes the requirements of a project for the purpose of achieving the essential functions at the lowest life cycle cost (Heralova, 2016). While value management is a process whereby the project is evaluated and scrutinized to obtain maximum value for money by following a prescribed methodology. It focuses on the value, rather the cost, in relation to the function of the element of the project (Olawumi & Arijeloye, 2016). In this research, both the methodologies will be described by terminology VE as both the approaches are combinedly applied in a project.

VE is widely accepted in the construction industry as an essential tool in the management of the projects (Ellis et al., 2005). Alphonse Dell'Isola was one of the first person to explore the application of VE in the construction industry (Dell'Isola, 1982). Many times, VE is confused with a cost cutting technique in the construction industry (Ilayaraja & Eqyaabal, 2015). The main objective of VE is to improve the value of the project (Zhang, Mao & AbouRizk, 2009). Many tools and techniques are applied during VE to improve value, these techniques consist of FAST diagram, creative thinking technique, life cycle costing and weighted scoring techniques and other (Rad & Yamini, 2016).

VE can be applied throughout the processes. Implementing VE at the right moment in a project increases the value of the project by focusing on the functional requirements of the project by generating multiple alternatives. Secondly, it encourages different stakeholders to discuss the ideas in a structured way. It is

recommended to apply VE at the FED as the cost of change increases as the project progresses as shown in figure 2-3 (Siterman, 2009).

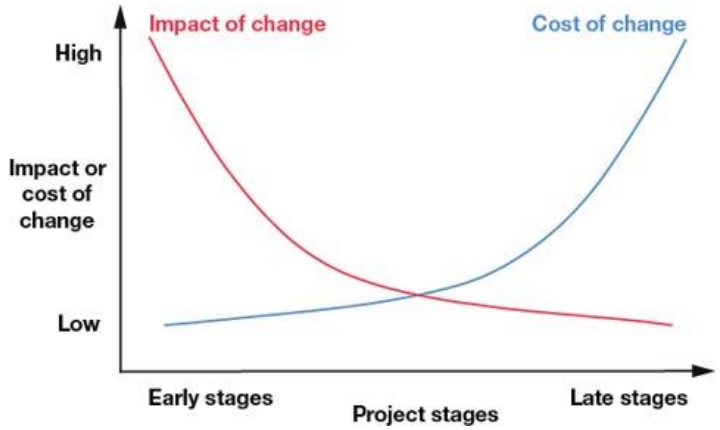

Figure 2-3 Cost of change increases as time progresses (Siterman, 2009).

Green (1994) observed that VE can be implemented at two different stages of the project life cycle. The first stage analysis is performed at the end of the concept stage where the product is suggested as a possible solution to the perceived problem. The main objective of this analysis is to verify the need before the client become committed for the financial expenditure. This can be used to develop a structured goal for the project which could be understood by all the stakeholders. The second stage of the analysis is performed at the end of the feasibility stage, where previously established design objectives are reviewed and the design option with the greatest value for money is selected. VE can be most effective at the preliminary stages of planning and designing where the client has more flexibility. However, the impact of conducting VE might change according to the phase in which it is conducted but it can be applied at each phase of the project (Rad & Yamini, 2016).

Many authors have discuss the benefits of conducting VE in a project (Shen and Chung 2002; Dell'Isola, 1982; Ilayaraja & Eqyaabal, 2015; Rad & Yamini, 2016). According to Shen and Chung (2002), benefits of a successful VE study in construction includes savings project costs, clarifying the client's objectives, improved communication between stakeholders, and enhanced creativity through the interaction of the participants of the VE workshop. VE brings all the stakeholder together during the decision-making process (Government of Western Australia, 2005). Dell'Isola (1982) mentioned that VE should not be just limited to improve the value of the project. It is also utilized for:

a) Lack of shared data and information exchange.
b) Limited ideas to generate and develop alternative solutions to fit the requirements of the stakeholders.
c) Developing the habit and attitude of the stakeholders as a response of doing the same thing with same procedure.
d) Limited communication and coordination within the stakeholders
e) Using outdated standards and technologies.
f) VE will help to focus on latest technology.

2.5.1 Six steps of VE

As mentioned earlier, many authors have discussed the importance and benefits of performing VE in different industries but still there is lack of document evidences showing the potential benefits of performing

VE in a construction project (Ahmed & Pandey, 2016). The public opinion on VE is controversial as shown in the engineering New Records website, in which almost half of the respondents think VE is a valuable constructability tool whereas the rest think it is a marketing ploy (Zhang, Mao & AbouRizk, 2009). In addition, there is lack of awareness in the construction industry about the VE and how it is performed in the construction industry (Olawuyi, 2009; Bowen,2010).

The methodology of VE consist of six steps which is a standard process. There are no significant changes in the six steps since the methodology is introduced. Discussing the six steps in detail might not add value as we are not bringing anything new to the literature but observing the limited awareness about the methodology in the construction industry, it was decided to discuss the six steps in detail to make our readers aware about the insights of the methodology. It will be a good base for the readers to understand the background story of the upcoming steps of the research.

As mentioned earlier, many authors have discussed the methodology in detail (Dell'Isola, 1982; Shen and Chung 2002; Ilayaraja & Eqyaabal, 2015; Zhang, Mao & AbouRizk, 2009) but we prefer to discuss the six step of the VE on the basis of SAVE (2007) as it was one of the initial organization that was set up for the VE in the year 1959.

According to SAVE (2007), the value study consists of three stages as shown in figure 2-4.

1) Pre workshop (preparation)
2) Workshop (six phases of job plan)
3) Post workshop (documentation and implement)

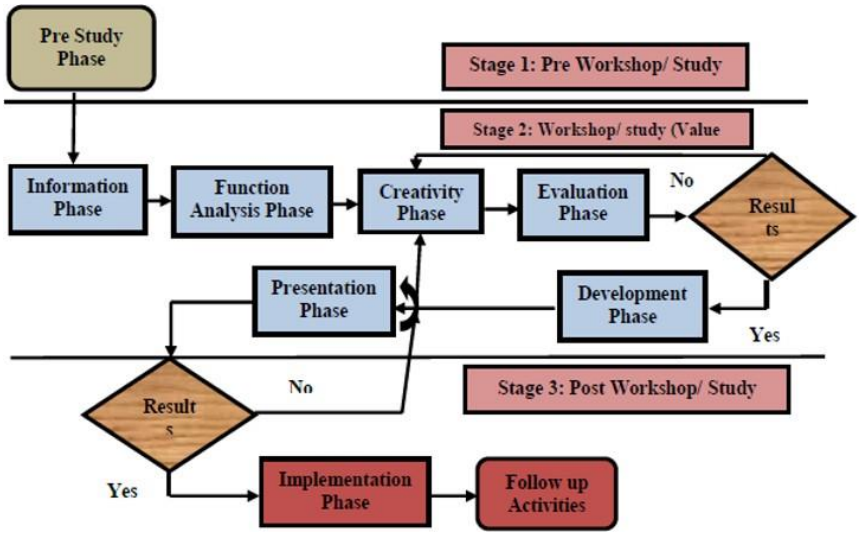

Figure 2-4 Value study process flow diagram (Phyo & Cho, 2014)

The six phases of job plan are as follow:

According to SAVE (2007), the six phases of the workshop (Job plan) consist of:

1) Information phase:

Purpose: Understand the current state of the project and constraints that influenced project decisions.
Fundamental question: What is really going on in the project?

Outcome: The phase is devoted towards bringing the stakeholders together and develop an extensive understanding of the project (Norton & McElligott, 1995). The main objective is to make all the participants understand the current state of the project and the constraints which will influence the decision-making process (SAVE International, 2007). The presentation by the designers and other stakeholders is presented during this phase to bring all the participants at the same level of understanding of the project situation (Che'mat, 2010). A mutual understanding is expected to reach among the stakeholders regarding the fundamental issues of the project.

2) Functional analysis phase

Purpose: Understand the project from a functional perspective; what must the project do, rather than how the project is currently conceived.
Fundamental question: What are the functions and how are they related?
Outcome: The objective of this phase is to understand the project from the functional perspective. Function directs towards "what project is supposed to do" instead of directly jumping to solutions. The phase helps to identify the scope of the project by reflecting the relationship between all the identified functions of the project (Canadian Society of Value Analysis, 2013). Performing the functional analysis at the early stage of the project helps to identify the project problems and offers multiple solutions with best value (Kelly, et al., 2004).This phase involves the workshop participants to work together to identify and define the functions for the project. FAST (Function Analysis System Technique) is used during this phase. According to Parker (1998), the FAST diagram is a tool to serve:

I. Organizing and listing the functions
II. Identifying the functions and scope of the study
III. Visualize and understand the problem of the study for better understanding of the project and functions
IV. Determine the relationship between the functions and system
V. Stimulate creativity.

The FAST diagram helps to understand the relationship among the functions, scope and project objectives. The functional understanding develops the benchmark for the alternatives and look for innovations. FAST is a technique to develop a graphical representation showing the logical relationships between the functions of a project, product, process or service based on the questions "How" and "Why" (Borza, 2011). Kaufman & Woodhead (2006) suggested two ways for managing functional analysis. The first one is the customer oriented FAST diagram which emphasis on the needs and wishes of the stakeholders. The second one is the technology oriented FAST method which is specifically applicable in a project where specific requirements or specifications are supposed to be met. It is advisable to invest sufficient time on collecting information and understand the problem to develop functions for the project.

3) Creativity phase

Purpose: Generate a quantity of ideas related to other ways to perform functions
Fundamental question: How else may the functions be performed?
Outcome: The creative phase brings all the participant together to explore and discover solutions according to the functional relationship found in the last phase (Parker, 1998). The team aims at developing broad array of ideas that provided multiple variety of possible ideas to fulfill the function of the project (SAVE international, 2007). The stakeholders and team's expertise are used during this phase. Brainstorming technique is the foremost approach in this phase. Brainstorming technique is a

collective problem-solving technique that stimulate quantity and quality of creative ideas with the involvement of participants (Al-Samarraie & Hurmuzan, S., 2018).

4) Evaluation phase

Purpose: Reduce the quantity of ideas that have been identified to a short list of ideas with the greatest potential to improve the project
Fundamental question: Of all these ideas, which are worth spending quality time to further develop?
Outcome: Ideas identified during the creativity phase are not judged as the free flow of ideas is preferred to stimulate creativity (Che'Mat, 2002). This phase consists of evaluating the alternative solutions generated in the last phase and narrowing down the list to develop into value-based solutions (SAVE international, 2007). The ideas generated in the last phase are weighted against the advantages and disadvantages it has towards the project (Dell'Isola, 1982). Set of evaluation criteria are established by the participants according to which each idea is ranked. Weighted comparison techniques are used to rank the ideas.

5) Development phase

Purpose: Further analyze and develop the short list of ideas and develop those with merit into value alternatives.
Fundamental question: What is an informed description of each selected idea? What is the rationale for making this change? Which ones are mutually exclusive and are independent?
Outcome: The ideas are transformed into alternatives. The phase aims further towards developing the generated solution in more detail (Che'Mat, 2010). Documents like cost calculations, drawings, cost comparison and CBA are developed to reach the best suitable solution (Dell'Isola, 1982).

6) Presentation phase

Purpose: Present value alternatives to management team and other project stakeholders or decision
Fundamental question: How can we help the project team and senior managers make more informed decisions so that they can select ideas that fit their strategic plans?
Outcome: In this phase of the job plan, ideas are presented to the decision makers in a way that they can select the ideas that fit their strategic plan. The aim is to present value alternatives to the management team and other stakeholders. The whole implementation process of Job plan phases reflects the importance of a sequential decision-making process which demands for active involvement of the stakeholders and the multi-disciplinary team.

"In the last section, VE was discussed in detail. It was observed that VE is just not limited to a cost cutting technique. It aims towards adding value to the project. It was also observed that VE can be applied at any stage of the project but it can be most effective at the FED phase of the project. The methodology of VE lacks awareness in the construction industry"

2.5.2 Benefits of performing VE

As mentioned previously, construction industry lacks awareness about the methodology of VE. There are lack of evidence about the benefits of VE in construction industry. Adding to it, public opinion in a survey about VE was mixed as some feel that VE can be a marketing ploy(Zhang, Mao & AbouRizk, 2009).

It can be observed that the clear evidences of benefits of performing VE in the construction industry is missing (Ahmed & Pandey, 2016). In addition, there are no clear evidence about the respondents who filled the survey mentioned by the author (Zhang, Mao & AbouRizk, 2009). From the details of the survey, it is not clear if the respondents had prior experience with VE and hence, it is important for our research to develop a list of benefits of conducting VE in a construction project and perform a survey with the respondents who have experience with VE. This can help to better understand the insights of VE for the further research.

A list of benefits was formulated based on the research of authors (Kelly, et al., 2004; Rad & Yamini, 2016; Ahmed & Pandey, 2016; Heralova, 2016; Zhang, Mao & AbouRizk, 2009; Ilayaraja & Eqyaabal, 2015) as shown in table 2-4. The idea of conducting a survey was originated from the research of Ilayaraja & Eqyaabal (2015). In the research of Ilayaraja & Eqyaabal (2015), a survey was conducted to get better understanding about the awareness about the VE. In a similar way a survey was conducted with the list of benefits observed during the literature review in this research only with the respondents who have experience with VE.

Table 2-4 Benefits of performing VE in a construction project

	Benefits of performing VE in a construction project
1.	VE helps to bring the stakeholders together
2.	VE stimulate exchange of information among the stakeholders
3.	VE enhances extensive understanding of the project among the stakeholders
4.	VE enhances interaction among the stakeholders
5.	VE bring stakeholders at same level of understanding
6.	VE helps to understand needs of the stakeholders
7.	VE helps to understand the project from functional perspective
8.	VE helps to look at the bigger picture instead of focusing on self-interest
9.	VE helps to strengthen teamwork among the stakeholders (Collaboration)
10.	VE helps to develop trust among the stakeholders
11.	VE helps to gain stakeholders support
12.	VE helps to reduce conflict among the stakeholders
13.	VE helps to enhances commitment of the stakeholders
14.	VE enhances transparency in decision making
15.	VE helps to develop confidence among the stakeholders
16.	Generate multiple ideas for the problem
17.	Analyzing the generated solutions for different risk scenarios
18.	Reducing the cost of the project without compromising on the functionality (Adding value)
19.	Reduces the time duration of the project
20.	VE helps to stimulate innovation
21.	Evaluating the best generated ideas

“It was observed that explicit evidences of benefits for performing VE in a construction projects are limited in literature. Hence, a survey will be conducted in the next chapter to get a better understanding of the identified benefits from the literature”

After performing the literature study, exploratory interviews were conducted with practitioners to understand their perspective about the flexibility in scope. During the interview, potential barriers for enhancing flexibility in a project were discussed. To conclude, the list of barriers identified during the exploratory interviews were comparable to the list of barriers identified in literature. The detailed analysis can be found in appendix 3.

Conclusion

Many authors have explored the concept of flexibility in project management. It was observed that research based explicitly on flexibility in project scope was limited. Thus, while conducting the literature review, flexibility in project management was also explored in detail. The chapter provided with different perspective of flexibility in a project. For our research, the definition of flexibility was narrowed down to two perspective that were “adjust” and “keeping the options open”. In total 13 enablers for flexible scope were identified out of which 3 enablers were selected for further research. In addition, barriers for implementation of the enablers were identified. The identified barriers were categorized into four clusters. That led to development of the theoretical framework.

The second key word for the research is VE. The literature helped to understand the insights of the VE. It was observed that VE is just not limited to a cost cutting technique. It aims towards adding value to the project. It was also observed that there is lack of awareness about the methodology and how it is performed in the construction industry. Keeping that in mind, the six steps of VE were discussed in detail. It was observed that the benefits of VE are not explicit in the construction industry and hence, a list of benefits was developed in the section.

Overall, the literature review helped to develop a baseline for upcoming steps of this research. This chapter provided answers to research question 1,2 &3. Furthermore, in the next chapter, a survey will be conducted regarding the benefits of performing VE in construction project and the barriers for implementing the enablers.

3. SURVEY

3.1 Introduction

This chapter is the first step towards the empirical research. In this chapter, a survey analysis was conducted consisting of the benefits of performing VE and the barriers for implementing the enablers for flexible scope. The literature review only provided the list of benefits and the barriers but didn't reveal to what extent these benefits are experienced by the practitioners or the barriers faced by the practitioners in a project. As discussed in the last chapter, there is limited clarity about the benefits of VE in construction industry and hence, it might be a good idea for this research to conduct a survey. The data gathered using the survey will be evaluated and based on the evaluation criteria and conclusions will be presented later in this chapter.

3.2 Survey design

The survey consists of two parts. The first part of the survey focuses on identifying to what extent the benefits of VE were experienced by practitioners in their projects. The second part of the survey focuses on the barriers for enhancing the flexibility in project scope.

3.2.1 Survey procedure

The survey was designed on an online based platform, Qualtrics. The survey was shared through email consisting of the link to the survey. The survey was in the Dutch language for improving the response rate. The email consisted of the abstract introduction to the research to provide the respondents with background information about the survey to the respondents. This will help them to understand the context of the survey. The survey was divided into three parts as discussed below:

a) The first part consist of four questions which aims to gather the background information of the respondents as discussed in detail in section 3.2.2. The questions were related to their "role in industry" "years of working experience", "company working in" & "number of VE studies they were part of".
b) The second part of the survey consists of 21 benefits of VE. The respondents were expected to score the benefits with respect to their experience after performing VE in their project. The respondents were given five options consisting of (1= strongly disagree, 2= disagree, 3= neither agree nor disagree, 4= agree, 5= strongly agree).
c) The third part of the survey consist of the barriers for implementing the enablers for flexible scope. The respondents were expected to give scores to the barriers according to their experience in projects. The respondents were given three choices consisting of (1= agree, 2= neither agree nor disagree, 3= disagree).

In the third part of the survey, three options were given instead of five because the survey was only filled by the respondents who have experience with VE. The population of respondents consisted of project managers, technical managers, value managers and environmental managers. The author was not sure if all the respondents will be in the position to fill the third part. To have minimum impact on the response rate, three options were provided rather than five to prevent over complication of the survey, especially for the respondents. The survey was shared with at least 100 respondents. In total 26 respondents filled the survey. It was observed that some respondents, from the list of 26, partially filled the survey. The protocol for the survey can be found in appendix 4.

3.2.2 Respondents characteristic

VE is not a mandatory step in the projects at RWS and hence limited practitioners have experience with VE. Hence, it was decided to share the survey with practitioners in multiple organizations. The survey was distributed only among the practitioners who have experience working with VE. The survey was shared with all the value engineers at RWS, Prorail, Arcadis, Witteveen+Bos and free lancers. The survey was also shared with the project teams who were involved in the VE study. Therefore, the data collected was from the practitioners in the field of VE. The same respondents also filled the second part of the survey that was about the barriers for implementing the enablers for flexible project scope. The characteristics of the respondents taking part in the survey in terms of working experience, experience with VE projects and current position in the organization is shown in figure 3-1, 3-2 & 3-3.

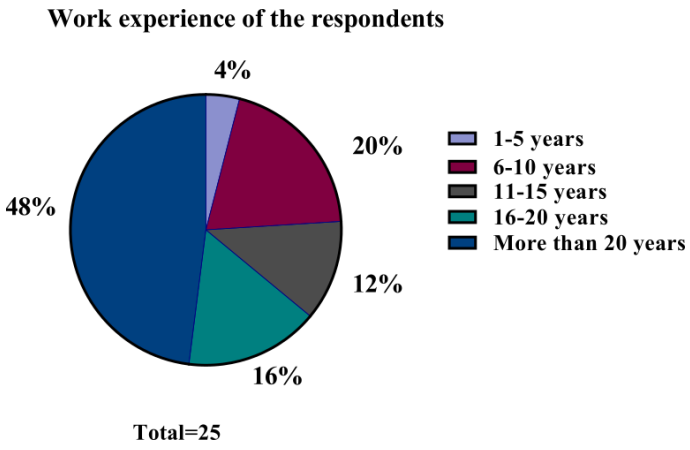

Figure 3-1 Pie chart depicting the number of years the respondents have been in the construction industry

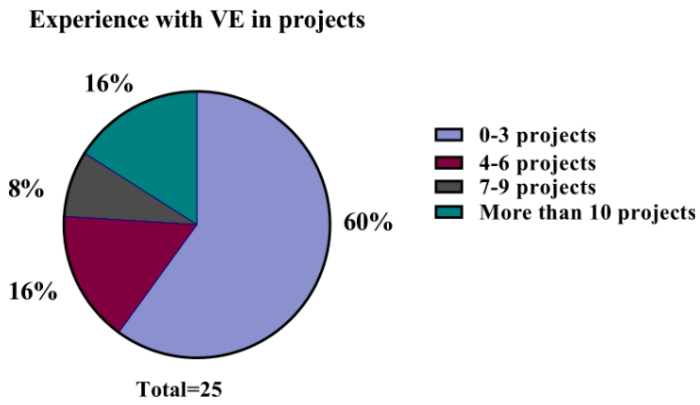

Figure 3-2 Respondent's experience with VE projects

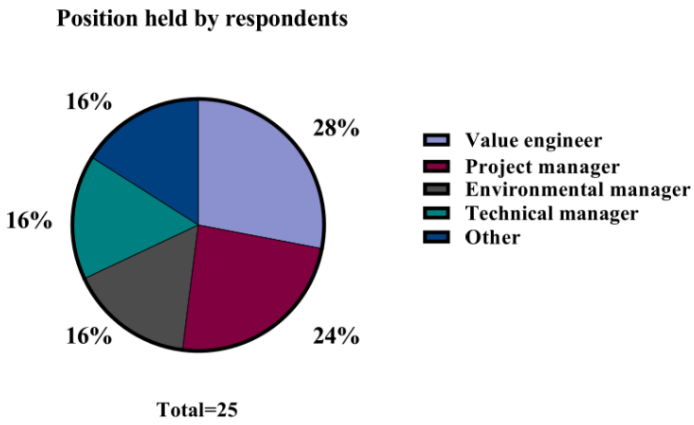

Figure 3-3 Position held by respondents of the survey

3.3 Analysis method

In total 25 respondents filled the survey. The survey aimed towards ranking the benefits of performing VE and barriers for implementing the enablers for flexible scope. Two methods were used for ranking the data gathered by the survey. The first method was Relative importance index (RII) which is explained in detail below. During the analysis, it was realized that some factors had similar RII score. Standard deviation was used as the second criteria for ranking the factors which had similar score. The two methods which were chosen for this research are explained below.

a) RII: Many authors have analyzed the survey data with the RII method and shown their support towards the method (Gunduz, Nielsen & Ozdemir, 2013; Johnson & Lebreton, 2004; Rooshdi, Abd Majid, Sahamir & Ismail, 2018). The same method was adopted in this research for ranking the factors. The RII aim towards identifying the most important factor based on the respondents response in comparison to the other factors. The RII value have a range from 0 to 1. Higher the RII value, more that specific benefit was experienced by the practitioners after performing VE in their project. Secondly, higher the RII value, more frequently that specific barrier was experienced by the practitioners for implementing the enabler.

The following formula is used for determining the RII:

$$RII = \frac{\varepsilon w}{AN} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + ln\,1}{5N}$$

Where “w” is the weighing factor given to each factor by the respondent, ranging from 1 to 5. For example, n_1 = number of respondents for little importance. n_2 = number of respondents for some important, n_3 = number of respondents for quite importance, n_4 = number respondents for important, n_5 = number of respondents for very important. “A” is the highest weight (5 in the study) and “N” is the total number of respondents.

b) Standard deviation: Many author have previously used this methodology to analyze the data for their research (Parker & Skitmore, 2005; Raz & Michael, 2001; Kenley & Wilson, 1986; Jeang, 2015). It was realized during the analysis of the data gathered from the survey, that some factors have similar RII scope. To act as tie breaker, there were several methods that could have been used like skewness, kurtosis and risk of exceeding the mean. Standard deviation was used as it can give an idea about the variability of the results. Standard deviation is a measure of the amount of variation or dispersion of a set of value around the mean (Lee, In & Lee, 2015). Greater the standard deviation, higher the magnitude of dispersion of the value from mean. The factors which had similar score, were awarded the rank based on their respective score of standard deviation. Higher the score of standard deviation, less is the reliability of the factor.

3.4 Analysis of the results for benefits of VE

The survey was shared with at least 100 respondents. In total 26 respondents filled the survey. It was observed that some respondents, from the list of 26, partially filled the survey. The table 3-1 reflects the results of the survey conducted with the respondents. The RII score was evaluated and based on the RII score, ranking was awarded. It was realized that some benefits have similar RII score. The second criteria for the ranking was standard deviation (SD). Based on the SD, final ranking was formulated. The colored section in the table reflects the benefits which had similar RII score. The first column that is the 'S.no' signifies the order in which the benefits were presented to the respondents.

Table 3-1 Ranking for the benefits of performing VE based on the survey

S.no	Benefits of performing VE	RII	MIN score	MAX score	Mean	Ranking on RII	SD	Final Ranking
16	Generate multiple ideas for the problem	0.92	3	5	4.6	1	0.645	**1**
13	Enhance commitment of the stakeholders	0.904	4	5	4.52	2	0.509	**2**
1	Bring the stakeholders together	0.904	3	5	4.48	2	0.585	**3**
4	Enhance interaction among the stakeholders	0.896	4	5	4.48	4	0.509	**4**
3	Enhance extensive understanding of the project among the stakeholders	0.88	2	5	4.24	5	0.83	**5**
2	Stimulate exchange of information among the stakeholders	0.864	3	5	4.32	6	0.748	**6**
8	Look at the bigger picture instead of focusing on self-interest	0.864	2	5	4.32	6	0.852	**7**
11	Gain stakeholders support	0.848	3	5	4.24	8	0.663	**8**
7	Understand the project from functional perspective	0.84	3	5	4.2	9	0.816	**9**
21	Evaluating the best generated ideas	0.824	3	5	4.12	10	0.781	**10**
9	Strengthen teamwork among the stakeholders (Collaboration)	0.816	3	5	4.08	11	0.640	**11**
15	Develop confidence among the stakeholders	0.808	3	5	4.2	12	0.577	**12**
5	Bring stakeholders at same level of understanding	0.808	2	5	4.04	12	0.675	**13**
17	Analyzing the generated solutions for different risk scenarios	0.8	2	5	4	14	0.912	**14**
10	Develop trust among the stakeholders	0.792	2	5	4.04	15	0.734	**15**
12	Reduce conflict among the stakeholders	0.792	2	5	3.96	15	0.934	**16**
6	Understand needs of the stakeholders	0.768	2	5	3.92	17	0.812	**17**
18	Reducing the cost of the project without compromising on the functionality	0.728	2	5	3.64	18	1.03	**18**
14	Enhances transparency in decision making	0.728	2	5	3.72	18	1.06	**19**
20	Stimulate innovation	0.712	2	5	3.56	20	0.869	**20**

19	Reduces the time duration of the project	0.664	2	5	3.32	21	1.07	**21**

Observation from the table 3-1:

Observation 1: All the benefits had a RII score more than 0.6. This reflects that all the benefits identified in the literature were recognized by the respondents.

Observation 2: Out of 21 benefits mentioned in the survey, 15 benefits had a RII score more than 0.8. As all the respondents were the practitioners who had experience with VE, this might increase the reliability of the benefits identified from the literature.

Observation 3: The top five benefits that were experienced by the respondents were “Generate multiple ideas for the problem”, “Enhance commitment of the stakeholders”, “Bring the stakeholders together”, “Enhance interaction among the stakeholders” & “Enhance extensive understanding of the project among the stakeholders”.

Observation 4: “Reduces the time duration of the project” was the least experienced benefit by the respondents according to the RII.

Observation 5: Benefits (2 & 8), (15 & 5), (10 & 12) & (18 & 14) had a same RII score. Standard deviation was used as the second criteria for evaluating the final ranking. The benefits having the higher standard deviation was ranked lower as the RII score will be less reliable.

Observation 6: The lowest four ranked benefit had a standard deviation almost more than 1. This reflects that as the RII score reduced, the reliability of the scores of RII also reduces.

The survey also consisted of a text box for the respondents to fill in any additional benefits/ drawbacks or their comments regarding their experience which were not specified in the survey. Some common responses are as follows:

1) VE makes the core needs of the parties explicit
2) VE accelerates the decision making process
3) VE can help to core with solutions which no one imagined during the front end phase
4) It was also mentioned by the respondents that the benefits will be experienced depending on the time VE is conducted in the project. There is also a lot of customization with the way in which the VE process is completed. This means that many more benefits can be achieved if desired.

The figure 3-4 reflects the response of the respondents for the benefits of VE. On an average, 25 respondents filled the survey. The “statement x” reflects the 21 benefits of VE which are mentioned in table 3-2.

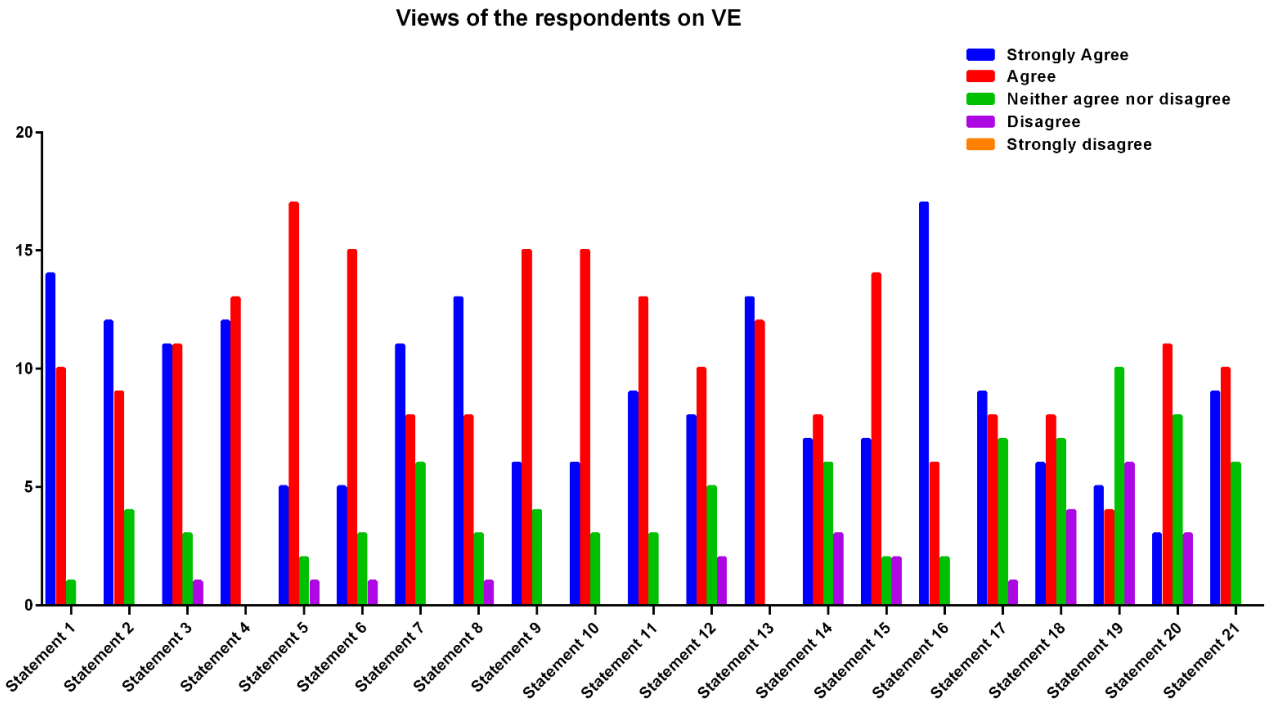

Figure 3-4 Responses of survey respondents on statements enlisted in table 5 on Value engineering

Table 3-2 Description of statement presented to the respondents

Statement Number	Description
Statement 1	VE helps to bring the stakeholders together
Statement 2	VE stimulate exchange of information among the stakeholders
Statement 3	VE enhances extensive understanding of the project among the stakeholders
Statement 4	VE enhances interaction among the stakeholders
Statement 5	VE bring stakeholders at same level of understanding
Statement 6	VE helps to understand needs of the stakeholders
Statement 7	VE helps to understand the project from functional perspective
Statement 8	VE helps to look at the bigger picture instead of focusing on self-interest
Statement 9	VE helps to strengthen teamwork among the stakeholders (Collaboration)
Statement 10	VE helps to develop trust among the stakeholders
Statement 11	VE helps to gain stakeholders support
Statement 12	VE helps to reduce conflict among the stakeholders
Statement 13	VE helps to enhances commitment of the stakeholders
Statement 14	VE enhances transparency in decision making
Statement 15	VE helps to develop confidence among the stakeholders
Statement 16	VE helps to generate multiple ideas for the problem
Statement 17	VE helps to analyze the generated solutions for different risk scenarios
Statement 18	VE helps to reduce the cost of the project without compromising on the functionality
Statement 19	VE helps to reduce the time duration of the project
Statement 20	VE helps to stimulate innovation
Statement 21	VE helps to evaluate the best generated ideas

3.5 Analysis of the results for barriers for implementing the enablers for flexibility in project scope

This section discusses the descriptive statistics for the data gathered from the survey about the barriers for implementing the enablers for flexibility in scope. A group of 26 respondents filled the survey and an average of 22 statements were answered by each respondent for this specific section. The table 3-3 reflects the RII and the SD score. The final ranking is based on the RII score. As there were no similar RII score, SD was not used as the criteria for ranking the factors.

Table 3-3 Ranking for the barriers for implementing the enablers based on the survey

S.no	Barriers	RII	MIN score	MAX score	Mean	SD	Final Ranking
8	Difference in perception among the stakeholders	0.904	1	3	2.71	0.56	**1**
10	Limited involvement of the stakeholders	0.888	2	3	2.66	0.483	**2**
9	Lack of trust among the stakeholders	0.873	2	3	2.61	0.497	**3**
7	Self-interest of the stakeholders	0.825	1	3	2.47	0.679	**4**
3	Risk averse behavior of the project managers and client	0.811	1	3	2.43	0.662	**5**
6	Poor communication among the stakeholders	0.809	1	3	2.42	0.746	**6**
14	Policy, standards, interface, norms, guidelines, laws and regulations	0.793	1	3	2.42	0.746	**7**
13	Available preparation time	0.777	1	3	2.33	0.795	**8**
4	Knowledge of specific products at the client	0.753	1	3	2.26	0.751	**9**
15	Structure of the contract limits the implementation of the scope	0.746	1	3	2.23	0.83	**10**
12	Limited training or coaching for interpreting the functions	0.714	1	3	2.14	0.654	**11**
11	Limited awareness of the enablers of flexibility	0.683	1	3	2.04	0.497	**12**
2	Limited transparency in decision making	0.652	1	3	1.95	0.858	**13**
5	Stakeholder Needs Are Unknown	0.637	1	3	1.91	0.596	**14**
1	Limited involvement of the business owner/client after allotting the budget	0.569	1	3	1.7	0.858	**15**

Observation from table 3-3

Observation 1: “Difference in perception among the stakeholder” had a RII score of 0.904. The score is quite high. This reflects that all most all the respondents have experienced the barrier in their projects. During the case analysis, extra attention should be given to this specific barrier.
Observation 2: The barrier “Limited involvement of the stakeholders” & “Lack of trust among the stakeholders” had a MIN score of “2”. This means that none of the respondents disagreed with these two barriers.
Observation 3: The top four ranked barriers according to the table 3-3 belongs to the category of “stakeholders driven barrier”.
Observation 4: “Limited involvement of the business owner/client” barrier was least recognized by the respondents. Almost 50% of respondent didn’t agree with the barrier.
Observation 5: No specific trend was observed for the standard deviation of the survey data.

The figure 3-5 reflects the response of the respondents for the barriers experienced by the practitioners for implementing the enablers. On an average, 21 respondents filled the survey. The “statement x” reflects the 21 barriers experienced by the practitioners for implementing the enablers which are mentioned in table 3-4.

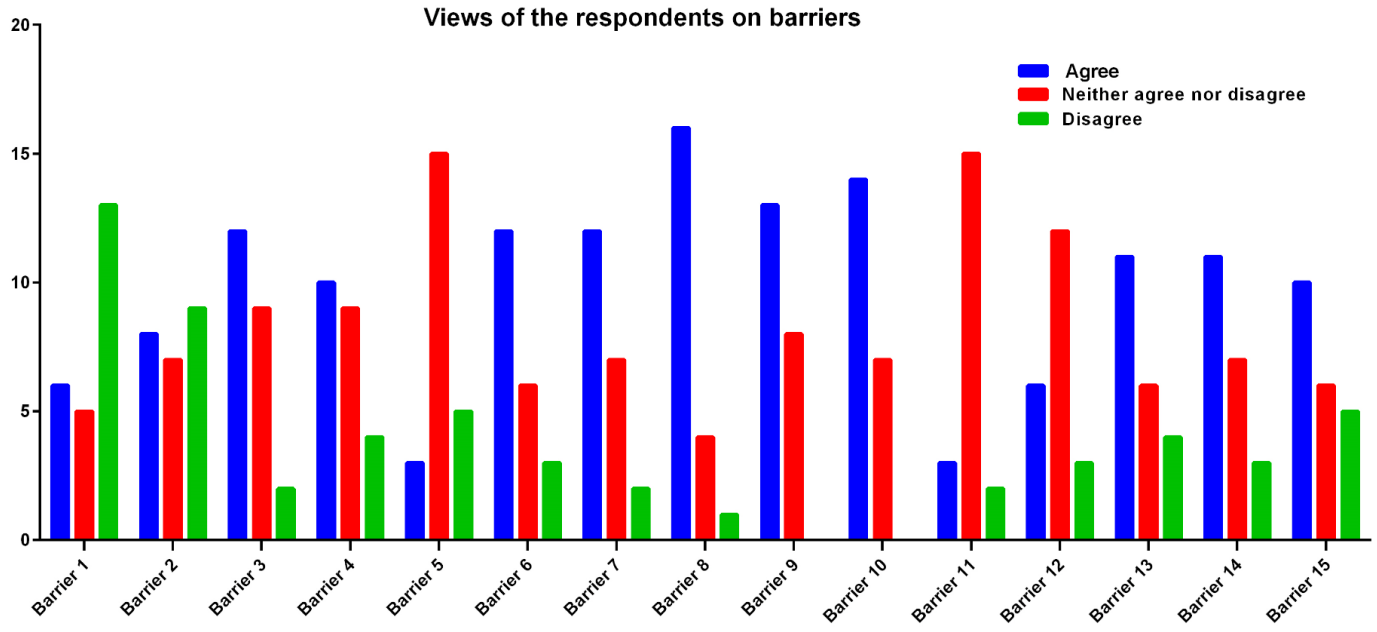

Figure 3-5 View of the respondents on 15 identified barriers enlisted in table 7

Table 3-4 Barriers presented to the respondents

Barrier 1	Limited involvement of the business owner/client after allotting the budget
Barrier 2	Limited transparency in decision making
Barrier 3	Risk averse behavior of the project managers and client
Barrier 4	Solution oriented thinking
Barrier 5	Stakeholder Needs Are Unknown
Barrier 6	Poor communication among the stakeholders
Barrier 7	Self-interest of the stakeholders
Barrier 8	Difference in perception among the stakeholders
Barrier 9	Lack of trust among the stakeholders
Barrier 10	Limited involvement of the stakeholders
Barrier 11	Limited awareness of the enablers of flexibility
Barrier 12	Limited training or coaching for interpreting the functions
Barrier 13	Available preparation time
Barrier 14	Policy, standards, interface, norms, guidelines, laws and regulations
Barrier 15	The structure of the contract limits the implementation of the scope

Conclusion

A list in the ranking order for the benefits of conducting VE in a construction industry and the barriers for implementing the enablers was formulated as shown in table 3-1 and 3-3 based on the survey conducted with the practitioners. RII and standard deviation was used as the criteria for ranking the factors. In the next step, the case analysis will be conducted to understand the perspective of the practitioners about the three enablers. The presence of all the 15 barriers identified in the last chapter will be observed in the next chapter. In addition, it will also be observed if VE can help to resolve the barriers for implementing the enablers.

4. CASE STUDY

Common barriers for implementation of the enablers of flexible scope management were identified during the literature review in the last chapter. Due to the limited literature available on the implementation of enablers of flexibility in the construction industry, it is important to investigate how the enablers are implemented in the projects. Thus, a case study methodology will be formulated to investigate the implementation of the enablers in practice. Simultaneously, the role VE play in the implementation of enablers of flexibility to enhance scope flexibility will also be investigated. The theoretical framework with the list of barriers was formulated in the second chapter which will allow to investigate the presence of the barriers in the infrastructure projects. The case study analysis will help understand the application of the enablers in projects. For that, it is vital to investigate the significance of the theoretical barriers in practice. In addition, it is important to understand the role of VE in implementing the enablers to become flexible on scope. In the next section, the research methodology consisting of case study protocol will be explained.

This chapter also comprises the results of the case study analysis conducted on the two projects. Apart from the literature study, it is essential to gather and analyze the data collected from the interviews to investigate the added value of performing VE for becoming flexible on scope. As mentioned in the last chapter, semi structured interviews were conducted with 8 respondents involved in the two projects. The respondents were the members of project team and the value engineers who were present during the front-end phase of the project. The aim was to investigate the presence of the enablers in the project and the barriers for implementing the enablers. The second aspect of the case analysis is to investigate if VE helped to resolve the barriers in the projects. An in-depth analysis was performed which helped to understand the perspective of the practitioners on the enablers and their implementations. Furthermore, the presence of the barriers for implementing the enabler is investigated during the in-depth analysis. Cross case analysis was followed by the thorough analysis.

4.1. Case study design

Case study is a vital tool, especially when limited literature is available in the scientific world (Dul and Hak, 2007). As mentioned earlier, there exists limited literature based on the implementation of the enablers and thus case study methodology will be performed in this research. A case study is an empirical inquiry, in which the main focus lies on a contemporary phenomenon and its application in the real world, where at times the boundaries between phenomenon and its context may not clearly be evident Yin (2017). In this case study design, the aim is to understand the application of the enablers and identify frequently occurring barriers in the case studies for each enabler as well as comprehend the significance of the VE and how it will help to implement the enablers for flexibility in scope. According to Yin (2014), four of the following main types of case study methodologies can be executed:

1) Single case: Sigle case unit of analysis
2) Single case: Multiple case unit of analysis
3) Multiple case: Single case unit of analysis
4) Multiple case: Multiple case unit of analysis

For this research, multiple case: multiple case unit of analysis will be performed. Multiple case will allow in depth analysis of the application of the enablers in infrastructure projects. It will give the opportunity to analyze the data within each situation and across different situations (Gustafsson, 2017).

4.2 Criteria for selection of the case studies

To select the relevant cases for this research, several criteria were established to investigate various cases.

The criteria for the selection are as follows:

1) Project type: The research is being conducted in RWS, a government organization and which is responsible for developing and maintaining the infrastructure projects in the Netherlands. Hence, the case should be an infrastructure project which is executed in the Netherlands.
2) Role of Rijkswaterstaat: It is important to specify the role of the firm in the selected cases. As the research is conducted at an organization which acts as the client in the project, those cases were selected in which RWS acts the client.
3) VE: VE is an essential part of this research and hence it is mandatory that the VE should have been applied in the selected projects. In addition, VE should be performed in the front-end phase of the project.

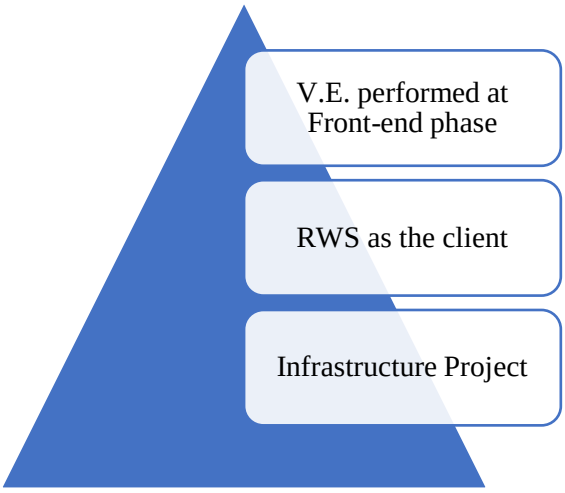

Figure 4-1 Characteristic for the selection of cases.

The selection criterion listed in figure 4-1 resulted in multiple potential cases for this research. For the final selection of the case, project managers were contacted from each case to understand their perspective regarding the suitability of the case for the research. Finally, two cases were selected in which VE was performed during front end phase of the project. The first project was Waalbrug and the second project was Friese bruggen.

After selecting the two cases, documents were reviewed related to the case. The documents consisted of the project summary, description, scope development process and VE report. The documents helped to understand the development of the scope and avoiding the misinterpretation of the facts during the interviews.

4.3. Interview

Interview is a source of collecting information through interactions with people (Kumar, 2011). Semi structured interviews were conducted in order to maximize productive discussions by keeping room for extra questions. The new questions can be formulated according to the circumstances with different interviewee. Due to the corona outbreak, it was decided to conduct interviews through online platform and not face to face. The interviews were recorded and analyzed further. The detailed interview protocol is present in appendix 5.

The first part of the interview consisted of general introduction of the interviewees and the interviewer, along with a brief enumeration of the overview of the research by the interviewer. This was done to familiarize the interviews with the overall objectives of the research. The second phase of the interview consisted of questions specific to the enablers of flexible scope. The questions were related to the application of the enablers and the challenges faced by the interviewees to implement them in the infrastructure project. Followed by the questions on enablers, questions related to the performance of the VE in the project were discussed. The interviewees were asked about the benefits they experienced by performing VE in their project. This discussion helped enhance understanding of the in-depth application of the enabler of flexible scope in the infrastructure project and how VE can help to implement the enablers.

4.4. Data Analysis

A qualitative analysis was performed after conducting the interviews and reviewing the documents. The aim was to perform in depth analysis of both the case to understand the application of the enablers and the barriers faced by the practitioner for incorporating the enablers. In the next step, the in-depth analysis helped to understand the role of VE for becoming flexible on scope. After performing the in-depth analysis, cross case analysis was performed. The cross-case analysis was a beneficial step and helped to identify the similarities and difference in the incorporation of the enablers in the two projects. The two main aims of conducting the data analysis. First, is to test the presence of the barriers in the selected cases for becoming flexible in terms of scope. Second, is to verify if VE can help enhance flexibility in scope by resolving the barrier for implementation of the enablers. After performing the data analysis, suggestions will be proposed for overcoming the barriers. Firstly, the general suggestions will be given for overcoming the barriers. Secondly, based on literature and data analysis, suggestions will be given if VE can help to resolve the barriers.

4.5. Expert session

After the analysis of the case and identifying the most common occurring barriers and the role of VE in implementing the enablers, a conceptual framework will be developed to stimulate flexibility in the scope of the project. The next phase of the research is to validate the proposed framework, experts will be invited to validate the results of the interviews and cross case.

4.6 Respondent characteristics

As mentioned in the last section, total of eight interviews were conducted for investigating the two cases in detail. Table 4-1 presents the characteristics of the interviewees along with the assigned code for the interviewees. The assigned codes will be used for the interviewees in the upcoming pages.

Table 4-1Respondents characteristics

Project	Code	Designation	Organization	Experience (years)
Waalbrug	1.1	Project manager	Rijkswaterstaat	34
	1.2	Environmental manager	Rijkswaterstaat	25
	1.3	Technical manager	Rijkswaterstaat	20
	1.4	Value engineer	Arcadis	30
Friese Bruggen	2.1	Project manager	Rijkswaterstaat	-
	2.2	Environmental manager	Rijkswaterstaat	27
	2.3	Technical manager	Rijkswaterstaat	-
	2.4	Value engineer	Witteveen + Bos	6

4.7 Case analysis results

The following sections reflect on the results and the analysis for the two cases studies along with a brief description about the respective projects. It is followed by the detailed analysis of how the enablers were applied and what was the need for applying the enablers by the practitioners in the industry. In the next section, a detailed analysis for the occurrence of the barriers faced by the practitioners for implementing the enablers were identified.

4.7.1 Case analysis results Case 1 – Waalbrug

4.7.1.1 Project description

The Waalbrug connects Nijmegen North (Lent) with the center area of Nijmegen. To the west of the Waal bridge lies the railway bridge and the recently built new bridge. The Waalbrug is an essential link in both the local and regional traffic networks and approximately 45,000 cars drive daily, and about 50,000 participants walk the bridge is due for maintenance. Rijkswaterstaat (RWS) was preparing to carry out major maintenance on the Waalbrug consisting of replacing the concrete floor, strengthening corroded parts, and installing a new preservation system. The aforementioned work will inevitably lead to significant traffic disruption and adverse effects on Nijmegen's accessibility and economic functions. De Waal is an essential route for shipping traffic. During the maintenance work on the bridge, the impact on shipping traffic should be minimized. Rijkswaterstaat has set aside money for this maintenance within the so-called Nomo budget. The condition is that the bridge's major maintenance is carried out before 1 January 2018 and is financially settled. This puts time pressure on the major maintenance of the Waalbrug.

The client had already a devised plan for the renovation of the bridge. According to the plan, the bridge was expected to be completely closed until completion of the renovation Replacing the concrete floor and preserving the steel of the Waalbrug cannot be carried out without traffic restrictions on the bridge. Complete closure of the bridge will hugely impact the municipality of Nijmegen. The client prefers the bridge completely closed during the maintenance, but on the other hand, Nijmegen's municipality wants to keep the bridge partially open during the renovation. Thus, the plan cannot be executed further. Therefore, it is essential to limit the traffic restriction during the work for Nijmegen's citizens. There was an urgent need for the changes in the original plan. On the other hand, the municipality of Nijmegen saw the maintenance work as an

opportunity. They had two inclinations:

1) Increase the width of the current cycle and footpath on the bridge

2) Add a bus lane on the east side of the bridge.

The urgency to develop a new scope with the support of the stakeholders, led to introduction of VE during the front-end phase of the project. Reducing the impact of traffic nuisance was an important focus during this VE study. An important starting point for this study is that the solution space about the final situation of the Waalbrug is minimal. This is because the bridge is a National Monument, so significant modifications to the bridge are not possible.

Within the context outlined, there is still no agreement between the RWS and the municipality of Nijmegen on:

1. the final situation of the bridge about the municipal wishes
2. the financing of municipal wishes
3. the construction process of major maintenance about the desire to limit road users' impact, the environment, the citizen, and the shipping traffic.

VE study was performed with the objective to:

1. Reaching an agreement between the RWS and Nijmegen's municipality on the construction process of the major maintenance of the Waalbrug and the associated environmental impacts.
2. Reaching an agreement between the RWS and the municipality of Nijmegenin about the final situation of the Waalbrug about the following aspects:
3. The final situation of the scope
4. Finances
5. Planning
6. Cooperation agreements

The municipality has pledged financial cover to extend the cycle path with a footpath on the west side. This did not work for the extra bus lane on the east side. The investigation was performed further regarding the partial operation of the bridge during the renovation. To achieve these goals, 3 VE workshops were organized, and four different scenarios were developed. These scenarios were designed to be as distinctive as possible to maximize learning the outcomes of different scenarios. The VE study was carried out by the project teams of the RWS and the Municipality of Nijmegen, and several independent experts, not involved in the actual project also participated (including from TU Delft and Royal Haskoning DHV).

4.7.1.2. Application of the enablers and the presence of barriers

In this section, the application of each enabler will be discussed. The section starts with the table showing the responses of the practitioners during the interviews as shown in table 4-2, 4-3 & 4-4. Interviews were conducted with four interviewees who were the part of the project team. The aim was to understand their perspective about flexibility in the project scope. After understanding the perspective of the interviewees about the flexibility, the methodology/practice used for implementing the three enablers based on the interviewees is discussed.

Enabler 1: Broad task definition

Table 4-2 Responses for the enabler 'broad task definition'

Question	Res	Response
Did you apply the enabler in your project and how?	1	• Functional thinking was used to look at the project from broader view. • VE was used as the methodology for implementing functional thinking.
	2	
	3	• Functional thinking was used to look at the project from broader view.
	4	• Functional thinking was used to look at the project from broader view.
What made you decide to develop a functional scope?	1	•Functional approach helps to understand if the wishes of the stakeholders are possible to implement or not.
	2	•Gives more freedom to other parties to use their skills and knowledge.
	3	•Helped to consider the problem broadly. •Helped to look at all possible solutions.
	4	•Helped to understand the project broadly. •Gives the parties opportunity to understand the needs of the other parties involved in the project
What benefits have you experienced in keeping the scope functional?	1	By going to the functional scope, the client was able to develop better relationship with the main stakeholder. The stakeholder realized that the client is serious about their needs as well.
	2	
	3	
	4	•By going to the functional level, the client realized that the original plan is not suitable for the project. •Worked on the solutions together with the stakeholders and developed the success criteria.
What were the obstacles/difficulties you encountered when viewing the project from a functional perspective?	1	•Initially, the client was unaware about the best possible solution for the project.
	2	•The client was unable to provide realistic facts and figures about the final solution to the stakeholders.
	3	
	4	• In this project, the client directly jumped towards the solution instead of going to the core need of the project and the stakeholders. • Psychologically it was difficult for the client to accept the flaws in the original scope and move towards an alternate plan. By going to the functions and understanding the needs of the stakeholders, the client realized that there is a need for change in scope.
What was the perspective of the	1	•The client was looking at the project only from their perspective and not from the perspective of other parties.

client while performing the functional specification?		• The client jumped directly towards the solutions instead of understanding the needs of the stakeholders.
	2	
	3	•Functional specifications helped to look at broader view and weigh different solutions.
	4	•It was difficult from the psychological mindset throwing out your original plan and moving to other or functional view.
Which is preferred more by the client : creative solution or tried and tested solutions and why?	1	
	2	
	3	•Risk towards creative solution was too big in the eyes of the client.
	4	•There was limited knowledge of working with functions among the practitioners
What are the problems that stakeholders face while working with functionalities?	1	• There was limited knowledge of working with functions among the practitioners
	2	•The practitioners were unaware about the end result.
	3	
	4	
Do you think standards and regulations limit the implementation of creative solutions?	1	
	2	
	3	•Standards and regulations limited the flexibility or creativity in the solution space. Proven concept were preferred in the project.
	4	•During the VE session, some creative solutions were developed but they were discarded as they didn't comply with the current standards and it was difficult to get permits.

The project team was not aware of the enabler at the beginning of the project. The client saw the problem of renovating the bridge. Looking at the problem, the client developed the scope of the project with limited involvement of the stakeholders. The original scope developed by the client was not accepted by the main stakeholder. It was observed that the scope was in conflict with the interest of the stakeholder. According to the original scope of the client, all the four lanes on the bridge will be closed until the time of renovation that was around 2 years. It was not acceptable for stakeholder as it will lead to increase in traffic in the municipality as it was the main bridge. The time of 2 years was too long for stakeholder to manage. The stakeholder had a requirement that the bridge should be partially operational. It was observed that the client overlooked the requirement of the stakeholder. There was a need for redefining the scope of the project and look at it from the broader perspective. That is the time, the project team realized the need for implementing the enabler "broad task definition" in their project. To look at the project from the broader view, functional thinking was implemented. According to all the interviewees functional thinking helped to consider the problem broadly. VE was used as the methodology for implementing functional thinking in the project as the second step of VE is functional analysis phase. According to interviewee 1.4, '*Psychologically it was difficult for the client to accept the flaws in the original scope and move towards an alternate plan. By going to the functions and understanding the needs of the stakeholders, the client realized that there is a need for change in scope'*. In addition, all the interviewees mentioned that it was difficult for some practitioners to work with functions as they had limited knowledge and experience working with functions. Based on the interviews and the case documents, it was observed that implementing the enabler was a reactive approach from the client side as the stakeholders didn't accept the original scope.

Enabler 2: Embrace change

Table 4-3 Responses for the enabler 'embrace change'

Question	Res	Response
Did you feel the need to change the scope at any point in the project?	1	• The client already had a fixed scope at the beginning of the project.
	2	
	3	
	4	• Initially, the client didn't had a mindset regarding the change in scope. On the other hand, the main stakeholder wanted to make changes in the scope.
If so, what was it all about and why was it necessary?	1	• The client and the stakeholder had conflicting interest regarding the scope of the project.
	2	
	3	
	4	• Their was difference in perception of the parties regarding the change. The change in scope was considered as planning change by the project team.
What were the obstacles/difficulties you encountered in implementing the change in scope?	1	•There was difference in opinion among the parties. •Lack of trust among the parties. • The client was skeptical about the change in scope.
	2	• Their was lack of trust among the parties for implementing the change in scope.
	3	
	4	•Lack of trust among the parties was a problem initially. •Working together towards the goal helped to gain support.
How does the client react to the change in scope?	1	• The had a normal reaction as they were the main stakeholder
	2	
	3	
	4	• The client was positive and accepted the change in scope after the VE session.
What problems were encountered on the part of the stakeholders in order to implement the change in scope?	1	•Funding the change in scope was a problem. •Lack of trust among the parties.
	2	• There was lack of trust among the parties for implementing the change in scope.
	3	
	4	• Their was difference in perception of the parties regarding the change. The change in scope was considered as planning change by the project team.
Do you think stakeholders have different perceptions about the change in scope? Every stakeholder understands the change from a different perspective.	1	• The stakeholder and the client should discuss their interest openly and try to align towards a common goal.
	2	• The client should make the stakeholders understand about the change in scope in the language they understand. For example: Stakeholders sometimes does not have the technical knowledge about the drawing. The client should communicate the drawing in a way, the stakeholder can understand.
	3	• There should be transparency in the choices that are made during the change in scope. This will give better understanding of tradeoffs to the stakeholders.

If so, how do you handle that?	4	

The enabler was implemented in the project once the client realized that it is not possible to implement the original scope and there is a need for redefining the scope. Initially, the client had a fixed plan and according to them there was no need for change in scope. On the other hand, the stakeholder wanted to add changes to the scope. According to interviewee 1.4 '*Initially RWS never felt the need for change in scope but if you look at the other side, Municipality wanted to make changes in scope*'. The client and the stakeholder had different perception about the change in scope due to which the parties lacked trust on each other. Interviewee 1.2 mentioned '*Lack of trust among the parties was a challenge for us*'. Looking at the different perceptions and trust issues among the parties, the client realized the need for implementing the enabler 'embrace change'. VE was used as the methodology in this project for embracing change. During the VE sessions, both the parties worked together and developed four different scenarios for new scope. Success criteria for both the parties were formulated. One of the success criteria that was decided by both the parties was 'traffic' which was one of the main requirements of the stakeholder. Both the parties voted from the four scenarios and the best optimal solution was chosen which was out of four lanes two will be operational. Interviewee mentioned 'Lack of trust among the parties was an issue initially. After the investigation together during the VE sessions, it was easy to have the consensus of the stakeholders'.

Enabler 3: Interaction among the stakeholders

Table 4-4 Responses for the enabler 'interaction among the stakeholders'

Question	Res	Response
Do you think stakeholders play an important role in being flexible in the scope?	1	•Invest on building relationship with the stakeholders. • There should be a structured communication management between the client and the stakeholders. The client can inform the stakeholders within time without getting late. • Don't just contact the stakeholders during the problem. • Act as a team • The vision of the parties was not communicate in the efficient way.
	2	• According to the client, the scope of the project was fix.
	3	
	4	• It is difficult for the client for implementing the scope in the Netherlands if the stakeholders are not convinced. The client will face lot of resistance in implementing the scope. • Due the resistance faced for implementing the change, there is a possibility that the project will get delayed. • When multiple stakeholders are involved in the project, it is important to bring them together and work towards a common goal.
How are the stakeholders' requirements and wishes collected or how do you deal with the stakeholders?	1	
	2	•Requirements are collected over phone
	3	•Requirements are collected by meeting the stakeholders individually.
	4	

Were the stakeholders involved closely in the project initially? In addition, do you think it is important to bring the stakeholders together at the table instead of collecting the requirements individually?	1	•Stakeholders were not involved or updated on regular basis which was the big reason for resistance for the implementation of the original scope.
	2	
	3	• Interface management can be introduced and physical meeting can be conducted to manage the interfaces among the client and the stakeholders.
	4	•The main stakeholder was not involved closely while developing the scope. This lead to conflict and lack of trust among the parties.
What were the benefits experienced by bringing them together on the table?	1	•The main stakeholder was used as a communicator for the smaller stakeholders in their network as they have better relation with them. •The knowledge of the main stakeholder was used.
	2	•By bringing the stakeholders together, they got the opportunity to get familiar and understand each other interest. This helps develop better end result.
	3	•By bringing the stakeholders together, they got the opportunity to understand each other interest. It helps to develop trust.
	4	
Do you think building trust between stakeholders is an important aspect to be flexible in the scope?	1	•Trust is important to become flexible as the client have more confidence for decision making.
	2	• It plays a important role as you need to have good relationship with the stakeholders for flexibility
	3	•Trust is important for flexibility. •It is important to be open and transparent about conflicting interest.
	4	•Lack of trust leads to inflexibility among the parties.
Why was VE implemented and what was the role of VE during the front-end phase of the project?	1	• VE was used to gain the confidence of the stakeholder • For building better relationship •Develop trust • To develop success criteria together •Work together and understand each other
	2	•VE should be applied at the right moment and in the right way.
	3	• Brings all the options on the table • Alternatives were assessed together • Enhanced understanding among the stakeholders
	4	•Helped to confront each other that we need each other to execute the project • Helped to build trust

Initially, the enabler was not recognized by the project team as the stakeholders were not involved closely during the development of the scope. The limited involvement of the stakeholders lead to mistrust and

conflict among the client and the stakeholders as their needs were overlooked by the client. Interviewee 1.1 mentioned '*In this project, we didn't take the stakeholders together. That was one of the issues in this project. This led to the feeling of mistrust among the parties'*. Regarding the involvement of the stakeholders, still interviewees had different opinions. According to interviewee 1.2 '*interested parties outside RWS have a minor role in the scope's composition. Stakeholders have limited influence on the scope of the maintenance bridges. Stakeholders can be of added value about how and under what conditions this result should be achieved*''. This reflects that the scope of project is fixed from the client side and there is not much for the stakeholders to influence. On the other side, interviewee 1.4 mentioned '*The Netherlands is a nation that believes in encouraging the stakeholder's involvement in a project. It is important to gain the stakeholder's support to achieve the project. The project can experience resistance in terms of not getting the permits*'. In addition, it was observed that the stakeholders were not informed about the progress of the project at regular basis. Looking at the resistance from the stakeholders' side, the client introduced VE session. During the VE session, the stakeholders got the opportunity to come together with the client and understand each other interest and needs from the project. Interviewee mentioned '*By bringing the stakeholders together during the VE sessions, they got the opportunity to get familiar and understand each other interest. This helped to develop better end result*'. All the interviewee mentioned that trust played an important role for achieving flexibility in project scope.

Value engineering

Table 4-5 Responses for VE

Question	Res	Response
Why was VE implemented and what was the role of VE during the front end phase of the project?	1	• VE was used to gain the confidence of the stakeholder • For building better relationship •Develop trust • To develop success criteria together •Work together and understand each other
	2	•VE should be applied at the right moment and in the right way.
	3	• Brings all the options on the table • Alternatives were assessed together • Enhanced understanding among the stakeholders
	4	•Helped to confront each other that we need each other to execute the project • Helped to build trust

VE played a vital role in the redefining of the project scope. VE was used as a methodology to bring the client and stakeholders together and discuss the issue in a structured way. All the interviewees mentioned that the process of VE helped to build trust among the stakeholders. The functional analysis phase of VE helped that client to realize that there is a need for change in scope as the needs of the stakeholder are in conflict to their original scope. During the next phase of the VE that was creativity phase, four different scenarios were developed which were the four different alternatives. All the parties together voted and the best optimal solution was chosen with the support of the stakeholders. According to interviewee 1.1, '*VE gave us a better opportunity to discuss the valuable alternative solutions for your project with the consensus of the stakeholder*'. It helped in gaining the support and confidence of the stakeholders.

4.7.1.3 Identified barrier in implementing the enablers

Based on the interviews, the barriers faced by the practitioners to implement the enablers were identified. The barriers identified during the case studies were compared with the theoretical framework developed during the literature study as shown in table 4-6.

Table 4-6 Barriers faced by the practitioners in case 1

	Barriers	Enabler 1	Enabler 2	Enabler 3
1	**Solution oriented thinking**	✓		
2	**Limited involvement of the business owner after allotting the budget**			
3	**Limited transparency in decision making**			
4	**Risk averse behavior of the project managers and client**	✓		
5	**Stakeholder needs are unknown**			
6	**Poor communication among the stakeholders**			✓
7	**Self-interest of the stakeholders**	✓	✓	
8	**Difference in perception among the stakeholders**		✓	
9	**Lack of trust among the stakeholders**		✓	✓
10	**Limited involvement of the stakeholders**			✓
11	**Limited awareness of the enablers**	✓		✓
12	**Limited training or coaching for interpreting the functions**	✓		
13	**Available preparation time**			
14	**Policy, standards, interface, norms, guidelines, laws, and regulations**	✓		
15	**Contractual limitations**			

Findings from the case:

1. In this case, the practitioners felt the need for flexibility because the stakeholders were not convinced with the original scope and there was resistance from the stakeholder for implementing the scope.
2. The enabler ‘broad task definition’ & ‘interaction among the stakeholders’ played a vital role for implementing the third enabler ‘embrace change’. This reflects that there might be a relationship among the three enablers.
3. The practitioners were initially unaware of the enablers. The major reason was the lack of awareness among the practitioners for implementing the enablers.
4. Functional thinking was used by the practitioners for implementing the enabler ‘broad task definition’.
5. The methodology used for implementing all the three enablers was VE.
6. Trust was observed as the important factor for achieving flexibility in project scope.
7. Most of the barriers from the theoretical framework were identified from the category of ‘stakeholder driven barriers’.
8. From the point of achieving flexibility in scope, involving the stakeholder from the beginning of the project and giving importance to their interest was observed essential.

4.7.2. Case analysis result

4.7.2.1. Project description

The case is divided into two phases. The first phase consists of the general description of the project and the second phase consists of how VE was performed in the project**.**

Phase 1: General description of the case

Transportation through waterways is increasing sharply, and thus the weight and size of the ships are increasing as well. Rijkswaterstaat is working with stakeholders to improve the main waterway. For this purpose, the widening of the main waterway Lemmer Delfzijl program was developed and included in the MIRT. In total, eight bridges are expected to be replaced as they are not suitable for transportation of CEMT class Va ships (standard large Rhine vessel with length 110 meters, a width of 11.4 meters, and a maximum draft of 3.5 meters). Five of these eight bridges will be replaced in Fryslan. For the three bridges, a MIRT procedure is required that starts with an exploration stage. The three bridges are at Oude Schouw, Spannenburg, and Uitwellingerga, as shown in figure 4-2. At the end of 2018, the minister agreed to the replacement of the three bridges.

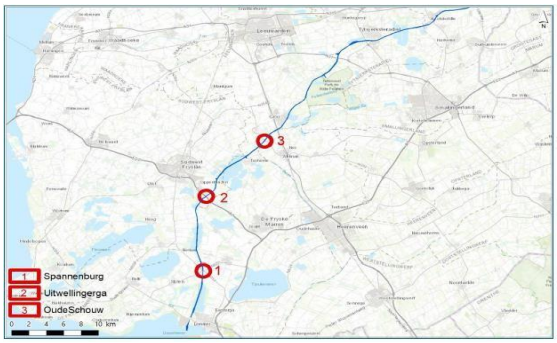

Figure 4-2 The three bridges are at Oude Schouw, Spannenburg, and Uitwellingerga

On behalf of the Minister, the Director General Aviation and Maritime Affairs (DGLM) is the client for the project. The project is commission to RWS. The direction and the project management of the MIRT procedure and the construction of the bridges is responsibility of the RWS. The table 4-7 reflects the different phases of the project along with the milestones.

Table 4-7 Outline of the project.

When	Milestone
1st quarter 2020	Exploration of possible solutions for the three bridges (Exploration phase).
Summer 2020	Selecting the most suitable alternative solutions based on an assessment Framework
Fall 2020	Preferred alternatives to the bridges.
End of 2020	The selected alternatives are presented to the minister for decision making.
Fall 2026	Realization of new river crossing.

In the exploration phase, what the problem is and what is the possible solutions are investigated. During the planning stage, the preferred solutions are worked out in more detail. Currently, the project is in the exploration phase.

Phase 2: VE process

Three different steps have been taken to determine the solutions. Firstly, VE has been applied. The VE sessions were used within the 3 Frisian Bridges exploration to arrive at a sharper assessment framework per location and provide an impetus to arrive at three promising alternatives per location. To this end, a total of two types of sessions were organized: an expert session and a general VE session (one per bridge).

Secondly, it was determined to what extent solution directions are suitable for marine traffic and road traffic. Thirdly, information meetings were organized, as shown in figure 4-3. At these information meetings, the main stakeholders were invited to think about the solutions.

Figure 4-3 Process to select the final solution

Based on the interviews and the case documents, the barriers to implement the enablers and methods used to implement the enabler were investigated, which are explained in the following sections.

4.7.2.2 Application of the enablers and the presence of barriers

In this section, the application of each enabler will be discussed. The section starts with the table showing the responses of the practitioners during the interviews as shown in table 4-8, 4-9 & 4-10. Interviews were conducted with four interviewees who were the part of the project team. The aim was to understand their perspective about flexibility in the project scope. After understanding the perspective of the interviewees about the flexibility, the methodology/practice used for implementing the three enablers based on the interviewees is discussed.

Enabler 1: Broad task definition

Table 4-8 Responses for the enabler 'broad task definition'

Question	Res	Response
Did you apply the enabler in your project and how?	1	• Functional thinking was used for looking at the broader view.
	2	• Functional thinking helped to look at broader picture instead of obvious solution.
	3	• Functions
	4	• Functional thinking was used for looking at the broader view.
What made you decide to develop a functional scope?	1	• The client was open to different solution from the beginning of the project and that is why we wanted to develop functional scope. •VE helped to investigate all possible solutions. • Functional thinking is best to be used at the beginning of the project.
	2	• The functional scope helped the client to look at the project from the interest of different stakeholders.
	3	• We wanted to look for different solution and that is why we implemented it. • By working with functions, you get to know what you want and you can become more creative.
	4	• The higher management of the client was open and was looking at the project from broader vision. In such a situation, VE is a perfect methodology to use.
What benefits have you experienced in keeping the scope functional?	1	• To look towards different solutions, you need functional thinking. •By thinking in functions, you become more realistic. •Project team have the tendency of overlooking the needs of the stakeholders. We wanted to understand the needs of the stakeholders and that is why went for functional scope. •VE helped to look towards the needs of the stakeholders.
	2	• Helped to build better relationship with the stakeholders. •Helped to look at the project from different perspective.
	3	• Helped to look at the project from broader view. •Helped to look at different solutions as we didn't want to miss on making a good choice for our project. We developed many solutions out of which we selected three solutions and in the upcoming VE session, we will choose the best solution out of the three.
	4	• A good FAST diagram helped to identify the unknowns in the project.
What were the obstacles/difficulties you encountered when viewing the project from a functional perspective?		
	1	• Stakeholders were not sure if the solutions are realistic by going to the functional domain. • Some practitioners had limited knowledge of working with functions. • Some stakeholders had limited understanding of the facts and figures of the functions.
	2	
	3	• People with limited technical knowledge have the problem in imagining the end result.
	4	• Their was limited knowledge among practitioners for working with functions. •Value engineer can help to resolve the issue.

What has been the perspective of the client while performing the functional specification. Do they encourage this approach and why?	1	• The client was open to any type of solution from the start.
	2	• I didn't had experience or awareness about the importance of VE and the enablers but the higher management and the project manager was actively encouraging this practice to be implemented in the project.
	3	• The client already mentioned it in the plan for implementing the VE sessions.
	4	• The client encouraged for implementing the enablers.
Which is preferred more by the client : creative solution or tried and tested solutions and why?	1	• The client was open to any kind of solutions within the boundaries.
	2	• Usually, tried and tested solutions are preferred but in this case, the client was open towards any kind of solution.
	3	
	4	• Creative solution were scored on the lower side but there are no evidences if the score was from the client or the stakeholders as voting was anonymous.
What are the problems that stakeholders face while working with functionalities?	1	
	2	•Having a rigid mindset towards the solution limits the broader view.
	3	•Sometimes stakeholders think that we know it will be a movable bridge, why are you doing this. They become bit suspicious. It was important for the client to make the stakeholders understand the reason behind such process and then they understood.
	4	
Do you think standards and regulations limit the implementation of creative solutions?		Everyone mentioned that it was not a problem until now in this project.

All the interviewees recognized the enabler 'broad task definition' and have implemented the enabler in the front-end phase of the project. Functional thinking was used for looking the project from broader view. The methodology that was used for implementing functional thinking was VE. All the interviewees mentioned that the higher management and the project manager encouraged the project team for implementing the enabler. The client was open to different solution from the beginning of the project. Interviewee 1.2 mentioned '*I didn't have experience or awareness about the importance of VE and the enablers but the higher management and the project manager was actively encouraging this practice to be implemented in the project'*. The client brought the stakeholders together with the help of VE at the beginning of the project and discussed their needs and interest together in a structured way. By understanding the needs of the stakeholders, multiple ideas for the solution were generated during the VE session. Interviewee 1.1 mentioned '*Project teams have the tendency of overlooking the needs of the stakeholders. We wanted to understand the needs of the stakeholders and that is why we went for functional scope'*. Out of all the generated ideas, three solutions were selected. In the upcoming VE session, the best suitable solution from the three alternatives will be selected. Interviewee 1.3 mentioned '*Functional thinking helped to look at different solutions as we didn't want to miss on making a good choice for our project*'. Overall, implementing the enabler was a proactive approach from the client as they were aware about the benefits of the enablers and VE. One out of the four interviewees mentioned that '*more creative solutions were scored on the lower side. It was not sure if it was from the stakeholders or the client side as the votes were anonymous'*. As mentioned in the last statement it was not sure if the votes were from the client or the stakeholders therefore not concrete evidence about the mindset of the parties can be concluded from this. Overall, it was a proactive approach from the client as they initially wanted to enhance flexibility in project scope.

Enabler 2: Embrace change

Table 4-9 Responses for the enabler 'embrace change'

Question	Res	Response
Did you feel the need to change the scope at any point in the project?	1	• There were 2 gemmnete on the sides of the bridge. The gemmente on the south side had some plans for summer houses. It was informed by the gemente later that the location already decided during the VE session won't be suitable for the summer houses because of the location of the bridge. The gemmente on the south side wanted to change the location. This requirement of gemmente came to us after the VE session. During the VE sessions we didn't hear anything from the gemmente about this wish.
	2	
	3	• We got the request for change in location of the bridge from the gemente.
	4	
If so, what was it all about and why was it necessary?	1	
	2	
	3	• We didn't make a real choice yet. Municipality had the opportunity for recreation at the place where we planned to build. Municipality was not fine with the location.
	4	
What were the obstacles/difficulties you encountered in implementing the change in scope?	1	• The policy man of gemente was invited for the VE session but he was unavailable for the sessions. Instead of him, the technical manager was the part of VE session who was representing the gemmente. • The requirement of the gemente to build summer houses was not mentioned by the technical manager as he was not aware about the future vison of the gemente. Later, the gemente came up with this wish for changing the location of the bridge which was already decided during the VE session. We are still in process about this issue as it came to us recently. But if the issue is not resolved in an efficient manner, it can lead to mistrust among the parties. • It is difficult to bring the stakeholders at the same vison. This requires lot of time as you have milestones that needs to be achieve in limited time. • Change of scope is always tricky in terms of planning. VE helped to bring the stakeholders at same level of information, vision and makes them creative. If you involve the stakeholders from starting, they are at the same vision.
	2	
	3	• The client seems to be skeptical about the change in scope before investigating it as they were considerate about the consequences and the cost of change.
	4	
What problems were encountered on the part of the stakeholders in order to implement the change in scope?	1	• We need to come up with facts and discuss the pros and cons of the location with them. It is our duty to explain them as it is our choice. If we succeed in that, there should not be a problem.
	2	
	3	• Some stakeholders had different perception about the change in location. Some of them were not happy about the change. But we are

		still at the initial stage about the change in location and completely not aware about the reaction of all the stakeholders.
	4	

All the interviewees were aware of the enabler, but the implementation of the enabler is under process. During the VE session, the client invited the representatives of the stakeholders to discuss everyone's requirements. After discussing the requirements, the most suitable location for the bridge was agreed by all the parties. After agreeing to the location, the gemmente on the south side came up with an issue after the VE session for the change in location of bridge as the gemmente had plans for developing summer houses next to the agreed location. A bridge just next to the summer houses won't be a suitable option for gemmente. Interviewee 1.1 mentioned that '*The policy man of gemmente was invited for the VE session but he was unavailable for the sessions. Instead of him, the technical manager was the part of VE session who was representing the gemmente*'. The client was surprised as they already discussed the requirements and interest of all the stakeholders together and the technical manger representing the gemmente did not come up with this specific requirement during the discussion. Interviewee 1.1 mentioned that '*Technical manager of gemmente attended the VE session. He didn't had sufficient information about the future vision of the gemmente'*.

There was no specific approach mentioned by the interviewees to implement the change as they got to know about the change recently. Interviewees gave an idea how they will approach this issue for change in location. The client will investigate and formulate their facts and figures in terms of cost and other factors. The client will discuss with the gemmente and accordingly both the parties will come to a conclusion. Some of the parties are not happy about the gemmente's action as they didn't inform about their requirement when everyone was discussing during the VE session.

Enabler 3: Interaction among the stakeholders

Table 4-10 Responses for the enabler 'interaction among the stakeholders'

Question	Res	Response
Do you think stakeholders play an important role in being flexible in the scope?	1	• Stakeholders were important to become flexible on scope. Flexibility in the interest of the stakeholders is a precondition for becoming flexible.
	2	
	3	• Stakeholders played a vital role for achieving flexibility in project scope.
	4	• It is important to expect the stakeholders who will be influenced by the project scope to be flexible. If they are rigid, it is difficult to implement or take decisions. • The client was really open to the discussion about other options. The project manager mentioned in the stating of VE session with the stakeholder that the scope is open to any kind of solution. • Functional thinking helped to open the people in the project.
How are the stakeholders' requirements and wishes collected or how do you deal with the stakeholders? (By e-mail, by meeting them individually or by	1	• Firstly, we collected the requirements of the stakeholders through email or meeting them personally. During the VE session, the requirements of the stakeholders were discussed together.
	2	Through face-to-face conversations, information meetings, mail, interactive website
	3	
	4	

meeting all stakeholders).		
Were the stakeholders involved closely in the project initially? In addition, do you think it is important to bring the stakeholders together at the table instead of collecting the requirements individually?	1	• By bringing the stakeholders together, they got inspired by each other. Stakeholders started understanding each other and think from other's perspective.
	2	• Bringing the stakeholder together helped them to understand the interest of other stakeholders.
	3	• Bringing the stakeholders was important for us as it helped us to build trust with them. They didn't get a feeling the everyone is already developed. In the process it is important keep them connected to the process.
	4	• Bringing the stakeholders together stimulates communication and exchange of information in an efficient manner. It gave the stakeholder opportunity for think about the solutions together.
What were the benefits experienced by bringing them together on the table?	1	• VE was the first session where stakeholders were brought together. •The stakeholders were happy as they were involved closely. It helped to gain their trust.
	2	• Bringing the stakeholders together helped the stakeholder to understand the reason behind any specific decision.
	3	
	4	• By bringing the stakeholder together , they got to know from each other what are their wishes are. If you discuss the functional needs together, if you disagree, but still you would know what the reason behind it is. It helped to develop trust.
Do you think building trust between stakeholders is an important aspect to be flexible in the scope?	1	• Trust is important for becoming flexible and to achieve that we made sure that the stakeholders and the client work together. • Stakeholders expect RWS to be open from the start. Hence, don't be from the starting that RWS does not have money. Be open from the start.
	2	• Having trust in the parties helped the client to look at different solutions and choose the best solution.
	3	•Trust stimulates communication among the parties. If you don't have trust among the parties, they won't interact in an efficient manner.
	4	• Change in scope can be beneficial for one party and not for other. If they trust you, you have higher chances of implementing them.

All the interviewees recognized the enabler and have implemented the enabler during the front-end phase of the project. VE was first session where the stakeholders were brought together to discuss the interest of the stakeholders in a structured manner. According to interviewee 1.4 '*By bringing the stakeholder together, they get to know from each other what are their wishes. If you discuss the needs together, if you disagree, but still you would know what the reason behind it is. It helped to develop trust*'. All the interviewees mentioned that trust plays an important role for achieving flexibility in a project scope. Interviewee 1.4 mentioned '*Change in scope can be beneficial for one party and not for other. If they trust you, you have higher chances of implementing them'*. Overall, the client was aware of the importance of the stakeholder for achieving flexibility and therefore from the beginning of the project, stakeholders were involved closely during the development of the scope.

Value engineering

Table 4-11 Responses for VE

Question	Res	Response
Why was VE implemented and what was the role of VE during the front end phase of the project?	1	• Before VE some stakeholders lacked trust to an extend but by bringing them together through VE sessions, it helped to understand their problem in a structured way and gain their trust.
	2	• Client need t support the process. • It was a structured process which helped everyone to understand each other interest and discuss the problem in a structured manner.
	3	• VE helped to build trust. We got the opportunity to know each other. •People initially face some problem in understanding the process.
	4	• VE helped us to step away from the only solution. We got to know lot of insights because of the open environment created by VE.

VE was introduced intentionally from the client side as they were aware of the benefits of the methodology from previous experiences. All the interviewees mentioned that VE gave all the parties opportunity to get to know each other and discuss their interest in a structure manner by creating an open environment. All the interviewees mentioned the VE helped to develop trust among the parties. Interviewee 1.1 mentioned '*Before VE some stakeholders lacked trust to an extend but by bringing them together through VE sessions, it helped to understand their problem in a structured way and gain their trust*'. The client needs to support the process and make the stakeholders familiar with process as sometimes stakeholders face problem in understanding the process. Overall, all the interviewees agreed that VE helped them to enhance flexibility in project scope.
Based on the interviews, the barriers faced by the practitioners to implement the enablers were identified. The barriers identified during the case studies were compared with the theoretical framework developed during the literature study as shown in table 4-12.

Table 4-12 Barriers faced by the practitioners in case 2

	Barriers	Enabler 1	Enabler 2	Enabler 3
1	Solution oriented thinking			
2	Limited involvement of the business owner after allotting the budget			
3	Limited transparency in decision making			
4	Risk averse behavior of the project managers and client	✓		
5	Stakeholder needs are unknown	✓		
6	Poor communication among the stakeholders			
7	Self-interest of the stakeholders			
8	Difference in perception among the stakeholders		✓	
9	Lack of trust among the stakeholders			
10	Limited involvement of the stakeholders			
11	Limited awareness of the enablers			
12	Limited training or coaching for interpreting the functions	✓		
13	Available preparation time			
14	Policy, standards, interface, norms, guidelines, laws, and regulations			
15	Contractual limitations			

Findings

1. All the interviewees were aware of the three enablers and have applied the enabler 'broad task definition' & 'interaction among the stakeholders'. The enabler '' is currently under process of implementation.
2. VE was used as the methodology for applying the enabler 'broad task definition' & 'interaction among the stakeholders''.
3. The higher management and the project manager played a vital role in implementation of the enablers as they were the one who encouraged the practice. VE was added officially to the project planning process.
4. Functional thinking was used for implementing the enabler 'broad task definition'.
5. It was observed that involving individuals who had sufficient knowledge to represent stakeholders could reduces possibility of missing on the needs of the stakeholders. However, it is essential to make sure that the representative is well aware of the expectations of the respective stakeholder as well as the future vision of the project.
6. Trust played a vital role for enhancing flexibility in the project scope.
7. Bringing the stakeholders together for discussing the interest of the parties helped to develop trust.
8. No barriers were experinced under the category 'interaction among the stakeholders'

4.8. Cross case analysis

The section represents the analysis of the two case studies conducted in the last section. The cross case analysis will help to get better understanding about the relationship between flexibility in project scope and VE. The intent is to observe if VE can help for enhancing flexibility in project scope by resolving the barriers.

The table 4-13 reflects the barriers faced by the practitioners for the implementation of the enabler in the two cases investigated in the last section.

Table 4-13 Comparison of barriers faced in both the cases

		Enabler 1		Enabler 2		Enabler 3	
	Barriers	**Case1**	**Case2**	**Case1**	**Case2**	**Case1**	**Case2**
1.	Solution oriented thinking	✓					
2.	Limited involvement of the business owner after allotting the budget						
3.	Limited transparency in decision making						
4.	Risk averse behavior of the project managers and client	✓	✓				
5.	Stakeholder needs are unknown		✓				
6.	Poor communication among the stakeholders					✓	
7.	Self-interest of the stakeholders	✓		✓			
8.	Difference in perception among the stakeholders			✓	✓		
9.	Lack of trust among the stakeholders			✓		✓	
10.	Limited involvement of the stakeholders					✓	
11.	Limited awareness of the enablers	✓				✓	
12.	Limited training or coaching for interpreting the functions	✓	✓				

13.	Available preparation time						
14.	Policy, standards, interface, norms, guidelines, laws, and regulations	✓					
15.	Contractual limitations						

VE was performed in both the cases, however, the circumstances in which VE was introduced in the projects were very different. As mentioned earlier, in case 1, the original scope was developed by the client with limited involvement of the stakeholders because of which, the scope was not accepted by the stakeholders. Stakeholders believed that it was conflicting with their interests. This created a need for introducing VE in the project to develop the scope of the project together with the stakeholders. The barriers that were observed in case 1 were experienced by the interviewees until the time VE was performed. As opposed to this, in case 2, the project manager was already aware of the importance of the enablers, stakeholders, and VE from his previous experiences. In this case, VE was introduced from the beginning of the project, making this approach a proactive one. The barriers observed in case 2 were experienced by the practitioners after performing VE in the project. Both these cases provide an opportunity to understand the occurrence of the barriers before and after VE is introduced based on table 4-13.

It was observed that in the case 1, 13 barriers were experienced by the practitioners until the time VE was introduced in the project according to table 4-13. On the other hand, the case in which VE was introduced as the first choice (case 2) experienced 4 barriers in total. The barriers experienced in the case 2 is less in comparison to the case 1. The difference between the observed barriers in the two cases is significant. There is a possibility that introducing VE during the front end phase might helped to achieve flexibility in project scope by resolving the barriers for implementing the three enablers as observed in the second case during the case analysis. The research is limited to only two cases and there is a possibility that the results might differ with increase in number of investigated cases.

Based on the table 4-13, the detail comparison of the two cases is discussed below.

1. The scope was fixed in the first case and there was not much room for the alteration for the stakeholders. On the other hand, the client was open to different solutions, and stakeholders had enough room in the solution space.
2. In case 1, implementing flexibility in the project scope was not the priority until the time stakeholders disagreed with the scope developed by the client without the involvement of the scope. On the other hand, in case 2, implementing flexibility in the project scope was the priority for the client from the beginning of the project.
3. Similar to flexibility, VE was conducted in the project as a reactive approach towards flexibility in the case 1. On the other hand, VE was applied by the client as a proactive approach for incorporating flexibility in scope in case 2.
4. The barriers ‘Solution oriented thinking’, ‘Self-interest of the stakeholders’, ‘Lack of trust among the stakeholders’, & ‘Limited involvement of the stakeholders’ were experienced by the practitioners in case 1 but not in the case 2.
5. Initially, in the first case, the stakeholder directly jumped to the solution instead of going to the core needs of the stakeholders which was in contrast to case 2. In case 2, the client first understood the needs of the project and the stakeholders, accordingly, the scope was developed.
6. In the case 1, it was observed that the client and some stakeholders were just focused on their self-interest. In the case 2, this barrier was not experienced as the stakeholders were familiar with the interest of the other parties and were able to understand the bigger picture.
7. In the case 1, there was conflict and lack of trust among the stakeholders and the client as their interest were in conflict with the original scope. On the other hand, there were no such issues of lack of trust among the parties in case 2 as the scope of the project was developed with the consensus of the stakeholders.

8. Initially, stakeholders were not involved closely during the development of the scope in the first case. On the other hand, stakeholders were acting as project team during the development of the scope.

In this chapter, the two cases were investigated to observe the presence of the enablers and the barriers in practice. This section helped to understand the role of VE with respect of flexibility in project scope. In the next step of the research, the barriers will be resolved based on the data extracted from the case analysis and the literature. It could be difficult to focus on all the barriers observed during the case analysis as it can widen the scope of the research largely. Therefore, in the next step, the ten most common barrier observed in the two cases will be resolved. A list of 10 most common observed barriers from the two cases was formulated as shown in table 4-14.

Table 4-14 Most common barriers observed in case analysis

Ranking	Barrier	Cluster	Identified for the enabler
1	Lack of trust among the stakeholders	II	Enabler 1,2,3
2	Limited training or coaching for interpreting the functions	III	Enabler 1
3	Risk averse behavior of the project managers and client	I	Enabler 1,2
4	Knowledge of specific products at the client	I	Enabler 1
5	Self-interest of the stakeholders	II	Enabler 1
6	Stakeholder needs are unknown	II	Enabler 2
7	Difference in perception among the stakeholders	II	Enabler 2
8	Poor communication among the stakeholders	II	Enabler 2,3
9	Limited involvement of the stakeholders	II	Enabler 1,3
10	Policy, standards, interface, norms, guidelines, laws, and regulations	IV	Enabler 1

5. DEVELOPMENT OF FRAMEWORK

The last chapter helped to understand the perspective of the practitioners on flexibility in project scope. A list of ten common barriers was formulated based on the results of the case analysis. To achieve flexibility by implementing the enablers, the barriers observed in the last chapter needs to be resolved for successful implementation of the enablers. In this chapter, a list of suggestions will be proposed for resolving the barriers identified in the case analysis. Based on the suggestions formulated, a framework will be developed depicting the step by step implementation of the proposed suggestions.

5.1 Suggestions based on case analysis

Before developing the framework, it will be a good idea to understand how the proposed suggestions in the framework related to each step is applicable to overcome the barriers for successful implementation of the enablers for enhancing flexibility in project scope. The suggestions arise from the case studies and the literature as well. The observation were made during the case studies based on the manner in which the practitioners (if) attempted to overcome the observed barriers. The suggestion based on each barrier is discussed below:

1. **Limited awareness about the enablers**: It was observed in 'case 1' that there was limited awareness about the enablers and the methodology for implementing the enablers among the project team. That was the reason that the enablers were not initially implemented in the project. The 'case 2' was interesting to understand the process behind the implementation of the enabler as it was a proactive approach from the client for implementing the enablers. In the second case, the project manager was already aware of the benefits of implementing the enablers in a project because of the previous experiences in different projects. The project manager explained the benefits of the enablers and the methodology to the higher management. From that discussion with the project manager, the higher management understood the importance of the enablers and they added officially VE as the part of the plan. Further, it was also observed that some members of their project team were not aware about the enablers and methodology but the client and the project manager were actively encouraging the project team for implementation of the enablers. The project team who was not aware of the enablers and the methodology got familiar with the impact and the benefits of the enabler in their project after experiencing it in the project. During the interviews, all the interviewees which were the part of project team agreed that enables were helpful for achieving flexibility in project scope by conducting VE in the project. This reflects that the people from the higher management or the project managers needs to **spread awareness about the benefits of the enablers and the methodology** for implementing the enablers among the practitioners. In addition the literature states that the higher management of an organization should **create a sense of urgency** among their employees regarding the benefits of implementing the enablers in a project (Nakigudde, 2019).

2. **Limited training or coaching for interpreting the functions**: The second barrier that was experienced by the practitioners was 'limited training or coaching for interpreting the functions'. In both the cases, it was observed that some practitioners during the VE sessions had limited knowledge for working with functions. In both the cases, value engineers were responsible for facilitating the VE study and providing guidance to the practitioners to work with functions. **Value engineers are trained experts** who have the knowledge and experience of working with function. Practitioners can make use of the knowledge of value engineers while working with functions. In addition, practitioners can be provided with training sessions to work with functions. **Training sessions can be provided at the**

organizational level. Furthermore, it was observed that VE session is a workshop where many stakeholders come together and discuss the issue in a structured way. There is still a possibility that the stakeholder who are not from the client side might not have the experience with working with functions. Prior the VE workshop, client can request the representatives of the stakeholders who will be attending the VE workshop to attend the training sessions. Again, there is uncertainty if the stakeholder have the time and the motivation to do it. Hence, as mentioned earlier, the client need to spread awareness about the benefits of the enablers among the parties.

3. **Lack of trust**: It was observed in 'case 1' that 'lack of trust' was interrelated with 'limited involvement of the stakeholders'. The original scope of the project was developed by the client with limited involvement of the stakeholders. The requirements or the needs of the main stakeholders were overlooked during the development of the scope. That led to conflicts and mistrust among the client and the main stakeholder. In the second case, the stakeholders were **involved from the early stage** of the project. In both the cases, VE was used as a methodology for bringing the stakeholders together and work towards developing the scope in a structured manner. Building the scope together gave the stakeholders opportunity to understand each other' interest and more importantly helped them to understand tradeoffs. This avoided conflicts at the later stage of the project. In addition from the literature, **developing shared goals** can help to develop mutual understanding between the actors which leads to enhancing trust among the parties (Khalfan et al., 2007).

4. **Limited involvement of the stakeholders**: The fourth barrier was 'limited involvement of the stakeholders'. As mentioned in the last paragraph, involvement of the stakeholders is directly linked to building trust among the parties. It was observed in the 'case 1' that limited involvement of the stakeholders during the development of the scope led to developing suspicious behavior among the parties. In addition, it was also observed that stakeholders were acting as validators for the developed scope by the client in the end. In result, the original scope was discarded by the stakeholder at the end as their interest was completely overlooked by the client. In this situation, the client introduced VE for bringing the stakeholders and develop the scope together. VE was used as a methodology in both the projects in which stakeholders were developing the scope of the project together at the abstract level. Their needs were discussed with respect to the project which made them feel important. Therefore, they were not just acting as validators in the end but were the part of project team for developing the scope which was missing earlier. It was also mentioned during the interviews that it is not practically possible to implement the needs or wishes of each stakeholder but it is important to discuss the needs of the stakeholders as it makes them feel important and in addition you as a client have higher chances to gain their support.

5. **Poor communication among the stakeholders and the client**: The fifth barriers was 'Poor communication among the stakeholders and the client'. It was observed in the first case that the client was not able to provide the reason behind specific decisions and the client didn't keep the stakeholders updated about the project regularly. This reflects that the communication channels between the client and the stakeholders were not clear. In the second case, it was observed that the client had monthly meeting on regular basis with all the stakeholders together. In between the monthly meetings, two VE sessions were performed. This helped the client to maintain clear communication channels as they kept their stakeholders updated about each step and more importantly, stakeholders also got the opportunity to bring their expertise or feedback at each decision during the monthly meetings. Hence, face to face meeting with the stakeholders on regular interval can help to keep the communication channels clear.

6. **Tendency to look towards self-interes**t: The sixth barrier was 'Tendency to look towards self-interest'. It was observed in the first case that the client was looking at the scope from their self-interest. During the development of the scope, they didn't think from the perspective of the stakeholder. In addition, it was observed that according to the client, the scope was already developed and fixed and there is not much for the stakeholders to influence or change in the original scope. During the VE session, by going on the functional level, the client realized that the original scope won't be suitable for the stakeholders at any cost. During the functional analysis phase in VE session, the needs of the stakeholders were discussed which gave the client better understanding about the needs of the stakeholders. During the VE session, the parties got familiar with the interest of the other parties and they have better understanding about the interest of each party. The parties were in better position to understand the specific behavior of each stakeholder towards the change in scope. This way the stakeholder are more motivated to switch from their self-interest towards the broader picture. VE was used as a methodology in both the project where stakeholders discussed the interests of each party and negotiated about everyone's interest. As mentioned earlier, it is not possible to implement everyone's requirement but the stakeholders were able to understand the reason behind the trade off and **look towards the bigger picture** instead of just keeping them limited to their self-interest. In addition, the literature says that stakeholders or clients who will face changes in terms of their benefits will resist implementing the change (Salaman, 2000, p.123). **Aligning the stakeholders towards a common goa**l can help the actors to look at the project as a joint task and not from their self-interest (Khalfan et al., 2007).

7. **Difference in perception among the stakeholders**: The seventh barrier was 'Difference in perception among the stakeholders'. It was observed in both the cases that the practitioners faced problem in understanding the end result. There was a tendency that the stakeholders might interpret the end result from their perspective. An example that was mentioned during the interview was that some stakeholders have problem in understanding the engineering drawings. There is a possibility that they misinterpret it. In such a situation, we as a client have the responsibility to **communicate in the language that the stakeholder understands**. This will reduce the probability of the stakeholders to misinterpret which can help to resolve the problem of difference in perception. Furthermore, in the case analysis, it was observed that the parties involved in the project tend to look at the change in scope from different perspectives. A different perspective will lead to interpreting different outcomes. This leads to resistance among the parties. According to Verenych et al. (2019), smooth implementation of change can be carried out if the stakeholders are at the **same level of understanding**. The lack of understanding among the parties leads to interpreting the change in scope from different perspectives. Thus, the client needs to keep everyone at the same level of understanding by bringing the stakeholders together regular basis.

8. **Stakeholders needs are unknown**: The eighth barrier under the category of 'stakeholder driven barriers' is 'Stakeholders needs are unknown'. In the second case it was observed that the requirement of gemmente was identified at the later stage of scope development. The project team mentioned that the technical manager representing gemmente joined the VE session. He didn't had sufficient knowledge about the future goals of the gemmente. During the VE session everyone agreed to a specific location for the bridge. Later the stakeholder wanted to make changes to the scope as they their future plans were in contradiction with the agreed location for the bridge. During the VE session, the technical manger representing the gemmente didn't bring up this specific requirement and hence it was not the part of the scope. It was mentioned during the interview that the client invited the policy man of gemmente for attending the VE session. The policy man didn't had time for attending the session. He was more aware about the future vision of the gemmente. It was observed that **right people with sufficient knowledge** should attend the VE session so that requirements of the

stakeholders can be identified during the VE session. In addition the, the “how-why” logic of FAST diagram helps to understand the core of each problem and identify the objective and needs of the stakeholders in a structure manner.

9. **Risk averse behavior of the project managers and client**: It was observed that the project team was skeptical towards the change in scope and creative solutions. In the second case, the project manager was aware about the importance of flexibility in the project scope from the previous experiences. He discussed the importance of flexibility and the stakeholders in the project. The higher management got convinced as they realized the importance after the discussion with the project manager. The project team was open to any type of solution as they had support from the higher management. The higher management plays a vital role in decision making as they are responsible for the taking the last call at most of the major decision. It is observed that there should be a clear communication channel between the client and project team on regular basis and the management needs to show confidence in the decisions of the project team. Higher management should not only be involved whenever the project is in crisis. They should be involved on regular basis. Adding to this, one of the interviewee mentioned that the higher management should be a part of at least one VE session so that they have better understanding about the background story of the tradeoffs in the project. Overall, it is important for the **higher management to trust their project manager's capabilities** and give them **more freedom for decision-making processes** to resolve this barrier. Simultaneously, higher management should have regular meetings with their project managers to be updated about each step.

10. **Solution oriented thinking by the project owners**: The last barrier that was experienced by the practitioner was ‘Solution oriented thinking by the project owners’. In the first case, it was observed that the client saw problem of renovation in the bridge and directly jumped towards solving the problem by developing the scope. It was further observed that some steps were missing in between. Firstly, the client didn’t **go to the core needs** of the stakeholders in terms of ‘what stakeholders expects from the project’. This eliminated the opportunity of looking at different solutions. In both the case, functional thinking was implemented in the project with the help of VE to understand the functions of the project. During the second phase of the VE session that is functional analysis phase, a FAST diagram was developed. The FAST diagram was developed on the basis of how-why logic. It gave the opportunity to understand the core needs of the project and how they can be achieved. It made it possible for to develop four different scenarios for development of the scope. All the parties voted for the best suitable scenario from their perspective. In addition, regular workshops focused on **creative thinking** can be encouraged by the client in their organizations. This will create an open attitude among the internal stakeholders in the organizations. Efforts by the client to enhance these skills in their internal stakeholders ensure the entire organization progresses together.

Based on the observations of the case analysis, the table 5-1 is formulated consisting of suggestions for resolving the barriers.

Table 5-1 Suggestions to resolve the barriers based on the case analysis

Barrier	Suggestions	Role of VE
Lack of trust Limited involvement of the stakeholders	• Involve the stakeholders at early stage of the project • Create shared goals	Stakeholders closely work together with the project team while developing the solution which helps to develop trust among the parties.
Poor communication among the stakeholders and the client Difference in perception among the stakeholders	• Communicate in the language in which the stakeholders understand. • Clear and open channels for communication by conducting regular meeting with all the stakeholders.	Creates an open environment among the stakeholders which stimulates exchange of information. Stakeholders are brought together during the VE sessions which gives the opportunity to discuss their issues with everyone which reduces the possibility of misinterpretation.
Tendency to look towards self interest	• Align the stakeholders towards a common goal • Help the parties to understand the project from broader view.	The functional analysis phase helps the stakeholder to look at broader picture instead of focusing on their self-interest.
Stakeholders needs are unknown	• Invite the appropiate people during the VE sessions.	VE helps to make the needs of the stakeholders explicit.
Limited training or coaching for interpreting the functions	• Provide training or coaching to work with functions	Value engineers can help the practitioner to work with functions.
Limited awareness about the enablers	• Spread awareness by sharing benefits of implementing the enabler • Create a sense of urgency among the organization	
Risk averse behavior of the project managers and client	• Higher management needs to show confidence in decision of project mangers • Regular meeting with their project mangers	
Solution oriented thinking by the project owners	• Going to the root cause of the problem (Dennis, 2017). • Organize workshops on creative thinking	Functional analysis phase helps to look at the project from broader view. This gives the opportunity to look at different solutions.

5.2 Step by step implementation

In order to establish how a project manger can apply the results in practice, a suggestive model is developed that represents the steps that a project manager can follow in order to enhance flexibility in the project scope as shown in figure 5-1. This suggestive model highlights plausible barriers to implementation of the enablers of flexibility and provides recommendations to move past the identified barriers.

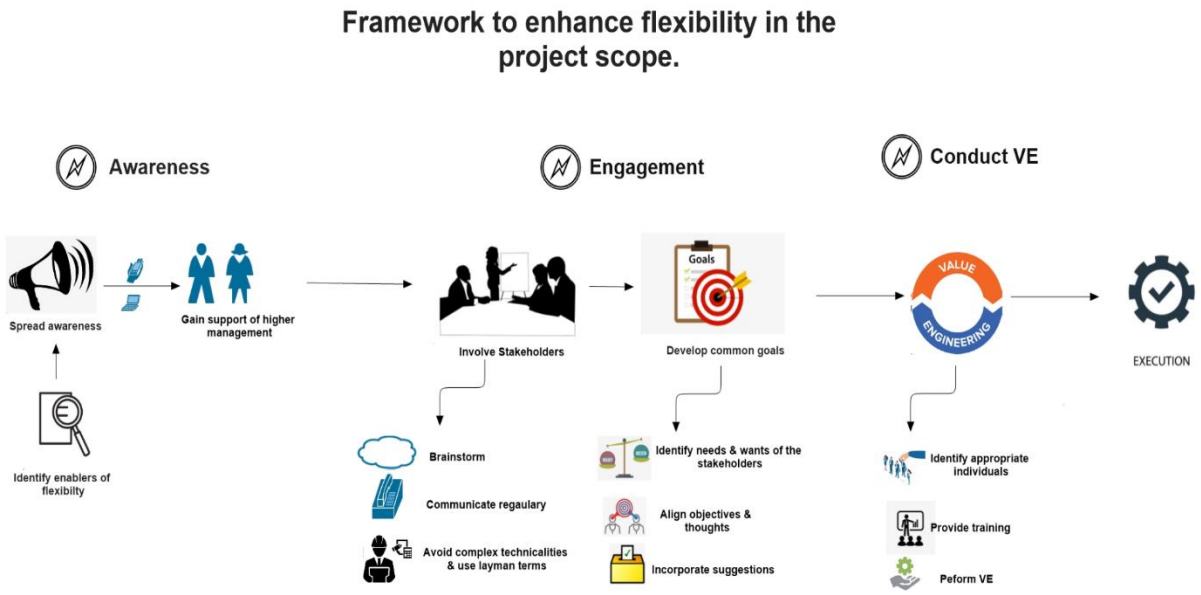

Figure 5-1 Framework to enhance flexibility in the project scope

The framework mainly consist of three sections that are ‘spread awareness’, ‘engage the stakeholders’ & ‘conduct VE’. Spreading awareness will be the first step according to the proposed framework. There was a possibility of conducting VE either before the step ‘engagement’ or after it. It was observed from the case analysis that it might be better if some meetings with all the stakeholders have already been conducted before the VE. The impact of performing VE can be on the higher side as the stakeholders will already be familiar to each other to an extent.

The process begins with identifying the enablers of flexibility in project scope and creating awareness about them. It is advisable to the project managers or the employees in the organization who have past experiences of implementing the enablers for spreading awareness about the enablers and the methodology for implementing the enablers amongst the higher management. They can share the importance of implementing the enabler for enhancing flexibility in project scope along with the advantages that come with it. Sharing the benefits among the higher management can help to create a sense of urgency among the higher management and gain their support for implementing the enablers. That will be the starting point of this framework. After gaining the support of the higher management, the project team can be open to different types of solutions instead of focusing on the tried and tested solutions.

After making the higher management aware and gaining their support, it is time for the scope development process. During the process, it is advisable to involve the stakeholders from the beginning. Here, involving the stakeholders does not merely mean that the stakeholders will only act as validators and rather involvement refers to encouraging them to engage with the project team during each step of scope development process at least until the scope of the project is developed at abstract level.

After involving the stakeholders in the project, it is advisable to perform monthly meetings with all the stakeholders together on regular basis. This can help to keep the stakeholders updated about the project and it might give the stakeholders the opportunity to share their feedback frequently. This might bring all the parties involved in the project to the same level of understanding.

During the meetings, there is a possibility that the stakeholders might not have similar technical knowledge which may lead to a communication gap. To avoid this, it is advisable to the project team to convey their messages in the simplest form or layman terms to avoid misinterpretation of any information decisions among the stakeholders. In addition, this might also help create a sense of belonging and purpose in the project for the stakeholders.

During the regular meetings, it is advisable to discuss the feedback of the stakeholders in order to understand their vision better. This might help to build a better relationship with the stakeholders as it can provide them with a sense of involvement and empowerment. Their ability to influence the scope might enhance their commitment to the project.

Once everyone is on board and aware of the objectives, it is time to start preparing for conducting a VE study. Before the VE sessions, it is advisable to the project team for developing a list of people who will be part of the VE. It is advisable to invite the representatives of all the stakeholders for the VE study. The most appropriate people who are aware of their respective organizations can be invited for the session so that there are lower chances of missing any insights or requirements during the VE session.

Before the VE session, it is advisable to the practitioners who do not have the experience of working with functions to attend training for working with functions and share some basic knowledge about VE. The training will take a maximum of 4 to 5 days. There is a possibility that the practitioners don't have time to attend the training sessions. After inviting the most appropriate people representing the respective stakeholders and providing them the training, it is time for conducting the VE sessions. During the VE session, the interest and needs of each stakeholder can be discussed in detail. Based on the needs of the stakeholders, functions can be formulated. This will give a base line for generating alternative ideas for the problem. Between the VE sessions, as suggested earlier, regular monthly meetings can be conducted with all the stakeholders.

Based on the case analysis, suggestions have been proposed in this section to resolve the barriers for incorporating the enablers for flexible scope.

The chapter explained the development of the framework for resolving the barriers. The framework was based on the suggestions observed during the case analysis. A step by step implementation procedure was formulated which can help the project manger to incorporate flexibility in project scope. It is advisable to follow all the steps of the framework. If the higher management is already aware about the enablers & the methodologies and are in favour of implementing the enablers, the first step of awareness can be skipped. In the next chapter, the proposed suggestions in table 5-1 will be validated by the experts.

6. EXPERT VALIDATION

In this chapter, the proposed suggestions mentioned in the table 5-1 in the last chapter will be validated with the help of productive sessions with expert panelists. The applicability of the suggestions and as well as the possible adjustments to the suggestions will be discussed.

6.1. Set up expert validation

The objective of this step was to receive the feedback from the experts on the suggestions for resolving the barriers formulated in table 5-1 in the last chapter. Three experts were consulted, and they were selected on the basis of their experience with both project management and VE. Each session was conducted for 90 minutes with one expert at a time. The session started with a presentation to give an overview of the research and the results from the case analysis. Along with this, the suggestions were also presented to the experts. Each and every plausible suggestion was discussed with the experts to validate its applicability in the construction industry. The expert interview protocol can be found in appendix 6.

6.2. Discussion about each suggestion in the framework

This section consisted of elaborate discussions on the proposed suggestions for resolving the barriers as mentioned in table 5-1. The experts were asked if the proposed suggestions will be capable in resolving the respective barriers for implementing the enablers. In addition, the experts were also asked about the constraints for implementing each suggestion. Similar questions were asked for the general suggestions about ideas and ways to perform VE can in order to resolve the barriers. All the three experts found the suggestions simple and easy to be implement in an organization. The following are results of the expert validation:

1) Barrier 1: Lack of trust among the client and stakeholders

All the three experts agreed to the general suggestions such as involving stakeholders at an early share and developing common goals proposed in the framework. However, they went to add that, at the same time it is also **important for the client to indicate the boundaries in which the stakeholder can play**. The boundaries here, refer to the time frame and the budget. The client should be wise about the boundaries as they should not be too narrow-minded as it will limit the involvement of the stakeholders. For the suggestion “Give importance to the reviews and audits of the stakeholder” it was mentioned by one of the interviewees to make it more explicit by changing it to “listen and understand the stakeholders”. Regarding the suggestion of VE, experts mentioned that VE is an impactful methodology for bringing the stakeholders and to work together and further build trust among the involved parties.

2) Barrier 2: Limited involvement of the stakeholders

The experts agreed with the suggestion about involving the stakeholders at the primary phases, but they also mentioned that it is **important to keep in mind whom you are involving and what they bring to the table, in terms of background knowledge and experience**. All the stakeholders that may be involved in the process, might not have the same technical knowledge and hence they might not be able to understand what you are trying to convey. Such situations may lead to confusion; thus, it is important for the project team to prepare for such situations beforehand. In addition, the stakeholders should feel that they are important and henceforth they are involved in the process rather than for the sake of

involvement. Overall, an efficient interaction between the stakeholders and the project team is a constant need during the project life cycle.

3) Barrier 3: Poor communication among the stakeholders and the client

The experts agreed to the suggestion about trying to maintain clear communication channels, but as mentioned earlier, all the stakeholders may not be on the same page, in terms of previous knowledge. It should be the **responsibility of the project team to communicate the results according to the technical expertise of the stakeholders**. Sometimes, citizens also play role of stakeholders in the project and some of the citizens may not understand the drawing or blueprints which may lead to a communication gap between them and the practitioners. Thus, the project team must make them comfortable and if needed, explain to them in layman terms about the steps involved in moving forward.

According to the experts, VE is a structured process which can stimulate communication among the parties involved. **Generally, the stakeholders and the client do not come together frequently, because of which, the communication channels may not be clea**r and VE can be a good solution to clear those channels. Hence, in addition to conducting VE, frequent meeting should also be organized with the stakeholders.

Barrier 4: Tendency to look towards self interest

The experts strongly agreed with the suggestion vis-à-vis pointing the stakeholders towards a common direction and they thought of it as an effective solution. According to them, in order to come to a common aim, it is very important to discuss the needs of the stakeholders at the early stage of the project. In addition, they also mentioned that, **having a self-interest is acceptable because that is the reason the stakeholder is interested in the project in the first place. However, it is important to be transparent as well as open to slight variations where need be.**

The FAST diagram in the VE is a perfect example for helping the stakeholders to look at the broader view. It helps in aligning the stakeholders towards a common goal. As a project team you must be aware of the technicality of FAST as all stakeholders may not have the same knowledge required to understand the FAST tool.

Barrier 5: Difference in perception among the stakeholders

The experts partially agreed to this suggestion about conducting regular meetings. According to one of the experts, meetings are already performed on regular basis, however, making the meeting an effective one should be the prime focus. There should be an **emphasis on two-way communication which is often missing**. It is also important to communicate in the language in which the stakeholders understand. There are less chances of them misinterpreting the information the client is sharing, the wording and the visuals the client might use. Sometimes the municipalities use difficult sentences and words. The citizens are not able to understand. The experts further mentioned that it is important for the project team to keep the stakeholders eager enough to be involved in the project.

The first step of VE helps in bringing the parties at the same level of understanding. The project team present the whole information about the project to all the stakeholders present in the meeting. When all the stakeholders are brought to the same level of understanding the chances of misinterpretation are greatly reduced.

Barrier 6: Stakeholders needs are unknown

All the experts agreed to the suggestion of performing VE, but they mentioned that the step of conducting VE should not be the first time where the project team identifies the needs of the stakeholders. This can greatly reduce the efficiency of the project. **The project team should do their background research by identifying the need of the stakehold**ers before the VE session and discuss those needs with them on the table during the VE session. There can be possibility that some needs are missed during the session.

Barrier 7: Limited training or coaching for interpreting the functions

All the experts agreed to the suggestion of organizing trainings; however, they highlighted some constraints vis-à-vis implementing the suggestion. Citizens are one of the stakeholders in the project. **It will be difficult to give them explaining and training to work with functions. This can be because of the time constraints or their interest**. **It is possible to implement the suggestions in the organization, but the higher management needs to take the first step towards it.**

Value engineers are right people for coaching the practitioners to work with functions as they have the experience and knowledge of working with functions.

Barrier 8: **Limited awareness about the enablers**

All the experts agreed to the suggestions of creating a sense of urgency but according to them, project owners don't have the intrinsic motivation to create more value in their project. **If one can trigger that intrinsic motivation, they will try to create a sense of urgency** among the other employees in the organization. In addition, experts mentioned that it will take time for the organizations to implement changes in the long-standing ways they have been approaching the projects from decades. Furthermore, it is just not about sharing the benefits of the enablers in the front but also in the background.

Barrier 9: Risk averse behavior of the project managers and client

All the experts agreed to the suggestions, but added that, keeping the higher management involved and updated about the whole process may be difficult. There is a normal tendency of the higher management to engage in the project when things do not go according to plan. This can be because of the time constraint. **As they are not closely engaged in the project, they are not familiar with the background story of each decision**. This can lead to communication gap between the manager and the higher official. Hence, closely engaging the higher official can help gain their confidence.

Implementation of VE, is a good opportunity to gain the support of the stakeholders. Involving the higher management in one of the VE sessions can help in gaining their confidence as they will then have the same level of information. The problem that is often faced in engaging the higher management is the lack of time from the higher management.

Barrier 10: Solution oriented thinking by the project owners

All the experts agreed to the suggestions about organizing workshops because they can be important to trigger the creative and innovative thinking of the project owners. It is also important to analyze the root cause of the problem. To identify the root cause, project owner should always ask the question "why". This will limit the practice of jumping to the conclusions.

VE is a methodology which can help the project owners, not jumping to conclusion. The “how-why” logic of the FAST diagram helps to understand the problem to the root cause.

Most of the suggestions provided in the framework are common, then what is the reason behind not applying the suggestions in an organization or project?

All the experts revealed that the suggestions mentioned are very simple and easy to implement but are not executed at most times. They believe that implementing the suggestions may face psychological barriers rather than physical or time-based barriers because most experienced practitioners tend to be rigid in their old faces and resistant to change. Due to the conservative perspective, practitioners in construction industry do not prefer changing their approach towards the project. Lack of urgency can be one of the reasons as the practitioner does not feel the need for implementing the enablers or the suggestions, outlined in their project.

In terms of VE, there is a lack of awareness and misinterpretation about the benefits of VE among the practitioners. There can be a suspicious feeling among the practitioners for implementing the VE as they are not aware about the whole methodology.

6.3. Main findings from the expert validation

1) Involve the stakeholders closely but it is important to specify the boundaries in which the stakeholders can operate. The boundaries can be in terms of finances as well as time duration.
2) All stakeholders do not have the same level of educational background. It is important for the client to communicate the information in the language in which the stakeholders are most comfortable with, including layman terminology. Miscommunication can lead to misinterpretation of results.
3) Regular meetings are perfomed in every project, their shoud be emphasis on two way communication.
4) Higher mangement does not have the time to engage often in the project. The project manager should try to insist them.
5) A new barrier was observed during the expert session that implementing the barriers may face physchological barriers as most of the experienced practitioners tend to be rigid and resistant to change.

7. DISCUSSIONS, CONCLUSIONS & RECOMMENDATIONS

This chapter concludes the closure of the research. The previous chapter have offered the detailed analysis and understanding of the concept of flexibility in project scope and how VE can help to resolve the barriers for implementing the enablers. This chapter reflects the finding of the research followed by the conclusion, recommendation for future research and limitations of the research.

7.1 Discussion

The first chapter of current research reflects the need for flexible approaches in project management as the traditional approaches are not always able to deal with the growing complexities and uncertainties in a project. Flexibility as such in project management is a very broad field, so the studied research focused only on the flexibility in project scope. Another objective of the research is VE, which is a structured process with six steps that aims towards enhancing the value of the project. Thus, the main research question was formulated that how flexibility in project scope can be enhanced with the help of VE. The starting point of studied research is the enablers for flexible scope from the research of Jalali Sohi (2018) that were “broad task definition”, “embrace change” and “functional based contracts”. The research is focused on the front-end phase of the project.

To answer the main research question, a detailed literature study was conducted. The literature study was carried out by identifying the enablers and strategies for enhancing the flexibility in project scope. 13 enablers and strategies were identified from the literature. During the literature review, it was observed that many authors have emphasized on the importance of dynamics among the stakeholders in terms of soft skills for enhancing flexibility in project scope. It was observed that six out of the 13 enablers and strategies identified from literature were focused on the soft skills of stakeholders. The enabler and strategies focusing on the soft skills include trust, involvement of the stakeholder, communication, commitment, collaboration and managerial review. Observing the importance of soft skills among the stakeholder, a third enabler was developed that was “interaction among the stakeholders”. For the next step of the research, three enablers from the list of 13 were chosen consisting of “broad task definition”, “embrace change” and “interaction among the stakeholders”. In addition, how these enablers are applied in the practice and the barriers for implementing the enablers were identified in literature. This led to a development of the theoretical framework consisting of the barriers for implementing the enablers for flexible scope.

The second aspect of the research as mentioned earlier was VE. VE is a management tool to achieve the essential functions of a product, service or project with the lowest cost. During the literature study, it was observed that the VE is just not limited to the cost cutting technique. VE aims towards adding value to the project. In addition, it was observed that there is limited literature about the benefits of performing VE in the construction project. A list of 21 benefits was developed for performing VE in construction industry from the literature.

To enhance the reliability of the identified benefits, a survey was conducted in which the practitioners were requested to rate their experience regarding the benefits after performing VE in their project. The survey was conducted parallel to the case analysis. On an average, 25 respondents filled the survey. It was observed that each benefit mentioned in the survey had a RII score more than 0.6 which reflects that identified benefits in literature were recognized on the higher side by the respondents.

The next phase of the research was the case study analysis for two different projects. In the first case, the client was not aware about the enablers initially. The scope was developed with limited involvement of the stakeholders. Once the original scope was developed, the stakeholders did not accept the scope as their interest were in conflict with the original scope. There was a need for redefining the scope together with the stakeholders. That is the time VE was introduced in the project. As opposed to the first case, the second case took a proactive approach as VE was performed at the beginning of the project. The project manager was already aware about the importance of enablers and the methodologies for implementing the enablers because of past experiences in the projects. The scope was developed with the consensus of the stakeholders from the beginning of the project. Firstly, the aim of case analysis was to check the presence of enablers in the project. In addition, how the enablers are implemented in the projects and what were the barriers faced for implementing them. Furthermore, the role of VE in the project in terms of resolving the barriers was investigated. The identified barriers in the cases were compared to the theoretical framework developed in the literature review.

It was observed that the enablers lacked awareness in the first case. Lack of trust was the most common barrier experienced by the practitioners. Furthermore, it was observed that in the first case where VE was not introduced until the time the stakeholders discarded the original scope experienced 13 barriers in total. On the other hand, the second case, where VE was performed at the beginning of the project experienced 4 barriers in total. A significant difference was observed between the barriers experienced in both the cases. There can be a possibility the VE might have helped in resolving the barriers for implementing the enablers in the second case where VE was introduced as a proactive approach. There is a possibility that with more investigated cases, the results might differ. It was observed that lack of awareness and limited engagement of the stakeholders during the development of the scope were the main root cause for the occurrence of the barriers. In addition, VE played a supporting role in implementing all the three enablers.

From the case analysis, a list of ten barrier was chosen based on their frequency of occurrence for the next step of the research. After analyzing the results of the case analysis, a list of suggestions was proposed for resolving the barriers. Based on the proposed suggestions, a framework was developed. The framework consisted of three main sections consisting of ‘spread awareness’, ‘engage the stakeholders’ & ‘conduct VE’. Implementing the framework may help to enhance flexibility in project scope by resolving the barriers. In the next step, an expert session was conducted to understand the applicability of the proposed suggestions from the perspective of the practitioners which was the last of the research to achieve the research objective of this research.

With the growing need for flexibility in project scope, this research can help the practitioners with the right methodologies and techniques to implement the enablers. Additionally, it can also help to resolve the barriers by implementing the framework in their organization.

7.2 Conclusion

The primary objective of the research was to enhance the flexibility in project scope with the help of VE. To reach the research objective, the following research questions were formulated. In this section, the sub research questions are answers to achieve the main research question.

1) **What are the enablers and strategies for becoming flexible on the scope?**

The definition of the flexibility in project scope was narrowed down for this research to “*the ability of the project scope to adjust and keep the options open*”. A list of 13 enablers and strategies for enhancing flexibility in project scope was formulated based on the literature. The list consists of:

1. Broad task definition
2. Embrace change
3. Functional based contracts
4. Iterative planning
5. Phased design cum late locking
6. Explorative learning **(Strategy)**
7. Adaption of solutions **(Strategy)**
8. Involvement of the stakeholders
9. Trust
10. Communication
11. Collaboration
12. Good will & commitment
13. Managerial review

A detailed discussion about the enablers and the strategies is mentioned in section 2.2.

2) Is flexibility limited to hard factors?

During the literature review, it was observed that many authors have emphasized on the importance of soft skills among the stakeholders for enhancing the flexibility in the project scope. Out of 13 enablers identified for flexible scope, six enablers were observed to be based on soft skills among the stakeholders. The enabler and strategies focusing on the soft skills include trust, involvement of the stakeholder, communication, commitment, collaboration and managerial review.

When multiple stakeholders are involved in a project, negotiation and discussion become an important aspect for the success of the project. Change in scope can be beneficial for one party and not for another. In such a situation, it is important to be flexible on the attitude of the stakeholders and that is how we can expect them to negotiate (Nystén-Haarala, 2010). Inadequate management or having a rigid mindset may lead to conflicts and issues among the stakeholders (Tillmann et al., 2011). The stakeholders can be in a better position to be flexible on their interest if they have sufficient understanding about the interest of the parties and have a good relationship. To achieve that, the client should engage the stakeholders closely during the development of the scope and communicate the vision for changes with the parties involved.

It is difficult to come up with efficient and creative solutions individually. The recombination of knowledge and expertise from different disciplines, can lead to development of creative solutions. Most efficient solutions are developed by negotiating and sharing of knowledge with the various stakeholders (Veeneman, 2012).Thus, it is vital to encourage frequent collaboration between the key stakeholders. This will not only help build relations but will also aid in coming up with novel solutions (Eriksson et al., 2017). In addition, it is also important to communicate the vision for changes at every possible level of organization. Everyone should understand what is being done and why (Bittner & Spence, 2006). John Kotter (1996) observed that communicating the vision is one of the most important factors in failing to implement the change efforts (John P. Kotter, 1996). The stakeholder relations should be focused on dealing with the dynamic nature of the project (Winter et al., 2006).

Therefore, soft skills among the stakeholders may play a vital for achieving flexibility in project scope.

3) What are the benefits of performing VE in a construction project?

VE is a creative, organized effort, which analyzes the requirements of a project for the purpose of achieving the essential functions at the lowest life cycle cost (Heralova, 2016). It was observed during the literature review that VE is just not limited to a cost cutting techniques, rather VE aims towards enhancing the value of the project. Many authors have discussed the importance and benefits of performing VE in different industries but still there is lack of significant evidences showing the potential benefits of performing VE in a construction project. Therefore, a list of potential benefits of VE in a construction project was formulated based on the literature. A survey was conducted to check if practitioners have experienced the identified benefits in their projects. A list of benefits based on the rank from survey is mentioned below.

Table 7-1 Benefits of performing VE

Benefits of performing VE	Ranking
Generate multiple ideas for the problem	1.
Enhance commitment of the stakeholders	2.
Bring the stakeholders together	3.
Enhance interaction among the stakeholders	4.
Enhance extensive understanding of the project among the stakeholders	5.
Stimulate exchange of information among the stakeholders	6.
Look at the bigger picture instead of focusing on self-interest	7.
Gain stakeholders support	8.
Understand the project from functional perspective	9.
Evaluating the best generated ideas	10.
Strengthen teamwork among the stakeholders (Collaboration)	11.
Develop confidence among the stakeholders	12.
Bring stakeholders at same level of understanding	13.
Analyzing the generated solutions for different risk scenarios	14.
Develop trust among the stakeholders	15.
Reduce conflict among the stakeholders	16.
Understand needs of the stakeholders	17.
Reducing the cost of the project without compromising on the functionality	18.
Enhances transparency in decision making	19.
Stimulate innovation	20.
Reduces the time duration of the project	21.

A detailed analysis of the benefits is mentioned in section 2.5.2. The results of survey are mentioned in section 3.4.

4) How are the enablers for flexible scope implemented in the industry?

The enabler ‘broad task definition’ aims towards looking at the project from a broader view. It was observed in the literature that thinking in terms of functions can help to look at the project from broader view. Two methodologies that can be used for implementing functional thinking include VE and system engineering. VE

was observed as more suitable until the scope is developed at the abstract level. Once the scope is developed at detailed level, system engineering was observed to be more appropriate.

The enabler 'embrace change' aims towards implementing the change in scope. The steps involved in the scope change process model can be followed for implementing the change in scope. Two approaches that can be used for implementing the change in scope are project-based approach and process-based approach.

The third enabler interaction among the stakeholders is tendency of the actors to influence each other by their actions in terms of communication, involvement, trust and collaboration. It was observed in the literature that stakeholder engagement plan can be used for implementing the enabler.

According to the case analysis, it was observed that VE played a supporting role for implementing all the three enablers in both the cases.

5) What are the barriers for implementing enablers for flexible scope management in a project?

A theoretical framework was developed as shown in table 2-3 which reflects the potential barriers for implementing the enablers. The barriers were categorized into four categories "stakeholder driven barriers", "limited awareness", "organizational behavior" and "contractual barriers". In total 15 barriers were identified. In the next step, through the case analysis, the presence of the identified barriers was investigated. It can be noticed that most of the identified barriers in the case analysis comes from the category "stakeholder driven barrier". The most common barriers faced by the practitioners for implementing the enablers for flexible scope were:

1) Lack of trust among the stakeholders and the client.
2) Limited involvement of the stakeholders during the development of scope.
3) Poor communication among the stakeholders and the client.
4) Tendency to look towards the self-interest.
5) Difference in perception among the stakeholders and the client
6) Stakeholders needs are unknown
7) Limited training or coaching for interpreting the functions
8) Limited awareness about the enablers
9) Risk averse behavior of the project manager and the client
10) Solution oriented thinking by the client

Main research question: How flexibility in project scope can be enhanced with the help of VE in the construction industry?

A list of barriers that hinder implementation of the enablers was formulated based on the literature. During the case analysis, the presence of enablers and the barriers was observed which was mentioned in the last sub research question. The root causes for most of the barriers was observed to be lack of awareness about the enablers and the methodologies for implementing the enablers. In addition, there was lack of engagement of the stakeholders during the development of the scope.

Furthermore, in both the projects, VE played a supporting role for implementing all the three enablers. A combination of 'spreading awareness', 'engaging the stakeholders' and 'performing VE' during the front end phase of the project may help to resolve the barriers. A framework was developed as shown below which consist several steps which may help to resolve the barriers for achieving flexibility in project scope.

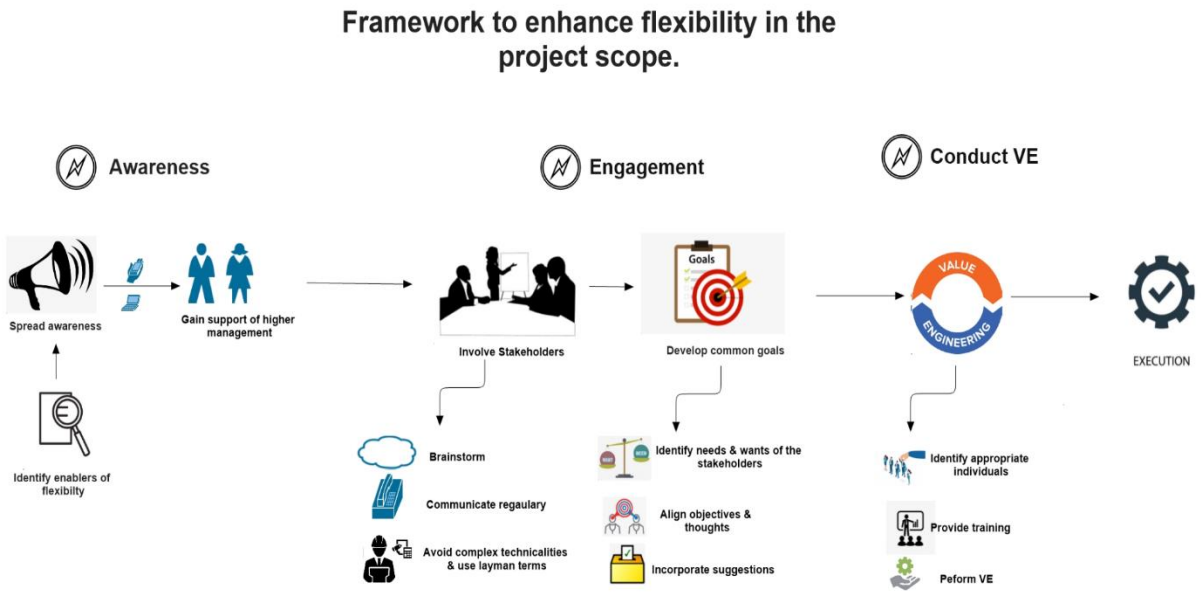

Figure 7-1 Framework for enhancing flexibility

7.4. Recommendation for RWS

7.4.1 Organizational based suggestions

1) During this research, it was observed that some project managers and other team members did not seem to be well versed with the enablers identified in this research. On the other hand, a few project managers were not only aware of the enablers but have also been implementing these enablers for enhancing flexibility in the project scope. The organization can organize more interactive session among the different departments and project teams from different projects. This will stimulate knowledge sharing among the employees about the enablers and their potential benefits of the project.
2) During the exploratory interview, it was observed that VE lacks awareness among the practitioners of organization. The organization can share the results and benefits experienced by other project teams after conducting VE in their project on organizational platforms. This may help to spread awareness among other employees.
3) The lessons learnt from past projects can be captured. A formal document can be developed by the organization which consist of lessons learnt from previous projects while incorporating flexibility in project scope. This will help the project managers who are implementing flexible approaches in their project for the first time.

7.4.2 Project based suggestions

4) The higher management (portfolio manager and directors, other line manager and etc.) can encourage the project managers to incorporate flexible approaches in the project. They can show confidence in the decisions of the project managers and give them more freedom in decision making.
5) Higher management and the project team should encourage the involvement of the stakeholders. The organization can invest time on building long term relations with the stakeholders. Officials of the

organization can meet the stakeholder informally once in a while as it is not necessary to meet the stakeholders only when there is a need.

6) Though, some project managers are implementing the enablers, but it was observed that there is no formal document which specify some specific steps that the project managers can follow in their project for achieving flexibility in project scope. A specific document can be developed which specify a step by step approach that project managers can follow for incorporating flexibility in project scope.

7.5. Recommendation for future research

In this section, the recommendations for future research in the field of flexibility in project scope is provided.

1) In the literature study, a list of 13 enablers and strategies were developed. Implementation of three enablers was discussed in the research. In future recommendation, implementation of the remaining 10 can be researched further.
2) Only client's perspective was investigated in the research. Stakholder's perspective can be researched further.
3) As the literature is limited about the benefits of VE, more concrete research can be conducted focusing on the benefits of VE.
4) The perspective of client is investigated for the VE in this research. The perspective of the stakeholders about the VE can be researched further.

7.6 Limitations of the research

This section discusses the limitations of the research.

1) The literature review specifically on flexibility in scope in construction project was limited and hence, some portion have been investigated from the flexibility in the project management.
2) Only 2 projects with VE were investigated for the case analysis, to have a better undestanding about the concept of flexibility and VE. This reduces the generality of the research.
3) Only client's perceptive was investigated in the case analysis. Investigating the perspective of other parties involved in the project could have led to more interesting outcomes.
4) Interviews were conducted with the project team but it would have been better if the researcher could understand Dutch. There was a communication gap in some of the interviews.
5) The survey was filled by most of the value engineers and hence there is a slight possibility for biased outcomes.

Reflection

As I sit down to reflect on my time as an intern at RWS, I think about all the positivity and support that I received from my company supervisor, graduation committee as well as all the employees who took out time so that I could interview them for my research. I distinctly remember when I started my thesis research in April, the chosen topic had two main parts, ‘Value Engineering’ and ‘Flexibility’. The former, was a completely new field for me and a big part of this research focused on it. I was still little aware, of the latter focus of my research, thanks to the courses which I studied during my M.Sc. at TU Delft. As I had little knowledge of Value Engineering, I was overwhelmed at first but at the same time I was also determined to learn more.

The first phase of this research involved conducting a literature review, which was a little challenging for me as I was not sure how can I connect two different keywords of my thesis. I got an opportunity to take a 3 month course at University of Twente to learn more about VE. That course really helped me in understanding about the insights of VE.

The second phase involved conducting interviews and this really helped me connect the dots and introspect everything that I learnt from the literature. It was great to hear from expert about their experiences in the industry. Their experiences help me shape my research. The last stage of this research was to compile my findings in the form a thesis based report, and this was what I found to be the most challenging part of my journey. I am not very expressive with my thoughts and while writing this thesis, I realized that my inability to express my thoughts, hindered my writing as well. During the final stages of my writing, I really worked on aligning my thoughts and improving my written communication skills.

Overall, this voyage was a great experience. However, I do believe that I missed out on gaining insights into the office environment. Due to COVID-19 outbreak, I could not go to the RWS office which I was really looking forward to while hunting for an internship. I wanted to be a part of experience working at a designated spot in the office and interact with other colleagues face to face. Despite the short comings, I am very grateful to my company supervisor for making me feel like an important part of this organization, even from a distance.

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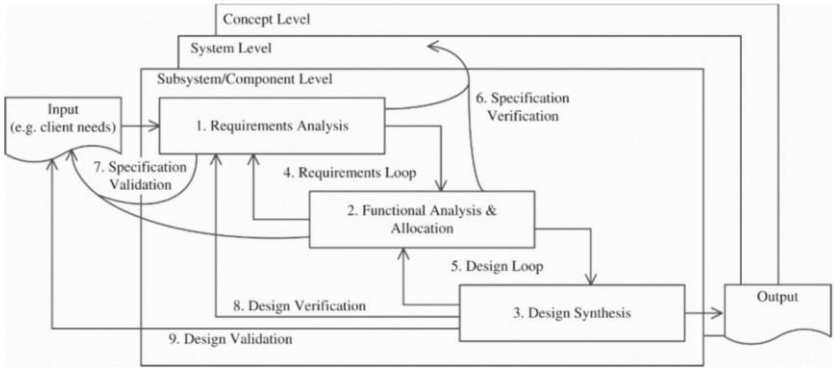
Appendix

Appendix 1

System engineering is an interdisciplinary, collaborative approach that derives, evolves, and verifies a life-cycle balanced system solution which satisfies customer expectations and meets public acceptability. It provides structural but flexible process to transform requirement into specifications, architecture and configuration baseline. This approach helps develop solutions that meets the customer needs. Considering the flexible nature of this approach and ability to develop solution, system engineering is explored in detail for this research (System engineering fundamentals, 2001).

According to Lynies, the difference between system engineering and other traditional engineering approaches is that the former focuses on the complete structure of the system instead of just analyzing the individual element. It can be used as a tool to enhance the creative thinking processes, essential for generating and developing solutions that fit the requirements of the stakeholders Furthermore, Lynies draws a comparison between system engineering and the education system practiced in schools. Schools around the globe teach students various courses which belong to different disciples, however, in reality, these courses and their respective disciples are integrated amongst each other. In fact, connecting the dots between the different course objectives will encourage students to look at the broader picture and identify the interconnection between the courses. Analyzing the system as a whole will help to gain deeper insight and understanding of the system and how the system should work (Lynies, 1995)A system engineering process model was developed which was tailored to be used int the civil engineering industry as shown in the figure 2 (De graff, 2017).



1.A System engineering model (De Graff, 2017).

The model consists of nine elements in total. The elements can be broadly classified in to the two following categories:
1. Core elements: The main steps of the system engineering model.
2. Feedback elements: The elements that connect the core element with the other core elements.

Core Elements
The first stage of the system engineering model is requirement analysis. The project team starts with investigating and analyzing the requirements. The requirements are based on the expectations and wishes

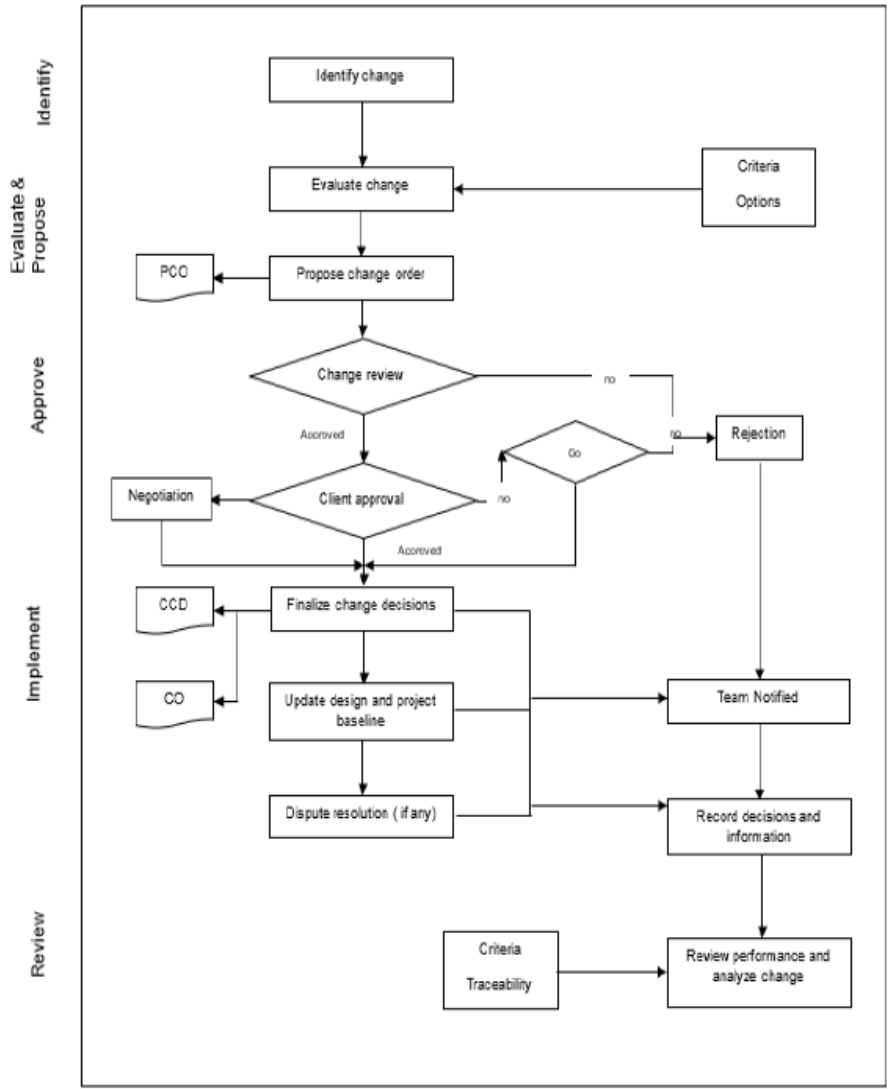
of the stakeholders. The requirements are structured hierarchically, and this arrangement is referred to as requirements breakdown structure (RBS). The next core element of the process is functional analysis and allocation. The functionality of the system is identified during this phase. This provides an opportunity to develop creative solutions to fulfill the requirements of the stakeholders. The developed functions are structured in a tree-like scheme, also called the Functional breakdown structure (F.B.S). Functions are then allocated to the objects during the functional analysis to create the system breakdown structure (S.B.S), which reflects the overview of the complete system. This helps in dividing the whole system into manageable and small objects. Every object consists of certain specifications including relation with the functions, requirement, and some other information relevant to the respective object. After the functional analysis and allocation, the next core elements involve design synthesis. In this element, multiple design solutions are generated with respect to the requirements identified during the processing of the prior elements. Brainstorming techniques can be used to generate solutions. It is important to record the decision-making process so that the decision can be traced back.

Feedback elements

It is important to link the core elements in an efficient and comprehensive manner. Iterations and feedback loops ensure the correct linkage of the core elements so that the design can be continuously updated, verified, and documented. The requirement loop is the first feedback element and an iterative process The requirement loop sprints between the functional analysis and allocation and the requirement analysis. The feedback loop is very important because functional analysis helps identify new functions, which in turn prompt changes in requirements. The second feedback element is the design loop. The design loop operates between design synthesis and function analysis and allocation. The main aim here is to ensure consistency among the core elements. The design loop aims at checking the suitability of the design solution with respect to the functions and object specifications. If not, adjustments in the function or the design solution are required. The sixth element is the specification verification. The elements intent to check the relatability among the lower functions, requirements, and objects with the higher-level functions, requirements, and objects. Once the specifications are checked, it is important to validate them with the stakeholders and the client. The “check” is called the specification validation. The design verification aims at proving the stability of the design with the requirements. The generated design is validated against the requirements and check their compatibility. The last elements of design validation assess whether the generated design matches the needs, interests, and expectations of the stakeholders and client.

The combination of 9 elements completes one cycle of the system engineering process. The cycle is carried out until the level of detail is sufficient enough to build the system.

Appendix 2



2. A. Scope change process model (Hao et al., 2008)

Appendix 3

Empirical studies

The chapter consist of the information collected during the exploratory interviews conducted with the practitioners within RWS and Prorail. The intent was to understand the perspective of the practitioner regarding the barriers for enhancing flexibility in project scope. First, a brief introduction of the company is presented, followed by the findings of the interview.

Company Introduction

Rijkswaterstaat is a branch of Dutch Ministry of Infrastructure and Environment. The organization was founded in the year 1798. The organization is the in charge of the maintenance and execution of the national roads, highways and waterways within the Netherlands. The country is divided into 10 regional departments. Rijkswaterstaat aims towards ensuring safety and smooth flow of traffic throughout the roads and waterways. Looking at the constant demands of the end users and taxpayers, it is important for RWS to accelerate the delivery of their projects and satisfying the taxpayers. System Engineering was introduced at RWS to enable efficient collaboration among the stakeholders and other external parties. The Value Engineering was also introduced at the RWS as the management understands the benefits of applying it in the project.

Prorail is a private limited liability company. On the behalf of the Ministry of Infrastructure and Water Management, Prorail is responsible for construction and maintenance of the railway infrastructure which includes the tunnels, overhead and level crossings. The Prorail aims towards ensuring safety to the passengers and smooth travel now and in future.

Initial Exploratory interview finding:

The intent to conduct the exploratory interview is to understand the perspective of the practitioners regarding the barriers faced for enhancing flexibility in project scope. Six interviews were conducted in total consisting of two project managers, two value managers and two system engineers. The details of the interview can be found in below mentioned table.

	Designation	Organization	Duration
1	Project manager	Rijkswaterstaat	60 minutes
2	Project manager	Rijkswaterstaat	60 minutes
3	Coordinator Value Engineering	Prorail	60 minutes
4	Coordinator Value Engineering	Rijkswaterstaat	60 minutes
5	System Engineer	Rijkswaterstaat	60 minutes
6	Policy advisor (Former experience with System engineering and VE)	Prorail	60 minutes

Interview findings

The outcome of the exploratory interviews is summarized below and explains about current barriers faced in the infrastructure projects to become flexible on scope.

1. **Limited transparency in the decision making**: Interviewer 5 mentions that asset manager gives the solution and they don't say why or how they came up to that decision. Project managers tell the solution but do not convey the process behind the decision making and thus it does not leave any room for changes in the scope. Interviewer 1 further mentions that it is important to be open to the project owners whenever there is a need for change in scope.

2. **Directly going to the solutions**: Interviewer 1 & 2 mentions that technical engineers looks from solution perspective and hence they already have a solution in their mind . In this way, it is difficult to give opportunity to the contractors to come up with a better solution. By giving contractors the opportunity, maintenance can be a problem sometimes. Cost of maintenance might be high.

3. **Limited budget to implement the change**: Interviewer 2 mentions that project managers do not have sufficient budget to implement the change in scope. It is difficult to convince the client to allot budget for implementing the change in scope as the client lacks confidence.

4. **Limited involvement of the stakeholders during the development of the scope**: Interviewer 5 mentions that the client is not willing to involve the stakeholder as the developed solution might not be the optimal solution for the client. Further interviewer 2 mentions that it is difficult to get the support of the stakeholder for implementing the change in scope.

5. **Fear of losing control over the project/scope**: Interviewer 2 & 3 mentions that the project managers are not confident to implement the change in scope. They have a fear of losing control over the project.

6. **Afraid to go to the functional domain as they won't get what they want**: All the interviewer mentioned that the client is not willing to go the functional domain as they are afraid that solutions that they will get from the market won't be an optimal solution for them and hence they provide detailed work packages to the contractors.

7. **Limited involvement of the business owner after the procurement**: Interviewer 3 mentions that business owners provide requirements of the stakeholders and allot the budget to the contractors. After that owner is out of the picture. Contractors have no one to go back to when there is a possibility for change in scope.

8. **Not bringing the stakeholders together and align them**: Interviewer 3 mentions that the biggest challenge is to bring your stakeholders together and align them. It is a lengthy procedure but if you plan them accordingly things will change. Interviewer 2 further mentions that stakeholders avoid the situation of scope change as it will lead to conflicts among them.

9. **Stakeholders does not understand the impact of change on other stakeholders**: Interviewer 3 mentions that stakeholders does not know exactly what they want. They don't know what the impact will be on the other stakeholders, resources and project. It is important to make them learn themselves as it is just not about stating requirements.

10. **Limited training or coaching for interpreting the functions**: According to Interviewer 1,2 and 5, practitioners face problem in interpreting the functions. Some practitioners does not have the sufficient experience or knowledge to work with functions which limits flexibility in scope.

11. **Lack of awareness**: Interviewee 1 mentioned that the practitioners are not aware of the enablers and their benefits for implementing in the project. There is no sense of urgency for them for implementing the enablers.
12. **Attitude "We know everything**": Interviewer 4 mentions that flexibility is just not limited to scope or project. It is about being flexible on attitude of the stakeholders. According to Interviewer 3, organizations are rigid and they don't want to implement change. They are not willing to look at the new things. According to them, new things will never get realized and thus they stick to the traditional solutions.
13. **Lack of trust**: Interviewer 3 mentions that it is important make the stakeholders collaborate but it is important to develop trust among the stakeholders to stimulate collaboration. The way stakeholders are involved is an important precondition to develop trust among the stakeholders.

Observation

Six exploratory interviews were performed to understand the practitioner's perspective on the barrier they faced to become flexible on scope. In total 12 barriers were identified during the interviews. It is noticed that10 barriers identified during the exploratory interview are identical to the barriers identified during the literature study in last chapter

Appendix 4

Vragenlijst voor Value Engineering

Naam:	Datum:
Positie:	
Organisatie:	Aantal project (en) met VE-ervaring:

Er is uitgebreid bewijs beschikbaar over de mogelijkheden voor kostenoptimalisatie van Value Engineering. Er is relatief beperkt bewijs beschikbaar over de soft skills van Value Engineering, waarbij belanghebbenden een sterke invloed hebben op het besluitvormingsproces in een project.
Ik zou je willen vragen om de voordelen van Value Engineering te beoordelen op basis van de mate waarin je ze hebt ervaren na het uitvoeren van een VE-studie in je project.
Vul de onderstaande tabel in met een schaal van 1 tot 5. Vermeld voor elk van de onderstaande voordelen uw antwoord dat het beste beschrijft hoe u over de stelling denkt, waarbij: 1 = Helemaal niet mee eens, 2 = Niet mee eens, 3 = Matig (noch mee eens, noch oneens), 4 = mee eens en 5 = helemaal mee eens.

	Voordelen van het uitvoeren van Value Engineering	1	2	3	4	5
	VE helpt de stakeholders bij elkaar te brengen	☐	☐	☐	☐	☐
1.	VE stimuleren de uitwisseling van informatie tussen de stakeholders	☐	☐	☐	☐	☐☐
2.	VE vergroot het uitgebreide begrip van het project bij de belanghebbenden	☐	☐	☐	☐	☐
3.	VE bevordert de interactie tussen de stakeholders	☐	☐	☐	☐	☐
4.	VE brengt belanghebbenden op hetzelfde niveau van begrip	☐	☐	☐	☐	☐
5.	VE helpt de behoeften van de belanghebbenden te begrijpen	☐	☐	☐	☐	☐
6.	VE helpt het project vanuit functioneel perspectief te begrijpen	☐	☐	☐	☐	☐
7.	VE helpt om naar het grotere plaatje te kijken in plaats van te focussen op eigenbelang	☐	☐	☐	☐	☐
8.	VE helpt het teamwork tussen de stakeholders te versterken (Collaboration)	☐	☐	☐	☐	☐
9.	VE helpt bij het opbouwen van vertrouwen bij de stakeholders	☐	☐	☐	☐	☐
10.	VE helpt bij het verkrijgen van steun van belanghebbenden	☐	☐	☐	☐	☐
11.	VE helpt om conflicten tussen de belanghebbenden te verminderen	☐	☐	☐	☐	☐
12.	VE helpt de betrokkenheid van de stakeholders te vergroten	☐	☐	☐	☐	☐
13.	VE vergroot de transparantie bij de besluitvorming	☐	☐	☐	☐	☐
14.	VE helpt bij het ontwikkelen van vertrouwen bij de stakeholders	☐	☐	☐	☐	☐
15.	Genereer meerdere ideeën voor het probleem	☐	☐	☐	☐	☐
16.	Analyseren van de gegenereerde oplossingen voor verschillende risicoscenario's	☐	☐	☐	☐	☐
17.	Verlaging van de kosten van het project zonder concessies te doen aan de functionaliteit (waarde toevoegen)	☐	☐	☐	☐	☐
18.	Verkort de tijdsduur van het project	☐	☐	☐	☐	☐
19.	VE helpt innovatie te stimuleren	☐	☐	☐	☐	☐
20.	Evalueren van de best gegenereerde ideeën aan de hand van de reeks evaluatiecriteria die door alle belanghebbenden zijn ontwikkeld	☐	☐	☐	☐	☐

Barriers

	English version	Dutch version
1.	Limited involvement of the business owner/client after allotting the budget	Beperkte betrokkenheid van de opdrachtgever na het toewijzen van het budget
2.	Limited transparency in decision making	Weinig transparantie in de besluitvorming
3.	Risk averse behavior of the project managers and client	Risicomijdend gedrag van de projectmanagers en opdrachtgever
4.	Knowledge of specific products at the client	Kennis van specifieke producten bij de klant
5.	Stakeholder Needs Are Unknown	Behoeften van belanghebbenden zijn onbekend
6.	Poor communication among the stakeholders	Slechte communicatie tussen de belanghebbenden
7.	Self-interest of the stakeholders	Eigenbelang van de belanghebbenden
8.	Difference in perception among the stakeholders	Verschil in perceptie tussen de stakeholders
9.	Lack of trust among the stakeholders	Gebrek aan vertrouwen tussen de belanghebbenden
10.	Limited involvement of the stakeholders	Beperkte betrokkenheid van de belanghebbenden
11.	Limited awareness of the enablers of flexibility	Beperkt bewustzijn van wat flexibiliteit mogelijk maakt
12.	Limited training or coaching for interpreting the functions	Beperkte training of coaching voor het begrijpen van de functies
13.	Available preparation time	Beschikbare voorbereidingstijd
14.	Policy, standards, interface, norms, guidelines, laws and regulations	Beleid, standaarden, interface, normen, richtlijnen, wet- en regelgeving
15.	Contractual limitation	Contractuele beperking

Appendix 5

Case study interview protocol

1) Introduction of the interviewer and interviewee
2) Introduce the thesis with research objective
3) Informing the interviewee that the information is confidential

Personal info of the interviewee is asked.
Specific question to each enabler were asked to the interviewee.

Broad task definition	
1	Did you apply the enabler in your project and how?
2	What made you decide to develop a functional scope?
3	What benefits have you experienced in keeping the scope functional?
4	What were the obstacles/difficulties you encountered when viewing the project from a functional perspective?
5	What was the perspective of the client while performing the functional specification?
6	Which is preferred more by the client : creative solution or tried and tested solutions and why?
7	What are the problems that stakeholders face while working with functionalities?
8	Do you think standards and regulations limit the implementation of creative solutions?
Embrace change	
9	Did you feel the need to change the scope at any point in the project?
10	If so, what was it all about and why was it necessary?
11	What were the obstacles/difficulties you encountered in implementing the change in scope?
12	How does the client react to the change in scope?
13	What problems were encountered on the part of the stakeholders in order to implement the change in scope?
14	Do you think stakeholders have different perceptions about the change in scope? Every stakeholder understands the change from a different perspective. If so, how do you handle that?
Interaction among the stakeholders	
15	Do you think stakeholders play an important role in being flexible in the scope?
16	How are the stakeholders' requirements and wishes collected or how do you deal with the stakeholders?
17	Were the stakeholders involved closely in the project initially? In addition, do you think it is important to bring the stakeholders together at the table instead of collecting the requirements individually?
18	What were the benefits experienced by bringing them together on the table?
19	Do you think building trust between stakeholders is an important aspect to be flexible in the scope?
VE	
20	Why was VE implemented and what was the role of VE during the front end phase of the project?

Appendix 6

Expert validation protocol

Step 1: Overview of the research consisting of research objective, main research question and the results of case analysis.
Step 2: Explaining the proposed framework.
Step 3: Discussion on the basis of questions mentioned below.

1) Do you think the proposed suggestion is important for resolving the barrier?
2) What are the constraints that can be faced by the practitioner or an organization to implement the suggestions?
3) What changes do you like to make for the proposed suggestion to enhance its impact for resolving the barrier?
4) Do you think that the proposed framework is applicable for public infrastructure projects?
5) Many authors and practitioners have talked about the proposed framework. What is the reason of not applying the framework until now?