Opportunity Management in Complex Infrastructure Projects: An Attempt at Exploiting Complexity

"Opportunity is everywhere … The key is to develop the vision to see it" – Anonymous

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Opportunity Management in Complex Infrastructure Projects: An Attempt at Exploiting Complexity

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By Christian Massaad

in partial fulfillment of the requirements for the degree of Master of Science in Construction Management and Engineering at Delft University of Technology

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Christian Massaad,

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Executive Summary

One of the reasons for the failure of large infrastructure projects is the increasing complexity of such projects. Complexity is in fact considered a major source of risks. Therefore, effective project risk management is key to the successful delivery of these projects. Risk is not only negative, but can also have a positive impact on objectives: it's called opportunity. Hence, complexity can be a source of threats but also opportunities. The current risk management process implemented in practice mainly deals with the downside, and the upside is almost not considered. Increasing awareness on the sources of opportunities in large infrastructure projects, such as project complexity, could drive practitioners to better implement opportunity management as part of the risk management process. Thus, illustrating the relationships between complexities and opportunities is needed. This research aims to study how Project Managers and their teams involved in complex infrastructure projects can better set the scene for opportunity management and capitalize on the opportunities that complexities offer. The main research question is formulated as follows:

How can Project Managers take the inherent complexities of large infrastructure projects into account in the opportunity management process and turn their unexploited potential into opportunities?

The following methodology was adopted: First, a literature study was conducted to define the relevant concepts. Then, to understand the current approach of identifying opportunities in practice, interviews with Project Managers, Process Managers and a Risk Manager in the field of infrastructure were conducted. The findings from the interviews were then compared to the findings in the literature and the gaps hindering the adoption of an effective approach for opportunities were identified. Next, the aim was to study the possibility of exploiting complexities. This was achieved by organizing a workshop session, where four Project Managers collaborated to identify opportunities, in four infrastructure projects, that result from the technical (T), organizational (O) and external (E) complexity elements of the TOE framework developed by Bosch-Rekveldt et al. (2011). As a result, a technique that aims particularly at identifying the opportunities that emerge from the complexities was developed: the Complexity-Driven Opportunity Identification Technique (CDOIT). Finally, this technique was integrated in a roadmap that was proposed to lead the effective implementation of opportunity management in complex infrastructure projects.

Opportunity is an "*uncertain event or condition that, if it occurs, has a positive impact on one or more project objectives*". Researchers claim that the management of opportunities should be included in the same process as risk management, with some additional considerations at every stage of the process. Despite that, they argue that opportunity management is still not implemented by practitioners, mainly due to some barriers such as 'ignorance', 'language', 'culture', 'psychology' 'inertia' and the lack of the 'right' positive mindset for opportunities. The growing interest in opportunity management in the literature is driven by the growing need to deliver more successful projects to better achieve the project objectives. This is attributed to the increasing complexity of projects, especially infrastructure projects, which require more effective management to improve performance and prevent failure. The two concepts of complexity and opportunity are related through the concept of uncertainty. Uncertainty is a driver and a consequence of complexity, and uncertainty is a source of risks (positive and negative). Hence, to identify opportunities from complexity in infrastructure projects, one should find the beneficial uncertainties that result from the complexities. Also, the opportunity management process should be tailored to the project's specifics, such as its complexity. As such, there is a need to understand how this can be achieved by looking more in detail at the relationship between the complexity elements in a project and the opportunities.

Before identifying opportunities, the right approach should be established. Based on the interviews, it was concluded that the opportunity management process is currently not effectively implemented in practice, or even not implemented at all. The main reasons are the lack of understanding of the concept of opportunity as a positive risk, and that opportunity management should be treated in the same process as risk management. Similarly, the lack of understanding of the relationship between opportunities and project objectives, and that these can also be internal and benefit the project team is also a major barrier. There is a need to increase awareness on the topic and stress on the added value opportunity management can have in a project. An important step forward is to start organizing separate opportunities sessions where people from different disciplines can collaborate together to identify opportunities following a structured approach that clearly separate the opportunity from its cause (fact) and consequence (positive impact on objectives).

This approach, called the risk metalanguage, was used in the workshop while considering the complexity elements of the TOE framework as facts. During the workshop, 26 opportunities were identified as a result of these elements and five possibilities were deduced into how the complexities can be exploited. These are: 1) using internal strengths, 2) taking advantage of external weaknesses (combined with internal strengths, 3) aiming to turn internal weaknesses into strengths, 4) a better use of the available resources, and 5) increasing the scope of the project. To apply these options, some considerations need to be taken into account first. Another aspect to consider is the dynamic character of complexity. Therefore, it is essential to re-assess complexity at least at the beginning of every phase, as new opportunities may appear. All these findings resulted in the CDOIT described in Figure 1.

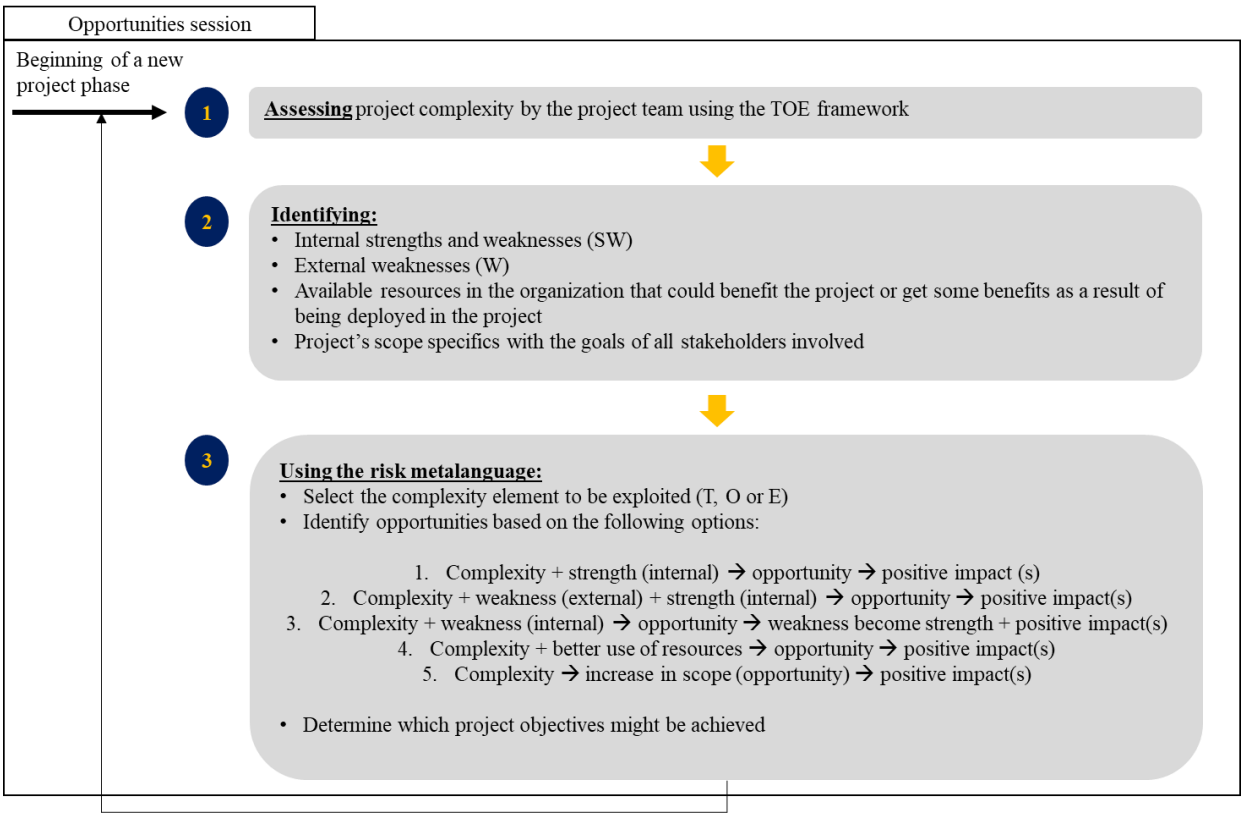

Figure 1: The Complexity-Driven Opportunity Identification Technique (CDOIT)

To conclude, identifying opportunities that can result from the complexity elements in large infrastructure projects requires having a strong foundation. This includes: 1) having a common understanding of the concept of opportunity as a positive risk and how it is linked to project objectives which can be internal and

external. 2) Specifying the project objectives that the team wants to achieve. 3) Including opportunity management from the start in the risk management plan (RMP), 4) Determining the people who should be involved in identifying opportunities, 5) Determining the techniques that can facilitate the identification of opportunities, 6) Defining how the activities for the assessment, response and monitoring stage will be performed and 7) Being equipped with the right positive mindset. Also, although opportunities and threats should be dealt with in the same process, this study suggests having a separate session for opportunities while identifying risks. The final roadmap is presented in Figure 2.

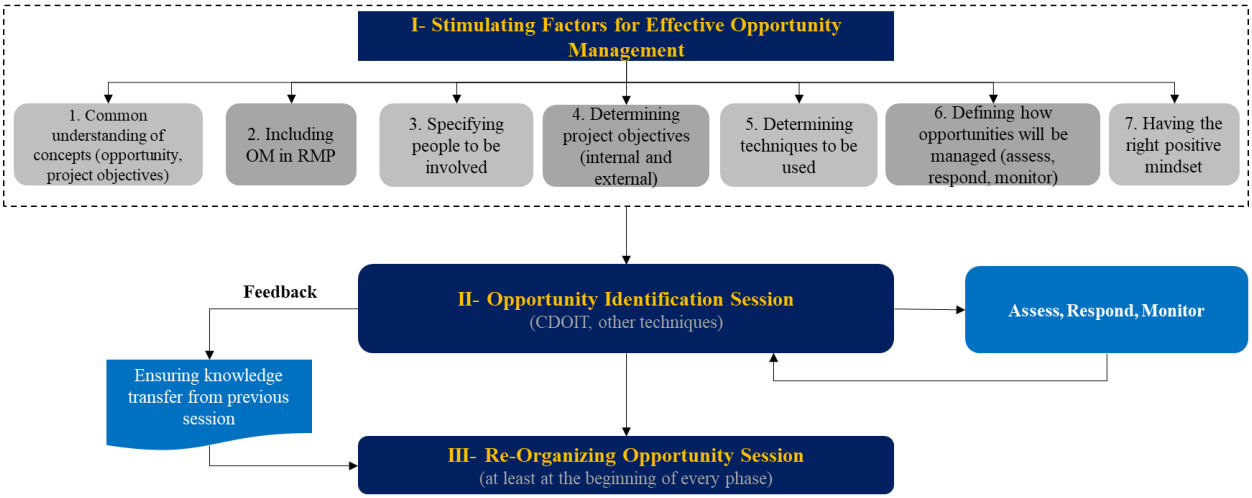

Figure 2: Roadmap for effective implementation of opportunity management in complex infrastructure projects

The recommendations that are made in this study are divided into two parts:

a) Recommendations for practice

- Checking the effectiveness of the proposed roadmap and the CDOIT by testing them on several infrastructure projects and providing feedback for continuous improvement and full maturation of the suggested approach and technique.
- Increasing awareness through trainings and workshops to make opportunity management part of the organization's culture.
- Organizing opportunity sessions at the beginning of every project and every project phase to harvest the benefits of opportunity management over time, and also showing these benefits to the client to make opportunity management part of the scope of the work.
- Organizing opportunity sessions at moments of chaos and deadline pressure in complex projects to improve project performance

b) Recommendations for further research:

- Extending this research to include the assessment, response and monitoring stages of opportunity management in order look at how the outcome of the CDOIT should be dealt with.
- Exploring new insights on how complexities can be exploited to extend the possibilities mentioned in the CDOIT.
- Searching for an effective method or tool to determine the requirements needed for the CDOIT (internal strengths/weaknesses, external weaknesses etc.).

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1. Introduction

This chapter starts with some background information about the topic of this research in Section 1.1. Next, the main problem is defined in Section 1.2 and the research objective is stated in Section 1.3. After that, the main research question and the sub-questions are formulated and described in Section 1.4. The chapter ends by explaining the theoretical and practical relevance of this research in Section 1.5.

1.1 Background

The demand is increasing not only for new or updated infrastructure, but also for more effective and efficient development of infrastructure resilient to risks, emerging trends and disruptions (McKinsey, 2018). The requirements and needs to deliver better infrastructure will not be lowered in the future, and Managers along with stakeholders need to improve their performance to meet the changing and rising demands (Westerveld & Hertogh, 2010). Large infrastructure projects are extremely risky investments, notoriously hard to manage, and often fail to achieve their objectives (Denicol et al., 2020). Many researchers are concerned with understanding why infrastructure projects fail so often, and try to identify and study some of the characteristics that make such projects very difficult to manage, such as their size (Cantarelli et al., 2013), uncertainty (Walker et al., 2017) and complexity (Bosch-Rekveldt et al., 2011). In fact, uncertainty and risk have been subjects of interest since a long time (Hillson, 2019). The analysis of uncertainty in infrastructure projects is considered an integral part of modern project management practices, such as project risk management (Johansen et al., 2019). Also, researchers have tried to prove that complexity is not independent from risks (Bosch-Rekveldt et al., 2011; Geraldi et al., 2011; Thomé et al., 2016). Complexity and uncertainty are usually considered as the major sources of risk events in projects (Erol et al., 2020). Therefore, effective project risk management is key to the successful delivery of large and complex infrastructure projects (Johansen et al., 2019).

The definition of risk has always been a source of ongoing debate in academic literature, and especially between practitioners and academics (Lehtiranta, 2014). Risk had a negative connotation that persisted until the beginning of the 21st century, when the shared perception on risk always suggested something negative or bad. The emphasis was on the adverse, harmful, unwelcome and negative effects of risk (Hillson & Simon, 2012). However, since the beginning of this century, risk practitioners began to be aware of the double-sided concept of risk, which includes both a downside and an upside, and a new debate started over whether "threat" and "risk" should be seen as synonyms, or whether "risk", in its meaning, should encompass "threat" as well as "opportunity" (Hillson, 2019). This debate appeared to be resolved when international guidelines and standards started to adopt a broader and more accurate definition of the concept of risk. According to the Project Management Body of Knowledge (PMBOK), risk is described as "an uncertain event or condition, that if it occurs, has a positive or negative effect on a project's objectives". Two levels of risk are identified in projects: individual project risk and overall project risk (PMI, 2017). The former is already defined above, while the latter is defined as "the effect of uncertainty on the project as a whole, arising from all sources of uncertainty including individual risks, representing the exposure of stakeholders to the implications of variations in project outcome, both positive or negative" (PMI, 2017). In fact, both levels of risk are addressed in the project risk management process which aims at exploiting or enhancing positive risks (opportunities), while at the same time, mitigating or avoiding negative risks (threats) (PMI, 2017).

Opportunities that are seized can have significant benefits for the project such as reduced cost and time, improved performance and reputation, while conversely, unmanaged threats can lead to major problems or issues such as cost and schedule overruns, poor performance and loss of reputation (Johansen et al., 2019). The responsibility for the effective implementation of project risk management lies under the umbrella of

project management, since the accountability for achieving the project goals and objectives is part of the role of the Project Manager (Olsson, 2007). Furthermore, performance data from projects across various industries indicates that project risk management is strongly related to project success: where it is well implemented, the chances for projects to meet their objectives are higher, and where poor risk management is in place, projects tend to fail more often (Cooke-Davies, 2002).

1.2 Problem Definition

Despite evidence showing that project risk management is one of the most influential factors to project success, research found that this technique scored the lowest in terms of effective deployment and use among all other project management techniques. This indicates that even-though most organizations realize the extent to which project risk management matters, the main problem lies in implementing it effectively (Hillson & Simon, 2012).

Despite reaching a conclusion over the exact definition of "risk" in favor of the broader concept which also includes the upside aspect, there still remains a gap between practice and theory (Hillson, 2002, 2016; Lehtiranta, 2014). Although guidelines and standards declare that risk includes threat as well as opportunity, and that the management of risk should consider both equally, many Project Managers are still limiting their approach to only dealing with threats (Denney, 2020; Denney & Powell, 2020; Hillson, 2002, 2019; Lehtiranta, 2014; Olsson, 2007; Ward & Chapman, 2003). Some are aware of the presence of opportunities in projects; however, they try to treat them separately from threats or just don't have a formal, structured and systematic way for identifying and dealing with opportunities (Hillson, 2016, 2019; Olsson, 2007; Waddell, 2004). Consequently, projects still struggle or fail, too many expected downside risks (threats) turn into actual problems or issues, and too many possible and achievable upside risks (opportunities) are missed (Hillson & Simon, 2012).

Managers in large and complex infrastructure projects encounter difficulties with capturing and exploiting opportunities, mainly due to the lack of project management practices that ensure continuous and active opportunity management during the whole project lifecycle (Hietajärvi et al., 2017). Instead, risk and opportunity management are often treated as static (Böhle et al., 2016), while project complexity, which is a major source of risks, has a dynamic character and changes throughout the project (Bosch-Rekveldt et al., 2018; Geraldi et al., 2011). Furthermore, many researchers provided evidence of the relationship between project complexity and negative risks but no explicit attempt was made at exploring the relationship between the different complexity elements in a project and potential positive risks or opportunities. Hertogh and Westerveld suggested that Project Managers should look for windows of opportunity in complex projects by having an interactive management approach that changes with the dynamic character of large infrastructure projects (Westerveld & Hertogh, 2010) but did not highlight the various types of opportunities that can be considered as a result of complexity or how this complexity can be exploited. Thus, an integrated approach showing the different relationships between complexities and opportunities is missing. The problem statement of this research is therefore:

In large infrastructure projects, literature has proved that complexities are major sources of risks. Researchers suggest that risks can be positive, called opportunities, or negative, called threats. Hence, complexities could be a source of opportunities and threats. However, many studied the relationship between complexities and threats but no attempt was made at finding the opportunities that result from the complexities in a project. This is leading to a lack of awareness of the different sources of opportunities and many valuable opportunities may be missed. The relationship between opportunities and complexities should be studied and integrated in the opportunity management process.

1.3 Research Objective

The objective of this research is twofold: 1) Guide the Project Managers in better setting the scene for opportunity management and 2) extend their views on the different sources of positive risks by looking into the various possibilities of exploiting complexity and seizing the opportunities that it can offer. This is achieved by proposing a roadmap which enables practitioners to effectively implement the concept of opportunity management in large and complex infrastructure projects, and a technique that helps in exploiting complexities. In order to achieve this objective, it is important to start first by setting the scene for opportunity management in the literature, and place it in the context of complex infrastructure projects. Also, investigating the current state of opportunity management in practice is essential to understand the perception of practitioners on the concept and identify the important gaps hindering them from implementing opportunity management in their projects. And finally, by filling these gaps and studying the relationship between complexities and opportunities in infrastructure projects, the roadmap and technique are developed. This will provide a clear structure on how to implement opportunity management in projects and integrating the complexity-opportunity relationship accordingly.

1.4 Research Question and Sub-Questions

Based on the problem statement and research objective defined previously, the main research question is formulated:

How can Project Managers take the inherent complexities of large infrastructure projects into account in the opportunity management process and turn their unexploited potential into opportunities?

In order to answer the main research question and achieve the research objective, a set of sub-questions is formulated:

SQ 1: What is in the literature the current state of opportunity management and its relationship to project complexity?

The aim of this sub-question is to review, in the literature, the process of opportunity management and study project complexity more consistently in the context of large infrastructure projects. Based on a clear definition of both concepts, the aim is to also study the relationship between the two and highlight their interdependency.

SQ 2: What is the current state of opportunity management in practice?

The aim of this sub-question is to review the process of opportunity management in practice based on practitioners' experiences. This is achieved by looking at how they perceive opportunity in projects and the current approach they are using for opportunity management. Also, the barriers and drivers of its effective implementation are investigated. Similarly, the goal is to understand the approach used to find opportunities in infrastructure projects and identify the types of opportunities that Managers are looking for during the project lifecycle. Finally, the aim is to look at the various ways to improve the implementation of opportunity management in practice.

SQ 3: How can complexities be exploited to find opportunities?

The aim of this sub-question is to study the interdependency between project complexity and opportunities in practice and find the various relationships between complexity elements (technical, organizational, environmental) and opportunities. This is achieved by investigating their relationship in actual infrastructure projects.

SQ 4: What procedure can help practitioners in effectively implementing opportunity management in complex infrastructure projects?

The aim of this sub-question is twofold: 1) To develop a technique that illustrates the relationship between complexity elements and opportunities in the identification stage of opportunity management to extend the view on the sources of opportunities and 2) To propose a roadmap that provides suggestions on what essential elements should be considered to effectively implement opportunity management in practice.

1.5 Research Relevance

1.5.1 Theoretical Relevance

In terms of scientific and theoretical relevance, this research provides a complexity driven approach for opportunity management, which is an opportunity in itself to expand the view on the sources of opportunities in large engineering projects. A shift towards focusing not only on complexity-related downside risks, but also upside risks, can be considered as looking through two lenses to gain new insights on risks and improve the process of their identification (Lechler et al., 2012). This research also puts more emphasis on the fact that both types of risks should be treated equally, and that any source of threats might also be considered as a source of opportunities (Hillson, 2002, 2019; Johansen, 2015; Kolltveit et al., 2005; Olsson, 2007). Hence, the research further supports the theoretical definition of risk which has two sides: a downside (threat) and an upside (opportunity).

1.5.2 Practical Relevance

In terms of practical relevance, identifying opportunities is most of the time a harder task for practitioners than identifying threats (Eik-Andresen et al., 2015). Thus, improving the opportunity identification process should be realized by considering more sources of project opportunities (Olsson, 2007), such as the inherent complexity of infrastructure projects. This can make a shift from a threat-focused management and thinking style to a broader approach that also focuses on searching for opportunities in a complex environment. This can provide concrete benefits to the project manager and the organization (Hillson, 2016, 2019), including:

- More opportunities are identified and realized, since using a structured way of looking into the possible opportunities will give the chance to tackle some missed opportunities and perhaps capture some of them.
- Increasing the chances of project success since the identified opportunities can lead to a better achievement of the project objectives, leading to increased reputation and business growth of the organization.
- A change in the view of the Project Manager from “fearing” complexity to exploiting complexity, thus encouraging the team to think creatively about ways to work faster, simpler, better or more effectively in complex environments, in an attempt to search for opportunities that complexity can offer rather than trying to reduce or avoid it.

2. Research Design

This chapter presents the research approach by first defining the boundaries of the research or research scope in Section 2.1, then elaborates on the methodology used to answer the research questions in Section 2.2, and finally show the outline of the study in Section 2.3.

2.1 Research scope

In order to complete the research assignment within the given time frame, it is important to delineate the boundaries of the research and define its scope. This research is conducted in collaboration with the

international consultancy and engineering firm Witteveen+Bos. The research deals with one of the subsets of risk management, opportunity management, in complex infrastructure projects.

To make the distinction clear between both types of risk in the research, the terms negative risk, downside risk and threat are used interchangeably as synonyms. On the other hand, the terms positive risk, upside risk and opportunity refer to the same type of risk. Therefore, the process of risk management can be divided into threat management and opportunity management. The former, as the name suggests, is related to threats and the latter to opportunities, although both are dealt with in the same process. This research mainly focuses on opportunities, and thus on opportunity management. The risk management process consists of 5 stages including: 1) Plan, 2) Identify, 3) Assess, 4) Respond and 5) Monitor (PMI, 2017). However, since this research focuses on improving the identification of opportunities based on an assessment of the project complexity elements in an infrastructure project, the research tackles the first two stages of the risk management process and the remaining three stages are disregarded. In the planning stage, the Project Manager defines the methodology used for the opportunity identification and management process, and then the identification stage is considered the core part of this research. The research scope is illustrated in Figure 3 (the white text indicates inclusion in the research):

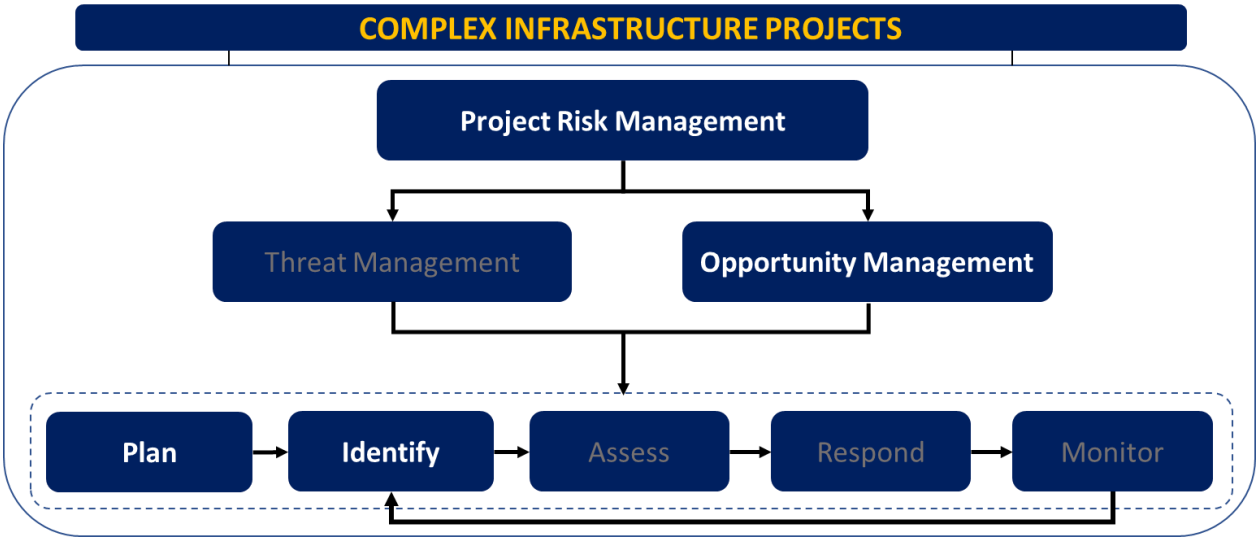

Figure 3: Research Scope

2.2 Methodology

This section presents the methodology used in the research to fulfill its objective and answer all the research questions. The research is mainly divided into three parts:

1) Literature study part: Defining the key concepts of the research by reviewing the available literature to illustrate the relationship between the concepts and their interdependency in the context of infrastructure projects. (sub-question 1).
2) Empirical study part: Investigating the opportunity management process in practice by means of semi-structured interviews with Managers at Witteveen+Bos. This is done to understand their different perceptions on opportunity and opportunity management, the barriers and drivers for implementing opportunity management in projects, the types of opportunities that can be found and where, and how to improve the process of identifying and managing opportunities (sub-question 2). Then, by means of an experts' workshop and using different infrastructure projects at

Witteveen+Bos, the aim is to understand how complexity can be exploited to find opportunities (sub-question 3).

3) Development part: Developing a roadmap which provides a structured way for implementing opportunity management in infrastructure projects and integrating the relationship between complexities and opportunities based on an assessment of the project complexity elements (sub-question 4). This is done using the Complexity-Driven Opportunity Identification Technique (CDOIT) developed in the research.

The research strategy is summarized in Figure 4:

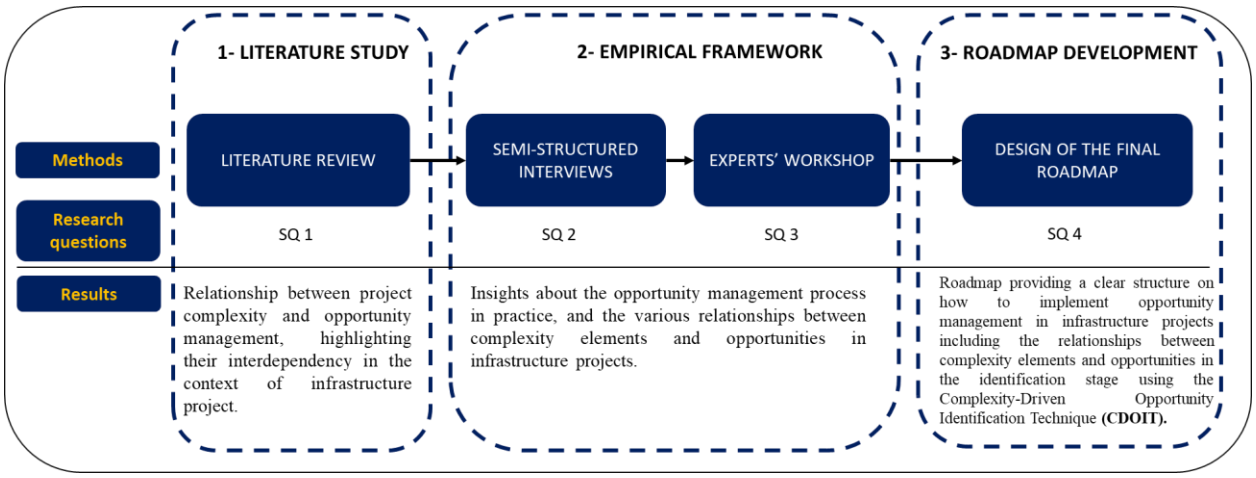

Figure 4: Research strategy: methods and their relationship with sub research questions and results

2.2.1 Literature Study

The aim of this part is to establish the relationship between project complexity and opportunities. This is achieved after a clear definition of all the relevant concepts. This part helps in answering the first sub-question by means of literature review:

Literature Review

The initial step of this research considered diving into the literature to review all the relevant terms and concepts needed to study their interdependency and look at the possibility of exploiting complexities in infrastructure projects later. This required defining infrastructure project, project complexity, the TOE framework, uncertainty, risk, opportunity and opportunity management. Then, since complexity is a source of risk events according to researchers, and since risk can have both a downside (threat) and an upside (opportunity), the link between project complexity and opportunity was illustrated.

The data needed for this part of the research is the existing literature of the different concepts in Scopus and in the TU Delft Repository, in the form of research articles, published books, previous thesis assignments and lecture slides.

2.2.2 Empirical Framework

Semi-Structured Interviews

As mentioned earlier, the main aim of interviews is to understand the current approach for identifying opportunities according to practitioners in the field of infrastructure projects.

All the interviews were scheduled for 30 minutes and conducted remotely using Microsoft Teams. An interview guide composed of 10 questions was prepared to fulfill the purpose of the interviews. This guide

is desribed in Section 4.2. The interviews were recorded in Microsoft Teams, transcribed into text, and then analyzed using the Qualitative Content Analysis approach (QCA). It is a method used for systematically describing the meaning of the gathered qualitative data by allocating successive parts of the qualitative material to categories of a coding frame (Mayring, 2000; Schreier et al., 2019). Content analysis is considered a descriptive approach to qualitative data analysis and is suitable when a relatively low level of interpretation is required (Vaismoradi et al., 2013). This approach is suitable in this research for analyzing the data generated from the interviews for many reasons: first, it aims at reducing data (Flick, 2014). The 15 interviews that were conducted generated a significant amount of data. Of course, not all the data is relevant to answer the second research question and thus the data should be reduced and the irrelevant parts removed. Also, the aim was to describe the data in a systematic way according to the interview questions without a thorough analysis of the results or a deep level of interpretation. A third reason is that QCA is flexible in that it combines different portions of data-driven and concept-driven categories within any one coding frame (Flick, 2014). This way, the generated coding frame offers a valid description of the data with regard to the material of the research. This point is further elaborated in Chapter 4. QCA consists of 1) preparing the interviews' data for analysis, 2) organizing the data and 3) reporting the results (Vaismoradi et al., 2013). Building the coding frame is achieved using the qualitative data analysis software tool ATLAS.ti. This tool is used since its logic aligns with the process of QCA in that it is built around the coding process which is at the heart of the QCA approach (building the coding frame) (Friese, 2012).

Finally, the findings of the interview analysis were discussed based on the LeCompte and Schensul (1999) suggestion which implies looking at the theoretical findings in the literature. The theoretical background of the research was thus used as a lens through which the collected data is viewed or examined and helped in situating the results in the theory. Hence, based on the results of the literature study section in this research, the findings of the interviews with practitioners were discussed. This way, a better understanding of the views of practitioners on the concept of opportunity management was achieved, and the gaps between theory and practice were identified. Those gaps were taken into account at a later stage in the research when developing the final roadmap.

Experts' Workshop

The main aim of the experts' workshop is to understand how complexities in large infrastructure projects can be exploited by identifying opportunities that emerge as a result of these complexities. This is achieved in a workshop setting where participants are invited to brainstorm about opportunities in projects in which they are actually involved. A workshop session is organized because the dynamic and interactive character of such a setting stimulates creative thinking among participants through collaborative working, which will yield more ideas about possible opportunities (Pavelin et al., 2014).

After deciding that an interactive workshop is the adequate method to brainstorm about opportunities, the participants were selected. Since the research deals with complex infrastructure projects, the selected projects in which opportunities should be identified must fit in the scope of the research. Hence, the participants had to be involved in complex infrastructure projects. Moreover, the participants are Project Managers since they have a broad understanding of the project in which they are involved and they are mainly responsible to ensure that projects are delivered within budget, on time and within scope. Identifying opportunities might help them in better achieving these (and other) objectives. During the conducted interviews, the interviewees referred to some complex infrastructure projects while discussing their experiences. A list of 13 infrastructure projects was obtained as a result. Five projects were already completed some years ago and thus were disregarded from the selection process because it might be difficult for the Project Manager to remember the circumstances in the project and what opportunities might arise. The remaining 8 projects are ongoing projects. The goal was to include all these projects in the workshop

to obtain more diversity in opinions and experiences, but this was not possible due to the unavailability of a common date for all the Project Managers involved. Hence, based on the pragmatic sampling approach, the workshop session was scheduled in such a way that the maximum number of participants could join at the same time. This resulted in four Project Managers participating in the workshop. In order to successfully fulfill its objective, the workshop was planned accordingly:

a) An assessment of the project complexity by the Project Managers assigned to the specific projects was conducted prior to the session, using the TOE (Technical, Organizational and External) framework developed by Bosch-Rekveldt et al. (2011) (this framework is further elaborated in Section 3.1.3). This way, the complexity elements that have the most influence on the project were highlighted and the focus in the workshop was on exploiting these complexities.

b) A technique was developed based on the findings in the literature and the interviews' results to help the Project Managers in identifying opportunities that emerge from the complexities. This technique is elaborated in Section 5.1.

c) The workshop session was planned for 2 hours remotely in 'MIRO', an online collaborative dashboard that enables teams to effectively work together and is mainly used for brainstorming sessions using digital sticky notes. Hence, this tool fits perfectly with the intent of the workshop in this research.

2.2.3 Roadmap Development

After highlighting the interdependency between complexity and opportunities in the context of infrastructure in the literature, and looking at this relationship in practice, a roadmap was developed. The objective of the roadmap is to provide guidelines for the effective implementation of opportunity management in projects focusing mainly on the first 2 stages of planning and identification, and integrate the relationship between the different complexity elements and positive risks in infrastructure projects.

Roadmap Design

In this part, a technique for the opportunity identification process driven by an assessment of the project complexity elements was proposed based on the findings in the previous section. This technique, called the Complexity-Driven Opportunity Identification Technique (CDOIT**),** is then integrated in the final roadmap. This roadmap takes into account the gaps identified in the research hindering the implementation of an effective approach for opportunities and try to fill in these gaps. Hence, the final result of the research is a roadmap that is twofold:

1) Providing suggestions on how to setup a risk approach that takes opportunities into account in infrastructure projects. These are configured based on the investigation of opportunity management in the literature and the various views and approach for opportunities in practice according to the performed interviews.
2) Developing the Complexity-Driven Opportunity Identification Technique based on the various relationships between complexity elements and opportunities deduced from the findings in literature and in the workshop session. The technique is specifically tailored to identify opportunities that come from the categorization of project complexity into the three types: technical, organizational and external. This technique is integrated in the identification phase of the opportunity management process.

The components of the final roadmap are illustrated in Figure 5:

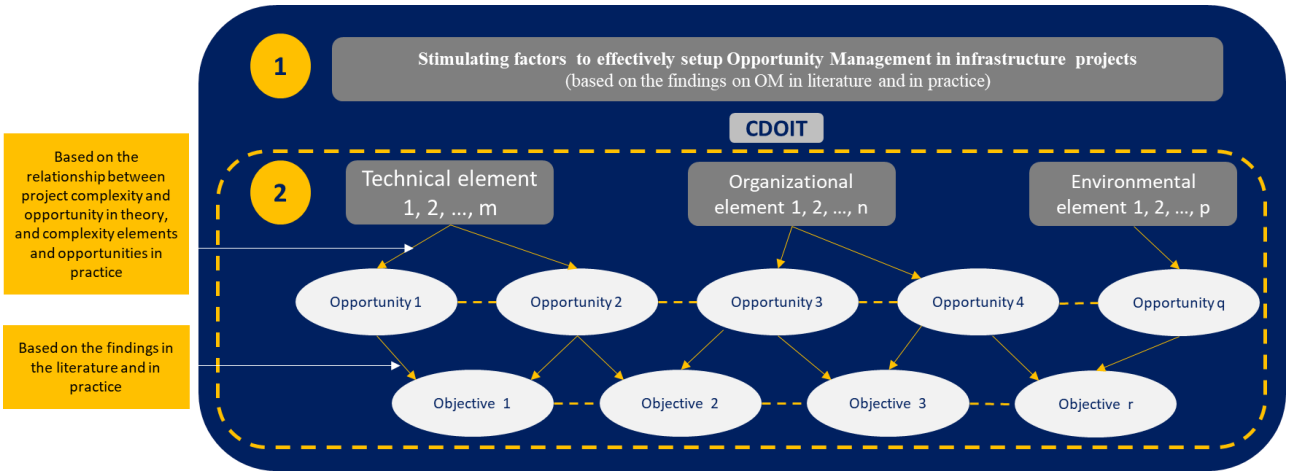

Figure 5: Roadmap Components

2.3 Research Outline

The outline in Figure 6 presents an overview of the different chapters of the research report:

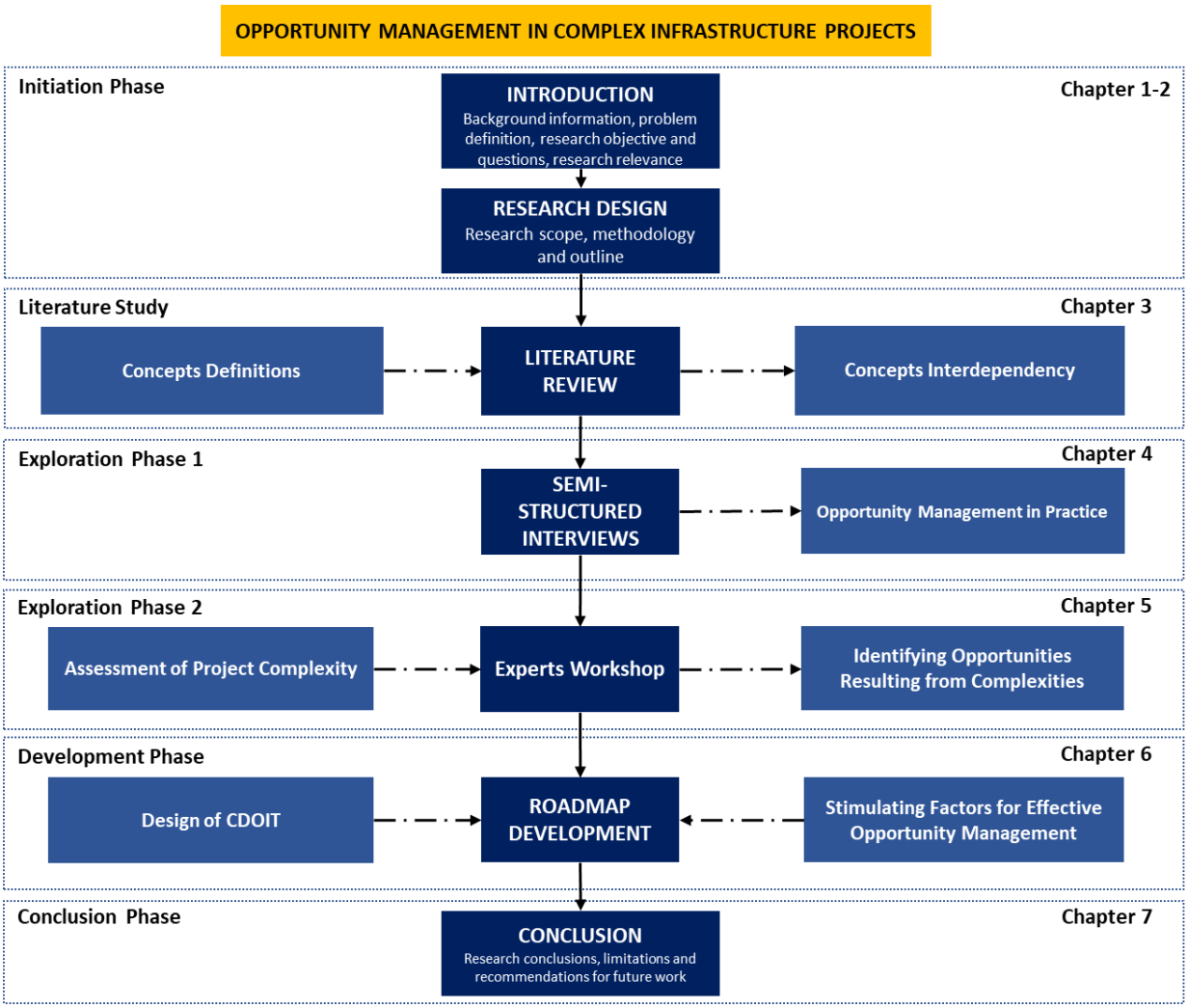

Figure 6: Research Outline

3. Literature Study

The main aim of this part is to establish the theoretical context by highlighting the relationship between project complexity and positive risks or opportunities. First, the concept of project complexity is reviewed in the literature and presented in Section 3.1. Next, the concept of opportunity management is examined in Section 3.2 after a clear understanding of the relevant terms related to it such as: uncertainty, risk and opportunity. Based on the definitions of the key concepts, the interdependency between project complexity and opportunities in infrastructure project is drawn in Section 3.3. Finally, conclusions are drawn in Section 3.4.

3.1 Complex Infrastructure Projects

In this section, project complexity is discussed in Section 3.1.2 based on the available knowledge on this concept in the literature. Also, the TOE (Technical, Organization, External) framework, a methodology to assess the complexity of projects, is elaborated in Section 3.1.3 since it is adopted at a later stage in the research. Before looking at the concept of complexity in infrastructure projects, this section starts by defining infrastructure projects in Section 3.1.1.

3.1.1 Infrastructure Projects

The scope of the research is centered on infrastructure projects. Thus, it is essential to define infrastructure first. According to Masrom et al. (2015), infrastructure is the basic physical systems of a business, region or nation. This includes for example: transportation (roads, bridges, rail transport, airport etc.), water (water supply, coastal restoration, sewage and draining systems, dams etc.), communication (telephone network, Internet network etc.) and energy (power grids, power stations, gas pipelines, wind turbines etc.) (Corporate Finance Institute, 2021). Investments in these systems tend to be high in costs but represent the basis for economic growth and prosperity (Masrom et al., 2015). Hence, the last decade has experienced a considerable increase in the frequency and magnitude of infrastructure projects. At the same time, it is clear that many large projects have an outstandingly poor performance in terms of environment, economy and public support, while success of such megaprojects is of ultimate importance that companies and even governments can collapse if they hardly fail (Flyvbjerg et al., 2014). Thus, infrastructure projects' performance should be improved in all its aspects and practices, and project risk management is an important one to be considered.

An infrastructure project consists of different phases that form the project lifecycle (Oliver Wyman, 2015): Development/Concept phase, Design/Planning phase, Construction/Execution phase and Operation/Maintenance phase. This study deals with infrastructure project in the Netherlands, and the project phases are named slightly differently. The first phase is the initiation phase ('Initiatief'). The second phased is called exploration ('Verkenning'). The third one is the development phase ('Planuitwerking'). The next phase is the realization phase ('Realisatie'), and the final one is the management phase ('Beheer') (Rijkwaterstraat, 2018). These project phases are briefly discussed (from a consultant's perspective) in Table 1:

Project Phase	Description
Initiation ('Initiatief')	Define the project at a broad level (problem, scope etc.)
Exploration ('Verkenning')	Searching for solutions for the problem
Development ('Planuitwerking)	Elaboration of the chosen solution
Realization phase ('Realisatie')	Execution of the developed solution
Management phase ('Beheer')	Operations and Maintenance

Table 1: Description of the 5 project phases in infrastructure projects

In fact, large infrastructure projects span over a long period of time, usually beyond 10 years from project initiation to delivery, making infrastructure projects highly challenging and hard to succeed (Johansen et al., 2018). The client demands and expectations continuously fluctuates until the end of the project, which implies a high degree of uncertainty that must be managed through effective project management practices (Hietajärvi et al., 2017; Johansen et al., 2018). Hence, an adaptive and flexible approach is needed from the Project Manager and his team to allow some changes into the initial plans and try to exploit possible opportunities along the way.

In fact, construction projects, and especially large infrastructure projects, are increasingly complex (Westerveld & Hertogh, 2010). Project complexity has been extensively explored in the literature because of its contribution towards the failure of major projects in terms of cost and time overruns (Erol et al., 2020; Thamhain, 2013; Thomé et al., 2016; Westerveld & Hertogh, 2010). Thus, it is important to study and understand project complexity, which is discussed in detail in the next section.

3.1.2 Project Complexity

Project complexity is a critical factor in the field of project management that offers many challenges to achieving the project's objectives (Dao 2017). In fact, many researchers made an attempt at defining project complexity which resulted in various definitions (Jaber et al., 2021). The lack of consensus regarding the definition of project complexity is one of the problems in understanding the concept (Bosch-Rekveldt et al., 2011). Thus, to better understand project complexity, this section aims at first looking at the various interpretations of this concept in the literature, then at the drivers of complexity in projects (causes) and the impact that it can have on the project (consequences), as presented in Figure 7:

Figure 7: Cause-effect relationship of project complexity

Definition

One of the first attempt at defining project complexity is introduced by Turner and Cochrane. They proposed that project complexity is the "*degree of whether the goals and methods of achieving them are well defined"*(Turner & Cochrane, 1993). In 1996, Baccarini suggested the following definition: "*Project Complexity consists of many varied interrelated parts and can be operationalized in terms of differentiation and interdependency*" (Baccarini, 1996). Differentiation represents the various items such as resources, tasks, components, connectivity, interdependence and degree of interrelationships between these elements. Thus, complexity results from the different interactions between the interrelated components of a project which can be seen as a system. A system is defined as "*an arrangement of interacting elements organized to achieve one or more defined objectives in a dynamic and evolving environment, exerting activity, organizing, and evolving without losing its identity*". Later on, Vidal and Marle (2008) defined project complexity as "*the property of a project, which makes it difficult to understand, foresee, and keep under control its overall behavior, even when given reasonably complete information about the project system".*

In terms of conceptualizing complexity, the work of Baccarani is considered the first attempt in the project management field. According to him, it can be categorized into technological and organizational complexity (Baccarini, 1996). The former is related to the number of different project tasks and their interdependencies, while the latter is related to the considerable number of organizational units and their interactions. Williams (1999) combined the technical and organizational dimensions into structural complexity and added a new complexity dimension which is the uncertainty in goals and methods, as seen in Figure 8:

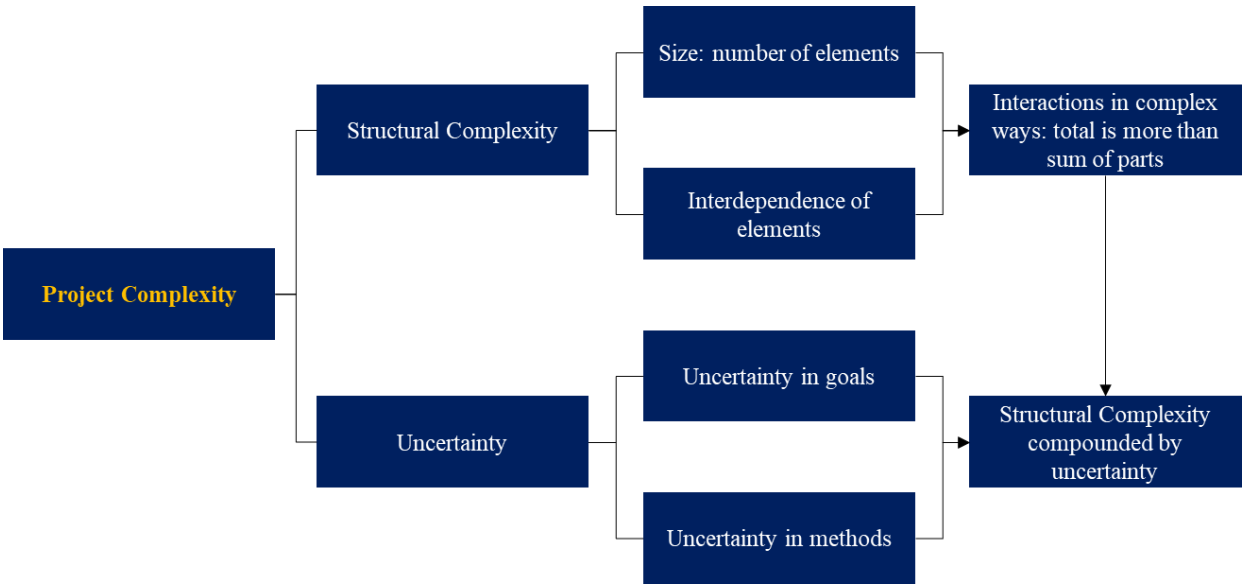

Figure 8: Dimensions of project Complexity (Williams & Hillson, 2002)

Later on, the framework of Williams was extended by Geraldi et al. (2011). Other dimensions were added such as: pace, dynamic and socio-political. The pace dimension relates to time pressure induced by the criticality and urgency of the goals scheduled. The dynamic dimension refers to changes in the elements of the project such as goals, specifications, project stakeholder's and environmental components. While as the socio-political dimension relates to the combination of emotional aspects pertaining to the behavioral attitude of stakeholders and political aspects pertaining to the importance of the project (Geraldi et al., 2011). Recently, Maylor and Turner (2017) further updated the previously established frameworks by combining the uncertainty and dynamic dimensions under one dimension called emergent complexity, and incorporated the pace dimension under the structural complexity (Maylor & Turner, 2017).

For this research, the definition of complexity proposed by Williams and Hillson (2002) is followed. First, because it combines the definition of Baccarini of project complexity with the concept of uncertainty discussed by other researchers. Second, because it forms the basis of the TOE framework which is adopted in this research to assess project complexity. Therefore, project complexity consists of structural complexity, the number and interdependence of elements, and uncertainty in goals and means.

Researchers continue to attribute new dimensions to project complexity to better understand it (Kermanshachi et al., 2020). Hence, it is clear that there is no universally accepted definition of the concept of project complexity, mainly due to its subjective character. It is important to discuss the subjective view of project complexity since not everyone perceive complexity in the same way (Maylor & Turner, 2017). The difference in perceiving complexity depends on some attributes of the person or project team defining and determining the degree of complexity such as: experiences, cultures, the specific project context, resource availability, stakeholders considerations, the observed impact of complexity and many other objective and subjective factors (Dao et al., 2016). Next, the drivers of project complexity are discussed.

Drivers of Project Complexity

Since there is a lack of consensus about the exact definition of complexity, some researchers shifted their focus on identifying the drivers of complexity, or in other terms, the factors contributing to project complexity (Bosch-Rekveldt et al., 2011; Geraldi et al., 2011; L. A. Vidal & Marle, 2008; Whitty & Maylor, 2009). For instance, Vidal & Marle (2008) suggested four drivers that they consider necessary but non-

sufficient conditions for inducing complexity in projects. These are: the size and variety of the project system, the interdependencies within the system, and context dependence. Similarly, Remington et al. (2009) studied different drivers of project complexity and suggested the following: technology, goals, time, stakeholders, management process, interfaces and interdependencies and work practices. Adding to these drivers is the concept of uncertainty. In fact, there exists two views on the concept of uncertainty in relation to project complexity (Padalkar & Gopinath, 2016). Some researchers argue that uncertainty is not a driver of complexity but rather a consequence (Floricel et al., 2016; L. A. Vidal & Marle, 2008). While others asserts that uncertainty is part of complexity and contribute to it (Bosch-Rekveldt et al., 2011; Geraldi et al., 2011; Williams, 1999). The relationship between project complexity and uncertainty will be further examined in Section 3.3.

Researchers continue to identify factors contributing to or increasing complexity to further understand the concept (Kermanshachi et al., 2020). To better conceptualize project complexity, many frameworks have been proposed taking the drivers of complexity into account (Qazi et al., 2016). Bosch-Rekveldt (2011) developed a framework that categorizes complexity into technical, organizational and external (TOE) elements, taking the drivers of size, variety, interdependence, context dependence, technology, stakeholders etc. into account. Also, the framework considers uncertainty to be a vital part of complexity. Since uncertainty will be further studied at a later stage in the research, and the drivers of complexity mentioned earlier are captured in different elements of the TOE framework, this framework is adopted in the research.

Impact of Project Complexity

As discussed previously, there is a lack of consensus on the exact definition of project complexity. And to better understand it, researchers tried to study the factors contributing to complexity in projects. But why is this concept important for Project Managers to understand? Mainly, because complexity is known as a potential characteristic that influences the outcomes of projects, usually in a negative way (Butler et al., 2020).

Project complexity affects the management of projects and is thus considered very important in the project management process (Erol et al., 2020). For instance, it has an influence on project planning and control, and it can have a significant impact on project outcomes such as cost, time and quality (Denicol et al., 2020). However, the influence of complexity is not always negative. The positive influences are considered opportunities that result from the complex project environment and the negative influences are considered threats that result from the difficulty to control the project. Thus, dealing with the complexity of a project requires the Project Manager and his team to mitigate or reduce the negative impacts of complexity, and seize and capitalize on the opportunities that emerge from it throughout the whole project lifecycle (Emblemsvåg, 2020; Marle, 2020; Westerveld & Hertogh, 2010). Managing the complexity of projects is considered to be one of the factors of success in modern project management (Rose, 2009).

To conclude, the definition of complexity is perceived in different ways among researchers. Many elements in a project can induce or increase the degree of complexity. If not well managed, complexity can have negative impact on the project. To better understand the concept of project complexity, it is important to clearly specify the type of complexity that is referred to when discussing project complexity. Therefore, many researchers provided a categorization and classification of project complexity. This resulted in various frameworks showing different complexity factors. Among these frameworks, is the TOE (technical, organizational and external) framework developed by Bosch-Rekveldt et al. (2011) for large engineering projects. This framework fits in the scope of this research which deals with large infrastructure projects. Hence, it is adopted in this study and is presented in more detail next.

3.1.3 TOE Framework

A framework for project complexity is a structure which includes a set of elements (drawn from literature and empirical data) that highlights the different sources of complexity facing the project and that may have a potential impact on its performance (R. J. Chapman, 2016). Various frameworks have been developed for this purpose. The TOE framework is one of them. It is developed by Bosch-Rekveldt et al. (2011) and can be used to assess complexity in projects. It can be used in early project phases or preferably more often, at the beginning of every phase, due to the subjective and dynamic character of complexity (Bosch-Rekveldt et al., 2011). This framework "fully appreciates the richness of project complexity" of particularly large engineering projects. Hence, it fits the scope of this research which deals with large complex infrastructure projects. This framework categorizes complexity into technical (T), organizational (O) and environmental (E) elements:

- The T-category includes 17 elements which represent potential drivers of complexity related to the scope or content of the project.
- The O-category includes 17 elements which represent potential drivers of complexity related to the project internal organization.
- The E-category includes 13 elements which represent potential drivers of complexity related to external issues or external organizational complexities.

The 47 elements of the TOE framework are represented in Figure 9. The elements of this framework are explained in Appendix A: TOE Framework Explanation.

Technical Complexity (17 elements)	Organizational Complexity (17 elements)	External Complexity (13 elements)
High number of project goals	High project schedule drive	Level of competition
Non-alignment of project goal	Lack of resource & skills availability	Instability of project environment
Unclarity of project goals	Lack of experience with parties involved	Company internal strategic pressure
Uncertainties in scope	Lack of HSSE awareness	Lack of experience in the country
Strict quality requirement	Interfaces between different disciplines	Remoteness of location
Project duration	Number of financial sources	Lack of company internal support
Size in CAPEX	Number of contracts	Political influence
Number of locations	Type of contract	Dependencies on external stakeholders
Newness of technology (worldwide)	Number of different nationalities	Variety of external stakeholders perspectives
Lack of experience with technology	Number of different languages	Number of external stakeholders
High number of tasks	Presence of JV partner	External risks
High variety of tasks	Involvement of different time zones	
Dependencies between tasks	Size of project team	
Uncertainty in methods	Incompatibility between different PM methods/tools	
Involvement of different technical disciplines	Lack of trust in project team	
Conflicting norms and standards	Lack of trust in contractor	
Technical risks	Organizational risks	

Figure 9: The TOE framework

This study dives deeper into the relationship between complexity and opportunity management. In the next section, the concept of opportunity management is studied by reviewing the literature, before carefully examining the aforementioned relationship in Section 3.3.

3.2 Opportunity Management

Risk management becomes increasingly more important and should be performed throughout the whole project lifecycle (Marle, 2020). Coming back to the broader definition of risk in the introduction of the

research, risk includes both a downside and an upside, and both should be considered equally in the risk management process (Hillson, 2002, 2019; Johansen et al., 2018; Waddell, 2004). This research focuses on the upside or, in other terms, on the identification and management of opportunities. However, the exploration of opportunities in projects is not an easy and direct task and requires a clear definition of some concepts related to it, such as: uncertainty (Section 3.2.1), risk (Section 3.2.2), and opportunity (Section 3.2.3. Next, the risk management process taking opportunities into account is presented in Section 3.2.4 and the techniques used to identify opportunities in Section 3.2.5. Finally, the main barriers and drivers for implementing opportunity management in the literature are discussed in Section 3.2.6.

3.2.1 Uncertainty

The concept of uncertainty has different perceptions and interpretations in the literature, and here are some of its definitions:

- In psychology, uncertainty is described as "*a state of mind characterized by a conscious lack of knowledge about the outcomes of an event*" (Bar-Anan et al., 2009).
- According to the American economist Frank Knight, uncertainty is either epistemic or aleatory. The former is described as an uncertainty which derives from a lack of knowledge and which could be foreseen given more knowledge. The latter is described as an uncertainty which cannot be foreseen and having to do with chance (Perminova et al., 2008).
- According to the British economist John Keynes, uncertainty is "*a state in which individual actors find it impossible to attribute a reasonably definite probability to the expected outcome of their choice*". In other words, uncertainty for him is a situation when it is impossible to calculate the risk (Linder et al., 2003).

Based on the broader definitions of uncertainty presented above, one can conclude that an uncertainty is a state or situation characterized by a lack of knowledge and difficulty to attribute a certain probability to it or predict its outcome. Although the concept of risk is not yet extensively defined in the research, a link between uncertainty and risk is drawn here, providing the starting point for the more detailed and concrete definition of risk which will help in better understanding the interdependency of the concepts: Risk is a measurable uncertainty and uncertainty is an unmeasurable risk (Waddell, 2004). In other words, uncertainty is considered a risk when it is measurable (attributed to a chance or probability).

Now let's put the concept of uncertainty in the context of projects. Perminova et al. define uncertainty as "*a context for risks, as events having a negative impact on the project's outcomes, or opportunities, as events that have beneficial impact on project performance*" (Perminova et al., 2008). This definition indicates a dual nature of uncertainty in potentially having a negative or positive impact on the project's outcomes.

Uncertainties are everywhere in a project, but not all the uncertainties really matter to the project team, client or other stakeholders (Hillson, 2002, 2019). There are only a limited number of uncertainties that the Project Manager and his team need to know, think and talk about in order to prepare for them, and those are called the uncertainties that matter (Chapman & Ward, 2011; Hillson, 2002, 2019). The question that arises is the following: How to know which uncertainties matter? The people working on the project define what matters through the project objectives or, in other words, what they are trying to achieve and by which progress and success is measured (Walker et al., 2017; Weiss & Ward, 2012). Of course, the project team should be concerned about the uncertainties that negatively affect the project objectives, such as: cost overrun, delay, injuries, reputational damage, reduced competitiveness, or reduced stakeholders 'support (Johansen, 2015). However, the attention should also be directed towards uncertainty that might generate

savings, reduce time, improve safety, ameliorate reputation, increase competitiveness, or enhance stakeholders' support (Denney, 2020).

Hence, one can conclude that:

- Projects includes many uncertainties.
- Some uncertainties matter.
- Uncertainties that matter can include both good and bad things.
- Both should be considered to increase project success.

3.2.2 Risk

As previously discussed, risk is "uncertainty that matters" (Hillson, 2019; Ward & Chapman, 2003). However, this is not the formal definition of risk as provided by international standards and guidelines. In the introduction of this research, risk was described as "*an uncertain event or condition, that if it occurs, has a positive or negative effect on a project's objectives*", according to the Project Management Body of Knowledge (PMI, 2017). Other definitions of risk are also presented in Table 2:

Source	Definition
A Guide to the Project Management Body of Knowledge or PMBOK, 6th Edition. (PMI, 2017)	Risk is *"an uncertain event or condition, that if it occurs, has a positive or negative effect on a project's objectives*"
ISO31000: 2018 Risk Management Guidelines. (IRM, 2018)	Risk is "a deviation from the expected. It can e positive, negative, or both, and can address, create, or result in opportunities and threats"
PM² Project Management Methodology Guide, Open Edition. (European Commission, Centre of Excellence in Project Management (CoEPM²), 2018)	Risk is "*An uncertain event r set of events (negative or positive) that, should it occur, will have an effect on the achievement of project objectives"*
APM Body of Knowledge, 6th Edition. (Association for Project Management, 2012)	Risk is "*the potential of a situation or event to impact on achievement of specific objectives*"
Risk Analysis and Management for Projects: A strategic framework for managing project risk and its financial implications, 3rd Edition. (Institution of Civil Engineers and the Actuarial Profession, 2005).	Risk is "*a possible occurrence which could affect (positively or negatively) the achievement of the objectives of the investment*"

Table 2: Risk definitions in the literature

By looking at these risk definitions and the more informal definition stating that risk is an "uncertainty that matters", one can see that the "uncertainty" dimension is implicitly or explicitly acknowledged through the use of the terms "uncertain", and "possible", while the need for the risk to "matter" is acknowledged in the terms "effect/impact/achievement" on "objectives". Furthermore, uncertainties are not always bad, and this is reflected by international guidelines and standards which indicate terms such as "positive or negative" effect or impact, "positively or negatively" and the terms "threat and opportunity". Therefore, opportunities are also considered uncertainties, because there is no guarantee that they will occur in the project, and they matter since their occurrence would help the project to accomplish one or more objectives (Hillson, 2019). In other words, opportunities are also "risks".

In theory, the debate about the exact definition of risk was solved through the definitions provided by international guidelines and standards. In practice, this is illustrated in the next exploratory phase of the research by conducting interviews with practitioners at Witteveen+Bos. Based on the theoretical definition, risk includes both opportunity and threat, and both should be addressed in the risk management process (Denney, 2020; Hillson, 2019; Johansen et al., 2018; Olsson, 2007). In this research, whenever "risk management" is mentioned, it includes the management of both threats (negative risks) and opportunities (positive risks), and whenever the term "opportunity management" is mentioned, it only refers to the management of opportunities. Thus, opportunity management can be considered a subset of project risk management.

3.2.3 Opportunity

The term 'opportunity' can be interpreted in different ways in the context of projects. In fact, there exists 3 different types of opportunity in the project environment and each type is related to risk in a particular way (Kendrick, 2015):

1- Type 1: Opportunity related to scoping choices. This type of opportunity involves the anticipated value from the delivery of the project. Initially, projects are undertaken based on the assumption that the value of the outcome exceeds the project's cost. To increase the value even more, the project team try to change or add something to the scope of the project, of course with the client and stakeholders' approval. Hence, this opportunity type is based on the constraints and choice of objectives in the project. It is also related to risk: opportunities (to add or change something to the project's scope) might introduce new risks to the project, and the bigger the opportunities the higher the overall risk.

2- Type 2: Opportunity related to planning choices. This type of opportunity, as the name suggests, involves choices related to planning the work. These choices are made to better meet the project's priorities and constraints, and implies adjustments and trade-offs to the project plans, aiming to find a more realistic approach to the work process, and which complies as much as possible with the client, stakeholders, and management team requests. This type of opportunity can also be related to risk: opportunities regarding planning choices will result in optimizing or improving plans but, at the same time, incurs additional risks in the process.

3- Type 3: Opportunity as a beneficial uncertainty. This type of opportunity involves the inherent uncertainties corresponding to the planned activities. Although uncertainty is mainly shifted to the downside, there still be some beneficial uncertainty that can potentially affect the project in the upside direction. This type of opportunities is also related to risk. They are called "positive risks" and should be managed as part of the project risk management process. In this research, this is the main type of opportunity considered. The clear definition of such opportunity is therefore: an uncertain event or condition that, if it occurs, has a positive impact on one or more project objectives. This kind of opportunities, if exploited, does not change the project goals and objectives, but make it easier, cheaper, faster etc. to achieve them.

When searching for opportunities not related to the scope or to the planning activities of the project, the project team should remember that the main source for those opportunities are uncertainties, not facts, requirements, choices or decisions. Opportunities are considered as the positive perception of uncertainty (Hillson, 2017; Lehtiranta, 2014). Also, those opportunities must matter, by making it faster, cheaper or easier to achieve the project objectives (Denney, 2020). This illustration of opportunities indicates that opportunities and threats are actually the same. They are both "uncertainties that matter", and the difference is just the sign of their impact: opportunities have a positive impact whereas threats have a negative impact. Therefore, because both are the same and are only distinguished by the sign of their impact, they should be

both included in the project risk management process using a common approach to identify, evaluate, prioritize, respond and monitor them (Agnar et al., 2019; Hillson, 2019; Thamhain, 2013). Since the focus of this research is on opportunities, it is essential to understand how these are identified and managed in the process. Next, the risk management process is discussed and the considerations to include opportunities are elaborated.

3.2.4 Risk Management Process

As mentioned earlier, since threats and opportunities are similar and only differ in the sign of their impact, it is clear that the risk management process can also be applied to opportunities, with just some modifications (Bekefi et al., 2009; Hillson, 2002, 2019; Lehtiranta, 2014). First, the main phases of the risk management process (ignoring opportunities) are briefly discussed, giving more details to the first 2 stages which are mainly dealt with in this research. Next, the small changes and modifications in the approach to also include opportunities are presented.

According to the Project Management Institute (PMI, 2017), the risk management process includes:

1- **Risk management planning:** This process defines how risk management activities are conducted for a project or, in other terms, how risks will be identified and managed. A risk management plan (RMP) is developed for this purpose at the beginning of the project (PMI, 2017). In this phase, some questions must be answered to set up the context for identifying and managing risks, for instance: Which techniques are adopted to identify risks? Who should be involved in the identification of risks? What are the different kinds of risks the project team is looking for? How will these risks be assessed and prioritized? How to calculate their probabilities and impact? How frequently will these risks be reviewed (PMI, 2017)? Of course, answering these questions depend on the nature of the project and factors such as the project size and project complexity (Walker, 2015).

2- **Risk identification:** This process deals with the identification of risks and documenting their characteristics. It is performed at the beginning and throughout the project (PMI, 2017). An important factor contributing to the effectiveness of this phase is the proper and effective consideration of the risk management planning defined earlier (PMI, 2017). Once the project's objectives at risk, the type of risks, the techniques to be used and the assessment criteria are well defined, the project team can actually start looking for risks. It is important to recognize that not all risks are knowable at this stage; some cannot be foreseen from the beginning of the project and are identified at a later moment in the project (Kolltveit et al., 2005). This is mainly due to the dynamic character of projects (Westerveld & Hertogh, 2010), which will be further elaborated along with the concept of complexity since they are both interrelated.

   A very important consideration in the identification of risk is to separate the risk from its cause(s) and effect(s) to avoid confusion (Hillson, 2005): Causes are definite facts which are present in the project environment and give rise to uncertainty. Some examples are: the need to adopt an unproven new technology, or the fact that the company did not undertake a similar project before. Risks are, as defined earlier, uncertainties which, if they occur, will affect negatively or positively the project objectives. Some examples are: the possibility of not meeting the planned productivity targets, or that the contractor might deliver his work earlier than planned. And finally, effects are negative or positive variations from the project objectives and which arise from the occurrence of the risks. Some examples are: finish a milestone earlier than planned, exceed the budget, or failure to meet the performance targets agreed in the contract. To better understand the relationship between causes, risks and their effect a structured description forming a metalanguage for risk is provided (Hillson, 2005):

"As a result of <one or more definite causes>,

<uncertain event> may occur,

which would lead to <one or more effects on objective(s)>."

To better understand the relationship between the 3 different types of opportunities described earlier, the risk metalanguage is used. This is illustrated in Figure 10:

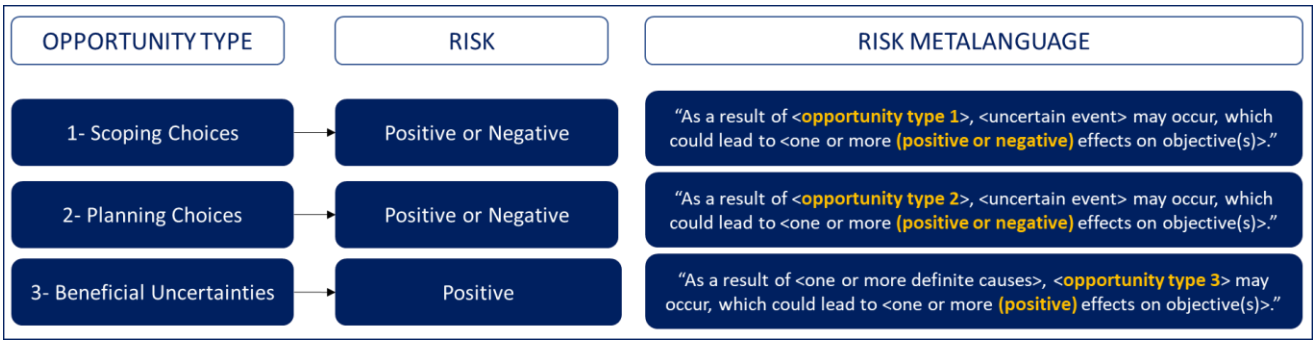

Figure 10: Opportunity types and their relation to risk

3- **Risk analysis and assessment:** This process includes a qualitative analysis for prioritizing the risks leading to a quantitative analysis of those risks to assess their probability of occurrence and potential impact on one or more of the project objectives (PMI, 2017).

4- **Risk planning and implementation response:** This process aims at developing and selecting response strategies to treat the identified and assessed risks and implementing those strategies to either avoid, reduce, transfer or accept the risks. It is performed throughout the project (PMI, 2017).

5- **Risk monitoring:** This process aims at monitoring the implemented response strategies, evaluating their effectiveness and keeping track of the identified risks. It is also performed throughout the project (PMI, 2017).

This is what a standard process for risk management covers. It should not be specific to the management of threats only, but should equally work for addressing and managing opportunities (Denney & Powell, 2020; Hillson, 2002, 2019; Jaafari, 2001; Johansen et al., 2018; Lehtiranta, 2014). At every phase, some additional considerations or modifications need to be performed to take the opportunities into account in the same process (Bekefi et al., 2009; Hillson, 2019; Lehtiranta, 2014), and these are:

- For the planning phase of risk management, if the project team is determined to identify and manage opportunities (positive risks) in the project, this should be made clear from the start and included in the risk management plan (RMP) (PMI, 2017).
- For the identification phase, there exist various techniques used to identify negative risks (threats) and which can be slightly modified to also look for positive risks (opportunities) (Bekefi et al., 2009; Hillson, 2019; PMI, 2017). Also, it would be possible to use techniques that can explicitly search for both together.
- For the analysis/assessment phase, the same approach adopted for assessing threats can also be used to assess opportunities (PMI, 2017).
- For the response phase, as discussed previously, there are mainly 4 response strategies to risks: avoid, reduce, transfer and accept. These are used when dealing with threats (PMI, 2017). Of

course, they are not used to react to opportunities, as no one wants to avoid, reduce or transfer an opportunity. The opportunities strategies are just the opposite of every response strategy used for threats, except for accepting the risk (Hillson, 2002; Johansen et al., 2018; Pandey, 2018; PMI, 2017). Instead of avoiding, one would exploit an opportunity. Instead of reducing, one would enhance the chances of realizing an opportunity. Instead of transferring, one would share an opportunity. Therefore, the 4 response strategies for opportunities are: exploit, enhance, share and accept.

- For the monitoring phase, there isn't a distinction in the way downside and upside risks are monitored and the same process applies equally to threats as well as opportunities (PMI, 2017).

3.2.5 Opportunity Identification Techniques

As discussed earlier, the project team should set the scene from the beginning of the project and one of the considerations is to choose the techniques that are used to identify the risks (threats and/or opportunities). Many techniques are developed to help in the identification process. Some are explained in Appendix G: Opportunity Identification Techniques

However, techniques do not identify risks; people identify risks through the use of techniques. And a main barrier to identifying risks, and more particularly opportunities, is the mindset of the people searching for them (Hillson, 2019). By definition, a mindset is "*a set of attitudes and beliefs that drive behavior in a particular direction*". Someone with a negative mindset for risks will only seek threats irrespective of the adopted technique. Hence, a mindset for opportunities is needed while using any technique, and this mindset has some defined characteristics (Hillson, 2019):

- Realism: Recognizing that the environment is not entirely antagonist, but also include friendly forces.
- Thinking positive: Bad things happen but good things happen do. Thinking positive makes someone aware of what could possibly be beneficial.
- Being curious: Looking around, exploring and asking questions can help in finding hidden opportunities.
- Being alert and ready: "*Expecting the unexpected"* and being prepared to capture opportunities in any circumstances.
- "Can do" attitude: Being aware of one's own capabilities, and being determined to achieving the objectives by using these capabilities while, at the same time, setting doable and achievable objectives, and not overestimating one's competences and abilities. In other words, using your strengths to find and exploit opportunities.
- Visualizing success: Envisioning successful results and positive outcomes, then looking backward to figure out ways to achieve them.

Hence, by effectively planning the risk management activities at the start of the project and listing the project objectives, by using the right tools and techniques to identify positive risks, and by having the right positive mindset, individuals in the project can effectively identify opportunities.

3.2.6 Barriers and Drivers

There are some reasons preventing Managers from dealing with opportunities and these constitute the barriers for not implementing opportunity management in projects. Other reasons can push Managers for looking for opportunities. These are called the drivers. The "mindset" barrier discussed earlier relates specifically to the identification of opportunities when using the identification techniques. Now, the main

barriers and drivers for effectively implementing opportunity management in projects in general are discussed.

Based on a survey conducted by Hillson et al. in 2019, it appears that nearly half of the organizations participating in the survey use a threat-focused risk management process without taking opportunities into account. The question that arises here: Why many organizations are still not adopting the broader approach of risk in practice? Hillson presents five important barriers:

- **Ignorance**: Despite the latest definitions of risks in international standards and guidelines, some people are not aware of the idea that the risk management process includes both the management of threats and opportunities and this ignorance prevents the adoption of a risk approach that covers both negative and positive risks equally.
- **Language**: For the majority of the people, the word "risk" has a negative connotation and the double-sided meaning is not perceived. Opportunities are seen as the opposite of risks, and threats as synonym for risks while, in fact, risks include threats as well as opportunities, and the distinction should be made between negative risks and positive risks.
- **Culture**: By definition, culture is "*the values, beliefs, knowledge, and understanding shared by a group of people with a common purpose".* Therefore, risk culture can be defined as ""*the values, beliefs, knowledge, and understanding about risk shared by a group of people with a common purpose".* If the organizational and project team culture considers and treat risk as being fully negative, then this perception will be naturally translated in the thinking and behavior of people conducting risk management.
- **Psychology**: According to Abraham Maslow's "Hierarchy of needs", people are driven to satisfy their needs, but not all the needs are equal. For instance, people want to satisfy their basic psychological needs first (air, food, water, sleep etc.) then look to satisfy higher needs (such as safety). In the context of risk management, threats are considered as deficiency (or primary) needs and opportunities as growth (or secondary) needs. Hillson claims that threats are always addressed before opportunities since "the drive to survive is stronger than the attraction of growth".
- **Inertia**: Despite being aware of the fact that the risk process should encompass both threats and opportunities, the project team find it easier to continue with the same adopted process and "do it the way they have always done it", even if the current process is not the "best" one.

On the other hand, certain factors can drive the Project Managers and their teams to implement a risk approach that also takes opportunities into account. The initial driver is the added value opportunities can have for the project (Denney, 2020). In fact, effective opportunity management could increase the chances of project success since the identified opportunities can lead to a better achievement of the project objectives, leading to increased reputation and business growth of the organization (Johansen et al., 2018). Other drivers include the increasing awareness on the double-sided nature of risk through education and training, and also more organizational support to include opportunity management as part of the organization culture (Hillson, 2019; Lehtiranta, 2014).

To summarize, opportunity is an uncertainty that, if realized, has a positive impact on the project objectives. The Project Manager and his team should look for these beneficial uncertainties (opportunity type 3) and include them in the risk management process to manage them. At every stage of the process, some considerations have to be made to take the opportunities into account. Also, there exist some techniques that can help in identifying the positive risks. However, it is clear from the literature that the risk management process mainly deals with threats in practice. Hillson attributes this to 5 main barriers: Ignorance, language, culture, psychology and inertia. Increasing awareness on the benefits of managing opportunities should drive practitioners to consider the upside of risk more consistently.

3.3 Project Complexity and Opportunities in Infrastructure Projects

The concepts of project complexity and opportunity management have been introduced in Sections 3.1 and 3.2 respectively. This section looks at the relationship between the two.

The increasing complexity of infrastructure projects makes it more difficult to predict potential risks that might have an impact on the project (Marle, 2020). As such, performing effective risk management based on the level of complexity in a project helps Project Managers in achieving higher rates of success (Jaber et al., 2021).

Various techniques were proposed to assess and evaluate complexity in isolation from risk. Such a separate approach in evaluating complexity and risk is considered to undermine the synergistic effect of interaction between the drivers of complexity and the complexity induced risks (Qazi et al., 2016). As such, evaluating project complexity is not sufficient without looking at the interaction between the two to prioritize risks and choose optimal risk response strategies (Emblemsvåg, 2020). Moreover, the identified risks must relate to one or more of the project objectives, since risk is considered uncertainty that matters for the project. Hence, the relative importance of the project objectives needs to be specified first (Qazi et al., 2016).

To better understand the relationship between project complexity and risk, it is essential to link these concepts to uncertainty (Emblemsvåg, 2020). As defined earlier, risk is "*an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives"* (PMI, 2017). Hence, the source of risks is uncertainty. Two schools of thoughts are distinguished regarding the causal relationship between uncertainty and complexity. The first suggests that uncertainty drives project complexity (Bosch-Rekveldt et al., 2011; Geraldi et al., 2011; Williams, 1999) by causing more dynamics and interactions that increase the level of complexity in a project. The second suggests that uncertainty is a consequence of project complexity (Floricel et al., 2016; L. A. Vidal & Marle, 2008), since complexity can make the project more unpredictable. Hence, there is a reciprocal and dynamic link between complexity and uncertainty.

This relationship is further emphasized in a study about complexity and uncertainty in mega infrastructure projects (Salet et al., 2013). In their research, the authors consider '…*complexity as the number and type of components and the number and type of relationships between these. Thus, an increase in complexity often means that it is more difficult to comprehend the effect of influencing one element; hence there is increased uncertainty. Put differently, uncertainty refers to the components, relationships and interactions we do not fully comprehend or of which we may not even be aware. Complexity and uncertainty are thus strongly related.' (p.3).*

Researchers also suggest that complexity can be a source of negative risks (threats) as well as a source of positive risks (opportunities), but limit themselves to suggesting the consideration of opportunities that emerge from complexity without going in a deeper analysis of the relationship between the two (Erol et al., 2020; L.-A. Vidal, 2009). According to them, opportunities may increase complexity but might reduce the impact of the negative effects of complexity on the project. Therefore, the Project Manager should not struggle to reduce complexity, but rather properly manage it to avoid its negative impacts and at the same time seize the opportunities that emerge from it (Emblemsvåg, 2020; Marle, 2020; Westerveld & Hertogh, 2010). Floricel et al. (2016) established a link between project performance and complexity indicating that proper response strategies on the risks resulting from complexity have a positive impact on project performance.

A summary of the key findings in the literature concerning the relationship between the three concepts of uncertainty, risk and complexity are listed, and the relationship with opportunities is deduced:

1. Uncertainty is a source of risks (PMI, 2017)
2. Risk is uncertainty that matters (Hillson, 2002, 2019)
3. Uncertainty causes complexity (Bosch-Rekveldt et al., 2011; Geraldi et al., 2011; Williams, 1999).
4. Uncertainty is a consequence of complexity (Floricel et al., 2016; L. A. Vidal & Marle, 2008).
5. Complexity is a source of risks (through uncertainties) (Emblemsvåg, 2020; Qazi et al., 2016).
6. Risks increase project complexity (Erol et al., 2020; Hartono, 2018; L.-A. Vidal, 2009)
7. Risk can be negative (called threat) or positive (called opportunity) (PMI, 2017).
8. Positive and negative risks can increase complexity (more planning and control), but positive risks reduce the impact of complexity on the project objectives (Erol et al., 2020; L.-A. Vidal, 2009): Complexity can be exploited. While threats enhance the negative impact of complexity on project objectives.
9. If exploited, opportunities might have a positive impact on the project objectives leading to a better performance and hence higher chances of project success (Floricel et al., 2016). (If not treated, negative risks will have a negative impact on the project's objectives leading to a lower project's performance.)
10. Complexity is known as a potential characteristic that influences project's objectives, usually in a negative way (Butler et al., 2020).

These conclusions are represented in Figure 11 (the numbers refer to every conclusion). The negative risks are not illustrated since this research deals with the positive risks that emerge as a result of the complexities in a project. In practice, both should be considered.

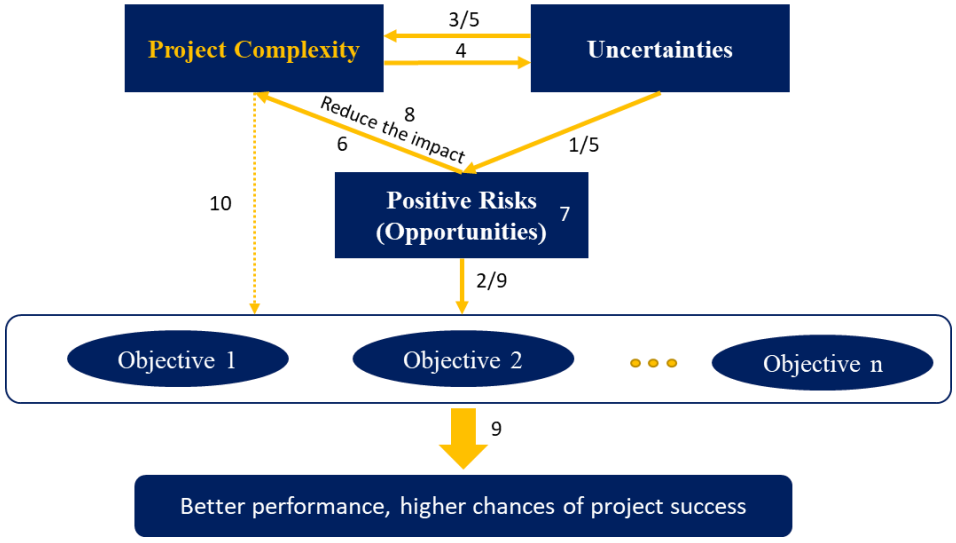

Figure 11: Relationship between complexity, uncertainty, opportunity and performance

One can conclude that uncertainty and complexity have a dual relationship representing their reciprocal and dynamic interaction. Uncertainty is a cause of complexity as well as a consequence. Furthermore, uncertainty is the main source of risks which can be positive: it's called opportunity. Thus, the uncertainty that emerges from complexity can lead to opportunities (and threats, but these are not considered in this research). Similarly, the uncertainty that contributes to complexity can include some opportunities. In both ways, these opportunities should be well managed in order to better achieve the project objectives. This results in a better project performance which leads to higher chances of project success.

3.4 Conclusions

The purpose of chapter 3 was to answer the first sub-research question:

SQ 1: What is in the literature the current state of opportunity management and its relationship to project complexity?

It can be concluded that, given the definition of risk by international standards and guidelines, opportunity is a risk and the management of opportunities should be included in the risk management process. No new process is needed. At every stage of the risk management process, some modifications or additional considerations might be required to take the opportunities into account. As for the techniques used to identify opportunities, researchers suggest that some techniques used to identify threats can be slightly modified to look for opportunities. Also, some techniques exist that can search for both threats and opportunities.

Despite the definition of risk which includes the downside and upside aspect, the fact that no new process is needed, and the availability of techniques to identify opportunities, it is clear from the literature that opportunity management still lags behind in practice. Researchers continuously try to attribute barriers for this reluctance, such as 'ignorance', 'language', 'culture', 'psychology' and 'inertia'. On the other hand, they stress on the drivers to implement opportunity management, such as increasing awareness on its importance in better achieving the project objectives and increasing the chances of success.

Furthermore, as infrastructure projects are becoming more and more complex, risk management, and consequently opportunity management, is becoming more and more important. This aspect was also studied in this research by looking at the relationship between opportunity management and project complexity. It can be concluded that these two concepts are related through the concept of uncertainty. Since uncertainty is a driver and a consequence of complexity, and since uncertainty is a source of opportunities (and threats) based on literature, then complexity is also a source of opportunities (and threats). Hence, complexity can have, not only a negative influence on project objectives, but also a positive influence. Complexity can in fact be exploited. The opportunity management process should be tailored to the project specifics, and project complexity is one of them. Hence, there is a need to capture the interactions between the complexity elements and opportunities to see how can complexities be exploited.

This is achieved through the experts' workshop elaborated in chapter 5. However, before trying to exploit complexity, it is essential to understand the current approach for opportunity management in practice to identify the gaps hindering the adoption of a risk approach that takes both threats and opportunities into account. This is achieved by conducting interviews with practitioners in the field of infrastructure (chapter 4). After filling the gaps by comparing the findings from the interviews to the theoretical findings in the literature and establishing the right approach, one can start identifying opportunities.

4. Results Exploration Phase 1: Interviews

This chapter provides the results from the exploration phase on opportunity management in practice by interviewing Managers at Witteveen+Bos. First, the selection of the interviewees is explained and general background information about them is provided in Section 4.1. Next, the interview guide is described in Section 4.2 to understand how the interview's questions were formulated. The generated coding frame based on the data gathered from the interviews is explained in Section 4.3. The findings are then presented in Section 4.4 and furthered discussed in Section 4.5. Finally conclusions are drawn in Section 4.6.

4.1 Interviewees Selection and Background Information

The purpose of the interviews was to understand the current views of practitioners on the concept of opportunity management before looking at the integration of project complexity in this process and the possibilities of exploiting complexities. The targeted practitioners included Project Managers, Process Managers and Risk Managers. The reason for interviewing Process Managers is that process management deals with managing the complex interactions between stakeholders in a dynamic environment, where actors with different characteristics and project objectives, enter and leave the process (Edelenbos & Klijn, 2009). The process contains many uncertainties due to its dynamic character and the variety of actors participating (De Bruijn et al., 2010). This means that opportunities can be found in the process (De Bruijn et al., 2010) and hence it is important to take the Process Managers' views into account. As for the Risk Manager, his role includes the evaluation and monitoring of the identified risks in a project by actively updating the risk register. He is also responsible to identify risks along with the Project Manager and other relevant project participants. The view of Risk Managers on opportunity management is thus also important to consider.

An invitation was sent to 24 practitioners at Witteveen+Bos. 15 out 24 Managers responded and accepted the invitation for an interview, having a response rate of nearly 63%. From the 15 interviewees: 11 are Project Managers, 3 are Process Managers and 1 is a Risk Manager. The participants have different backgrounds: Civil Engineering, Structural Engineering, Mechanical Engineering, Business Development and Agriculture Engineering. All participants (N=15) have at least 10 years of experience with infrastructure projects. The distribution of interviewees according to their role and background are seen in Figure 12 and 13 respectively:

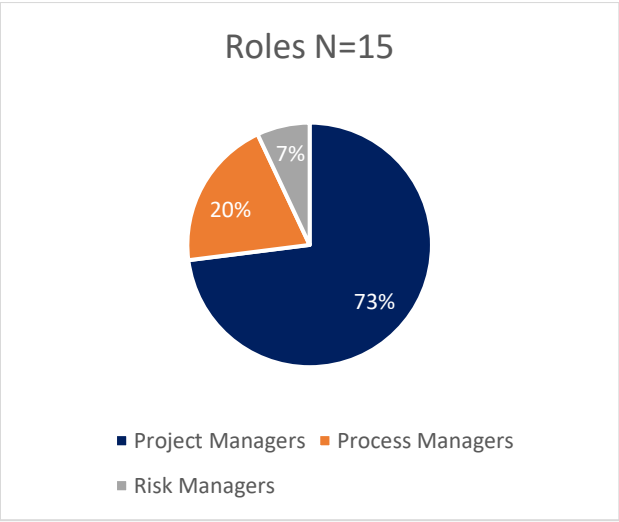

Figure 12: Division of roles among interviewees by percentage

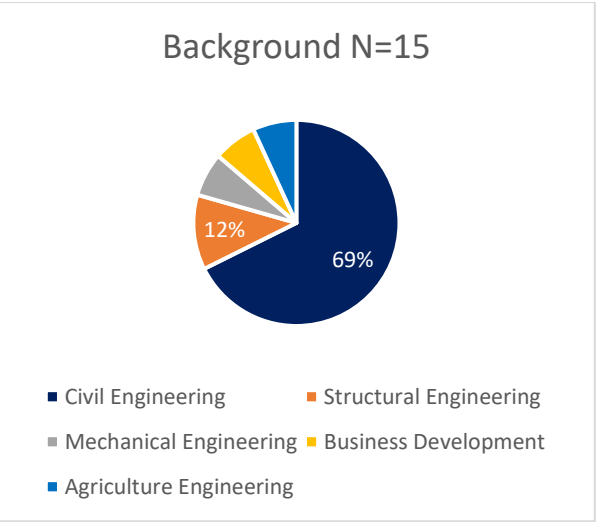

Figure 13: Different backgrounds of interviewees by percentage

4.2 Interview Guide

An interview guide composed of 10 questions was prepared to fulfill the main objective of the interviews. The interview guide is found in Appendix B: Interview Guide.

An explanation of the aim of every interview question is provided:

1. Opportunity Definition: There exists, based on the literature, different interpretations of the concept of opportunity (Kendrick, 2015). Therefore, it is important to understand the perception of practitioners on this concept. This research deals with opportunities as positive risks (Opportunity type 3 as suggested by Kendrick (2015)). The aim is to try to exploit complexity in infrastructure projects and capture the positive risks that emerge from it. After all, these cannot be identified without first understanding the definition of opportunity as positive risk.

2. Planning OM: The first stage of risk management is to plan how risks will be identified and managed during the project, including positive risks (PMI, 2017). Understanding the current planning approach in practice is essential to identify the gaps needed for having an effective implementation of opportunity management from the start of the project.

3. Opportunity Identification: Identifying opportunities requires the use of some techniques that make it easier to the project team to find these opportunities (Hillson, 2019; PMI, 2017). The aim of this research is to develop a new technique to identify opportunities that emerge from complexities in infrastructure projects. It is therefore important to understand the techniques currently used by practitioners as these can serve as inputs for the new developed technique.

4. Barriers for implementing OM and identifying opportunities: It is clear from the literature that, despite the definition of risk which includes the downside and upside aspects, practitioners remain more threat focused (Hillson, 2002, 2016, 2019; Lehtiranta, 2014). As a consequence, the opportunity management process is not effectively implemented (or even not implemented at all), and identifying opportunities remain challenging. Hillson (2019) attributes some barriers for this reluctance. Better understanding these and investigating other barriers is essential to understand what should be improved and how, before identifying opportunities.

5. Drivers for implementing OM and identifying opportunities: On the other side, there should exist certain drivers that will incentivize the project team to identify and manage opportunities (Hillson, 2019). These are also important to consider as they can serve as inputs for the final results of this research.

6. Phases where opportunities can be found and exploited: In fact, complexity in projects is dynamic and changes over time (Bosch-Rekveldt et al., 2011). Hence, it is also important to understand how opportunities vary per project phase to better study the correlation between the two and take it into consideration while integrating project complexity in the opportunity management process.

7. Kind of infrastructure project with most opportunities: Infrastructure projects differ in many aspects. For instance, they differ in size, budget, goals, and level of uncertainty involved (Bosch-Rekveldt et al., 2011; Westerveld & Hertogh, 2010). These characteristics, along with others are considered as drivers of complexity in a project. Furthermore, some of these characteristics, can be considered as sources of risks (Bosch-Rekveldt et al., 2011), hence opportunities. Understanding how practitioners look at the relationship between the kind of infrastructure project and

opportunities might provide insights on the most important complexity element to consider while looking for opportunities.

8. Types of opportunities with examples: The aim of this question was twofold: Firstly, to discover the various types of opportunities identified by practitioners. Secondly, to obtain a list of infrastructure projects through the provided examples, in order to select the projects that fit in the scope of the research for the next phase: the workshop.

9. Ways to improve OM: Since the aim of this research is to, aside from trying to exploit complexity, improve the implementation of opportunity management in infrastructure projects, considering the views of practitioners in this regard is also important. This can also serve as inputs for the final outcome of the research.

10. Recommendations: The last question of the interview aimed at inviting the interviewees to provide recommendations that could benefit the results of this research, in case they had something to say which was not covered by the previous questions.

4.3 Coding Frame

The data collected from the interviews is analyzed according to the Quantitative Content Analysis approach using ATLAS.ti. Qualitative Content Analysis is a systematic method in that it requires a sequence of steps to be followed and assigning segments of the material to main and sub-categories of the coding frame (Flick, 2014).The process consists of preparing the data for analysis, organizing the data and reporting the results (Vaismoradi et al., 2013).

In the preparation phase, the 15 interviews were transcribed and familiarization with the data was achieved by reading the transcripts and highlighting the relevant and important information related to every question. These highlighted segments are called ‘quotations’ in ATLAS.ti. This way, 209 quotations were created. Then, codes were assigned to these quotations. The goal of coding is just to describe the data, so that at a later stage one can retrieve data segments by subjects or topics in order to group them (Friese, 2012).

Creating the codes is done in a data-driven way using a subsumption strategy (Mayring & Fenzl, 2014). This strategy implies examining one ‘quotation’ after the other, following these steps:

1. Reading the ‘quotations’ and summarizing them into concepts or ideas.
2. Checking, for every ‘quotation’, if a code covering its concept/idea has already been generated.
3. If so, ‘subsuming’ the concept/idea under the corresponding code. If not, a new code is created to cover it.
4. Continuing to read until all the relevant concept/ideas are encountered.

This way, 55 codes were generated in total. On the other hand, creating the code groups (group describing a collection of codes), was done in a concept-driven way, which means basing the categories on prior research, previous knowledge, theory or the interview guide (Schreier et al., 2019). In this case, the interview guide was used to define the code groups which resulted in 9 different groups: opportunity definition, planning OM, techniques, barriers, kind of infrastructure projects, phases, types of opportunities, drivers and improvement of OM. Combining the results obtained in a data-driven and concept-driven way, the coding frame is built and insights are discovered. Finally, the results of the analysis process are reported. The findings are presented in Section 4.4.

The whole process of analyzing the data collected from the interviews is summarized in Figure 14.

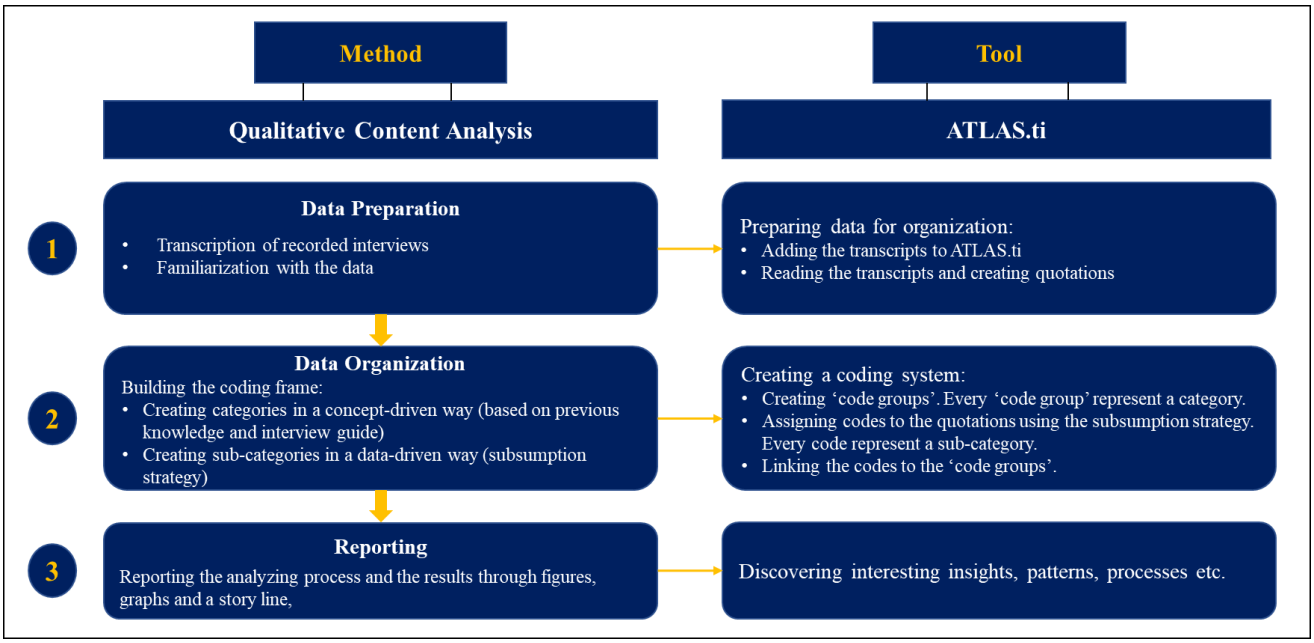

Figure 14: The process of analyzing interviews' data using Qualitative Content Analysis and ATLAS.ti

The quotations related to every code, and the code groups including these codes are presented in Appendix C: Quotations, Codes and Code Groups in ATLAS.ti. Figure 15 provides an illustration of the coding frame.

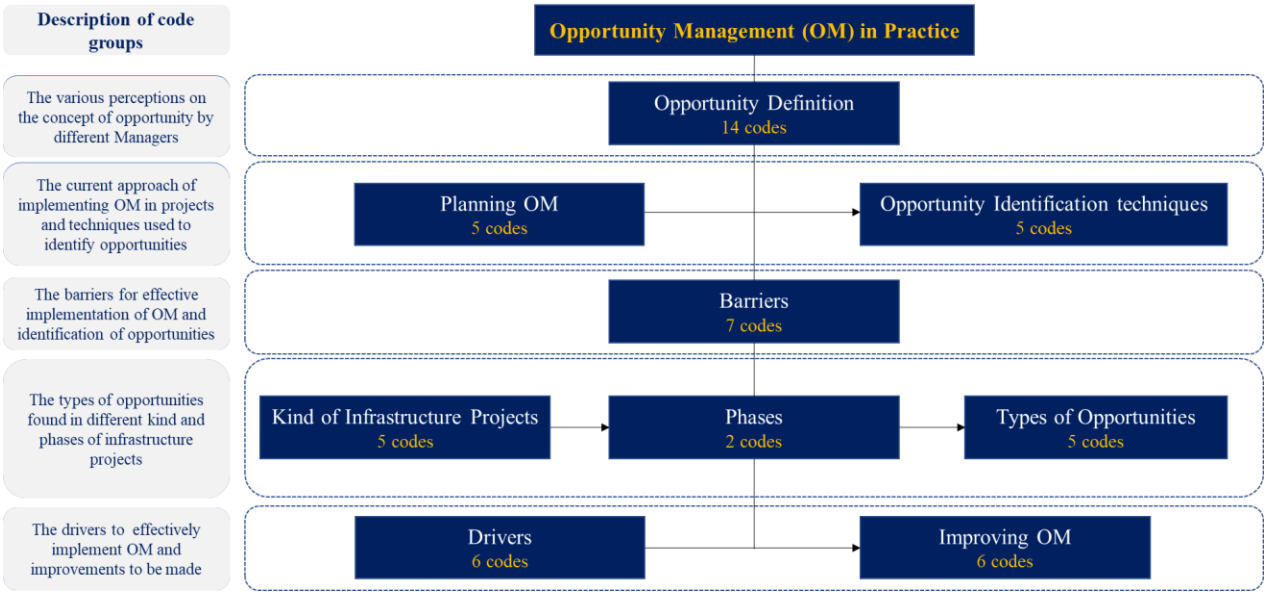

Figure 15: Interviews' analysis- Coding frame

The code groups that are directly related are illustrated at the same level as seen in Figure 15. For instance, while planning the implementation of opportunity management at the beginning of a project, the Project Manager and his team should determine, in the risk management plan, the techniques used to identify opportunities. Also, it is relevant to discuss the different types of opportunities in infrastructure project by considering the kind of project and the project phases, since opportunities vary per project and per phase. Similarly, improving the implementation of opportunity management is based on certain drivers that will

incentivize the Managers to effectively identify and manage opportunities. The discussion of all these aspects is done in a systematic way according to those relationships. First, the results of the interview analysis are presented in a descriptive way before being discussed with respect to the findings in the literature.

4.4 Interviews' Findings

Following the coding frame, the outcomes of the conducted interviews are presented:

Opportunity definition

The first interview question aims to understand the views of practitioners on the concept of opportunity. Table 3 shows the different definitions of opportunities that were mentioned by the interviewees, whether Project Managers, Process Managers or Risk Manager. Their different views based on their roles is further interpreted in the discussion part. After all, every member of the project team can identify opportunities, and therefore it is important to have a common understanding of the concept (opportunity as beneficial uncertainty).

Role	Opportunity Definition
Project Manager	Opportunity is a chance to make the project more efficient
Project Manager	Opportunity is something around the project which, if exploited, add value to the project
Project Manager	Opportunity is not the goal of the project but can bring more value to the end result
Project Manager	Opportunity is combining different goals in the same project
Project Manager	Opportunity is an option that one can implement, with limited time and cost, to gain support in the project
Project Manager	Opportunity is a chance to make the project easier to achieve
Project Manager	Opportunity is a chance to improve the design or process and requires some effort to be realized and add value to the project
Project Manager	Opportunity has different interpretations: It's a chance to make more money or reduce cost, a possibility that can be realized to gain support from stakeholders, and it can make the process in a project easier
Project Manager	Opportunity has different interpretations: acquiring a project, doing more to the client than what is asked, and a possibility to improve certain processes in the project
Project Managers (x2)	Opportunity is a chance to better achieve the project goals
Process Manager	Opportunity is something more than what is required and which involves improving the environment and working on sustainability
Process Manager	Opportunity is the possibility of incorporating the ambitions of stakeholders related to improving the project environment in terms of ecosystem, sustainability or changes in the project scope to satisfy them
Process Manager	Opportunity has different interpretations: a new project is an opportunity, adding to the scope of a project a potential possibility is an opportunity and stakeholders demands and wishes are opportunities
Risk Manager	Opportunity is an uncertainty with a positive impact on the project goals

Table 3: Different opportunity definitions provided by practitioners

Planning OM and opportunity identification techniques

As discussed previously, risk management planning defines how risk management activities are conducted for a project or, in other terms, how risks will be identified and managed. The second question of the interview aimed to understand how this process is actually planned in infrastructure projects. Identifying and managing opportunities depends on the view of practitioners on the concept. This is also depending on the role of the Manager. Everyone has his own way of chasing opportunities, without a standardized and structured process in place.

All Project Managers stated that opportunity management is not planned in their projects, but some attempts are made to find opportunities without a clear process in place. For instance, some mentioned that opportunities are not planned to be identified in risk sessions, but are rather sometimes planned in a separate session if possible. They consider that risks (threats) should be monitored more often and opportunities are optional and not mandatory to have in the project. Others indicate that opportunities are just registered in a document when someone in the project team comes up with an opportunity that can be implemented in the project. These opportunities are assessed at different intervals in the project to see which ones are worth keeping to implement in the next phases if possible. On the other hand, some Project Managers mentioned that opportunities just arise during discussions with the client based on his requirements and wishes. Others only consider the identification of opportunities when defining the scope of the project and looking for possibilities to integrate at this stage.

According to the Process Managers, opportunities are found during discussions with the client and stakeholders in the proposal phase and at the beginning of every phase. They indicate that opportunities appear on an ad-hoc basis during the project, on different topics and with different stakeholders. This depends on the ambitions of the stakeholders with regard to sustainability and the environment. They stated that opportunities are also identified through brainstorming sessions and sometimes value engineering workshops with the stakeholders, as part of the stakeholder engagement process.

According to the Risk Manager, opportunity is an uncertainty with a positive impact on the project goals. He argues that the process of opportunity management is not implemented at all, and risk management only deals with negative risks. Nothing is planned to identify opportunities. He also mentioned that there isn't a technique to find opportunities mainly because uncertainties are outside the company.

Barriers

It is already clear that the process of opportunity management is not implemented in projects, or at least not in an explicit way. This fact is explained by the existence of some major barriers. Many barriers were mentioned more than once by different kind of Managers. Thus, comparing the views of the three roles concerning the barriers is irrelevant. In total, 7 major barriers were identified as seen in Table 4.

Barriers	Explanation
Lack of awareness	Not all members of the project team are aware of the process of OM in the risk management process. It is not part of the organization culture. This also applies to the client
Human nature and mindset	By nature, people tend to focus more on the negative side before considering the positive side, to prevent any harmful impact. The human mindset is trained this way.
Lack of a clear and structured process for OM	People working on a project try to identify and manage opportunities in different ways due to the lack of a structured process. OM is therefore not effectively implemented: many opportunities may be missed, or at least not effectively managed.
Lack of collaboration between different disciplines	Opportunities are difficult to find by looking only from one perspective. An integrated approach is needed to identify opportunities. This not achieved due to the lack of collaboration between the various disciplines in projects.

Opportunities cost money and time	Identifying and managing opportunities require additional work in the project. For instance, opportunity sessions cost money and time. Also, opportunities are not included in the initial project budget.
Opportunities change the project's scope	Opportunities can change or add something to the scope of the project (for instance, design opportunities). This may imply a contractual change which the client doesn't want. Therefore, the team choose not to look into the opportunities to prevent any disturbance to the process.
OM is not asked by the client	The project team makes sure to deliver the project based on the client requirements. Since OM is not asked, it is considered an addition to the project which is optional, but not mandatory to implement.

Table 4: The barriers for effectively implementing OM in projects according to practitioners

Kind of infrastructure projects, phases and types of opportunities

Next, the interviewees were asked to determine in which kind of infrastructure projects and in which phases of such projects could opportunities be found. Also, they were asked to specify the types of opportunities considered.

Many interviewees mentioned a positive correlation between the complexity of the project and opportunities. According to them, the larger the project and the more complex, the more opportunities can be found. They referred to three types of complexities: technical, environmental and social.

Furthermore, some suggested that the more disciplines involved in the project, the more opportunities can be found. In other terms, when the scope of the project is not limited to the infrastructure itself but rather include the broader area or surrounding of the infrastructure, more opportunities come along the way due to the interactions between the different disciplines. Similarly, all Process Managers and some Project Managers argued that, the more stakeholders are involved in a project, the more opportunities can be identified as a result.

The Risk Manager was the only interviewee to state that opportunities are mainly identified in infrastructure projects that have space within the boundaries of quality, time and budget. He referred to the triple constraint in project management practice arguing that, when there is flexibility in time, cost and quality requirements, more opportunities can arise as a result.

Opportunities vary depending on certain project characteristics. Opportunities also change throughout the project lifecycle depending on the project phase. In this regard, there was a divide among practitioners on where to find opportunities in a project. Some stated that opportunities can be identified only in the early project phases and it's difficult to create opportunities after agreeing on the scope and having a contract in place. While the remaining interviewees argue that opportunities can be identified in every phase, from the beginning until the end of the project, but the size of opportunities diminish over time. Also, the chances of exploiting and realizing the opportunities become smaller. The Risk Manager referred to the graph in Figure 16: "Risk event graph" (Larson & Gray, 2010) which shows the variation of risk over time. The same applies for opportunities, since opportunities are also positive risks. He also argues that the cost of realizing the opportunities become higher as the project proceeds.

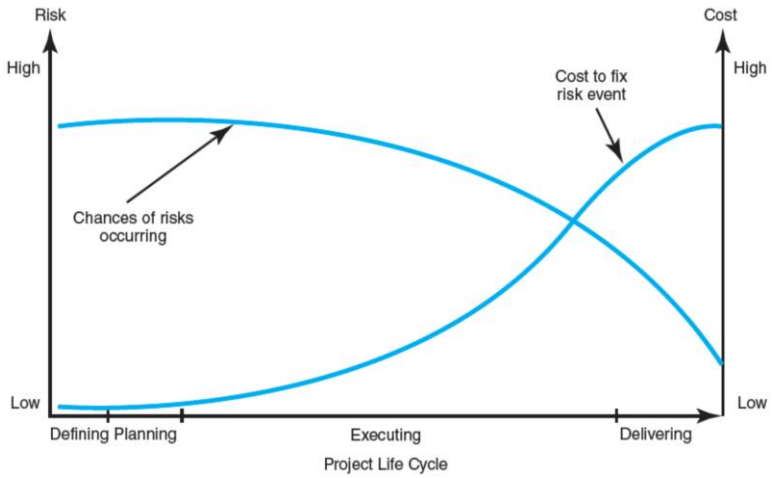

Figure 16: "Risk event graph" (Larson & Gray, 2010)

Opportunities vary in size during the project lifecycle, but also vary in nature or type. Also, opportunities have a positive impact on the project objectives. The interviewees determined some types of opportunities that they perceive in projects along with their impact. The mentioned opportunities with their impact are presented in Table 5.

Opportunity	Impact
Adding something to the scope of the project	• Gain support from stakeholders • Realize something extra for the social community in the surrounding
Combining 2 projects or different aspects and goals in one project	• Reduce overall cost • Satisfy more stakeholders • Make some processes faster (permitting for instance)
Opportunities related to climate change: adaptation and mitigation	• Improve the quality of the infrastructure • Satisfy stakeholders ambitions with respect to sustainability
Design opportunities	• Achieve a better design quality • Reduce cost and time
Change in the construction methods	• Reduce cost and time (for instance by making permitting faster)

Table 5: Opportunity types and their impact according to practitioners

Finally, there is consensus among all the interviewees that, although some opportunities are captured during the execution of their projects, the process of opportunity management is not well or explicitly implemented. The focus is more on the negative side of risks or threats, and many opportunities are missed, or at least not well managed. But there exist some drivers that should incentivize practitioners to better identify and manage opportunities or, in other terms, improve the implementation of opportunity management in practice.

Drivers and improving OM

Similar to the identification of barriers, no significant difference was observed between the three roles with regard to the drivers or even the ways to improve the implementation of opportunity management. Many aspects were mentioned by Project Managers, Process Managers as well as the Risk Manager. Comparing

their views here is also not relevant. In total, 6 drivers were identified along with 6 ways to improve opportunity management. The drivers are presented in Table 6.

Drivers	Explanation
Increase the chances of project's success: reduce cost, reduce time, improve quality	The positive impact of opportunities on quality, cost and time is a driver for the project team to realize the opportunities
An easy process for OM	Having a simple process in place makes it easy to understand and implement OM in the project
Value added	The project team needs to be convinced that the extra effort spent to identify and manage opportunities will actually add value
Project team's satisfaction	Achieving more than what is asked and achieving better results increase the satisfaction of the project team
Stakeholders' satisfaction	Realizing opportunities for the stakeholders make them satisfied, which in turn, increases support and improves reputation
The client asking for OM	The client asking to identify positive risks and not only negative risks, will drive the team to do so

Table 6: The drivers to effectively implement OM in projects according to practitioners

The drivers call for some improvements to be made with regard to the implementation of opportunity management. According to the interviewees, these are some possible ways to improve:

1. Increasing awareness on the topic of opportunity management is the first step in the right direction.
2. Having opportunities sessions organized and not only (negative) risk sessions.
3. Having a clear, standardized and structured process for opportunity management to be implemented in every project.
4. Improving collaboration between the different disciplines.
5. Including the process of opportunity management in the proposal and project management plan.
6. The Risk Manager proposed having a special tool to visualize all the uncertainties in the context of the project.

Next, the results of the interviews are discussed based on the LeCompte and Schensul (1999) suggestion which implies looking at the theoretical findings in the literature. The theoretical background of the research is thus used as a lens through which the collected data is viewed or examined and helps in situating the results. This way, a better understanding of the data is achieved within the established theoretical background, and the gaps between theory and practice are identified. Those gaps are taken into account at a later stage in the research and serve as inputs for the workshop session and when developing the final roadmap.

4.5 Discussion

The discussion is conducted in a systematic way based on the code groups that are considered at the same level, as seen in Figure 15. The difference in views between the three different roles (Project managers, Process Managers and Risk Manager) is also highlighted while discussing the perception of practitioners on opportunity (opportunity definition). For the remaining parts, no significant difference was observed.

Opportunity definition

The first question aimed at understanding the perception of practitioners on the concept of opportunity and resulted in 14 different definitions. Nevertheless, these definitions share some ideas among the same role. The Project Managers see opportunity as a "chance", "possibility", "option" or "something" that makes the process more efficient in the project, better achieve the project goals or add value by improving the scope or design. Looking back at the exact definition of opportunity as positive risk (an uncertain event or condition that, if it occurs, has a positive impact on one or more project objectives), it is clear that the Project Managers don't really acknowledge the difference between opportunities as choices (type 1 and 2 discussed in the literature) and opportunities as risks. This lack of distinction between the types of opportunities hinders the adoption of a risk approach that takes the upside into account. They rather treat opportunity and risk as opposite.

On the other hand, the Process Managers, which role is to manage the stakeholders and their requirements, refer to opportunity as a possibility or choice that will benefit the stakeholders and increase their satisfaction. For instance, the possibility of incorporating the ambitions of stakeholders with respect to sustainability. Also, they don't perceive opportunity as a positive risk, but rather choices that can be made. Here, an opportunity (as positive risk) will make it easier to the Process Manager to incorporate the ambitions of stakeholders with respect to sustainability rather than looking at the opportunity of which further ambitions to include or not. In fact, in the stakeholder's management process there exist many uncertainties, of which some might be beneficial to the project. The Process Manager should identify and exploit these opportunities which do not involve choices regarding the scope of the project, but make it easier to achieve the project goals. Increasing the scope of the project can be an opportunity in itself, but then the choices involved are not seen as positive risks but rather opportunities as scoping choices. Hence, the Process Managers also lack a clear distinction between the different opportunity definitions which make them treat risk as threat only.

The Risk Manager was the only one providing the definition of opportunity as a positive risk. He is responsible for evaluating and monitoring the risks, but he is not the only one responsible for identifying the risks in a project. The Project Manager and his team should also assist the Risk Manager in identifying risks.

Hence, each role treat opportunity as he perceives it in the context of his work: Project Managers look for opportunities to better achieve the project goals or deliver more scope, Process Managers focus on opportunities related to the stakeholders and their ambitions (mainly related to sustainability), and the Risk Manager treats opportunity as a risk. However, it is important to note that only 1 Risk Manager was interviewed and this result cannot be generalized. In any way, the aim is to have a common perception of opportunity among all parties involved in identifying opportunities.

<u>Gap 1:</u> The concept of opportunity is interpreted in different ways among practitioners. Opportunity is not perceived as a positive risk by most practitioners.

Planning OM and opportunity identification techniques

The planning stage of risk management is considered vital because it specifies how threats and opportunities will be identified and managed in the project. As a result of having a lack of acknowledgement among practitioners about the upside aspect of risk, the process of opportunity management is not implemented at all. Some attempts of identifying opportunities during the project are made, but without a clear and structured process in place. Without proper planning from the beginning, it is more difficult for the project team to capture opportunities. The planning stage is essential because it determines the project objectives

at risk, the techniques that are used to identify opportunities, the people who should be involved, the kind of opportunities that the project team is interested in, and how these are assessed and monitored.

Despite stating that no explicit process for identifying and managing opportunities exist, practitioners still try to capture some opportunities during the project. No special techniques are used for this purpose. Opportunities arise from discussions within the project team or with the client and stakeholders. Sometimes, brainstorming sessions are organized, but no special techniques to identify opportunities are in place, although many exist based on the findings in the literature. Some techniques can be used for both types of risks, while others are tailored to look at each separately. Also, it is clear from the literature that both threats and opportunities should be managed in the same process, since they are both risks and only differ in the sign of their impact. Hence, no new process for opportunities should be developed. Identifying and managing opportunities should just be considered when planning the risk management activities.

<u>Gap 2:</u> The current risk management process only deals with threats. Some opportunities are captured during the project but not dealt with as part of the risk management process.

Barriers

The process of opportunity management is not implemented in practice due to some barriers. One of the barriers according to practitioners is the lack of awareness on the concept. This can be associated to the barrier of 'ignorance' provided by Hillson (2019). He claims that, despite the latest definitions of risks in international standards and guidelines, some people are not aware of the idea that the risk management process includes both the management of threats and opportunities. This 'ignorance' prevents the adoption of a risk approach that covers both negative and positive risks equally.

Another barrier suggested by practitioners is the human nature and mindset. They argued that people naturally tend to focus on mitigating what is considered negative before looking at the positive. This is also associated with the 'psychology' dimension provided by Hillson (2019). He claims that people want to first satisfy their basic needs and then look at satisfying higher needs. In the context of risk management, threats are considered as primary needs and opportunities as growth or secondary needs. As a result, threats are always addressed before opportunities. Opportunities are seen as "nice to have" or optional.

The lack of a clear and structured process is also a barrier to implement opportunity management according to practitioners. This barrier can be associated with the 'inertia' dimension also suggested by Hillson (2019). Some practitioners are actually aware of the fact that the risk process should encompass both threats and opportunities. Despite that, they find it easier to continue with the same adopted process and "do it the way they have always done it", by only looking for negative risks.

Another barrier is the lack of collaboration between the different disciplines in a project. In fact, in the planning stage of opportunity management, the parties involved in identifying the risks should be specified. This is because uncertainties are everywhere in the project, and so are risks. Involving the different disciplines in the identification of risks and having an integral approach increase the sources of risks in the project.

Furthermore, some practitioners see that opportunities cost money and time, and sometimes imply a change in the scope. In fact, opportunities (as positive risks) should make it easier to achieve the project objectives by, for example, reducing cost and time and improving quality. It is thus clear that there is a problem of 'language', as suggested by Hillson. He claims that, for many people, the word "risk" is seen as synonym for threat and opportunities as the opposite of risk. While, in fact, risks include threats as well as opportunities, and the distinction should be made between negative risks and positive risks.

A final barrier proposed by the interviewees was that the client does not ask for opportunity management. As a result, the project team is always concerned with identifying negative risks only. Treating risk as negative only became part of the organization's culture. Hillson also elaborate on the 'culture' dimension, arguing that this organizational culture translates in the thinking and behavior of the people conducting risk management. Consequently, positive risks are just disregarded. It is important to note that opportunities can be internal, and not only related to the client. Opportunities, if exploited, lead to a better achievement of the project objectives from a project management perspective. Some objectives can be internal, such as improving the company's reputation or having a more efficient working process, and these will reflect back on the performance of the project and consequently the client.

<u>Gap 3</u>: The barriers of ignorance, language, organization's culture, psychology, inertia and lack of collaboration between disciplines should be treated in order to adopt a risk approach that also deals with opportunities.

Kind of infrastructure projects, project phases and types of opportunities

The kind of infrastructure project refers to the project characteristics rather than the type of infrastructure. Most practitioners see a positive relation between the complexity of the project, the variety of disciplines and the number of stakeholders involved on one side, and opportunities on the other side. They argue that the more complex the project is, the more disciplines and stakeholders are involved, the more opportunities can be found. They treat complexity as an overall characteristic rather than the aggregate effect of different drivers. In fact, having multiple disciplines and many stakeholders involved are considered drivers of project complexity. These are included in the technical and external dimensions of the TOE framework respectively. Hence, based on the relationship between project complexity, uncertainty and positive risks deduced from the literature, these project characteristics can be considered as sources of opportunities.

The majority of practitioners argue that opportunities can be found in every project phase, but the size of opportunities change as the project proceeds, and the chances of realizing the opportunities decrease. Looking back at the definition of risk, it is clear that the main source of risks is uncertainty. In fact, the level of uncertainty in a project decreases over time. Hence, so do risks, and consequently opportunities. Similarly, project complexity is dynamic and vary during the project lifecycle. As a result, identifying opportunities also vary depending on the level of complexity in the project. It is therefore important to understand the relationship between the variation of complexity and opportunities over time, and not treat them as static. This can be achieved by integrating the project complexity more consistently in the opportunity management process. As the PMI suggests, the risk management process should be tailored to the project characteristics such as project complexity.

Opportunities vary in size during the project lifecycle, but also vary in nature or type. Opportunities have a positive impact on the project objectives. It is important to note that the identified opportunities by practitioners (Table 5) are not necessarily related to uncertainties, but also include opportunities which involve choices. For instance, choices related to the design, the scope of the project or sustainability goals. These choices, although they could add value to project, they might also introduce new risks. Whereas opportunities as positive risks do not change the project goals or objectives, but make it easier, cheaper, faster etc. to achieve them. For instance, instead of looking at more possibilities for the design (opportunities as choices), an opportunity could make the design process more efficient (opportunities as positive risks). This lack of distinction between the different types of opportunities among practitioners is again explained by the lack of a clear definition and awareness on the concept of opportunity management.

<u>Gap 4:</u> The relationship between complexities and opportunities should be illustrated. At the same time, a distinction between the different types of opportunities is needed.

Drivers and improving OM

The majority of interviewees sees that opportunities increase the chances of project success by reducing cost or time and improving quality. By definition, an opportunity has a positive impact on the project objectives. Hence, the fact that opportunities help in achieving better results is already a driver. Some also claim that opportunities are important to consider because they can increase satisfaction for the stakeholders and the project team. In fact, these can also be considered as project objectives that the team should strive for to also increase the chances of project success. Project objectives are not only related to the triple constraint of time, cost and quality. A better understanding of the relationship between the positive risk and its impact is therefore needed.

Also, some interviewees argued that, having an easy process in place, can drive the project team to implement opportunity management. This also indicates the lack of acknowledgment that opportunity is also a risk and should be treated in the same process. No new process is needed, but just some considerations and modifications need to be performed to take opportunities into account in the risk management process.

Another driver is evidence: the project team needs to be convinced that the extra effort spent in identifying and managing opportunities will actually add value. In fact, opportunity is a risk, and risk has a certain probability of occurrence. Before identifying an opportunity, the project team specifies the objectives at risk or the goals that the team wants to achieve. The added value of the opportunity is thus the positive impact it has on one or more of the project objectives. Hence, to realize the opportunity and capture its value, the project team should increase the chances of realizing the opportunity or, in other terms, increase its probability of occurrence. This can be achieved by properly planning opportunity management from the beginning and specifying how to treat and respond to opportunities. This way, the project team increases the likelihood of realizing the added value they want to see in the project.

The last driver that the interviewees proposed is the client asking for opportunity management. In fact, opportunities are not only related to the client. There also exist some uncertainties within the organization, and these can be exploited to make the process in the project more efficient for instance. The project team can set internal goals or objectives that they want to achieve. Therefore, practitioners need to understand that opportunities don't only have an impact on the client.

Since many drivers exist to effectively set opportunity management in projects and identify opportunities, some improvements have to be made. Most of the interviewees claim that increasing awareness is the first step. This can solve the barrier of 'ignorance' discussed earlier. Another improvement is to organize opportunities sessions and not only sessions for threats. In this case, there exist some techniques that are particularly used to identify opportunities. Of course, techniques do not identify opportunities, but people identify opportunities through the use of techniques. Hence, a mindset for opportunities is needed as discussed in the literature. This mindset has some defined characteristics: realism, thinking positive, being curious, being alert and ready, "can do" attitude, and visualizing success.

Also, the interviewees proposed having a standardized and structured process for opportunity management to be included from the beginning of the project, in the proposal and project management plan. Since risk management is already implemented, no new process is needed. Treating opportunity as a risk imply identifying and managing threats and opportunities in the same process, with just some modifications.

Another suggestion is to improve collaboration between the disciplines. As discussed earlier, involving various disciplines in the identification of risks increase the sources of risks, since uncertainties are everywhere in the project. The Risk Manager also suggest having a tool to visualize all these uncertainties.

<u>Gap 5:</u> A better understanding of the relationship between positive risks and project objectives is needed. There is also a lack of acknowledgement that opportunities are treated in the same process as risk management. Also, many practitioners are not aware that opportunities can be internal and benefit the organization.

4.6 Conclusions

The purpose of chapter 4 was to answer the second sub-research question:

SQ 2: What is the current state of opportunity management in practice?

It can be concluded that opportunity management is currently not effectively implemented, or even not implemented at all, and some attempts to realize opportunities is achieved but in an implicit way. The reason for that is the lack of a well-established foundation that is needed to effectively set opportunity management in projects. There is a lack of understanding of the concept of opportunity as a positive risk, and that opportunity management should be treated in the same process as risk management. Practitioners continue to do things the way they have always done it, by only looking for threats in their projects and not addressing the opportunities, because "the drive to survive is stronger than the attraction of growth". This attitude became embedded in the organization's culture and in the behavior of people conducting risk management. Also, it was concluded that a better understanding of the relationship between opportunities and project objectives is needed, as these objectives are considered essential elements for a firm basis for opportunity management. Before identifying the opportunities, the project team should know what they want to achieve. Opportunity is uncertainty that matters. It matters because it can better achieve the project objectives. Moreover, practitioners always look for opportunities outside the project team or organization, while some internal opportunities can also be beneficial to realize.

On the other hand, it can be concluded that most practitioners are aware that opportunities can be continuously pursued throughout the project, from the initiation phase to the operations and maintenance phase. The type and size of the opportunities vary, but they are always present. Also, they argued that the bigger the project, the more complex and the more stakeholders are involved, the more opportunities one can find. Being aware of the existence of such opportunities without chasing them, calls for some actions to be taken with regard to better implementing opportunity management. Practitioners see that increasing awareness, including opportunity management in the project management plan, organizing opportunities sessions, following a structured process, improving collaboration between disciplines and better visualizing the uncertainties in the project can actually improve the current state of opportunity management.

After understanding the view of practitioners on the concept of opportunity management and identifying the gaps needed to effectively implement it, the next step involves looking particularly at the relationship between the different complexity elements in infrastructure projects and the opportunities that can emerge as a result. This is achieved by conducting a workshop session with experts in the field. Findings from the interviews are used to prepare the workshop. These are further discussed in chapter 5.

5. Results Exploration Phase 2: Experts' Workshop

The main aim of the experts' workshop is to understand how complexities in large infrastructure projects can be exploited by identifying opportunities that emerge as a result of these complexities. This was achieved by looking at four complex infrastructure projects selected at Witteveen+Bos. The projects are all located in the Netherlands: one project deals with the improvement of a dike and three are characterized as road infrastructure projects. The four Project Managers involved in these projects were invited to attend a two hours online workshop session, during which they could brainstorm together about possible opportunities in every project.

The participants were also part of the interviews' process. It was therefore relevant to consider the results of the interviews in designing the workshop. This chapter starts by explaining how proper planning and organization of the workshop was achieved to ensure that it would effectively fulfill its objective (Section 5.1). Then, Section 5.2 shows how the complexity of the four projects was assessed prior to the workshop session which was conducted virtually using Microsoft Teams and the MIRO dashboard. The whole session was also recorded to ensure that all the necessary information can be reviewed during the reporting of the results. The results are presented in Section 5.3. Next, these are discussed in Section 5.4 and insights into how complexities can be exploited are deduced. Finally, conclusions are drawn is Section 5.5.

5.1 Workshop Design

As a first step in conducting the experts' workshop, this research followed the recommendations of the Dutch facilitator, Jac Geurts, who stated that the successful implementation of a workshop requires "3Ps": Proper Prior Planning. Hence, this workshop was planned and designed in detail prior to the scheduled session. This was achieved based on the findings in the literature and the results of the interviews reported in chapter 4.

It is clear from the previous chapter that at this stage opportunity management is not effectively implemented in projects due to many reasons. Hence, before trying to exploit project complexity, these should be taken into consideration to ensure that the results fit the purpose of the workshop: identifying opportunities as positive risks emerging from the complexity elements in infrastructure projects. The different considerations are presented here:

1) The concept of opportunity is interpreted in different ways among practitioners **(gap 1)**. The definition of opportunity as a positive risk should thus be provided to the participants. This way, the participants will share a common perception on opportunity, and the identified opportunities will fit in the scope of the research (type 3 opportunities). In the literature, opportunity is "*an uncertain event or condition that, if it occurs, has a positive effect on one or more project objectives*". Providing this definition at the beginning of the workshop will also solve the 'language' barrier **(gap 3)**.

2) The current risk management process adopted by practitioners only deals with threats **(gap 2)**. Opportunities that were identified in their projects were most often ad-hoc, and no techniques were used to identify them. Therefore, it was important to use a technique that will facilitate the identification of positive risks during the workshop. In this research, the positive risks that result from complexities are dealt with. Hence, it is important to adopt a technique that also clearly highlights this relationship **(gap 4)**. Furthermore, it was deduced from the interviews that there is a lack of understanding of the relationship between positive risks and project objectives **(gap 5)** This causal relationship should also be underlined.

The identification technique was chosen based on all the aforementioned factors. This technique is the risk metalanguage, considering the complexities as facts and the positive effects on objectives as the consequence as seen in Figure 17:

Figure 17: Risk metalanguage (Hillson, 2005) *showing the relationship between complexity, opportunity and project objectives*

The complexity elements are selected from the categories of the TOE framework. These are further elaborated in Section 5.2. Then, the participants interactively brainstormed to come up with opportunities. These were linked to the project objectives determined at the beginning of the workshop as explained under 3).

3) According to literature (PMI, 2017), while planning the risk management activities, the project objectives should be determined. This way, the project team will search for the risks that will help in achieving these objectives. Hence, the goal was to ask the participants at the beginning of the workshop to determine the objectives that they wanted to achieve in their projects. These goals are seen from a project management perspective and not goals related to the scope of the project. In fact, project complexity usually has a negative impact on the project's performance. This complexity should be well managed to reduce the magnitude of its impact on the objectives such as cost, time or quality. Other objectives could be to increase satisfaction for the stakeholders, the client, and even the project team. The aim was to provide the participants with examples of project objectives to better understand which kind of objectives we are looking for.

Taking these 3 considerations into account, the workshop session was designed based on the workshop structure proposed by Gray et al. (2010). This structure is composed of an opening part (divergent), an exploration part (emergent) and a closing part (convergent). The reason for using this structure is that it is essential to start the workshop by explaining the scope and purpose of the session, and the methodology used (opening), while taking into account the gaps discussed earlier. This will better prepare the participants to engage in creative thinking during the identification of opportunities in the selected projects (exploration). And finally, it is important to conclude the workshop by providing participants the chance to reflect on their experience, as this might generate insights for the results of the research. The session started in Microsoft Teams with a presentation about the workshop: the scope, goal, and methodology used. Also, clear definitions about 'opportunity' and 'opportunity management' were provided. Then, the MIRO dashboard was introduced to familiarize the participants with the tool. Also, the Project Managers were asked to determine the project objectives that they wanted to achieve in their projects. All these activities were planned for the first 20 minutes of the workshop. Next, for 1 hour and 30 minutes, opportunities were identified in MIRO using the risk metalanguage and finally, 10 minutes were designated for the participants to provide feedback and reflect on the workshop. The workshop structure is illustrated in Figure 18:

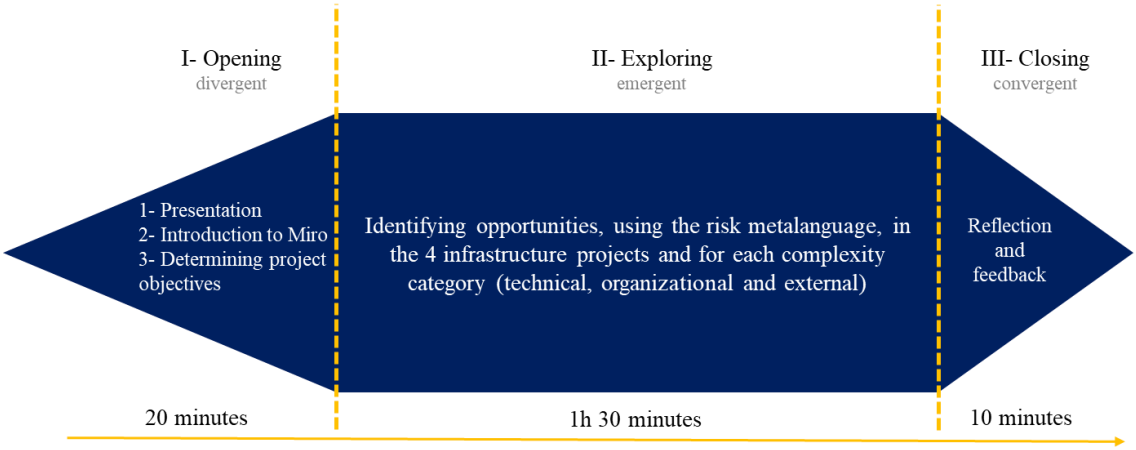

Figure 18: Workshop structure

The process of identifying opportunities in MIRO, using the risk metalanguage, in the four infrastructure projects and for each complexity category (technical, organizational and external) is explained in detail in Appendix D: Method used in MIRO to Identify Opportunities.

To identify the most critical complexity elements in the selected projects and try to exploit them, the TOE framework was sent through email prior to the workshop to the four Project Managers to assess project complexity in their projects.

5.2 Complexity Assessment Using the TOE Framework

To identify the opportunities that might result as a consequence of complexity elements in the four selected infrastructure projects, the focus should be on the complexity elements that are critical and significantly contribute to the complexity of the project. The reason is that, the higher the complexity, the more uncertainties emerge as a result. Consequently, more opportunities can be found. This way, the impact of the most critical complexity elements could be reduced.

As discussed earlier, the assessment of project complexity was done using the TOE framework. Every Project Manager was asked to assess the complexity of the project he was directly involved in. It is important to mention the subjective character of complexity. In order to assess complexity more objectively, the assessment should be conducted by different members of the project team, and then the average complexity can be calculated. However, in this case, the main goal is not to determine the level of complexity and reduce the degree of subjectivity, but rather try to exploit the complexity elements that the participants perceive as most critical. Of course, different participants would consider different complexity elements based on their experiences and other factors. The focus would be on exploiting these. However, the aim here is to study the approach adopted by the Project Managers in their attempt at exploiting complexity, and the complexity assessment is just a means to focus on the elements that they perceive as most complex.

The four Project Managers assessed the complexity of their own project by scoring the technical, organizational and external complexity elements of the TOE framework. They provided the scores using the following scale: None (1), little (2), some (3), substantial (4) and very much (5). For example, a score of 5 indicates that the complexity element is very critical and has a high potential in contributing to the complexity of the project. Moreover, the projects are currently in different phases. Therefore, to account for the highly dynamic character of complexity and identify opportunities in all project phases, the participants were asked to take a step back to the beginning of the project (t=0) and assess complexity. This

is the moment in time where the Project Managers started working on their project and first perceived its complexity. The results of the complexity assessment of the four projects are presented in Figure 24, Figure 25, Figure 26 and Figure 27 in Appendix F: Results of the Workshop in the MIRO Dashboard.

The advantage of the workshop is in its dynamic and interactive character which stimulates creative thinking among participants through collaborative working. For this reason, it was important to focus on the common most critical complexity elements among participants, since they will brainstorm together about possible opportunities in every project. To achieve that, the average scores were calculated (see Figure 28 in Appendix F: Results of the Workshop in the MIRO Dashboard) and the highest scoring elements (score of 3 or higher) were selected to be included in the workshop in an attempt to exploit them. These elements are presented in Table 7: the elements in red have a score of 4 or higher, which means that they substantially or highly contribute to project complexity. While the elements in orange have some potential contribution to project complexity (Bosch-Rekveldt et al., 2011).

Comparing the results in Table 7 to the work of Bosch-Rekveldt et al. (2018) which involved comparing the complexity of projects across five different sectors, some insights can be deduced. In fact, the research concluded that some complexity elements of the TOE framework appeared in three or more of the industries under investigation. These are: the 'High project schedule drive', the 'Lack of resources and skills availability', the 'Variety of external stakeholders' perspectives' and the 'Interference with existing site'. These elements demonstrated their broad applicability and importance in determining the complexity of projects in the five different industries. In this research, these four elements highly contribute to the complexity of the four infrastructure projects within the same industry: the construction industry. For the element 'High project schedule drive', a better preparation of the project is needed rather than trying to comply to unrealistic deadlines (Bosch-Rekveldt et al., 2018). In other words, a more efficient working process is needed. Also, to prevent the 'Lack of resources and skills availability', it is recommended to take actions in time by, for instance, realistically planning the resources to be deployed in the project or better training the resources. Similarly, the element 'High variety of external stakeholders'' can be dealt with by actively involving the stakeholders from the beginning of the project. Also, the complexity element 'Interference with existing site' could benefit from "*embracing complexity approach that the interference as such is part of the project anyway"* (Bosch-Rekveldt et al., 2018). For the other complexity elements presented in Table 7, a similar approach can be used to exploit those complexities, by actually trying to "play with complexity" and find ways to embrace it, rather than attempting to reducing it (Westerveld & Hertogh, 2010). This strategy will be adopted when answering the third question: *How can complexities be exploited?*

Technical Complexities	Organizational Complexities	External Complexities
Size in CAPEX	Size of the project team	Number of external stakeholders
High number of tasks	Number of contracts	Variety of external stakeholder's perspectives
High variety of tasks	Interfaces between different disciplines	Dependencies on external stakeholders
Dependencies between tasks	High project schedule drive	Political influence
Project duration	Lack of resources and skills availability	Interference with existing site
Number of locations	Lack of HSSE awareness	Level of competition
Involvement of different technical disciplines	Type of contract	Lack of company internal support
Lack of experience with technology		
High number of project goals		

Table 7: The common most critical complexity elements (T, O and E) among the 4 selected infrastructure projects

In summary, the preparation prior to the workshop included:

- Designing the method used during the workshop to identify opportunities (based on the findings in the literature and the interviews).
- An assessment of the complexity of the four selected infrastructure projects using the TOE framework and determining the common complexity elements that highly contribute to the complexity of the projects.

5.3 Results

The results of the workshop session were directly saved in the dashboard. These are presented in Appendix G: Opportunity Identification Techniques. Moreover, the session was recorded and later transcribed. This helped in reviewing how the participants elaborated on the identified opportunities and their feedback and reflection at the end of the session. Three different sets of data were generated as a result: the project objectives discussed in Section 5.3.1, the opportunities in Section 5.3.2 and the feedback and reflection in Section 5.3.3.

5.3.1 Project objectives

The Project Managers were asked to specify the project objectives they want to achieve in their projects before looking for opportunities. Five project objectives were provided as examples, and the participants, together, came up with 18 objectives through brainstorming. This resulted in 23 project objectives in total. These are listed in Table 8. This marked the end of the 'opening' phase, and the exploration part started as described previously.

#	Project objectives
1	Reduce cost*
2	Reduce time*
3	Improve quality*
4	Increase safety
5	Increase sustainability
6	Improve company recognition/reputation*
7	Improve relationship with client and client satisfaction
8	Increase stakeholders' satisfaction/support*
9	Increase project team's satisfaction
10	Improve collaboration between disciplines
11	Reduce objections
12	Train junior advisors
13	Product innovation
14	On the job training
15	Implement and utilize new systems
16	Be a reference project for future projects
17	Having a nice working environment
18	Keeping budget above costs
19	Getting the work for the next project phase
20	Improve commercial results
21	As soon as possible approval of contract requirements
22	Better cooperation of design and execution
23	More efficient process

Table 8: Project objectives identified during the workshop session

*Project objectives that were provided as examples to the participants.

The project objectives listed in Table 8 can also have a secondary positive effect and fulfill other objectives. For instance, reducing objections from stakeholders might save some time in the project. Similarly, improving collaboration between disciplines might save time and/or improve quality. Such considerations should also be taken into account when identifying the project objectives in order to assess the impact of the opportunities on these objectives and prioritize the opportunities as such.

5.3.2 Opportunities

Using the risk metalanguage which shows the relationship between the complexity elements, opportunities and project objectives, the Project Managers identified 26 opportunities in total: 11 opportunities related to the technical category, 8 opportunities related to the organizational category and 7 opportunities related to the external category. Also, the project phase where the opportunity can be identified was determined. Opportunities related to the technical complexities are presented in Table 9, opportunities related to the organizational complexities in Table 10 and opportunities related to the external complexities in Table 11 (A refers to the dike improvement project, and B, C and D are road infrastructures).

Since the Project Managers were looking back at their projects, the questions that arise are the following: Were these opportunities actually identified and realized in the respective projects? If so, what factors helped in identifying these opportunities? To answer these questions, some examples of opportunities are further elaborated:

- For the technical complexity 'Lack of experience with technology' in project C, the Project Manager sees such complexity as an opportunity to adopt the technology and learn from it. This way, the team will gain knowledge and experience, and the technology can serve as a reference for future projects. As a result, it can improve the company's reputation since it is not widely used in the Netherlands and this might provide an advantage for the company. In project C, part of the highway is below the water table. The project team needed to find a way to keep using the existing part of the road without flooding the entire section. The area to protect was so deep compared to previous works in the Netherlands. This urged the team to come up with innovative solutions. Many technologies were proposed and a feasibility study was conducted to choose the optimal one. Despite many uncertainties, the technology that is considered new was chosen and the team saw it as an opportunity to learn from it. By conducting some research and calculations, the team was able to implement this technology.
- For the technical complexity 'Lack of experience with technology' (from the contractor and client perspective) in project D, the Project Manager saw the opportunity to help the contractor with specialist knowledge. The team was working in a joint venture with a contractor. In the beginning of the project, they conducted several brainstorm sessions about the technical solution. They developed a complete plan which consists not only of the technical solution but also took many considerations into account. The Project Manager found out that, from a design point of view, Witteveen+Bos had more knowledge with the technology, but also with the environmental aspects and the stakeholders involved. That was helpful for the contractor. Together, they developed a plan as part of the tender phase. This plan was presented to Rijkswaterstraat which is the client of the contractor. As a result, the bid was won by the joint venture.
- For the technical complexity 'High number of tasks' in project D, the Project Manager identified the opportunity to implement the ISO15288 (a technical standard in systems engineering which covers processes and lifecycle stages). In fact, this was a requirement provided by Rijskwaterstraat in a previously completed project and it was new for many members of the team. As a result of seeing the benefits of the ISO15288, the Project Manager offered to implement it in the new project (Project D).

- For the organizational complexity ‘Lack of resource and skills availability’ in project C, the Project Manager identified the opportunity to engage designers from different business lines. In fact, he argues that after starting with the project, the team realized that it didn’t have enough resources within the same business line and was searching for experience in terms of technical design. This experience was available in another business line, and collaboration was a must to complete the design.

In fact, these opportunities and many others were actually realized in the projects but were not identified from the beginning. The Project Managers with their project teams identified the opportunities only when there was a need to do so (engaging designers from other business line for instance), or after seeing the benefits of an opportunity that was basically a requirement addressed by the client to make the work more efficient (the ISO15288 for instance). If the project team invests some time at the beginning of the project to search for opportunities, some could be identified earlier and better managed to increase the likelihood of realizing them, or even identify other opportunities that could help in achieving the project objectives.

#	Project	Fact=Complexity element As a result of...	Risk= Uncertain event or condition … would occur	Effect=Positive impact which would lead to…	Project Phase
1	A	High number of tasks	Assigning less people on the project but having more specialists who will put more effort	Reducing cost Improving quality	Exploration
2	A	Very long project duration	Assigning junior advisors for the whole project to gain experience, develop and grow within the same project environment	Training junior advisors	Exploration
3	A	Very long project duration	Generating more revenues through scope extension	Getting the work for the next phase Improve commercial results	Exploration
4	A	Very long project duration	Implementing and utilizing new systems/methods	Having a more efficient work process	Exploration
5	B	Involvement of different technical disciplines (+foreign contractor with lack of experience in the NL)	Assisting and supporting the contractor in the integrality of the project during the execution phase through Rijkwaterstraat (RWS)	Improving relationship with client Increasing stakeholders' satisfaction/support Increasing project team's satisfaction Better cooperation of design and execution	Execution Operations and Maintenance
6	B	High number of project goals	Developing more variants of the design and creating more options	Increase stakeholders' satisfaction/support Increase project team's satisfaction Reduce objections Getting the work for the next phase	Exploration Development
7	B	High number of project goals (+ understanding the requirements of all the stakeholders in the project)	Assisting the contractor with connecting the different goals	Earlier start of execution (due to a faster permitting process)	Development
8	C	Lack of experience with technology (+ conducting research, calculations etc.)	Gaining new knowledge/experience	Improving company recognition/reputation On the job training Being a reference project for the future	Development
9	C	High variety of tasks	Assigning different personnel based on experience and competences	Train junior advisors On the job training	Development
10	D	Lack of experience with technology (from the client and contractor side)	Helping the contractor with specialist knowledge and innovation	Improving client satisfaction Product innovation Improving commercial results (due to a big change in scope)	Execution
11	D	High number of tasks	Adding more disciplines and implementing new methods such as: systems engineering, interface management, ISO15288	Product innovation Improving relationship with client Having a more efficient process	Execution

Table 9: Opportunities related to technical complexities

#	Project	Fact=Complexity element As a result of...	Risk= Uncertain event or condition … would occur	Effect=Positive impact which would lead to…	Project Phase
1	A	Type of contract (start with 0 euro and decide, together with the client, on the scope)	Creating a bigger scope	Improving commercial results	Exploration
2	A	Lack of HSSE awareness	Creating a bigger scope in health and safety	Improving commercial results Improving safety	Exploration (realizing the opportunity) Operations & Maintenance (Impact of the opportunity)
3	B	Interfaces between disciplines	Working together with RWS in the back office and leading the team	Improving relationship with client Improving collaboration between disciplines Improving commercial results Gaining experience in the execution phase (in which usually there is no involvement)	Development Execution
4	B	Multiple contracts involved	Gaining knowledge about putting together the execution contract at different levels	On the job training Being a reference for future projects	Development
5	B	Type of contract (In the BOK contract, it is specified that part of the scope will be elaborated later without any detail or requirement)	Helping the client with developing the design for the additional scope	Improving commercial results Increasing stakeholders' satisfaction/support Reducing objections	Development
6	C	Lack of resource and skills availability	Engaging designers from other business lines	Improving collaboration between disciplines Training junior advisors On the job training	Development
7	C	Type of contract (new two-phase contract)	Adopting this new kind of contract	Improving company recognition/reputation Implementing and utilizing new systems Better cooperation of design and execution Being a reference project for future projects	Development
8	D	Type of contract (DBFM)	Taking advantage of RWS not understanding the DBFM contract	Faster approval of contract requirements Better commercial results	Execution

Table 10: Opportunities related to organizational complexities

#	Project	Fact=Complexity element As a result of...	Risk= Uncertain event or condition … would occur	Effect=Positive impact which would lead to…	Project Phase
1	A	High number of external stakeholders	Providing services to as many stakeholders and increasing the project scope	Improving company recognition/reputation Increasing stakeholders' satisfaction/support Reducing objections	Exploration
2	A	High variety of external stakeholders' perspectives	Combining different goals (meekopelkansen) to increase the scope from just the infrastructure to an area development approach	Improving quality Increasing sustainability Increasing stakeholders' satisfaction/support Reducing objections	Exploration
3	B	High variety of external stakeholders' perspectives (+ already highly involved in the project and knowing the stakeholders' and their requirements)	Supporting the client with tendering for a bicycle-pedestrian bridge (a new addition to the scope)	Increasing stakeholders' satisfaction/support	Development
4	C	High political influence	Increasing the scope/budget after changes are induced by politics	Reducing cost Reducing time	Development
5	C	Interference with existing site	Coming up with innovative designs	Improving company recognition/reputation Reduce objections Product innovation Implementing and utilizing new systems Being a reference for future projects	Development
6	D	High number of external stakeholders (+knowing the stakeholders and their needs)	"Selling" the designs to the stakeholders using the experience of W+B	Reducing time Improving relationship with client Increasing stakeholders' satisfaction/support	Execution
7	D	Strong level of competition (+ experience of W+B in having an integral approach for the bid of a project)	Helping the contractor in winning the contract using an integral approach (rather than just focusing on the technical options)	Winning the contract Improving relationship with the client Increasing stakeholders' satisfaction/support	Execution

Table 11: Opportunities related to external complexities

5.3.3 Feedback and reflection of participants

In the final part of the workshop, the participants were asked to provide feedback and reflect on their experience in the workshop. The main ideas expressed are:

- That the methodology used in the workshop helped them a lot in finding the opportunities, "… *especially by showing how the dots are connected between the complexity elements and the project objectives*".
- They also argued that they usually only look at the negative risks and it's hard to see the positive chances: "…*You need certain people to see these positive risks*". Another reason is that they "… *are always busy with realizing the project goals and solving problems that arise from the complexities"* adding that "…*mitigating risks is the need to have and realizing opportunities is nice to have".*
- They also stated that "… *it is interesting to see how many opportunities can be found internally and not just for the client".*
- In addition, they saw that such sessions "… *increase awareness on the importance of opportunities and their different sources*" such as the complexities.

5.4 Discussion

The workshop session was conducted with the aim of identifying opportunities that result from complexities in infrastructure projects and discover insights into how practitioners can actually exploit complexity. The workshop produced 26 different opportunities that were identified in the four selected infrastructure projects. With reference to Darsø (Darso, 2001), she argues that, in a workshop session, one should distinguish between primary and secondary data. The list of opportunities is considered as primary data, while *"secondary data are retrospective representations and accounts of 'what happened'".* In this case, secondary data are considerations that the participants took into account in order to find the opportunities or, in other terms, what the participants considered to be able to exploit the complexities.

Looking at the various opportunities resulting from the technical, organizational and external complexities, five major insights were deduced:

1) The participants exploited the technical complexities 'High number of project goals' and 'Lack of experience with technology' (#7 and #8 in Table 9 respectively) and external complexities 'High variety of external stakeholders' perspectives' and 'High number of stakeholders' (#3 and #6 in Table 11 respectively) by using the strengths of the project team or organization (internal). Taking as an example the technical complexity element 'Having a high number of project goals' (complexity): Having a clear understanding of the requirements of all the stakeholders involved (internal strength), the project team could assist the contractor with connecting the different goals (opportunity) which would lead to an earlier start of execution (positive impact). Similarly, for the external complexity element 'Having a high variety of external stakeholders' perspectives (complexity): using the fact that the team is already highly involved in the project and knowing the stakeholders' and their requirements (internal strength), the team could support the client with tendering for a new addition in the scope (opportunity), which would lead to increasing stakeholders' satisfaction/support for instance (positive impact). Hence, an assessment of internal strengths (capabilities, competencies, etc.) is needed to exploit the complexity. As such, the following relationship is deduced:
   Complexity + strength (internal) → opportunity → positive impact(s)

2) The participants exploited the technical complexities 'Involvement of different technical disciplines' and 'Lack of experience with technology' (#5 and #10 in Table 9 respectively), the organizational element 'Type of contract' (#5 and #10 in Table 10) and the external element "Strong level of competition' (#7 in Table 11) by using the strengths of the project team or organization (internal) and looking at the weaknesses from the client or contractor side (external). Taking as an example the 'Involvement of different technical disciplines' (complexity): the contractor has a lack of experience in working in the Netherlands (external weakness). The project team has a lot of experience in similar projects (internal strength). Therefore, the team could assist the contractor in the integrality of the project during the execution phase (opportunity), which would lead to a better cooperation of design and execution for instance (positive impact). Similarly, for the element 'Type of contract' (complexity): In the contract, it is mentioned that part of the scope will be elaborated at a later stage in the project without any detail or requirement (external weakness). Having the knowledge and experience needed to develop this scope (internal strength), the project team could help the client with the design of this additional scope (opportunity), which would improve commercial results for the company for instance (positive impact). Hence, an assessment of internal strengths and external weaknesses is needed. This complementarity can help in exploiting the complexity. As such, the following relationship is deduced:
Complexity + weakness (external) + strength (internal) → opportunity → positive impact(s)

3) The participants exploited the technical complexities 'Very long project duration' and 'High number of tasks' (#4 and #11 in Table 9 respectively), the organizational elements 'Interfaces between disciplines', ' Multiple contract involved' and 'Type of contract' (#3, #4 and #7 in Table 10 respectively) and the external element 'Interference with existing site' (#5 in Table 11) by trying to turn an internal weakness to a strength. Taking the technical elements together as an example: The project team lacks the implementation of internal processes, methods or systems (internal weakness) that could make the process in the project more efficient (positive impact). By having a long project duration (complexity #4) or a high number of tasks (complexity #11), the participants see the possibility of turning their weakness into a strength by implementing new systems, methods or disciplines such as system engineering, interface management, the ISO15288 etc. (opportunity). Similarly, for the organizational element 'Interfaces between disciplines': The project has many interfaces between the disciplines (complexity) and has a lack of experience with regard to the execution phase (internal weakness). The participants would try to work with the client (Rijkwaterstraat) and lead the team in the execution phase (opportunity) which would lead to, for instance, the team gaining experience in a phase in which usually there is no involvement (positive impact). Other positive impacts can also result, such as improving relationship with client. Hence, an assessment of internal strengths and weaknesses is needed here. Turning a weakness to a strength increases the organizational capability over time through learning. This learning attitude is achieved by exploiting the complexity. As such, the following relationship is deduced:
Complexity + weakness (internal) → opportunity → weakness becomes strength + positive impact(s)

4) The participants exploited the external complexities 'High number of tasks', 'Very long project duration' and 'High variety of tasks' (#1, #2 and #9 in Table 9 respectively), and the organizational element 'Lack of resource and skills availability' (#6 in Table 10) by trying to better use the resources in the project team or organization. Taking the 'High number of tasks' as an example: There is a high number of tasks in the project (complexity). A possibility could be to assign more specialists in the project team who will put more effort (opportunity), rather than having a larger

number of people working on the project with less expertise. This would reduce cost and improve quality (positive impact). Similarly, for organizational element: There is a 'Lack of resource and skills' availability' in the project (complexity). A possibility could be to engage designers from other business lines (opportunity). This would lead to improving collaboration between the disciplines and training junior advisors from the other business line for instance (positive impact). Hence, the following relationship is deduced:
Complexity + better use of resources → opportunity → positive impact(s)

5) The participants exploited the technical complexity 'Very long project duration' (#3 in Table 9), organizational elements 'Type of contract' and ' Lack of HSSE awareness' (#1 and #2 in Table 10 respectively), and external elements 'High number of external stakeholders', 'High variety of external stakeholders' perspectives' and 'High political influence' (#1, #2 and #4 in Table 11 respectively) by increasing the scope of the project. Taking the organizational element #1 as an example: The 'Type of contract' in the project was considered very complex since it was placed before agreeing on the scope (complexity). The revenues will be based on what will be decided upon between the project team and the client. The team sees the possibility of creating a bigger scope (opportunity) in order to improve commercial results (positive impact). Similarly, for the technical element #2: As a result of having a 'Variety of external stakeholders' perspectives' (complexity), the project team would try to combine different goals by increasing the scope of the project from just the infrastructure itself to an area development project including the infrastructure. (opportunity). This would increase stakeholder's satisfaction/support for instance. Hence, the following relationship is deduced.
Complexity → increasing the scope (opportunity) → positive impact(s)

Besides identifying the opportunities that result from the complexity elements and determining their impact, the participants also indicated the project phase in which the opportunities can be realized. Opportunities were identified in all project phases. This confirms that uncertainties are present during all project phases, since uncertainties are sources of positive risks. Moreover, these uncertainties are the consequence of complexities. The identified opportunities also differed per project phase. Recognizing the dynamic character of complexity, it would also be essential to assess project complexity at the beginning of every phase. This can better reflect the actual opportunities present in the specific project phase. In this research, this was not necessary since the goal was just to study how complexities can be exploited. But this should be taken into consideration for future application.

The participants also reflected on their experience in the workshop. First, they claimed that the way the methodology showed the relationship between the complexities, the opportunities and the project objectives made it easier to identify the opportunities. Therefore, it is very important to differentiate between the positive risk, its cause and its consequence, especially when people are not used to identify the positive risks. They also argued that opportunities are not easily identified by everyone, and that it is easier for some to find the opportunities. Hillson (2019) discussed the 'mindset' for opportunities by attributing certain characteristics for it. These can also be considered to make it easier for anyone to identify opportunities. Also, they mentioned that opportunities are 'nice to have' or optional, and individuals are always busy mitigating the threats that arise from complexities. Recognizing that complexities can also be sources of opportunities and that these will reduce the impact of complexity on the project can be a driver for the project team to start chasing the opportunities as a necessity to have in order to improve project performance. In addition, they could recognize that many opportunities can be internal and not only related to the client, which is also important as it provides a wider perspective for the person or team looking for opportunities, and more opportunities can be identified as a result. Finally, they claimed that such

workshops increase awareness on opportunity management. Therefore, conducting more opportunity sessions can drive the organization to adopt a risk approach that takes both types of risks into account, making this approach part of the organization's culture.

5.5 Conclusions

The purpose of chapter 5 was to answer the third sub-research question:

SQ 3: How can complexities be exploited to find opportunities?

After clearly setting the scene to capture opportunities in infrastructure projects (assessing complexity, defining project objectives etc.), it can be concluded that, to exploit complexities, different possibilities can be considered. Also, it is important to note that the same complexity element can be exploited in different ways. Before opting for a possibility, an assessment of the internal strengths and weaknesses of the project team or organization with regard to the project at hand should be conducted. Also, the weaknesses that lie in the context of the project but outside the project team's environment should be identified. The resources that can be deployed in the project should be determined. A final consideration is related to the scope of the project. Therefore, it is essential to have a clear understanding of the project's scope and goals of the relevant stakeholders. Taking all these considerations into account, five possibilities were deduced:

1. Exploiting complexities using internal strengths.
2. Exploiting complexities by taking advantage of external weaknesses combined with internal strengths.
3. Exploiting complexities by aiming to turn internal weaknesses to strengths.
4. Exploiting complexities through a better use of available resources.
5. Exploiting complexities by increasing the scope of the project.

Using the findings from chapters 3, 4 and 5, the Complexity-Driven Opportunity Identification Technique (CDOIT) and the final roadmap which constitute the final result of this study are developed in chapter 6.

6. Roadmap for Opportunity Identification in Complex Infrastructure Projects

The aim of this chapter is to provide suggestions regarding the identification of opportunities in complex infrastructure projects by providing a roadmap that is designed to fit the purpose of this research. This is achieved by taking the findings collected from the literature study, the interviews and the experts' workshop. Also, a special technique (CDOIT) used to identify opportunities from the complexity elements is developed and integrated in the final roadmap. The goal and the inputs of the roadmap are presented in detail in Section 6.1. Next, the CDOIT is elaborated in Section 6.2 and all the components of the roadmap are described in Section 6.3. The results are discussed and evaluated in Section 6.4 and conclusions are drawn in Section 6.5.

6.1 Goal and inputs of the roadmap

The main goal of the roadmap is to suggest an effective approach for the identification of opportunities in infrastructure projects by also taking into account the complexity of the projects. This way, the roadmap will aid in bridging the identified gap between what is actually being done (current approach) for the identification of opportunities and what is recommended (desired approach), as represented in Figure 19.

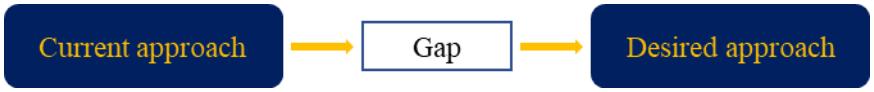

Figure 19: Approach for improving opportunity identification

The proposed roadmap in this chapter is in fact a combination of inputs gathered from all the steps conducted previously in this study. Not all findings from each part of this research will directly serve as input for the roadmap, since many findings from one section already served as inputs for the one that followed. For instance, some findings generated from the literature study served as inputs for the interviews and the workshop. Also, findings from the interviews served as inputs for the workshop.

The current approach for the identification of opportunities was studied through the interviews. The gaps were then identified by comparing the findings from the interviews with the theoretical findings in the literature. By filling these gaps, the workshop was designed with the purpose of particularly looking at the identification of opportunities that result from the complexity elements in a project. From the workshop, insights were deduced into how complexities can be exploited. Also, the workshop served as a pilot to prove that by a) providing a clear definition of opportunity as a positive risk, b) determining the project objectives from the beginning, c) using a special technique to identify opportunities, and d) collaborating with each other, the Project Manager and his team can actually succeed in identifying opportunities.

The inputs for the roadmap are presented in Figure 20. The five gaps identified in the interviews based on a systematic discussion of the results according to the coding frame in Figure 15: Interviews' analysis-Coding frame are summarized in four gaps as illustrated in Figure 20.

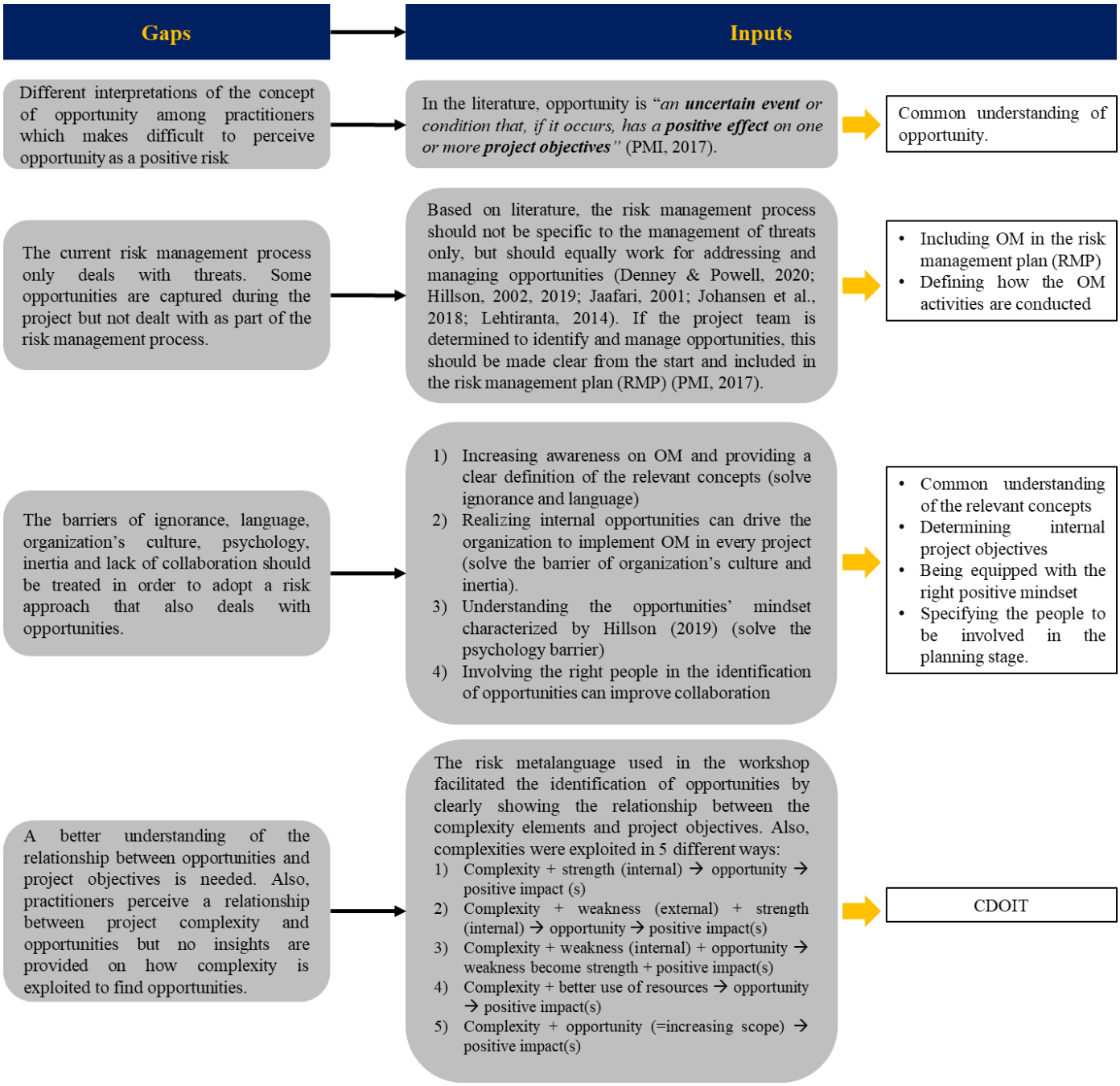

Figure 20: Gaps identified and inputs for final roadmap

The inputs provided above are incorporated in a roadmap for the identification of opportunities in complex infrastructure projects. One of the inputs of this roadmap is the technique specifically used to exploit complexities and capture the opportunities that emerge as a result. The next section elaborates more on this technique.

6.2 The Complexity-Driven Opportunity Identification Technique (CDOIT)

The Complexity-Driven Opportunity Identification Technique (CDOIT) is developed by combining 2 major findings in this research. These findings emerged as a result of the experts' workshop.

In preparation for the workshop, a technique was developed in a first attempt at exploiting complexities. This technique was based on the risk metalanguage. Its main aim was to facilitate the identification of opportunities by illustrating the relationship between the risk (opportunity), its cause (complexity element) and its consequence (positive impact on objectives). However, this technique did not provide guidelines or directions on how an individual can exploit the complexity elements. The participants were just invited to freely brainstorm about opportunities related to the complexity elements of technical, organizational and external categories. This led to the identification of 26 opportunities in total among the four participants. Moreover, while reflecting on their experience in the final part of the workshop, the Project Managers claimed that, the way in which the method connected the different elements (complexity-opportunity-project objectives), made it actually easier for them to identify the opportunities. This method already took into account some of the gaps that were identified during the interviews. Also, it was proven to be effective based on the expert's feedback. Therefore, the risk metalanguage which considers complexity as a fact, opportunity as a risk and the positive impact on objective(s) will form the basis of the CDOIT:

As a result of <**complexity element *x***>,

<**opportunity**> may occur,

which would lead to <**one or more positive effects on objective(s**)>.

The second major finding was deduced based on the observations of 'what happened' during the workshop while identifying opportunities, or in other terms, how the participants were able to exploit the complexities. Five options were identified, which require some key elements to be determined. These include the internal strengths and weaknesses of the project team or organization, the external weaknesses (weaknesses that lie outside the organizations' environment and the project team, for instance related to the client, the contractor or to the contract), the available resources in the company that could benefit the project or get some benefits as a result of being deployed in the project, and the project's scope specifics with all the goals and requirements of the involved stakeholders.

Aside from the two main findings, other considerations that are integrated in the CDOIT include:

1) The assessment of project complexity using the TOE framework. Due to the subjective nature of complexity, it is advisable to score the complexity elements by the project team and not just by the Project Manager. This way, a better perception of the complexity of the project can be achieved and the focus will be on exploiting the most critical elements. These usually have a high potential of affecting the project objectives in a negative way. Seizing the opportunities that complexities offer may reduce their negative impact.
2) The dynamic character of complexity and the fact that opportunities can be found in all project phases. To account for these, it is essential to re-assess the project complexity using the TOE framework at least at the beginning of every phase. This might result in different opportunities which were not perceived in previous phases.

The CDOIT, which can be applied during an opportunities' session, is presented in Figure 21:

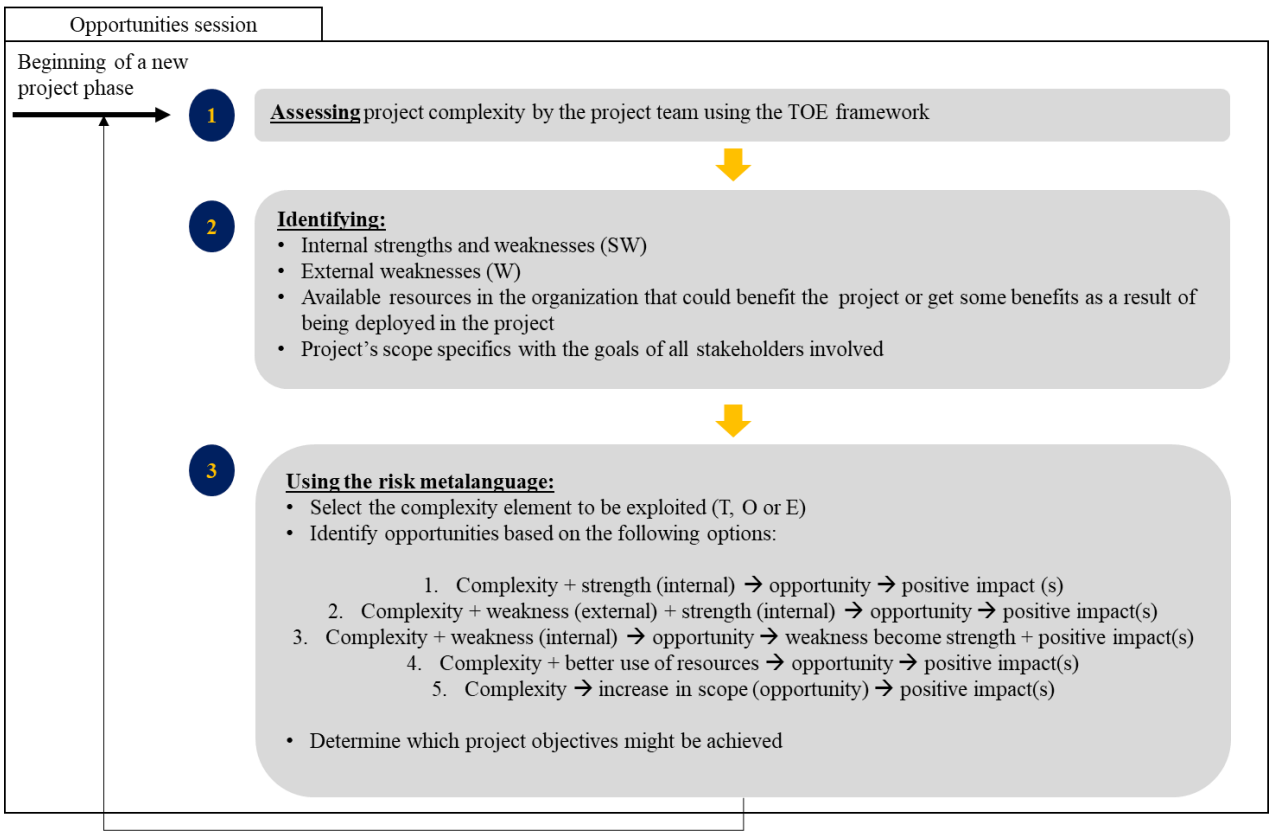

Figure 21: The CDOIT

The CDOIT is integrated in the final roadmap. However, it is important to note that complexities are just one of the sources of opportunities. In fact, any source of uncertainties can be a source of opportunities. Therefore, other techniques could be used (see Appendix G: Opportunity Identification Techniques) when identifying opportunities not related to the complexity elements. The final roadmap is described in the next section.

6.3 Description of the roadmap

The final roadmap for opportunity identification in complex infrastructure project consists of 3 major elements: 1) Setup for effective opportunity management taking into account seven stimulating factors (Section 6.3.1), 2) Opportunity identification session (Section 6.3.2) and 3) Re-organization of an opportunity session (Section 6.3.3). These elements are presented in Figure 22.

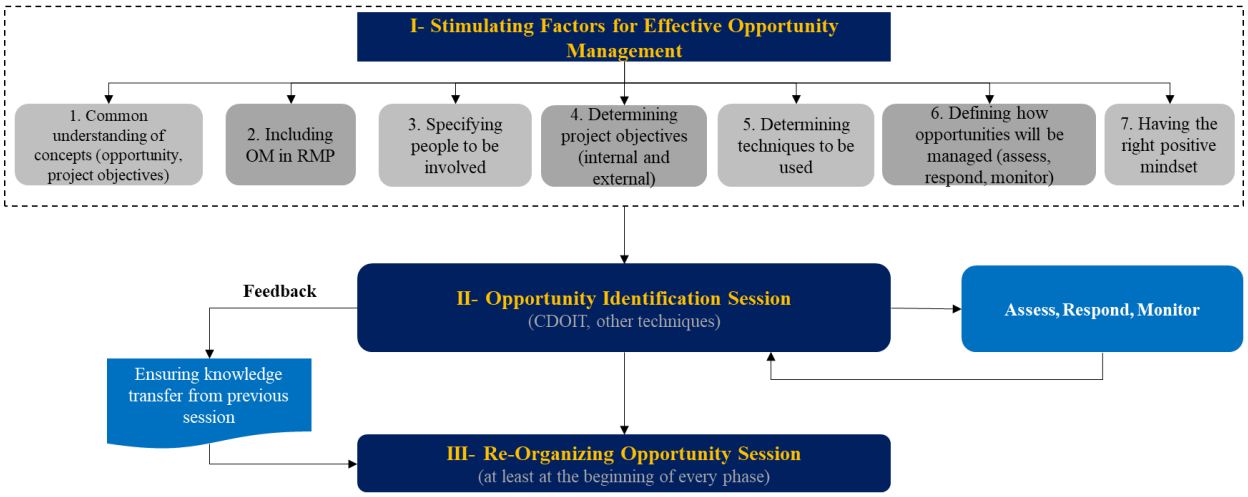

Figure 22: Roadmap for effective implementation of opportunity management in complex infrastructure projects

6.3.1 Stimulating factors for effective opportunity management

Associating the findings from the interviews with the theoretical background on opportunity management in the literature as discussed in Section 6.1, seven stimulating factors were generated. These provide a firm foundation and serve as a prerequisite to establish an effective approach for opportunity identification and management. The 7 factors are:

1. Common understanding of concepts (opportunity and project objectives): All members of the project team should have a common risk language and be aware of the concept of opportunity as a positive risk. Also, they should recognize that objectives can also be internal and benefit the team or the organization.

2. Including OM in the RMP: If the project team is determined to adopting a risk approach that deals with both the downside and upside aspects, it should be clearly expressed in the risk management plan (RMP), and consequently in the project management plan (PMP).

3. Specifying the people to be involved: The individuals in the project who can potentially contribute to the identification of opportunities should be determined from the beginning. These can be individuals from different disciplines. This will also increase collaboration between the disciplines and stimulate creative thinking. For instance, while looking for external opportunities related to the stakeholders, it is important to include the Process Managers, since they are more involved with the stakeholders and can better understand the uncertainties in their environment.

4. Determining project objectives (internal and external): Not all risks in the project matter. The project team should determine from the beginning what objectives matter to them and what they wish to achieve. These could be internal objectives, associated with the benefit of the project team or organization, or external, associated with the client or other relevant stakeholders. It is important to note here that, even for internal opportunities, the realized benefits could also reflect on the client. For instance, working more efficiently due to the implementation of new methods, could also mean delivering earlier to the client as a result. Examples of project objectives are provided in Appendix F: Results of the Workshop in the MIRO Dashboard (these are the objectives identified in the workshop session).

5. Determining techniques to be used: Some techniques are developed to identify threats and opportunities while others are tailored to look specifically for opportunities. These can help the participants while brainstorming during the identification of opportunities, instead of just brainstorming without a clear guide or direction. The identification techniques that can be used are listed in Appendix G: Opportunity Identification Techniques. The CDOIT can be used to find the opportunities that complexities offer. Other sources of opportunities exist and thus different techniques can also be used. These should be specified from the start.

6. Defining how the opportunities will be managed: This research only deals with the first two stages of opportunity management. However, it is important to keep in mind that opportunities are treated as risks, and hence they should be managed after being identified. This include assessing the opportunities (evaluate and prioritize), responding to the opportunities (exploit, enhance, share and accept), and monitoring them throughout the project. These activities should also be defined from the start like for the management of threats.

7. Having the right positive mindset: Since individuals are used to only or mainly identify threats, a shift in their mindset is needed for the identification of opportunities. This mindset has some defined characteristics as suggested by Hillson (2019): Realism, thinking positive, being curious, being alert and ready, "can do" attitude and visualizing success (see explanation in Section 3.2.5).

6.3.2 Opportunity identification session

Threats and opportunities are included in the same process: the risk management process. They can also be identified in one common session. However, this study suggests having a separate session for opportunities since practitioners are not used to the identification of these positive risks, and a different mindset, different techniques, or even different people are needed for this purpose. Furthermore, since this research deals with complex infrastructure projects, the proposed technique (CDOIT) can be used during this session, in an attempt to exploit the complexity of the project. For this technique, the project objectives determined from the beginning (stimulating factor 4) should be considered.

6.3.3 Re-organizing opportunity session

Opportunities vary throughout the project lifecycle. They vary in size and in nature. Complexity is also dynamic and changes during the project. As the project proceeds, different opportunities may be identified as a result. Hence, an opportunity session should be re-organized, at least at the beginning of every phase. Also, it is very important to provide feedback at the end of every session, mainly because practitioners are less familiar with opportunity sessions than threat sessions. This feedback will provide the opportunity to improve the identification process and serve as food for future improvements. Also, information related to the previously identified opportunities should be transferred to the next session, as some opportunities may not be realized yet and still need to be monitored, others may change, and new opportunities might arise as a result of previous opportunities.

6.4 Discussion and evaluation

The proposed roadmap was developed with the aim of filling the gaps identified in the current approach for opportunity management in practice and establishing a new desired approach. If this roadmap is to be used by practitioners, it should satisfy their needs and requirements. Therefore, this roadmap should at least take into account the 6 drivers and 6 suggestions for improvement that the practitioners provided during the interviews. These, together, constitute 12 criteria. A check is performed to see how these criteria are addressed, whether explicitly or implicitly, in the components of the roadmap, as seen in Table 12.

Evaluation Criteria	Roadmap Components										
	Stimulating factors							Opportunity Session	Re-organizing Opportunity Session	Knowledge transfer + feedback	Assess, Respond, Monitor
	Common understanding of concepts	Include OM in the RMP	Specify the people to be involved	Determine project objectives	Determine technqiues to be used	Define how opportunities will be managed	Have the right positive mindset				
Drivers											
Increase the chances of project's success: Reduce time, reduce cost and improve quality	✓			✓							
An easy process for OM	✓										
Seeing the benefits and added value of opportunities				✓				✓	✓	✓	
Project team's satisfaction	✓			✓							
Stakeholder's satisfaction	✓			✓							
The client asking for OM	✓			✓							
Improvements											
Increasing awarness on OM	✓							✓	✓	✓	
Having opportunities sessions							✓	✓	✓		
Having a structured process for OM		✓	✓	✓	✓	✓		✓	✓	✓	✓
Improving collaboration between disciplines			✓					✓	✓		
Including OM in the proposal		✓									
Having a tool to visualize the uncertainties in the project											

Table 12: Evaluation criteria for the final roadmap

An explanation on how each criterion is considered is explained here:

1) Increasing the chances of project's success: An opportunity, if realized, will have a positive impact on one or more project objectives. Understanding this definition of opportunity as a risk and its relation to project objectives, will make it easier to the project team to determine the objectives that they want to achieve to increase the chances of success. The roadmap suggests identifying these objectives from the beginning to make sure that the identified opportunities will actually fulfill the team's objectives.
2) An easy process for OM: It was already argued in this study that no new process is needed to identify and manage opportunities. Opportunities are also risks and should be included in the same process as risk management. The roadmap suggests having a common understanding of the concepts, such as opportunity. Once this definition is clear, practitioners will use the same process and have the same approach for threats and opportunities.

3) Seeing the benefits and added value of opportunities: Determining the project objectives from the beginning, make the team sets the benefits they want to see in the project, rather than wait for some benefits to be achieved. Also, by organizing opportunity sessions several times during the project, providing feedback and ensuring knowledge transfer from one session to the other, as the roadmap suggests, the team would harvest the benefits of opportunities over time (if these are well managed). It should be a continuous and iterative process, because the benefits and added value will only be seen through evidence which builds over time.
4) Project team's and stakeholder's satisfaction: These are actually project objectives that the team can achieve. So, practitioners should understand the relationship between opportunities and project objectives, and determine these objectives from the beginning of the project. This is clearly highlighted in the roadmap.
5) The client asking for OM: The definition of opportunity as a risk and how it can be linked to a project objective should also be made clear for the client. The client should know that opportunities, if realized, will have a positive impact on the performance of the project, by making the work faster for instance. Also, opportunities can be internal and external. The internal opportunities mainly benefit the project team but also reflect on the client. For instance, having a more efficient working process will mean delivering the work earlier. The external opportunities are identified based on the objectives of the client or the stakeholders involved. Once these opportunities are realized and the client starts recognizing the benefits, he would start asking for conducting risk management that takes both threats and opportunities into account.
6) Increasing awareness on OM: This can be achieved through workshops or training sessions by providing the definitions of the relevant concepts needed to conduct opportunity management. Also, awareness can develop by organizing many opportunity sessions over time and providing feedback for improvement. This criterion is also covered by proposed roadmap.
7) Having opportunities sessions: This constitutes a main component of the roadmap. Also, having a separate session from threats and only for opportunities require having the 'right' positive mindset to only look for what positive events could happen.
8) Having a structured process: As discussed earlier, opportunity management should follow the same process as risk management. This roadmap also provides some key steps to be done for the successful identification of opportunities. These are: 1) Including OM in the RMP in which the teams determine the people to be involved, the objectives and the techniques to be used and 2) Organizing opportunity sessions continuously throughout the project.
9) Improving collaboration between disciplines: This is achieved by specifying the people to be involved and having those people in the same opportunity session, as shown in the roadmap.
10) Including OM in the proposal: Including OM in the RMP as proposed in the roadmap means including it also in the project management plan and consequently in the proposal.
11) Having a tool to visualize the uncertainties in the project: This is the only criterion not taken into account in the roadmap, and can serve as food for future research, since the source of any risk, whether threat or opportunity, is uncertainty. Identifying these are very important to identify more opportunities.

After checking the content of the proposed roadmap which also includes the CDOIT, these were also evaluated by 3 Project Managers at Witteveen+Bos who participated in the interviewees and the workshop session. They have more than 15 years of experience with complex infrastructure projects. A feedback session of 30 minutes was conducted with every Project Manager. The focus was on the practicality of the

technique and roadmap and some criteria were set in advance to validate them. These, along with the comments and suggestions of the Project Managers are presented in Appendix H.

For the CDOIT, the Project Managers claimed that the technique is understandable but few clarifications are needed with respect to the second step. This step involves identifying strengths and weaknesses. They all claimed that the definition of a strength and a weakness should be clear, and also how these can be identified should be explained. This can be part of future research, as this step is crucial in helping the project team exploiting the complexities. Also, they declared that the technique provides a clear goal and the steps to follow are logical. The final criterion was to see if the technique is appropriate to use in practice by implementing it in complex infrastructure projects. One Project Manager suggested having an implementation guideline that clearly shows the steps needed to use the technique. Hence, an implementation guideline for the CDOIT was developed and is presented in Appendix I: Implementation Guideline for the CDOITAnother Project Manager find it necessary to know the amount of time needed to properly use the technique and the costs associated with it, since a session needs to be scheduled for this purpose. This can also be part of future research by piloting the technique on different projects and studying the time and cost associated with its implementation. Also, this will help in proving the effectiveness of the CDOIT. The third Project Manager suggested implementing the technique before starting the project, to find opportunities and try to reduce the impact of the complexity of the project, He argues that this is important to show the benefits to the client, as this might help in acquiring the project. A downside is that it would be difficult to approach the external stakeholders in the project and know all their goals and requirements, which is essential especially when exploiting the external complexities.

For the proposed roadmap, the Project Managers claimed that it is understandable but one of them argued that the connection between the moment in the project timeline and the types of opportunities is missing. A possibility could be to add it as an 8th stimulating factor in the first block on how to setup opportunity management or it can be taken into account with the determination of the project objectives, as these might change with time during the project. Next, all Project Managers confirmed that the roadmap provides a clear goal of planning how opportunities can be identified and managed in complex infrastructure projects. Finally, the Project Managers claimed that the roadmap is appropriate to follow, but some further considerations are needed. One suggested having also an implementation guideline for the roadmap. This was developed and is presented in Appendix J: Implementation guideline for Another Project Manager proposed extending the roadmap by focusing more on the opportunity session, and also how the opportunities are managed and realized (the decision process on how to go for an opportunity or not). The scope of this research deals with the first two stages of opportunity management which are the planning and identification phase, and the suggestion to extend the roadmap can be part of future research, which can also help in looking at how the outcome of the CDOIT should be dealt with. The third Project Manager recommended adding an evaluation part after the opportunities are realized to see what the effect they actually had and whether they met the expectations of the project team. Also, he added that it's important to consider the opportunities from previous projects and share then in the opportunity session in the new project. A suggestion would be to have a database for opportunities as these can serve as insights for future projects. This will be further elaborated in the recommendations in Section 7.3.

6.5 Conclusions

The purpose of chapter 6 was to answer the fourth sub-research question:

SQ 4: What procedure can help practitioners in effectively implementing opportunity management in complex infrastructure projects?

Identifying opportunities that can result from the complexity elements in large infrastructure projects requires a procedure that takes some considerations into account. This includes: 1) having a common understanding of the concept of opportunity as a positive risk and how it is linked to project objectives which can be internal and external, 2) specifying the project objectives that the team wants to achieve, 3) including opportunity management from the start in the risk management plan (RMP), 4) determining the people who should be involved in identifying opportunities. 5) determining the techniques that can facilitate the identification of opportunities, 6) defining how the activities for the assessment, response and monitoring stage will be performed, and 7) being equipped with the right positive mindset. Also, although opportunities and threats should be dealt with in the same process, this study suggests having a separate session for opportunities while identifying risks. Such sessions should be re-organized at least at the beginning of every phase since infrastructure projects usually spans over a long period of time and the complexities and opportunities change throughout the project.

In the opportunity sessions, a technique to identify opportunities from the complexity elements was developed: the Complexity-Driven Opportunity Identification Technique (CDOIT). This technique is composed of 3 major steps: Start by assessing the complexity of the project by various members of the project team using the TOE framework developed by Bosch-Rekveldt et al (2011). Next, identify some key features that help in exploiting the most critical complexity elements in the project such as the internal strengths and weaknesses, the external weaknesses, the available resources, and the project's scope with all the requirements and goals of stakeholders. Next, using the risk metalanguage, select a complexity element (fact), identify an opportunity (uncertain event or condition) that result from this element by considering five options: 1) using internal strengths, 2) taking advantage of external weaknesses (combined with internal strengths, 3) aiming to turn internal weaknesses into strengths, 4) a better use of the available resources, and 5) increasing the scope of the project. Next, determine which project objectives might be achieved as a result (consequence).

Finally, the proposed roadmap was checked based on 12 criteria deduced from the interviews. Every component of the roadmap was checked and the roadmap turned to be effective. Then, validation of the CDOIT and roadmap was conducted with 3 Project Managers to further assess the effectiveness of the results. Overall, both, the technique and the roadmap are considered understandable, provide a clear goal, and are appropriate to follow in practice. Some suggestions were proposed which will be taken into account in the recommendations for future work in Section 7.3.Recommendations for future work

7. Limitations, Conclusions and Recommendations

In this final chapter, the limitations of the research are discussed in Section 7.1, and the overall conclusions of the research are highlighted in Section 7.2. Finally, recommendations for the application of the results in practice and recommendations for further research are provided in Section 7.3.

7.1 Research limitations

The methodology used in this research provided many insights into the opportunity management process and the relationship between opportunities and complexity elements. However, the research has some limitations which are listed as follows:

- All the participants in the interviews and in the experts' workshop were employees of Witteveen+Bos, which is an engineering consultancy firm. Therefore, conducting similar interviews and workshops with practitioners from a contractor's or client's side, or even another consultancy firm, could result in different findings since they might have different perspectives. The results of this research might need some additional considerations to be able to apply them in a different organization, if any new gap is identified that was not already taken into account in the current roadmap or technique.

- The results in the workshop were based on an assessment of project complexity in four infrastructure projects. The focus was on the complexity elements of the TOE framework that were considered most critical according to the participants. The five possibilities deduced on how complexities are exploited are based on exploiting these complexity elements which resulted in 26 opportunities. Some complexity elements resulted in more than one opportunity. The participants in the workshop were able to exploit, together, 6 technical, 5 organizational and 5 external elements. So, in total, 16 elements out of the 47 elements of the TOE framework were actually exploited. This constitutes a limitation, as more possibilities (other than the five deduced) into how complexities can be exploited might result while trying to exploit the other complexity elements that were not considered (31 elements) in the same projects or even the same elements but in other infrastructure projects.

- The CDOIT and the proposed roadmap were not tested in practice to check or prove their effectiveness. The results were checked based on certain criteria from the findings of the interviews and by an expert from the same sample of interviewees in the research. Hence, it cannot be concluded that the proposed suggestions, such as the stimulating factors for effective implementation of opportunity management, are enough when trying to apply them in a different organization.

7.2 Conclusions

This study focused on understanding the concept of opportunity in complex infrastructure projects with the goal of developing an effective approach to identify opportunities in such projects while taking their complexity into account, in an attempt to exploit this complexity. To achieve the research objective, the research question was formulated as follows:

How can Project Managers take the inherent complexities of large infrastructure projects into account in the opportunity management process and turn their unexploited potential into opportunities?

To answer the main research question, 4 sub-questions were developed which divided this study into 3 main parts. 1) First, a review of the relevant concepts in the literature was conducted, such as project complexity, uncertainty, risk, opportunity and opportunity management. The relationship between these concepts was illustrated. 2) To understand the current approach of identifying opportunities in practice, interviews with practitioners in the field of infrastructure were conducted. The findings from the interviews were compared with the findings in the literature to identify the gaps hindering the adoption of an effective approach for opportunities. 3) After that, the aim was to look into the possibility of exploiting complexities and seizing the opportunities they can offer. This was achieved in a workshop setting, where four Project Managers collaborated to identify opportunities that result from the complexity elements of the TOE framework developed by Bosch-Rekveldt et al. (2011). The workshop was prepared by taking the gaps identified in the interviews. The results were then analyzed and insights into how complexities could be exploited were deduced.

As a result, a technique that aims particularly at identifying the opportunities that emerge from the complexities was developed: the Complexity-Driven Opportunity Identification Technique (CDOIT). And finally, this technique was integrated in a roadmap that was proposed to effectively implement opportunity management in infrastructure projects.

To conclude this study, the 4 sub-research questions and the main research question are answered:

SQ 1: What is the current state of opportunity management in the literature and its relationship to project complexity?

Opportunity is an "*uncertain event or condition that, if it occurs, has a positive impact on one or more project objectives*". Given this definition, opportunity is considered as a risk, and researchers claim that the management of opportunities should be included in the same process as risk management. No new process is needed. Some modifications or additional considerations are needed at some stages of the process to take the opportunities into account. Despite that, researchers argue that opportunity management is still not implemented by practitioners. Some barriers for this reluctance are found in the literature, such as 'ignorance', 'language', 'culture', 'psychology' 'inertia' and the lack of the 'right' positive mindset for opportunities. Consequently, researchers continue to stress on the importance of opportunity management as they consider it one of the factors that can contribute to the success of a project through a better achievement of the project objectives.

The increasing interest of researchers with regard to opportunity management comes from the increasing need to deliver more successful projects. This is because projects are becoming more and more complex, and a better performance is required to prevent failure. From the literature, it was also proven that complexity is not only a source of threats, but can also be a source of opportunities. Threats and opportunities from one side, and complexity from the other are in fact related through the concept of uncertainty. Since uncertainty is a driver and a consequence of complexity, and since uncertainty is a source of positive and negative risks, then complexity is a source of threats and opportunities. This research deals with the upside of risk: Exploiting complexity. It is also clear from the literature that the opportunity management process should be tailored to the complexity of the project at hand. As such, there is a need to understand how this can be achieved by looking more in detail at the relationship between the complexity elements in a project and the possible opportunities that might arise as a result.

SQ 2: What is the current state of opportunity management in practice?

The opportunity management process is currently not effectively implemented, or even not implemented at all. Some opportunities are identified during the project but without a clear and structured approach in place.

This is mainly attributed to a lack of understanding of the concept of opportunity as a positive risk, and that opportunity management should be treated in the same process as risk management. Practitioners have a threat-focused approach to risk and don't actually address opportunities. They consider that threats must be mitigated but opportunities are optional and nice to have. Over the years, this attitude towards risk became part of the organization's culture. As a consequence, it is translated in the behavior of the individuals conducting risk management. Additionally, it is clear that the lack of understanding of the relationship between opportunities and project objectives, and that these can also be internal and benefit the project team is also a major reason for currently not chasing opportunities.

It was also concluded that the current state of opportunity management in practice can be improved by first increasing awareness on the topic and stressing on the added value it can have in a project. Also, practitioners suggest organizing opportunities sessions where people from different disciplines can collaborate together to identify opportunities, by following a structured and clear process and having the tools to visualize the uncertainties in the project.

SQ 3: How can complexities be exploited to find opportunities?

After an assessment of the complexity of a project, the most critical complexity elements can be exploited by the project team in different ways, such as by: using internal strengths, taking advantage of external weaknesses combined with internal strengths, aiming to turn internal weaknesses into strengths, a better use of the available resources, and increasing the scope of the project.

This requires an assessment of the internal strengths and weaknesses of the project team or organization with regard to the project at hand, and the weaknesses that lie in the context of the project but outside the project team's environment. The available resources that can be deployed in the project should also be determined. Also, it is essential to have a clear understanding of the project's scope and goals of the relevant stakeholders. Equipped with these tools, the project team can try to exploit the complexities in the project.

Also, since complexity is dynamic and changes through the project, it is important to re-assess project complexity, at least at the beginning of every phase. Opportunities also change as the project proceeds. As a result, different opportunities can be identified from the complexity elements.

SQ 4: What procedure can help practitioners in effectively implementing opportunity management in complex infrastructure projects?

A roadmap consisting of three main elements is proposed to help practitioners in effectively implementing opportunity management in complex infrastructure projects: First, seven stimulating factors are considered essential to effectively set opportunity management in complex infrastructure projects. These can be seen as pre-requisite for identifying and managing opportunities. These include: 1) having a common understanding of the concept of opportunity as a positive risk and how it is linked to project objectives which can be internal and external. 2) Specifying the project objectives that the team wants to achieve. 3) Including opportunity management from the start in the risk management plan (RMP). 4) Determining the people who should be involved in identifying opportunities. 5) Determining the techniques that can facilitate the identification of opportunities. 6) Defining how the activities for the assessment, response and monitoring stage will be performed. 7) Being equipped with the right positive mindset. Also, although opportunities and threats should be dealt with in the same process, this study suggests having a separate session for opportunities while identifying risks. Such sessions should be re-organized at least at the beginning of every phase since infrastructure projects usually spans over a long period of time and

opportunities might change throughout the project. Secondly, this research suggests organizing a separate session for opportunities from threats. The CDOIT and other techniques can be used in this session to help the people involved in identifying opportunities. The CDOIT is a technique that particularly help in identifying opportunities from the complexity elements in the project, in an attempt to exploit such complexities. Lastly opportunity sessions should be re-organized at least at the beginning of every phase since infrastructure projects usually spans over a long period of time and the complexity of the project along with the opportunities might vary or change throughout the project.

Finally, through the answers of the 4 sub-research questions, the main research question can be answered:

How can Project Managers take the inherent complexities of large infrastructure projects into account in the opportunity management process and turn their unexploited potential into opportunities?

Identifying opportunities that can result from the complexity elements in large infrastructure projects requires having a strong foundation for opportunity management first. This foundation would serve as a catalyst for identifying opportunities. This study suggests some requirements that could be followed by the company, the Project Manager and the project team to have an effective implementation of opportunity management and better identify opportunities as a result. So, it is necessary to have a common understanding of the concept of opportunity as a positive risk and how it is linked to project objectives which can be internal and external. These objectives should be clearly stated from the beginning of the project, so that individuals know what opportunities to look for in order to achieve them. After all, not all risks matter. Also, if the team is determined to identify and manage opportunities, and even more, the opportunities that result from the complexity of the project, this should be clear from the start and included in the risk management plan (RMP). Another important factor is to determine the people who should be involved in identifying opportunities by taking into account the importance of collaboration between the different disciplines, as uncertainties are everywhere in the project. Furthermore, the techniques that can facilitate the identification of opportunities should be determined. Of course, after their identification, opportunities should be assessed, handled and monitored. Hence, this requires defining from the start how these activities will be conducted during the project. Last but not least, individuals looking for opportunities should be equipped with the right positive mindset. This will help in switching from a threat-focused mindset to a mindset that focuses on the positive side of risk. Therefore, although opportunities and threats should be dealt with in the same process, this study suggests having a separate session for the identification of opportunities.

With the aforementioned stimulating factors for the identification of opportunities, opportunities that emerge as a result of exploiting the complexity elements in a project can be effectively identified. This can be achieved in three steps according to this study: First, the project team has to assess the complexity of the project using the TOE framework and determine the complexity elements that have a high potential of affecting the project. This step should be repeated at least at the beginning of every project phase to account for the dynamic character of complexity. Then, this study suggests five possibilities into how individuals can turn the unexploited potential of complexities into opportunities:

1. Exploiting complexities using internal strengths.
2. Exploiting complexities by taking advantage of external weaknesses combined with internal strengths.
3. Exploiting complexities by aiming to turn internal weaknesses to strengths.
4. Exploiting complexities through a better use of available resources.
5. Exploiting complexities by increasing the scope of the project.

These consider looking into the internal strengths and weaknesses of the company or project team and the weaknesses that lie outside their environment. Other considerations to exploit complexities require being aware of the available resources in the company that could benefit the project or get some benefits as a result of being deployed in the project. A final consideration deduced in this study with regard to exploiting complexities is looking carefully at the project's scope and recognizing the goals and interests of all the stakeholders involved. Other possibilities on how complexities can be exploited might exist. This constitutes a limitation of this research which is considered a first attempt at exploiting complexity. Therefore, it is important to provide feedback and ensure transfer of knowledge from one session to the other, as new insights might be discovered that can help in better identifying opportunities. An open and flexible approach is needed for continuous improvement. Nevertheless, being aware of the complexities in the project and integrating it more consistently in the opportunity identification process of project risk management is an important step in better managing the upside of risk, irrespective of the technique to be used.

7.3 Recommendations for future work

Multiple recommendations can be provided from this research. These are divided in two parts: practical recommendations in Section 7.3.1 and recommendations for further research in Section 7.3.2.

7.3.1 Recommendations for practice

- To check the effectiveness of the proposed roadmap and the CDOIT, it is recommended to start using and applying them on several infrastructure projects and continuously provide feedback to improve them and ensure full maturation of the suggested approach and technique.
- On the organizational level, more support by top management should be provided to implement opportunity management on large and complex infrastructure projects. This can be achieved by increasing awareness on opportunity management through training and workshop sessions to reach a common risk language (one that takes the downside and upside of risk into account). Over time, this might help individuals in changing their threat-focused approach to one that also look for opportunities. This perception would become part of the organization's culture and opportunity management could be seen as something regular to implement on every project.
- During the interviews conducted with employees at Witteveen+Bos, it was found that the tight project's budget constitutes a constraint to organize opportunities sessions. Hence, it is important for the organization to also show the benefits of opportunity management to the client (For instance, Rijkwaterstraat), since opportunities can also have a direct positive impact on the client, and find a solution for the budget problem.
- In complex projects there are always several moments of chaos and deadline pressure. At these moments an opportunity session can be helpful to improve the work and get back on track to meet the deadlines.
- It was also observed in the interviews, that opportunities that are identified were not properly chased and left unmanaged. The reason for this is that the employees were always busy with their work and solving problem or mitigating the risks. No one was assigned to manage the opportunities. Since, opportunities are managed in the same process as risk management, the Risk Manager should be responsible to coordinate all the activities related to opportunity management, However, if the company would want invest more in opportunity management as a result of seeing its benefits, perhaps an Opportunity Manager can be assigned whose sole purpose is to focus on effectively implementing the process and managing the opportunities identified by the project teams.
- It is also recommended to create a database for opportunities, in which the identified opportunities in projects are listed and can serve as evidence and reference for future projects. This database can

also provide the project teams with information on the sources of opportunities and which can be encountered in new projects. The availability of information regarding opportunities would improve the opportunity management practice by helping in identifying more opportunities. Similarly, it is recommended to have a database of the complexity assessments conducted on the infrastructure projects. This way, more insights can be discovered by identifying patterns or relationships between the recurring complexity elements and opportunities.

7.3.2 Recommendations for further research

- The scope of this research is limited to the planning and identification phase of risk management. Evaluating, prioritizing, responding and monitoring the opportunities are not taken into account. Therefore, this study should be extended and look at how the outcome of the CDOIT should be dealt with.
- It is known that every risk may introduce new risks in the project. Hence, the identified opportunities can also introduce new risks, whether more positive risks or negative risks (the opportunity to increase the scope of the project for instance). Sometimes, the new induced risks can be bigger than the opportunity itself. Studying the emergence of secondary risks as a result of exploiting an opportunity is therefore important to consider for future research.
- One of the limitations of the research is that the CDOIT was developed based on an attempt at exploiting 16 complexity elements out of the 47 elements in the TOE framework. As result, five possibilities on how complexities can be exploited were deduced. However, more possibilities might exist while trying to exploit different complexity elements, or even the same elements but in different projects. This research constitutes a first attempt at capturing the positive risks from the complexities, and further research is recommended to discover new insights on how complexity can be exploited and further extend the CDOIT.
- Also, the five possibilities suggested in the CDOIT require the consideration of some elements, such as the internal strengths and weaknesses of the project team or organization and the external weaknesses that lie outside their environment. The research could be extended on how can these be determined with regard to the project at hand.
- It was clear from this study that many improvements need to be made in order to help practitioners in switching from a threat-focused risk approach to one that takes threats and opportunities into account. The main question that arises here is how much are individuals actually willing to change their approach. This study could be extended with literature on barriers to organizational change and see how top management can have an influence in overcoming those barriers.
- A limitation of this research is that all the inputs came from participants of an engineering consultancy firm. This research could also be extended to include insights from the contractor or client side since they have different perspectives regarding opportunities. Exploring their practice could lead to other or additional results related to how can the current approach for identifying and managing opportunities be improved, or even possibilities into how complexities can be exploited, hence enriching the results of the CDOIT and the final roadmap.

Reflection

As a final note, I would like to reflect back on this challenging, yet exciting journey.

Over the past months, I was working with ambition and motivation on the topic of opportunity management, mainly for 2 reasons: First, I am a very optimistic person who always like to look at the positive side of things, no matter how bad the situation is, and try to capture the opportunities amidst all the chaos and problems around. I actually believe that "opportunities are everywhere… the key is to have the vision to see them" and the will to chase them. In this sense, I was very curious after taking the course "Dynamic Control of Projects" (which explores the concept of complexity and stresses on how it should be managed to reduce its negative impact on the project), to see how one can take advantage of this complexity and turn it into something positive. Hence, amidst all the complexities in large infrastructure projects, I wanted to prove in this study that some opportunities can be found. My conclusion is the following: if the project team is equipped with the right tools to identify opportunities and has the will to chase them, there is no reason not to do it, full stop. A second reason that incentivized me to work with passion on this assignment was the high interest of the people at Witteveen+Bos in the topic. When introducing opportunity management, the common reaction was: "That's very interesting, why we don't do it actually?". Throughout this report, I tried to answer this question constantly, and my final answer to all practitioners who wants to achieve more successful results in their projects: There is no reason. Just do it.

I learned many lessons during this journey, here are the most important ones:

- Every problem that one encounters, whether in his professional career or day-to-day life, can be solved using the same approach used in research. Starting by defining the problem and its scope, breaking it into different pieces, determining the method and the tools needed to solve each piece, all while keeping the final goal in mind. The solution will just be putting all the pieces of the puzzle together.
- To introduce new methods or ways of working in a company, two basic requirements are needed: awareness and evidence. Awareness comes by feeding the people with the required knowledge and information through trainings, workshops or other activities. Evidence is more difficult because it can be achieved with time. Some people have to lead the way and then others will follow after seeing the results or benefits.

Now, looking at the final outcome of my research, I can proudly claim that I am pleased with the obtained results given all the ambitious plans and deadlines that I imposed on myself. If I had more time, I would have piloted the CDOIT technique and the roadmap on an actual infrastructure project to see their effectiveness in practice and provide all the necessary adjustments or additions.

Lastly, I would say that, if there is to be a future for opportunity management, it should be seen as normal routine practice and not as something special or unusual. I've spent the past 67 pages talking about how to do opportunity management. Now it's time to act.

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Appendices

Appendix A: TOE Framework Explanation

This appendix explains the different complexity elements of the TOE framework developed by Bosch-Rekveldt et al. (2011). This framework is categorized into technical, organizational and external complexity elements. An assessment of these 3 categories provides a better understanding of the complexity of a project which aids in the implementation of adequate management strategies to better manage the complexity and improve project performance. The assessment is performed by scoring the different elements on a scale from 1 to 5. The technical complexity elements are explained in Table 13, the organizational complexity elements in Table 14 and the external complexity elements in Table 15. Also, an indication of the scale is provided to better illustrate the degree of complexity of each element.

Technical Complexity (17 elements)	Explanation (scale)
High number of project goals	Think of "strategic" project goals (single – many)
Non-alignment of project goal	Only if more than one strategic goal is present: amount of non-alignment (completely aligned – completely unaligned)
Unclarity of project goals	Unclarity of project goal(s) amongst team members (totally clear – totally unclear)
Uncertainties in scope	Presence of uncertainties in agreed scope of work (no uncertainties – lots of uncertainties)
Strict quality requirement	Think of quality requirements for project deliverables (normal – extraordinary high)
Project duration	How long is the planned duration, compared to your reference (short – very long)
Size in CAPEX	Capital expenditure: total investment for the realization of the project (small for the company – very large for the company)
Number of locations	The number of different sites / locations involved in the project, including contractor's locations (one – multiple)
Newness of technology (worldwide)	Does the project make use of new technology e.g. non- proven technology (technology which is new in the world for this application (no new technology – highly innovative)
Lack of experience with technology	Do the involved parties have experience with the technology used in the project (lot of experience – no experience)
High number of tasks	Does the project have a lot of tasks, count for example work packages or subprojects (single – many)
High variety of tasks	Does the project have lots of different types of tasks? (very similar tasks – very different tasks)
Dependencies between tasks	What is the number and nature of dependencies between the different tasks? (small – many & pooled)
Uncertainty in methods	Are there lots of uncertainties in technological methods to be expected (no - yes)
Involvement of different technical disciplines	What is the level of multi-disciplinarity? (single – very multidisciplinary)
Conflicting norms and standards	Are there conflicting design standards and country specific norms included in the project (few – many)
Technical risks	Do you consider the project being high risk (number, probability and/or impact) in terms of technical risks (no risk–very high risk)

Table 13: Explanation of the 17 technical complexity elements of the TOE framework, adapted from Bosch-Rekveldt et al. (2011)

Organizational Complexity (17 elements)	Explanation (scale)
High project schedule drive	How high was the pressure on the project schedule? (not at all – should be finished yesterday)
Lack of resource & skills availability	Are there any problems in the availability of the resources (materials, personnel) and skills required for the project (all available – major problems in availability)
Lack of experience with parties involved	Did you work before with the parties involved in the project, like JV partner, contractor, supplier (many times – no experience)
Lack of HSSE awareness	Are the involved parties aware of the importance of Health, Safety, Security and Environment (HSSE) issues? (fully aware – not aware at all)
Interfaces between different disciplines	Are there many interfaces between the different disciplines involved (like mechanical, electrical, chemical, civil, finance, legal, communication, accounting, etc) that could lead to interface problems? (few interfaces – many interfaces)
Number of financial sources	How many different financial sources does the project have, like own investment, bank investment, subsidies, JV-partners, customer(s)? (single source – multiple sources
Number of contracts	How many different contracts are involved in the project, think of contracts with the customer, the contractors, suppliers, etc (single contract – multiple contracts)
Type of contract	Are these all different or all the same and Is the chosen contract type adequate for the project? (all the same / OK, all different / not adequate)
Number of different nationalities	What is the number of different nationalities involved in the project? (single – multiple)
Number of different languages	How many different languages are used in the project communication? (single – multiple)
Presence of JV partner	Do you cooperate with a JV (joint venture) partner in the project? (no – yes)
Involvement of different time zones	Are there different time zones involved in the project, as a result of which for example planning of joint meetings is more difficult? (single time zone or limited impact – multiple time zones, major impact)
Size of project team	How many persons are within the project team (few (1-5) - many (>200))
Incompatibility between different PM methods/tools	Do you expect compatibility issues regarding project management methodology or project management tools between involved parties? (no compatibility issues expected – major issues expected)
Lack of trust in project team	Do you trust the members of the project team (completely – not at all)
Lack of trust in contractor	Do you trust the contractor(s) involved (completely – not at all)
Organizational risks	Do you consider the project being high risk (number, probability and/or impact) in terms of organizational risks (no risk –very high risk)

Table 14: Explanation of the 17 organizational complexity elements of the TOE framework, adapted from Bosch-Rekveldt et al. (2011)

External Complexity (13 elements)	Explanation (scale)
Number of external stakeholders	How many external (e.g. outside the project team) stakeholders are involved in the project (like NGO's, (local) governments, different departments, suppliers, local residents, etc); those parties that can influence or are influenced by the project? (few – many)
Variety of external stakeholders'perspectives	To what extent do the perspectives of the different stakeholders differ? (not so much differences – completely different)
Dependencies on external stakeholders	What are the dependencies on the external stakeholders (no dependencies – many and very crucial dependencies)
Political influence	To what extent does the political situation influence the project (no political influence – severe political influence)
Lack of company internal support	Is there enough company internal management support for the project? (enough support – not supported)
Required local content	To what extent are local parties obliged to participate in the project in order to have permission to execute the project (no local parties required – large part of the project should be executed by local parties)
Interference with existing site	Do you expect interference between the current site or the current use of the site and the (foreseen) project location? (no interference, Greenfield – lot of interference, Brownfield)
Remoteness of location	How remote is the project location located, think of reachability, availability of infrastructure and other facilities (easily reachable – very remote)
Lack of experience in the country	Do the involved parties already have worked in the country before? (yes, several times – no experience at all)
Company internal strategic pressure	Is there internal strategic pressure from within the company/organization, for example from the business or competitive departments? (no internal pressure – high internal pressure)
Instability of project environment	What is the stability of the project environment, think of exchange rates, raw material prices, economic situation (very stable environment – very instable environment)
Level of competition	What is the level of completion related to current market conditions (no competition – very strong competition)
External risks	Do you consider the project being high risk (number, probability and/or impact) in terms of external risks (no risk –very high risk)

Table 15: Explanation of the 13 external complexity elements of the TOE framework, adapted from Bosch-Rekveldt et al. (2011)

Appendix B: Interview Guide

In this appendix, the interview guide developed for conducting the 15 interviews with Project Managers, Process Managers and Risk Managers is presented. First, the interview started by asking the interviewee about his personal profile. Then, the main questions formulated to guide the discussion were asked.

Interviewee: Name

Date: dd/03/2021

Profile questions:

1) What is your background and your current role?
2) How many years of experience do you have with large infrastructure projects?

Main questions:

1) How do you define opportunity in an infrastructure project?

   _____

2) How do you plan opportunity management (OM) in projects?

   _____

3) How do you identify opportunities, or what are the techniques that you use?

   _____

4) What are the barriers for setting OM and identifying opportunities in infrastructure project?

   _____

5) What are the drivers to effectively set OM and identify opportunities in infrastructure projects?

   _____

6) In which phases of an infrastructure projects, opportunities can be found and exploited?

   _____

7) What types of opportunities do you recognize in infrastructure projects? Can you recall any identified opportunities in previous infrastructure projects that you worked on?

   _____

8) Based on your experience, in what kind of infrastructure projects are opportunities most found or realized? And why?

   _____

9) How could the opportunity identification process in large infrastructure projects be improved?

   _____

10) As a final question, do you have anything to add concerning opportunities in large infrastructure projects? Or do you have any recommendations that can help in the research?

    _____

Appendix C: Quotations, Codes and Code Groups in ATLAS.ti

This appendix shows the codes assigned to every code group in ATLAS.ti. These codes were generated in the following way:

1) The 15 interviews were transcribed and uploaded in ATLAS.ti.
2) Quotations (highlighted segments of the material that are important and relevant to the interview aim and questions) were created.
3) Codes (labels or description of the quotations) were assigned to each quotation.
4) Codes that related to each other with than assigned to a code group.

This way, 9 code groups were generated in total:

1) Opportunity definition (14 codes)
2) Planning OM (5 codes)
3) Opportunity identification techniques (5 codes)
4) Barriers (7 codes)
5) Kind of infrastructure projects (5 codes)
6) Phases (2 codes)
7) Types of opportunities (5 codes)
8) Drivers (6 codes)
9) Improving OM (7 codes)

The codes groups, codes and quotations are presented below, in the form of reports generated from ATLAS.ti. These reports are configured as follows:

Code Report- Grouped by: Code Groups

(‘*# of codes’*) codes

Local filters:

Show codes in group ‘*Name of code group’*

‘Name of code group’

Active: ‘# of codes’:

- *‘Name of code’*
  ‘# of quotations’:
  List of the quotations
  …

In total, 9 reports are generated, 1 for each code group:

Code Report – Grouped by: Code Groups

(14) codes
Local filters:
Show codes in group Opportunity definition

Opportunity definition

Active: 14 Codes:

○ **Opportunity has different interpretations: a new project is an opportunity, adding to the scope of a project a potential possibility is an opportunity and stakeholders demands and wishes are opportunities**

1 Quotations:

Interview 11- Rianne Albers-Schouten

I interpret opportunities in different ways: as a head of office, I'm looking to what's happening in the market, what are the demands of our clients, what are the themes they are working on so I'm talking to our clients and what are your struggles, can we help you with your struggles so for example for a grid operator it's new for them the energy transition they have to work on their network. First they would only operate and manage their network, now they have to build new networks, how do we deal with it? so then with a pilot project we help them, what is it to do planning study so that's investigation together with your client. So in different ways when I read the news and see opportunities I contact the client and say Oh I read the news, are you working on this? What do you do on climate adaptation, or plans on energy transition? so that's before you have any kind of projects so just looking what's happening and to see if there is an opportunity and within projects then I'm looking: okay, I have a certain assignment and they ask you for something and then I tell you: Oh, but did you know that we can also do this or that. So I look broader, I know what we can do within W+B. Also, you have opportunities with stakeholder's management. In Dutch you have something called 'Meekopel Kansen'. So you have the project itself then you ask also to your stakeholders what are the opportunities you see within the same area while we are working on the project, what can we also develop next to it.

○ **Opportunity has different interpretations: acquiring a project, doing more to the client than what is asked, possibility to improve certain processes in the project**

1 Quotations:

Interview 15- Jeroen de Leeuw

I think about opportunities in different ways. First opportunities as in acquiring projects, also opportunities when you see a client for instance and you can connect experiences and services that we have in house to a problem which the client has and, in that case, you can generate work from such a lead. But there are also opportunities in the work, offering the clients additional services for additional things that we can to enhance the projects, but there are also opportunities which are more internal where we can implement or innovate on certain processes.

○ **Opportunity has different interpretations: It's a chance to make more money or reduce cost, a possibility that can be realized to gain support from stakeholders, and it can make the process in a project easier.**

1 Quotations:

Interview 12- Niels Monster

Opportunities have a lot of different interpretations. One of the most obvious opportunities is always the one related to money. If I see a chance which means that I have to make less investments it's an opportunity which is very money driven. But opportunities and also prevent extra costs on another side. If a stakeholder is against some kind of new infrastructure and he wants to prevent this new infrastructure then an opportunity could be that you develop a new common social housing project for this stakeholder and then he says OK then I will agree with the new infrastructure as well. So that's not money driven but you gain support from your stakeholder. So, you can gain on money but you also can gain support or you can gain on space, I suppose. So, sometimes you're not aware if you want to reconstruct infrastructure or you want to create new infrastructure. When its reconstruction so you want to widen the existing infrastructure, you want to make a new extra lane, so sometimes you have to create a new area just to make a new bridge and then you can put the temporary infrastructure back to its original place, then you need a lot of more space, so an opportunity is not always money driven, is not always stakeholder driven, but is also in area or space driven. So, opportunities are very important for the progress of your project

○ **Opportunity is a chance to improve the design or process and requires some effort to be realized and add value to the project**

1 Quotations:

Interview 7- Jeroen Kwast

It's a possibility to improve your design or process with a certain amount of chance that you need to take. So, you have to make some effort and then you can add some value to your project or your process.

○ **Opportunity is a chance to make the project easier to achieve**

1 Quotations:

Interview 8- Ingrid Mouwen

It's something that pop-up, so when you start a project you start thinking what are the chances that you have to make your project easier to achieve.

○ **Opportunity is a chance to make the project goal better**

2 Quotations:

Interview 1- Arno Hofmeijer

it's a chance to make the project better. You have a goal with your project, when you can make it better then it's an opportunity.

Interview 5- Christiaan Loeber

opportunity as a change to the projects which makes the project better but it's not a change that you actually implement but you sort of store or register for later implementation.

○ **Opportunity is an option that one can implement, with limited time and cost, to gain support in the project**

1 Quotations:

Interview 10- Jeroen Radix

Opportunity is an option which you can integrate in a project with minimum amount of money or time to gain support in the surrounding.

- **Opportunity is an uncertainty with a positive impact on the project goals**

1 Quotations:

Interview 4- Ben Strating

An opportunity is an uncertainty with a positive impact on the project goals.

- **Opportunity is combining different goals in the same project**

1 Quotations:

Interview 9- Tom Petersen

I think opportunity in my field of the work is so make use of combined opportunities: if you were making a bridge-the need for a bridge comes from transportation movements- but do not limited only to designing a bridge

- **Opportunity is not the goal of the project but can bring more value to the end result**

1 Quotations:

Interview 14- Berto Meeuwissen

Opportunity is something that's not the goal of your projects but can bring more value in the solution you develop

- **Opportunity is something around the project which, if exploited, add value to the project**

1 Quotations:

Interview 6- Ben-Jaap Pielage

I think opportunities are what you see around you and which if you can exploit them can bring you value, nicer projects, they can bring you things you do not have so I think that's the way I look at opportunities and sometimes they are very small, for instance I see the sun and I think that's a nice opportunity to go out with the kids and have an ice cream. And sometimes in business or in port development in my case you see you're working on a project and you see other development going on in the world or just around the corner and you could see those as possible future business or other developments that could be beneficial and you try to use that to make it a better world sometimes.

- **Opportunity is something more than what is required and which involves improving the environment and working on sustainability**

1 Quotations:

Interview 13- Anne Springer-Rouwette

For me the opportunities are to do more than just the project itself. So, I work on a project in which the highway should be broadened and so for me opportunities are everything concerned with improving the environment, working on sustainability. Everything which is more than just what we are obliged to do.

○ **Opportunity is the possibility of incorporating the ambitions of stakeholders related to improving the project environment in terms of ecosystem, sustainability or changes in the project scope to satisfy them**

1 Quotations:

Interview 3- Hilke van Strijp-Harms

the stakeholder environment we always look for opportunities like environmental opportunities, can we improve the ecosystem and but also the sustainability aspect. We have some tools that together with the stakeholders we see what the ambitions are in regard to sustainability and then based on the ambitions we seek for opportunities we can include in the project

○ **Opportunity makes the project more efficient**

1 Quotations:

Interview 2- Marcel Wauben

It is something that make the project more efficient.

Code Report – Grouped by: Code Groups

(5) codes
Local filters:
Show codes in group Planning OM

Planning OM

Active: 5 Codes:

○ **Discussions with the client and stakeholders on opportunities in the proposal phase and at the beginning of every phase**

4 Quotations:

Interview 3- Hilke van Strijp-Harms

It happens more on ad-hoc basis during the project on different type of topics or with different types of stakeholder

Interview 11- Rianne Albers-Schouten

First, within the tender phase or sometimes before: you ask a question in a conversation with the client so that you know what their questions are and then you're searching for what can we do more, then you have the tender phase itself then you make your proposal and you look what can we have like added value or see as type of opportunities within this project and the most infrastructure projects I work on are big projects so then you have different phases within the project so each phase you look again, you update your project plan and you look again okay, what are the opportunities from the stakeholders. You also discuss it with your clients, you lean back and ask together what's happening in the project and what kind of opportunities we have. So, what kind of risks do we see but also what kind of opportunities we see.

Interview 13- Anne Springer-Rouwette

opportunity workshops with the environment, so this is mostly part of the stakeholder engagement process.

Interview 13- Anne Springer-Rouwette

And in the sustainability studies we also have workshops to discuss ambitions with all the parties involved to look at opportunities.

○ **In the tender stage opportunities are registered in word or excel and checked on a regular basis to see if they can be implemented in the plans of the tender**

3 Quotations:

Interview 2- Marcel Wauben

before this project start up then we make a proposal for projects we also look into possible opportunities in which we can stand out against our competitors with an innovative approach, digital models, those kinds of things.

Interview 5- Christiaan Loeber

In the past word we had done some sort of a register where we would anyone working on the project could record opportunities and they would assess those on a regular basis, whether it's biweekly or monthly, but at least we had an internal cycle where we need to go through the list, discussed them and see if it was worth keeping them in the register or implementing them, or sometimes there are opportunities for later phases

Interview 15- Jeroen de Leeuw

in a tender stage then of course opportunities are actively pursued and often written down in Word or Excel something like that, and then the tender manager or members of the tender team check on regular basis better whether opportunities can be incorporated into the plans of the tender.

- **Look at opportunities when defining the scope of the project**

1 Quotations:

Interview 14- Berto Meeuwissen

That depends on the goal of the project.

- **Opportunities are not managed at all during execution**

13 Quotations:

Interview 1- Arno Hofmeijer

In most projects we call it 'meekopelkansen'. It looks like OM

Interview 2- Marcel Wauben

opportunities we call it in Dutch 'meekoppelkansen

Interview 3- Hilke van Strijp-Harms

the opportunities are more like 'meekoplkansen'

Interview 3- Hilke van Strijp-Harms

I don't think there is a real process with the client itself for all those opportunities during the entire project. It's not a framed process or systematic process.

Interview 4- Ben Strating

that's easy we don't do it at all, nothing

Interview 5- Christiaan Loeber

I'm not doing it in a structured manner

Interview 6- Ben-Jaap Pielage

I would say no I have never done it

Interview 8- Ingrid Mouwen

The risk management is reviewed every month, you really look at it unless the project is really on hold then it's not necessary but depending on the dynamics of a project you always check once a month the risks and I always try to do that every time in a different way; sometimes with a session with everybody sometimes with challenge meetings one of one.

Interview 9- Tom Petersen

only focusing on the things that are there and missing the opportunities

Interview 10- Jeroen Radix

We don't have a separate process for opportunities, they pop-up in a risk session or a design process. It's not a structure process.

Interview 11- Rianne Albers-Schouten

First, within the tender phase or sometimes before: you ask a question in a conversation with the client so that you know what their questions are and then you're searching for what can we do more, then you have the tender phase itself then you make your proposal and you look what can we have like added value or see as type of opportunities within this project and the most infrastructure projects I work on are big projects so then you have different phases within the project so each phase you look again, you update your project plan and you look again okay, what are the opportunities from the stakeholders. You also discuss it with your clients, you lean back and ask together what's happening in the project and what kind of opportunities we have. So, what kind of risks do we see but also what kind of opportunities we see.

Interview 12- Niels Monster

opportunity management is not a standard process, it's more like an implicit thing

Interview 15- Jeroen de Leeuw

opportunities are not managed at all

○ **Separate process from risk management because risks should be monitored more often and opportunities are something that you can have but not necessary**

4 Quotations:

Interview 2- Marcel Wauben

before this project start up then we make a proposal for projects we also look into possible opportunities in which we can stand out against our competitors with an innovative approach, digital models, those kinds of things.

Interview 7- Jeroen Kwast

do it in separate sessions with the same team, so we have designers, we have project leaders, project managers etc. We do risk sessions by then on opportunities with the same organised structure, only it's a separate session

Interview 13- Anne Springer-Rouwette

within the risk management process we don't look at opportunities.

Interview 14- Berto Meeuwissen

In my projects opportunities are never part of the risk analysis

Code Report – Grouped by: Code Groups

(7) codes
Local filters:
Show codes in group Barriers

Barriers

Active: 7 Codes:

- **Lack of awareness on the concept of OM**

6 Quotations:

Interview 6- Ben-Jaap Pielage

Not being aware is of course a big issue or barrier

Interview 6- Ben-Jaap Pielage

the client also it is knew or unknown so you will also have to guide the client or help the client understands

Interview 12- Niels Monster

It's more of acknowledgement, it's more that we need to know that it exists.

Interview 13- Anne Springer-Rouwette

I think we do a lot of opportunity management but we don't call it opportunity management or maybe it's not structured like opportunity management so I think the barrier is that we don't know that process so much. It's not one of the common processes in our projects but I think if we combine all the small pieces we do in a project and you give it a name opportunity management then maybe we are already almost there

Interview 15- Jeroen de Leeuw

it's the awareness of such a thing, of the whole concept of managing opportunities as something that could be part of your work

Interview 15- Jeroen de Leeuw

we are familiar with risk management and risk management sessions, challenges, but somehow, we are not accustomed to having the same kind of execution for opportunities, sadly enough. We never sit down to discuss what more could we do with opportunities we have on this project

- **Opportunities are something extra and not mandatory to find**

6 Quotations:

Interview 1- Arno Hofmeijer

opportunities are mainly a plus for the project but not for our process

Interview 4- Ben Strating

I think our focus as a business as a company is to focus on highly efficient realization of the project goal and nothing more than that

Interview 9- Tom Petersen

The clients should be also able to widen their view and scope, and that's not always the case.

Interview 11- Rianne Albers-Schouten

For opportunities with stakeholders, the barriers are that the client just wants to achieve his own goals just within budget and within schedule, so they don't want extra disturbance by opportunities

Interview 13- Anne Springer-Rouwette

Maybe it's never asked for: risk management is asked for but opportunity management is not.

Interview 14- Berto Meeuwissen

Opportunities are not an integral part of your scope but something at the nearby of your scope

- **Opportunities change the scope of the project and implies a contractual change**

1 Quotations:

Interview 2- Marcel Wauben

we get changes in scope, so it implies a contractual change and that's a difficulty because normally we first enter a contract, the client will prepare a request for proposals and there they define the project, we prepare a proposal that fits according to our opinion best for that request for proposals and those two things form the contract, and if you then go to look for other opportunities that's changes the contract possibly and that's something that makes it for the client sometimes more difficult cause they have asked for certain product and we try to change their product or to add something to that product.

- **Opportunities cost money and time**

8 Quotations:

Interview 1- Arno Hofmeijer

when there are opportunities and we are willing to develop that, mostly it costs us a lot of time, it's holding on our process

Interview 3- Hilke van Strijp-Harms

Cost. So, I had an example where the opportunities were cost reducing but most of the times it feels like that the opportunities cause something extra and that's what you a lot of time see with those 'meekopelkansen'. It's really great to improve this and that, have a better quality of the environment or surrounding but that's always costs more if you want to do that, and especially if it's a bigger construction then it will cost a lot more and who's going to pay that

Interview 3- Hilke van Strijp-Harms

opportunities are not included in the budget but at the end you have to realize this project for that budget, and those costs for the opportunities has to come from other budgets. It's really hard to make decisions about the finance of those opportunities because who's going to finance those

Interview 5- Christiaan Loeber

I think it takes quite some time and focus to identify opportunities and at the moment we don't allow for this part of our work so we should schedule or structure at least the process and allow some time spending and feedback for your client.

Interview 6- Ben-Jaap Pielage

A possible barrier could be that it creates maybe additional work for us as being very practical

Interview 9- Tom Petersen

Opportunities usually cost more money so the financial part is usually one of the barriers, and time as well

Interview 10- Jeroen Radix

It costs money to organize a separate session for opportunities

Interview 13- Anne Springer-Rouwette

I think finance or the budget, also our clients they think that every opportunity has a cost, like a risk also has

- **People from different disciplines don't collaborate to identify opportunities**

1 Quotations:

Interview 14- Berto Meeuwissen

you don't set up an integrated designing process with all the disciplines that are needed to develop and to recognize opportunities.

- **The focus during the project is on negative risks so that the project doesn't fail**

6 Quotations:

Interview 1- Arno Hofmeijer

we always need to realize that opportunities can be a plus for the project but it can disturb our process

Interview 5- Christiaan Loeber

As engineers we are always used to identify problems and I think partly it's a change of mindset where we also identify opportunities

Interview 6- Ben-Jaap Pielage

I think it's in the nature to look at the worst-case type of scenario.

Interview 7- Jeroen Kwast

during the process the focus is mainly on risk management to not fail our current process

Interview 8- Ingrid Mouwen

people always think about problems but you can also just think okay what's the best for our projects

Interview 9- Tom Petersen

I think it's a mindset as well I think we're trained mostly into thinking into risks.

- **There is no clear and structured process for OM**

1 Quotations:

Interview 4- Ben Strating

there is not a clear approach or a clear process or tools to find those.

Code Report – Grouped by: Code Groups

(5) codes
Local filters:
Show codes in group Kind of infrastructure projects

Kind of infrastructure projects

Active: 5 Codes:

- **Large projects with high complexity**

9 Quotations:

Interview 2- Marcel Wauben

Th larger the project the more opportunities there are. By larger I don't only mean the area but also in budget and in complexity

Interview 6- Ben-Jaap Pielage

So, one hand you would think it may be easier to do it with large projects because in large projects you have more money and more people, so more minds to think about opportunities which is probably true but on the other hand you also have probably more negative threats, and people are more worried about timing and budget and may be less willing to take a chance to look if opportunities will actually work so maybe that's a downside. So, I'm not very sure if a large project or a small project is better for opportunities.

Interview 7- Jeroen Kwast

In every project you have opportunities but in smaller projects you have small risks and also smaller opportunities I think because you don't have many options. If we have a new crossword maybe you could make it a roundabout and that's it, and then the options are over, or you make it bridge or something like that but that would be not an opportunity maybe. But that also doesn't mean that you don't have to do it with smaller projects of course.

Interview 9- Tom Petersen

the more complex the project and the bigger, the more opportunities you can find

Interview 11- Rianne Albers-Schouten

I think the more opportunities you can find but not always the more opportunities you can realise/exploit. Sometimes you can realize more within a simple biking lane but sometimes it's so complex so they just focus on how do we just get that complexity arranged. It's like a paradox.

Interview 12- Niels Monster

And yeah of course the more complex the project and the more stakeholders you have the more opportunities.

Interview 13- Anne Springer-Rouwette

And the more the complexity, the more stakeholders, the better.

Interview 15- Jeroen de Leeuw

The bigger the project and the more complex it is, the more opportunities you can find.

Interview 15- Jeroen de Leeuw

Especially the technical complexity and environmental complexity, by environmental I mean the built environment (the cities etc.) but also nature. Also, the complexity of social resistance when these three come together that's where most opportunities arise

- **Projects that have less strict rules and regulations**

2 Quotations:

Interview 5- Christiaan Loeber

I don't think there's a difference. Maybe I'm answering too quickly. If you look at for instance the hydraulics type of projects as the ports and waterways or stuff like that, the rules and regulations in the design or more often more relaxed than for instance road design, you know if your design speed is 100 kilometers per hour you need to allow for a certain radius etc. etc. and there's no way to deviate from this and the more sort of wet types of projects those are bit more relaxed or there's more design creativity allowed and so that makes it easier to implement opportunities

Interview 8- Ingrid Mouwen

I think in the projects which have very strict requirements it's really hard to implement just something else or opportunities. So, the more flexible is the project the more opportunities can be realized.

- **Projects with many integrated disciplines**

5 Quotations:

Interview 1- Arno Hofmeijer

Well it's not very specific but I think it's the projects that are very integral, where many disciplines come together

Interview 5- Christiaan Loeber

if we have a lot of different disciplines involved there would be more opportunities specially on the interfaces between those disciplines.

Interview 9- Tom Petersen

The ones there are situated in urban areas, in cities. Now, they are renovating a lock (a sluice) and they do not limit their scope to only the lock but they make a little bit larger and it makes it kind of park around the lock and give it not only function of transporting ships but also a social function, but also a little additional cost.

Interview 13- Anne Springer-Rouwette

I think you can find the most opportunities in the larger scale projects especially when they are not only focused on the line infrastructure but when they are focused on the whole area, if it's a project which includes the complete development of an area including the infrastructure. I think there are more opportunities if the project's scope is broader than just infrastructure itself

Interview 14- Berto Meeuwissen

I think when you don't only have a line infrastructure but also the surrounding area to consider, that is important to enlarge the possibilities for opportunities that you can arrange

- **Projects with many stakeholders involved**

5 Quotations:

Interview 1- Arno Hofmeijer

So it's about the disciplines and the stakeholders involved

Interview 3- Hilke van Strijp-Harms

I think those with a lot of stakeholders with decision-making power, if they work together then there can be many opportunities

Interview 7- Jeroen Kwast

the larger the projects the more chances you have because you also have more stakeholders

Interview 12- Niels Monster

And yeah of course the more complex the project and the more stakeholders you have the more opportunities.

Interview 13- Anne Springer-Rouwette

And the more the complexity, the more stakeholders, the better.

- **Projects with space within the boundaries of quality, time or budget**

3 Quotations:

Interview 2- Marcel Wauben

Th larger the project the more opportunities there are. By larger I don't only mean the area but also in budget and in complexity

Interview 4- Ben Strating

project where there is space within the boundaries of quality, time or budget then you create a movement then you create that space to work with possible opportunities but when the boundaries of the projects are very sharp so there's a low budget we don't have much time and we have a high project targets target then then you don't want to invest extra time or money in the realization of opportunities because the base goal is hard enough to get.

Interview 11- Rianne Albers-Schouten

I think a lot of projects who are for the Waterschappen (water authorities) because for their projects there is a lot of big budgets to realize those projects so there is extra money because like for 'ruimte rivieren' they also set extra goals like water safety, quality of the surrounding, so there was a lot of money available on gaining extras within the project, so that helped.

Code Report – Grouped by: Code Groups

(2) codes
Local filters:
Show codes in group Phases

Phases

Active: 2 Codes:

- **In all phases but the size and realization of opportunities diminish over time**

9 Quotations:

Interview 1- Arno Hofmeijer

I think it starts from the beginning and you need to take it with you during the whole project.

Interview 4- Ben Strating

In an early stage I think also that is the same as with risk management. I was thinking about a graph that visualizes that risks in an early stage can have far more space to manage it then in a later stage if you want to exclude risks in the realization stage is much harder and it costs more money than in an early stage and the same with opportunity.

Interview 5- Christiaan Loeber

I think in all phases but I think the opportunities with the maximum effect are in the early phases because those often allow you to redefine the scope or the extent of the project. When you are in detailed design or in the construction design phase, in my projects we spend most time on that side of the project life cycle , the opportunities tend to be smaller and one of the issues that we have is that once it gets to practicality and the way you construct something in infrastructure we lack the actual experience because that experience is usually part of a construction contractor and is not quite often part of our engineering business

Interview 7- Jeroen Kwast

I think in every phase actually there are opportunities to be found. Every phase has a different goal and for each goal you have different opportunities

Interview 8- Ingrid Mouwen

All phases, and when you are really in the in the starting phase then you can have a lot more impact or chances by changing the scope of the project or goals or the way of contracting, and during the realization of the project you still have some chances but the chance that you really implement a chance is less

Interview 11- Rianne Albers-Schouten

In every phase but in each phase it will be more detailed and when you're in the beginning then you have big questions of choosing alternatives and something can be added but when you're almost in executing the project, it will be more like what type of color can we add on this biking lane or it will not be really big opportunities. So, in every phase you have opportunities with more like a funnel and will be more detailed on what kind or type of opportunities can still be added to the project.

Interview 12- Niels Monster

In every phase because also when you're constructing in the construction phase or in the realization phase, well if you don't know what you don't know sometimes you forget that there is a new opportunity, and especially that you have some infrastructure projects which last for at least a decade between initiative and realization, somewhere between 5 and 10 years, so also after five years or after 8 years you can think about well, we have and you knew development for the maintenance

Interview 13- Anne Springer-Rouwette

I think in every phase but maybe the earlier you start the better.

Interview 15- Jeroen de Leeuw

In all phases. Always, in anytime of the day and of course the size and the realization of the opportunity diminishes over time, but there are always possibilities.

- **Mostly in the early phases**

9 Quotations:

Interview 2- Marcel Wauben

Yeah, during the start I think because at the start that's where you agree on the scope

Interview 3- Hilke van Strijp-Harms

In the 'verkening' phase or pre-conceptual (I think once one step further than the initiation phase). So, it's after the initiation when you start thinking about what will it actually look like. At this point the budget isn't fixed but once you go to the realization phase then it's already set. Of course, there can be some opportunities as this point although it's more from the construction company side

Interview 6- Ben-Jaap Pielage

I think normally at the beginning because if you start with the project you have the phase where you get to know the client if you don't really know him yet, you have to make the kind of basic design and basic design documents, where you sketch the system boundaries of the project; what is in the scope and what is not etc. and that's also the phase where you can talk with the client about an additional scope or other possibilities which he might not know or have thought about, so I think you have to make time at the beginning of the project and after the project is ongoing. I think it's more and more difficult to discuss additional scope. It's also the way people think and how people work I think, and of course towards the end of the project there's more time pressure to get it done and there is less room for new ideas and opportunities.

Interview 9- Tom Petersen

Mostly within the early phases, I think. It's very difficult to create opportunities if there's already a contract.

Interview 10- Jeroen Radix

Mostly in the early design phase.

Interview 11- Rianne Albers-Schouten

In every phase but in each phase it will be more detailed and when you're in the beginning then you have big questions of choosing alternatives and something can be added but when you're almost in executing the project, it will be more like what type of color can we add on this biking lane or it will not be really big opportunities. So, in every phase you have opportunities with more like a funnel and will be more detailed on what kind or type of opportunities can still be added to the project.

Interview 13- Anne Springer-Rouwette

the opportunities differ per phase and if you start early in the feasibility study phase it's about to big choices you make

Interview 14- Berto Meeuwissen

the biggest opportunities you'll find are in the first phase: the verkenning phase.

Interview 15- Jeroen de Leeuw

the biggest opportunities are often in the planning phase

Code Report – Grouped by: Code Groups

(5) codes
Local filters:
Show codes in group Types of opportunities

Types of opportunities

Active: 5 Codes:

○ **Add something to the project's scope to satisfy a stakeholder**

4 Quotations:

Interview 1- Arno Hofmeijer

Yeah we had a project in Giesbeek in Arnhem and we had to develop a harbor, and it started with looking for a place to build the harbor, it's along the river, and in the area there were some shipping families in Giesbeek and they also needed some places to stay when they are at home just to park the ships. That was already when we started the project, they were talking to each other and in the end we realized some places for them. We needed place for 11 passing ships to rest overnight and we built 6 extra places for the shipping families in Giesbeek

Interview 3- Hilke van Strijp-Harms

Yeah well for example an opportunity was that we were redesigning a bridge of the A2 highway in the Netherlands and it had to become a new bridge and it was over the Maas, and in a lot of business areas there was no crossing for cyclists so we said if we're going to build this highway bridge why don't we make it a little bit bigger so cyclists can pass at this point as well and of course it's not the most nicely ride to have next to the highway but it's an opportunity to have a crossing at this point as well and it was an important crossing for a lot of people.

Interview 4- Ben Strating

In general, I would think and what sometimes clients also asked us to do when searching for opportunities is for example, we are working on the strengthening of a dike no and then we also ask for the people living around it if they see some extra opportunities because when we are working there, we can also implement, we can easily implement something extra, so if they see opportunities and they want to play a little bit with it then we can take that extra scope with this. I think that is the main form of opportunities which we implement in our projects right now and with that way of working you create some more social support

Interview 11- Rianne Albers-Schouten

In my ongoing project the region said okay we want this project only if we get something for the area in return so that can be anything: better landscape or different things that they want, but also like for the community so they can benefit like public housing or public facilities they can gain from it

○ **Change in construction method to reduce cost, time of execution or make it easier to get a permit**

1 Quotations:

Interview 2- Marcel Wauben

Yeah, sometimes also methods, the client has a construction method in mind and another construction method leads to less cost or less impact

○ **Combine two projects or different aspects and goals in one project to increase value and make it easier than having the 2 separately (reduce cost, satisfy more stakeholders, easier permitting, reduce traffic hindrance etc.)**

5 Quotations:

Interview 5- Christiaan Loeber

One example is that where we had two parallel projects and we identified an interface where actually if you combine the two projects would make it actually easier and cheaper to build so than just one

Interview 8- Ingrid Mouwen

But it's definitely good to really in the start of a project see if we can combine it with other initiatives in the community so we can combine things and make it a better project, or even have less costs in it.

Interview 9- Tom Petersen

the users of the road benefit from it and it is also a combination of reducing costs.

Interview 12- Niels Monster

The first thing which I remember is I worked in a very large area development project in Almere, we have worked the last two to three years in the project 'Floriade', it's an area development which starts with a world Expo, it's a about greening the city (the most important part of it), but after it has been a world Expo afterwards, it will be for six months, afterwards it will be a housing area so it changes from a world Expo into a new part of the city of Almere. In this project, the previous design had two separated infrastructures and in between housing, and so it was a problem because of the noise produced by the cars on both sides of the new housing, so there was an opportunity to combine those two infrastructures into one. So, the housing could be on the North side so there won't be a noise both sides but only on one side and then you can make a quiet side on the other side and that made the permitting of the housing a lot easier. So, we changed the plans, we combined the infrastructure of buses and cars in one big infrastructure bundle and it made the permitting of the houses on the other side al lot easier. So, that was an opportunity because it wasn't built yet and we could quickly change this and made permitting for housing a lot easier.

Interview 14- Berto Meeuwissen

In one project we combine a strengthening of a dike with making nature nearby the river so the sand and clay which will be dragged out of the river project can be used to strengthen the dike, but then they have to be worked out at the same time with a good quality and at sufficient quantities and so on and so on.

○ **Design opportunities**

3 Quotations:

Interview 7- Jeroen Kwast

all the opportunities are design opportunities

Interview 15- Jeroen de Leeuw

I came up with a completely different solution which was incorporated 2 weeks ago into the project. So, that's an example of a major change which is millions or tens of millions on the project

Interview 15- Jeroen de Leeuw

I think the opportunities range from very large conceptual changes which shift the whole picture to very small life hacks which make life much easier in our every day's life

- **Opportunities related to climate change (adaptation and mitigation)**

3 Quotations:

Interview 3- Hilke van Strijp-Harms

Another thing is that you see a lot of climate change and climate adaptation concerns, so when you have the reconstruction of a road or reinforcement of a dike, you have to directly incorporate those and take climate change into account by designing for future scenarios.

Interview 6- Ben-Jaap Pielage

I think if we look for instance at the developments in Rotterdam now the Port Authority is much more than they used to be focused and willing to invest a little bit more to make the infrastructure more future-proof and more flexible so that's I think something that is really going on at the moment in the port of Rotterdam. So in the in the past, they said okay I want you to develop three alternative concepts for quay wall for instance and then we will select the cheapest one and then we build it. And nowadays they say okay I would like to have three alternatives for the quay wall and please also indicate how flexible it would be if we don't want this or that but maybe something else in the future and can you also then give the possible impact, in price or in other things. And now it's actually happening with one of the quay walls. It's a project that I can't share it with you as in naming it, but it's in the port of Rotterdam where the port authority eventually selected to make the quay wall I think it was 10 or 15% more expensive but it was much more able in the future to be used in any which way you want so you could use it for bulk but also for containers or other heavy duty transhipments of goods and as you may know the Rotterdam port was focusing much on containers but the container volumes haven't been as large as they predicted 10 years ago so now the development is also to look at other type of business for ports imports structures and that's why they're looking at making it more future proof. Future proof for climate change also? The climate change was already foreseen so they expect that between now and I think 50 years the sea will rise so many meters and this is already incorporated in the design, but I think more future-proof in normally they build a quay wall, they do the landfill for the terminals that's the Port Authority work and then the operator that needs to do the actual transhipments loading of goods or whatever you need to do over the quay wall they specify what they need as for instance rail span for the cranes or the forces on the quay wall and then the Port Authority calculates how strong the keywords should be, and that's what we normally also do for the Port Authority and then we build that quay wall. But what happens if in 10 years' time this operator goes bankrupt or doesn't want to have the terminal anymore or whatever, then maybe another operator comes and he has a different set of requirements for the quay wall and the terminal and it should then also be possible for him to operate that quay wall and that piece of land, that's what I mean with more future-proof.

Interview 13- Anne Springer-Rouwette

I know lots of opportunities to combine your project with for instance ecological measures to like have a new connection under the road or to choose the way you design your project in such a way that it's nature inclusive, things like that. But also, a lot sustainability options like if you have a viaduct or a bridge over the road if you can reuse it instead of building a new one, opportunities like that but a lot in the field of sustainability and ecology. Sometimes opportunities for a better environment like extra measures to reduce the noise or to improve air quality.

Code Report – Grouped by: Code Groups

(6) codes
Local filters:
Show codes in group Drivers

Drivers

Active: 6 Codes:

- **An easy process for OM**

1 Quotations:

Interview 12- Niels Monster

An easier process

- **Be convinced that the extra effort spent to realize opportunities will bring back value**

3 Quotations:

Interview 3- Hilke van Strijp-Harms

So, drivers are that we all seeking to make something to be proud of. And as Witteveen+Bos I think even more we want to design something that will gain something for the community. We don't only look at what is asked from our clients but we also look what will it bring for the broader community of the Netherlands or what will bring to the Netherlands as a whole. Like what makes it better or can we do something for the climate, can we incorporate something that will also improve that aspect. So, we always look for opportunities to give more value not only to the project but also to the end user or bigger picture.

Interview 4- Ben Strating

we first need to be convinced that the extra time we spend will bring something back or add value

Interview 13- Anne Springer-Rouwette

we want to work on the sustainable development goals, we want to have content stakeholders. So, I think that our motivation and ambition to do more than what is asked for and to do something extra to make the world a little bit better I think this is one of the main drivers

- **Increasing project's success**

14 Quotations:

Interview 1- Arno Hofmeijer

We as engineers we want to do the best, we want to achieve the best project, and that's the most important driver, and also as a company we want to do the best for the society, for our client, to increase the performance and reputation

Interview 2- Marcel Wauben

it's a reduction of general cost

Interview 2- Marcel Wauben

making the product better, better quality

Interview 2- Marcel Wauben

some opportunities concerning the environment so that permitting becomes easier.

Interview 5- Christiaan Loeber

we want to do projects really well so that drives that we want to make a perfect project

Interview 7- Jeroen Kwast

every opportunity we see now in the design phase leads to less cost and less cost means that they make more profit at the end

Interview 7- Jeroen Kwast

make less cost for our work as W+B

Interview 7- Jeroen Kwast

make the process more efficient so we can have more profit at the end of the project.

Interview 8- Ingrid Mouwen

Faster way of working or making the process more efficient is a driver to exploit opportunities

Interview 9- Tom Petersen

I think that opportunities are one of the main ingredients for a project to be a success

Interview 10- Jeroen Radix

some opportunities can be better for the design cost.

Interview 12- Niels Monster

have an easier process because these are always when you need a permit, so the permitting process will be easier

Interview 15- Jeroen de Leeuw

Another major driver could of course to make our lives better and easier, for instance automation or innovation of processes.

Interview 15- Jeroen de Leeuw

And of course, there is money. I think the best opportunities also generate money for the company, or are even better for the project or for the community as a whole.

- **Satisfaction by achieving more than what is asked**

2 Quotations:

Interview 13- Anne Springer-Rouwette

to do more than what is asked for and to do something extra to make the world a little bit better

Interview 15- Jeroen de Leeuw

Most of us are triggered and happy to see opportunities come by and making the best out of it

- **Satisfying stakeholders**

5 Quotations:

Interview 2- Marcel Wauben

not only for the project but also for the stakeholders, so to create optimal support for the project

Interview 9- Tom Petersen

if you can do just a little bit more and please them by integrating some other functions that they can benefit from, I think that's perfect for everybody, for clients and for everybody who has been working on it.

Interview 10- Jeroen Radix

More support in the surrounding

Interview 11- Rianne Albers-Schouten

the support of the stakeholders will go up by implementing those opportunities

Interview 13- Anne Springer-Rouwette

we want to have content stakeholders

- **The client asking for OM**

1 Quotations:

Interview 6- Ben-Jaap Pielage

At the moment there are not so many drivers because you mostly focus on what the client wants, if the client says yeah well interesting but I want this, well you're the consultant or expert and you tell the client maybe this and this and this, and then the client says no I want this then you do what the client wants and that's the normal way it works so in order to have more or less threshold and develop this thinking more I think we also have to look at how you can convince and market it with the clients that we have

Code Report – Grouped by: Code Groups

(7) codes
Local filters:
Show codes in group Improving OM

Improving OM

Active: 7 Codes:

○ **Clearly identify the project goals and determine if these are realized in a effective and efficient way**

1 Quotations:

Interview 8- Ingrid Mouwen

Also, we need to ask some kind of questions like are we doing the right things? Is the goal the right goal? And are we doing it in the right way? (doing the project effectively and efficiently).

○ **Have a standardized and structured process**

5 Quotations:

Interview 2- Marcel Wauben

To make it more structured eyes like you set the risk analysis

Interview 3- Hilke van Strijp-Harms

I think we should start to make opportunity management a structured process which is part of the entire process we work on, and know where to plug it in the whole process.

Interview 6- Ben-Jaap Pielage

Well first by making it clear that you should do it and making a clear definition of it and of all the issues as well but then you also have to make it tangible so you have to make a model which is easy or clear to understand

Interview 12- Niels Monster

We have to make it standardized because then the we are more aware of knowing it exists

Interview 12- Niels Monster

It should be a standardized process in so what I called before the GROTIK.

○ **Have a tool to visualize the uncertainties in the context of the project**

1 Quotations:

Interview 4- Ben Strating

If we have a process or tools to visualize the context of a project and the uncertainties which are there, which exists within the context of the project

- **Increase awareness on OM**

8 Quotations:

Interview 1- Arno Hofmeijer

Maybe it's too simple to say, but we need more focus on opportunity management

Interview 5- Christiaan Loeber

I think we should start by making it specific before we start the project, so whole process of opportunity management needs to be implemented before you actually start the project, because now it's usually a hand side or some good ideas that we develop along the way, in my experience, and I would advocate thinking about opportunities and making them explicit when you're already working on the proposal or thinking about writing a proposal.

Interview 7- Jeroen Kwast

Make it more explicit

Interview 9- Tom Petersen

To get it not only in the back of our heads but into the front of our heads and more explicitly into the time schedule

Interview 9- Tom Petersen

we have to be aware that it's an important factor of the success of your project

Interview 12- Niels Monster

it should be more expect explicit instead of implicit

Interview 13- Anne Springer-Rouwette

I think we should first raise the awareness to look at opportunities

Interview 15- Jeroen de Leeuw

To start with, it's the whole awareness towards the concept.

- **Inlcude OM in the proposal and project management plan**

2 Quotations:

Interview 5- Christiaan Loeber

I think we should start by making it specific before we start the project, so whole process of opportunity management needs to be implemented before you actually start the project, because now it's usually a hand side or some good ideas that we develop along the way, in my experience, and I would advocate thinking about opportunities and making them explicit when you're already working on the proposal or thinking about writing a proposal.

Interview 12- Niels Monster

included in the proposal and project management plan.

- **Organize opportunities session and not only risk sessions**

6 Quotations:

Interview 1- Arno Hofmeijer

just put more focus on OM by arranging some sessions like we do risk session

Interview 7- Jeroen Kwast

Also, during the design loops, I think it's good to focus on making it at the start of every design loop by making opportunity sessions or something like that

Interview 10- Jeroen Radix

A separate process where you have the ability to think more about opportunities may be ideal.

Interview 11- Rianne Albers-Schouten

at the same time when you are doing your risk assessment, also do assessment of opportunities that could be a good measure

Interview 12- Niels Monster

if there is a risk session there should also be an opportunity session

Interview 15- Jeroen de Leeuw

So, instead of only having risk management sessions we can also have opportunities sessions

- **Working and collaborating with the different disciplines in the project**

4 Quotations:

Interview 8- Ingrid Mouwen

I think when you have a project and you get into a new phase, that you take time for brainstorm session with new people because when you get new people involved with the project you have new ideas.

Interview 9- Tom Petersen

if you're working for a client you have to involve him as well and you have to make it clear for him what is the additional value for him as well: improvement of their image or financial or socia

Interview 13- Anne Springer-Rouwette

Working together with different disciplines so not the technical roads engineers on one side and the ecologists on the other side but let them work together so I think that increase the opportunities

Interview 15- Jeroen de Leeuw

. I think that when we connect the people who are great at the execution of a project to the people of the planning stage, great opportunities can be generated. If only they talk with each other's.

Appendix D: Method used in MIRO to Identify Opportunities

The identification of opportunities in MIRO using the risk metalanguage was done in the following way:

- 30 minutes were planned for each complexity category (T, O and E).
- For each category, the Project Manager directly involved in the project chooses a complexity element. Then, the 4 participants brainstorm together about possible opportunities that result from the chosen complexity element. After that, the project objectives positively affected are determined. Also, the project phase in which the opportunity can be realized is specified. This process is repeated for every project (7.5 minutes per project) and similarly for the other complexity categories.
- To make the process efficient, sticky notes were used, and the complexity elements, the project objectives and project phases were coded. The codes for the complexity elements are shown in Table 16. For example, the complexity elements were designated by T1, T2 … for the technical elements, O1, O2… for the organizational elements and so on. The project objectives were numbered 1,2, … and similarly for the 5 project phases: (1) Initiation, (2) Exploration, (3) Development, (4) Execution, and (5) Operations and Maintenance. Following is an example of how the Project Managers wrote the risk metalanguage:

T1, opportunity, 1/3/10, 2 → As a result of <Technical complexity element 1>, <opportunity> may occur, which would lead to project objectives 1, 3 and 10 during the exploration phase.

This process in the MIRO dashboard is illustrated in Figure 23 (the same applies for the organizational and external complexities):

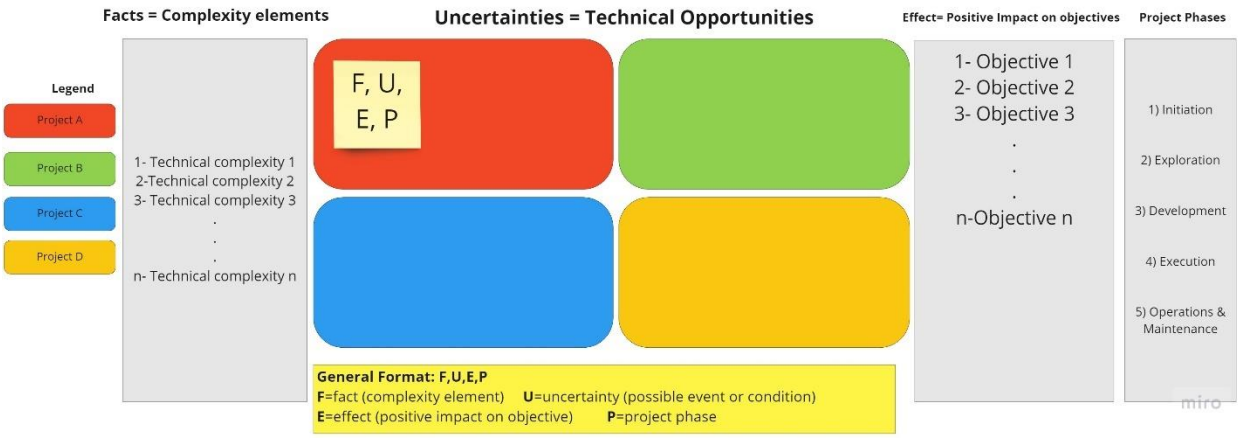


Figure 23: Process of identifying opportunities in MIRO

	Complexity elements	Codes
Technical	Size in CAPEX	T1
	High number of tasks	T2
	High variety of tasks	T3
	Dependencies between tasks	T4
	Project duration	T5
	Number of locations	T6
	Involvement of different technical disciplines	T7
	Lack of experience with technology	T8
	High number of project goals	T9
Organizational	Size of the project team	O1
	Number of contracts	O2
	Interfaces between different disciplines	O3
	High project schedule drive	O4
	Lack of resource and skills availability	O5
	Lack of HSSE awareness	O6
	Type of contract	O7
External	Number of external stakeholders	E1
	Variety of external stakeholder's perspectives	E2
	Dependencies on external stakeholders	E3
	Political influence	E4
	Interference with existing site	E5
	Level of competition	E6
	Lack of company internal support	E7

Table 16: Coding of the technical, organizational and external complexity elements

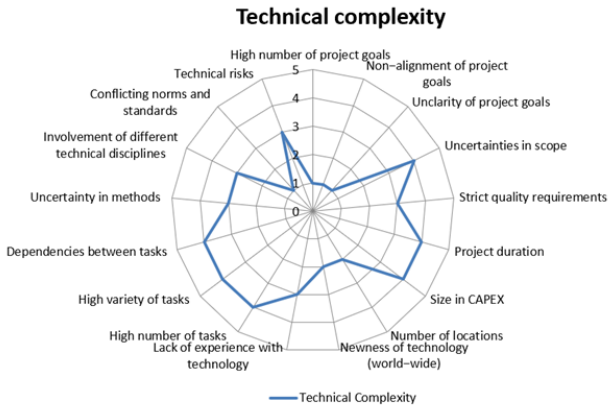
Appendix E: Results of the Complexity Assessments using the TOE Framework

In this appendix, the results of the complexity assessment using the TOE framework of the 4 selected infrastructure projects are presented. The complexity of each project was assessed by the Project Manager responsible for the project. The average scores (Figure 28) for the 4 projects were calculated to obtain the common most critical complexity elements, since the Project managers were invited to a workshop session where they can think collectively about the possible opportunities that emerge as a result of the complexities. Project A is a dike improvement project (Figure 24), and projects B (Figure 25), C (Figure 26) and E (Figure 27) are road infrastructures. The results are presented as follows:

Technical Complexity (17 elements)	Score
High number of project goals	1
Non–alignment of project goals	1
Unclarity of project goals	1
Uncertainties in scope	4
Strict quality requirements	3
Project duration	4
Size in CAPEX	4
Number of locations	2
Newness of technology (world–wide)	2
Lack of experience with technology	3
High number of tasks	4
High variety of tasks	4
Dependencies between tasks	4
Uncertainty in methods	3
Involvement of different technical disciplines	3
Conflicting norms and standards	1
Technical risks	3
average T-elements	2.765

Organizational Complexity (17 elements)	Score
High project schedule drive	2
Lack of Resource & Skills availability	2
Lack of Experience with parties involved	4
Lack of HSSE awareness	3
Interfaces between different disciplines	3
Number of financial sources	2
Number of contracts	2
Type of contract	1
Number of different nationalities	1
Number of different languages	1
Presence of JV partner	1
Involvement of different time zones	1
Size of project team	3
Incompatibility between different pm methods / tools	2
Lack of trust in project team	3
Lack of trust in contractor	1
Organizational risks	2
average O-elements	2

External Complexity (13 elements)	Score
Level of competition	3
Instability of project environment	2
Company internal strategic pressure	3
Lack of experience in the country	1
Remoteness of location	2
Interference with existing site	4
Required local content	2
Lack of company internal support	3
Political influence	4
Dependencies on external stakeholders	4
Variety of external stakeholders' perspectives	4
Number of external stakeholders	4
External risks	4
average E-elements	3.077



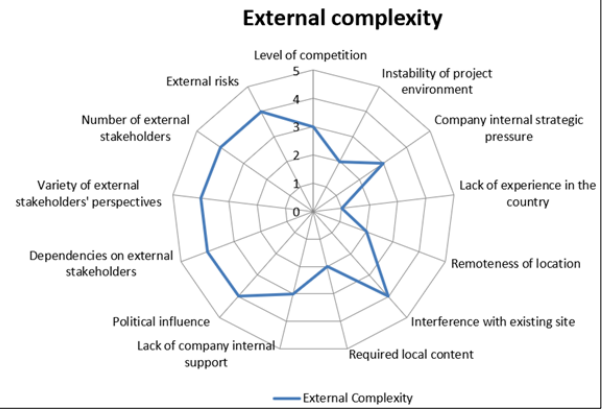


Figure 24: Results of the complexity assessment using TOE framework for project A

Technical Complexity (17 elements)	Score
High number of project goals	3
Non–alignment of project goals	2
Unclarity of project goals	2
Uncertainties in scope	2
Strict quality requirements	4
Project duration	3
Size in CAPEX	3
Number of locations	1
Newness of technology (world–wide)	1
Lack of experience with technology	1
High number of tasks	5
High variety of tasks	3
Dependencies between tasks	4
Uncertainty in methods	1
Involvement of different technical disciplines	4
Conflicting norms and standards	1
Technical risks	4
average T-elements	2.588

Organizational Complexity (17 elements)	Score
High project schedule drive	4
Lack of Resource & Skills availability	2
Lack of Experience with parties involved	2
Lack of HSSE awareness	1
Interfaces between different disciplines	5
Number of financial sources	3
Number of contracts	1
Type of contract	1
Number of different nationalities	1
Number of different languages	1
Presence of JV partner	1
Involvement of different time zones	1
Size of project team	3
Incompatibility between different pm methods / tools	2
Lack of trust in project team	1
Lack of trust in contractor	3
Organizational risks	3
average O-elements	2.059

External Complexity (13 elements)	Score
Level of competition	3
Instability of project environment	2
Company internal strategic pressure	3
Lack of experience in the country	1
Remoteness of location	1
Interference with existing site	5
Required local content	1
Lack of company internal support	1
Political influence	3
Dependencies on external stakeholders	3
Variety of external stakeholders' perspectives	3
Number of external stakeholders	5
External risks	3
average E-elements	2.615

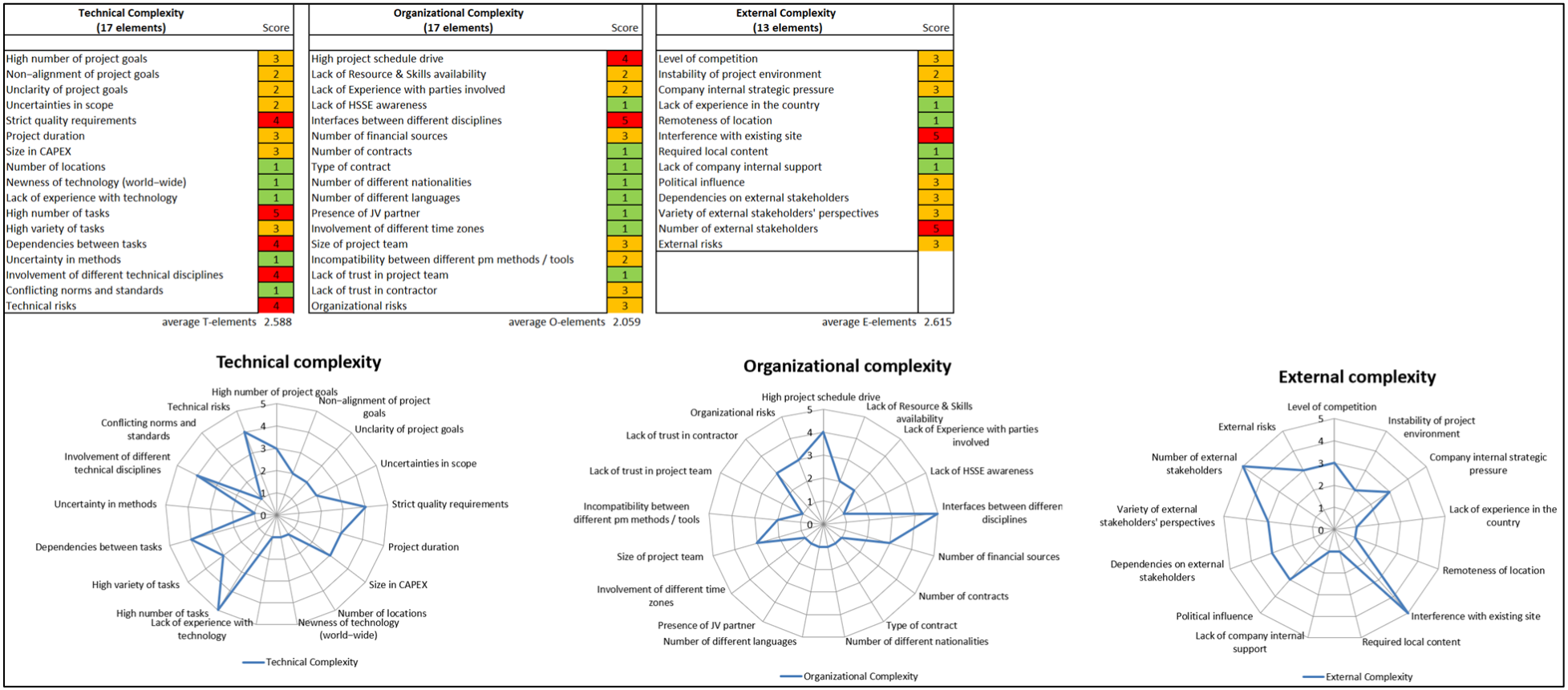


Figure 25: Results of the complexity assessment using the TOE framework for project B

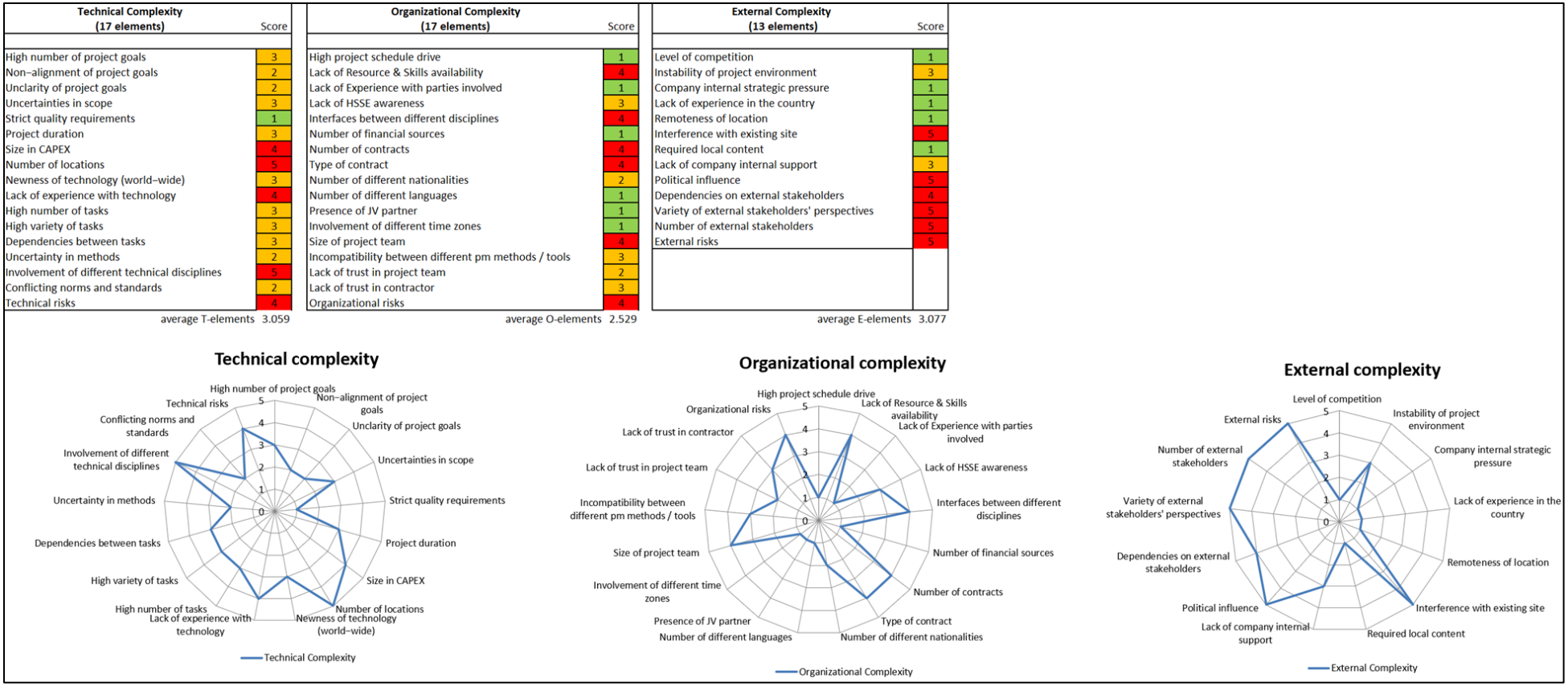


Figure 26: Results of the complexity assessment using the TOE framework for project C

Technical Complexity (17 elements)	Score
High number of project goals	5
Non–alignment of project goals	3
Unclarity of project goals	3
Uncertainties in scope	1
Strict quality requirements	4
Project duration	4
Size in CAPEX	5
Number of locations	4
Newness of technology (world–wide)	3
Lack of experience with technology	3
High number of tasks	5
High variety of tasks	5
Dependencies between tasks	4
Uncertainty in methods	3
Involvement of different technical disciplines	3
Conflicting norms and standards	3
Technical risks	4
average T-elements	3.647

Organizational Complexity (17 elements)	Score
High project schedule drive	5
Lack of Resource & Skills availability	3
Lack of Experience with parties involved	2
Lack of HSSE awareness	3
Interfaces between different disciplines	3
Number of financial sources	5
Number of contracts	5
Type of contract	4
Number of different nationalities	4
Number of different languages	3
Presence of JV partner	5
Involvement of different time zones	2
Size of project team	5
Incompatibility between different pm methods / tools	3
Lack of trust in project team	2
Lack of trust in contractor	2
Organizational risks	3
average O-elements	3.471

External Complexity (13 elements)	Score
Level of competition	4
Instability of project environment	2
Company internal strategic pressure	3
Lack of experience in the country	1
Remoteness of location	2
Interference with existing site	4
Required local content	2
Lack of company internal support	2
Political influence	4
Dependencies on external stakeholders	3
Variety of external stakeholders' perspectives	3
Number of external stakeholders	5
External risks	2
average E-elements	2.846

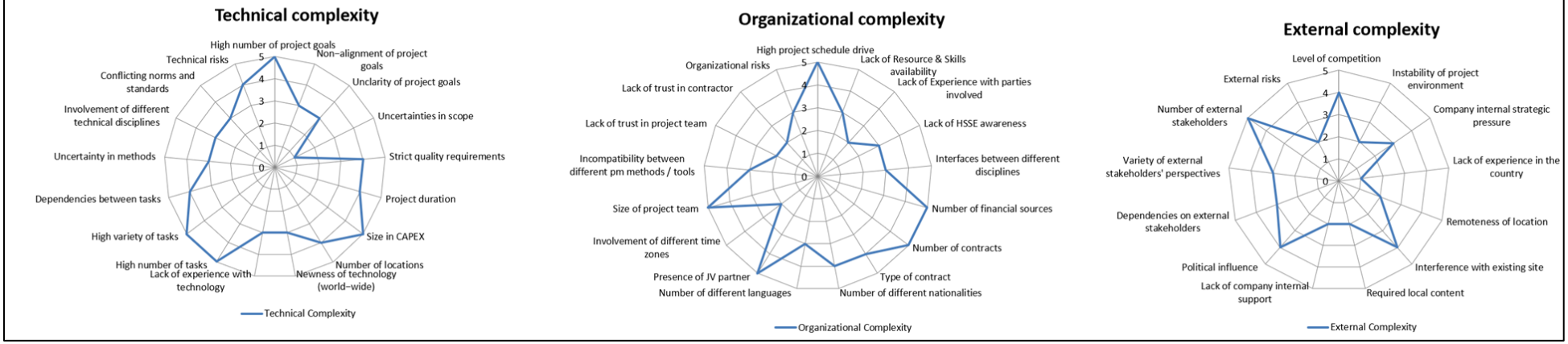


Figure 27: Results of the complexity assessment using the TOE framework for project D

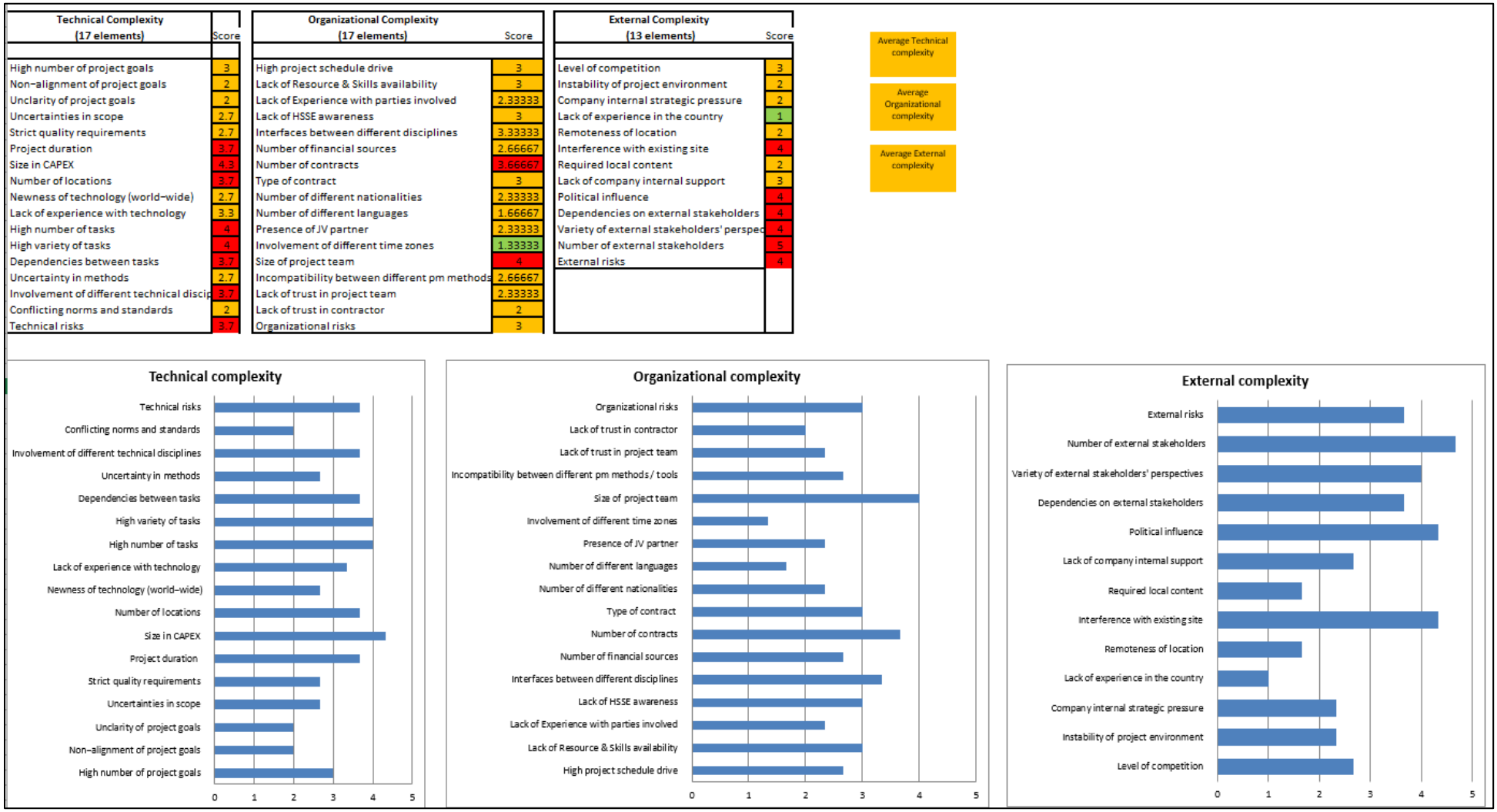


Figure 28: Average complexity elements' scores of the TOE framework for projects A, B, C and D

Appendix F: Results of the Workshop in the MIRO Dashboard

This appendix presents the results of the experts' workshop that was conducted in the MIRO dashboard. The methodology used to identify opportunities was introduced in appendix D. Using this method, the 4 Project Managers were actively participating in the dashboard through the use of sticky notes. The opportunities related to the technical, organizational and external complexities are presented Figure 29, Figure 30 and Figure 31 respectively.

The opportunities were identified using the risk metalanguage. The complexity elements are considered as facts in the project. The uncertainties are the opportunities. The consequences are the positive impacts the opportunities might have on the project objectives. The project phases are: 1) Initiation, 2) Exploration, 3) Development, 4) Execution and 5) Operations and Maintenance.

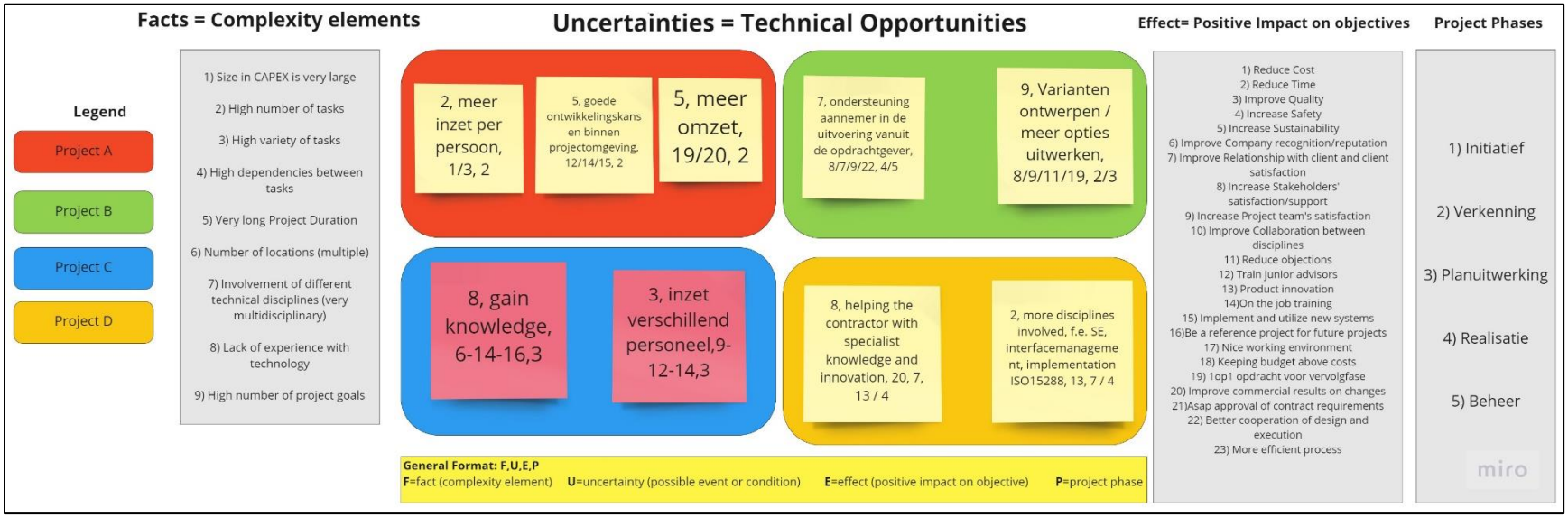


Figure 29: Technical opportunities identified in the MIRO dashboard

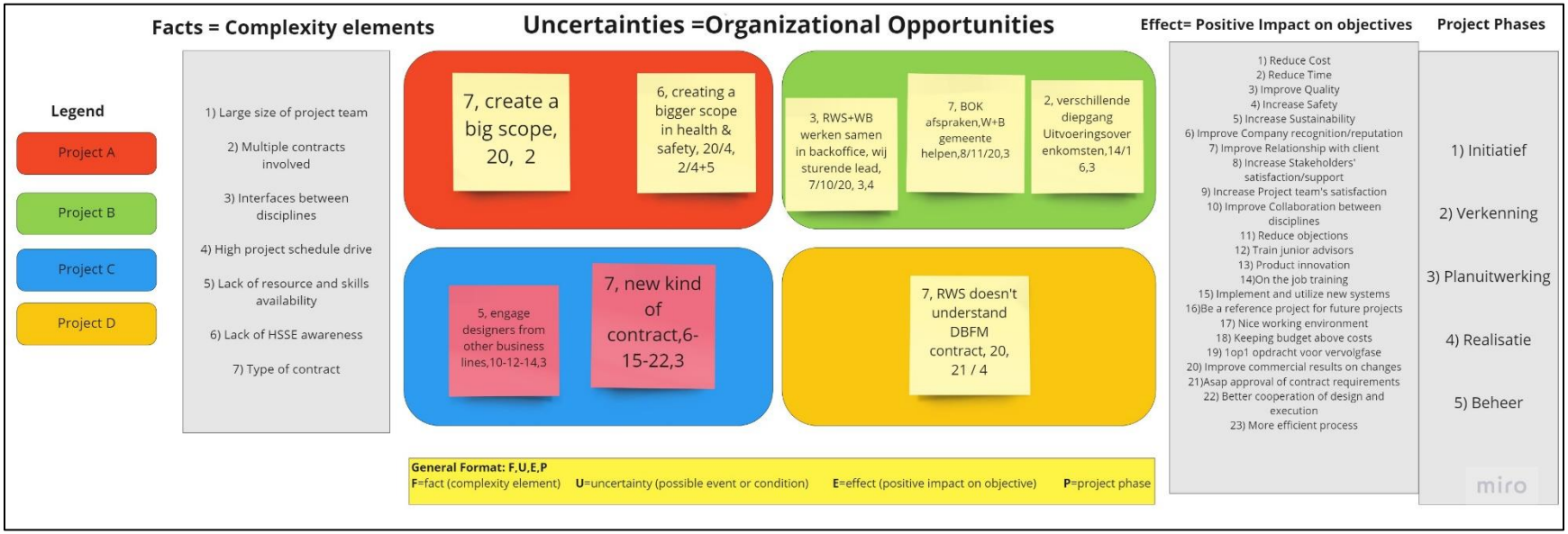


Figure 30: Organizational opportunities identified in the MIRO dashboard

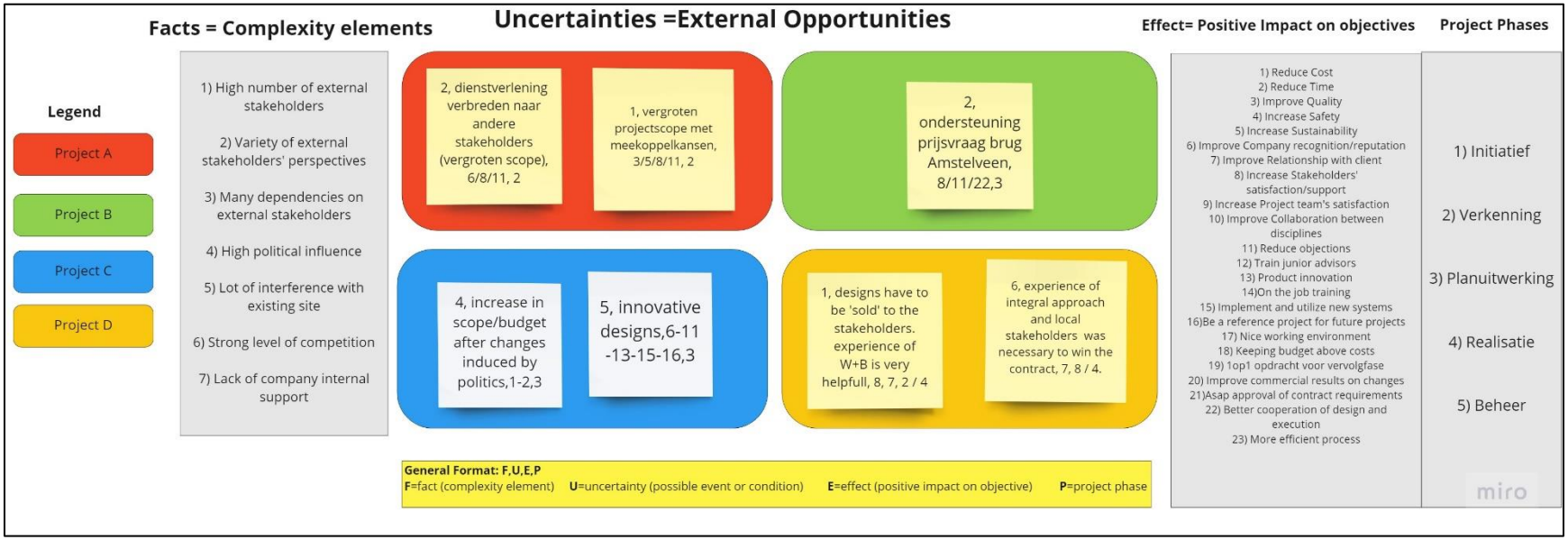


Figure 31: External opportunities identified in the MIRO dashboard

Appendix G: Opportunity Identification Techniques

The project team should set the scene from the beginning of the project on how the risk management activities will be performed and define their approach to the management of threats and opportunities in the risk management plan (RMP). After indicating the objectives that are "at risk" or which they want to achieve in the project, the team should choose the techniques that are used to identify the risks (threats and/or opportunities). The three most widely used techniques include (Hillson, 2019):

- **Benefit Tree Analysis**

This technique starts by stating a success state or benefit (reducing time, delighting the client, reducing cost etc.) and asks what drivers might lead to this positive outcome. The technique uses a backward path. Then, the uncertainties that could strengthen the drivers of success are considered opportunities. These should be managed to maximize the likelihood of success occurring. An example of this technique is presented in Figure 32.

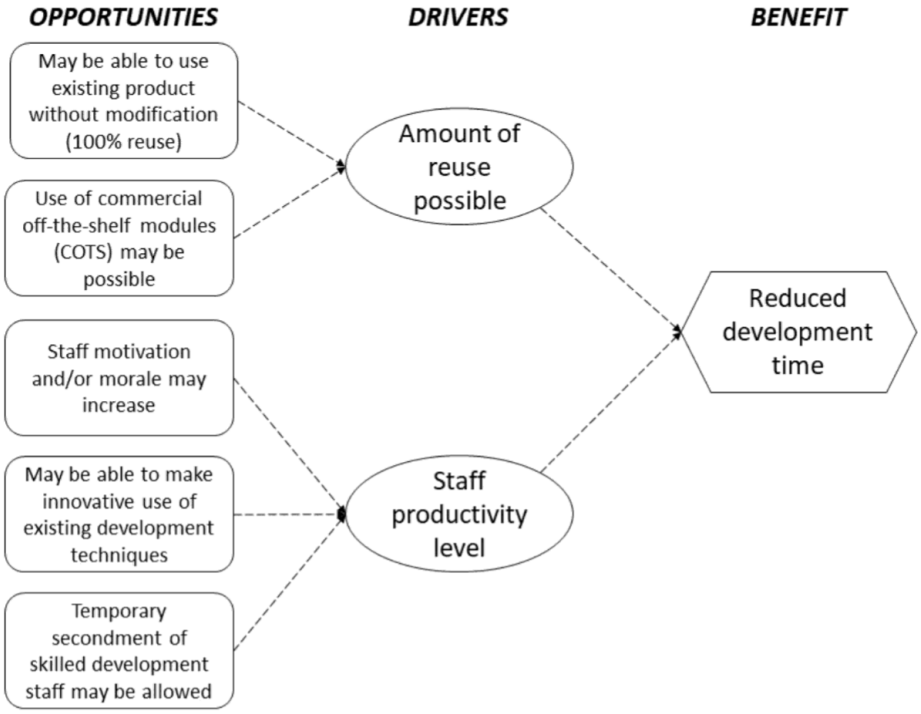


Figure 32: Example of Benefit Tree adopted from (Hillson, 2019)

- **Constraint Analysis**

This technique can usually be used to identify threats but can also be extended to identify opportunities. This is achieved by addressing the project constraints. Constraint analysis implies testing different types of constraints such as technical, resourcing, contractual, scheduling etc. and asking two main questions:

1) *"How likely is this constraint to be false?*
   Some constraints in the project are fixed and have a very low chance of changing. For instance, the budget is fixed at 1M dollars. But there may be some flexibility in other constraints —as in, all deliverables must be signed off by two senior managers. And others may just be plain wrong—such as, the project must end on 31 December this year.
2) *If it was false, how much would it affect the project's ability to achieve its objectives?*
   It may be that some constraints could indeed be relaxed or removed, but that this would not have any significant effect on the project— for example, the client said that their staff would only be available during working hours, and even if we could contact them in the evenings, it wouldn't be useful. But we might find

some flexible constraints whose removal would be really helpful to the project— as in, no contact is allowed between the project team and user representatives. But if we could ...

A false constraint is one which is imposed on the project, either externally or internally, but which might possibly be relaxed or removed. If changing the constraint would affect the project, then the constraint is risky. Because most constraints have an inhibiting effect on the project, a changeable constraint might offer an opportunity to the project.

A simple table format can be used to test project constraints, as shown in the examples in Table 17. *This is used as follows:*

1) *List all project constraints in the left-hand column. (Hint: These can often be found in standard project documentation, such as the project charter, business case, contract, statement of work, technical requirements specification, estimating database, etc.)*
2) *Identify whether each constraint might prove false (Yes/No), and whether it might affect the project if actually did turn out to be wrong (Yes/No).*
3) *Where both answers are Yes, mark the constraint as a risk (opportunity).*
4) *Rewrite risky constraints using risk metalanguage."* (Hillson, 2019)

Constraint	Could be false (Y/N)	Would matter if false (Y/N)	Convert to opportunity (Y/N)	Opportunity description (Cause/Opportunity/Effect)
Detailed design work cannot start until all high-level design is approved by client	Yes	Yes	Yes	The client requires prior approval of high-level design before detailed design can proceed. The client may agree to approve and release low-risk design elements for development before full design approval. This would save time in the development phase.
The development team cannot be increased due to a recruitment freeze.	Yes	Yes	Yes	The current recruitment freeze prevents additional staff being hired. If an urgent need for a specific skill became evident, it might be possible to negotiate a one-off recruitment, preventing project delay.

Table 17: Example Constraints Analysis technique adopted from (Hillson, 2019)

- **Force-Field Analysis**

Force-Field Analysis is a process to identify the positive and/or negative influences on achievement of objectives. It constitutes of the following steps:

1) *"State the project objective being analyzed.*
2) *List all forces or influences which support or drive achievement of the objective, and those forces or influences which oppose or restrain change.*
3) *Rate the strength of each force, using a scale from 1 (Weak) to 5 (Strong), and draw a force-field diagram for the objective, with the size of each force reflecting its strength.*
4) *Assess the current situation to determine the balance of existing forces.*
5) *Consider what risks might affect the various forces:*

○ *Threats are uncertainties that would either strengthen a restraining force or reduce a driving force, making it harder to achieve the project objective.*

○ *Opportunities are uncertainties that would either weaken a restraining force or strengthen a driving force, making it easier to achieve the project objective.*

6) *Estimate the effect of each risk on the driving and restraining forces.*
7) *Reassess the balance of forces in relation to the selected objective, taking account of identified risks"* (Hillson, 2019)

An example of Force-Field Analysis diagram is shown in Figure 33 for a project that aims to introduce new production hardware. For this objective, threats would include any uncertainty that might reduce customer demand, lead to lower productivity gains, or increase cost. Example opportunities include uncertainties that might lead to lower staff resistance, less environmental impact, or make maintenance easier/cheaper. The challenge for people using this technique is to be specific about the threats and opportunities that might affect the balance of forces. The advantage is that Force-Field Analysis naturally leads to identification of both threats and opportunities as part of the same analytical process and can also be used to just identify threats and opportunities separately.

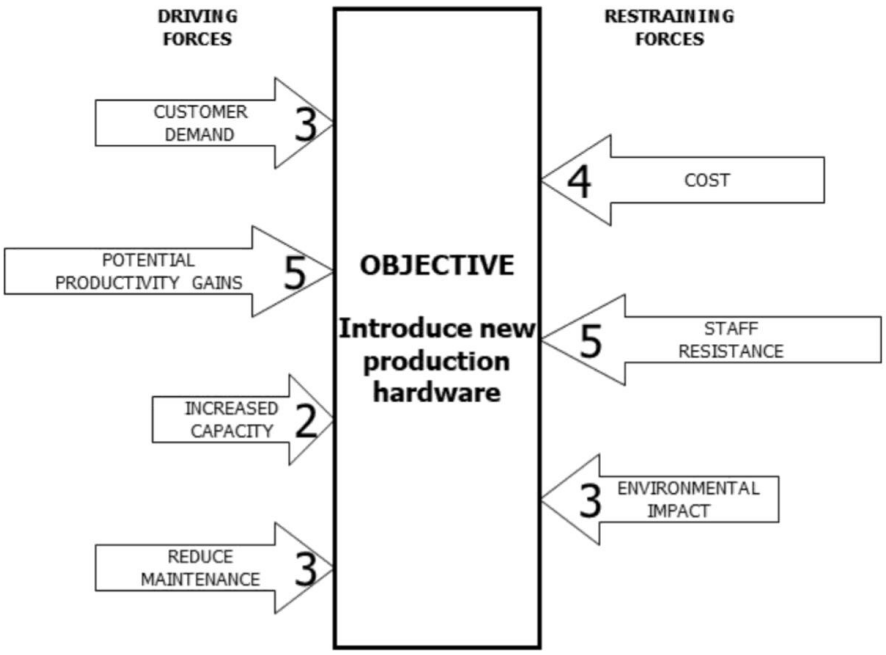


Figure 33: Example of a Force-Field Analysis Diagram adopted by (Hillson, 2019)

Appendix H: Validation

The proposed technique in Section 6.2 and the roadmap in Section 6.3 were validated through feedbacks collected from 3 Project Managers at Witteveen+Bos. The criteria, comments and suggestions were collected and summarized in Table 18 (CDOIT) and Table 19 (roadmap).

Criteria	Comments	Suggestions
Is the technique understandable?	The technique needs some improvements in the second step to make it more understandable.	When people start using the technique, it should be clear what is the definition of a strength and a weakness, and how these can be identified. Also, the step from turning a weakness into a strength is difficult to understand and should be further explained.
Does the technique provide a clear goal?	The technique provides a clear goal of exploiting complexities by identifying the opportunities that result from the complexity element of the TOE framework.	---
Are the steps logical?	The steps are logical	---
Is technique appropriate to use in practice?	The technique is practical and appropriate to use if some considerations are taken into account.	An implementation guideline is needed to follow the steps accordingly. Another consideration is the amount of time needed to properly use the technique and the costs associated. It is nice to use this technique before the start of the project to show the benefits to the client, as this might help in winning the project. But it would be difficult to approach external stakeholders before the start of the project and know all their requirements.

Table 18: Criteria for validation of the CDOIT

Criteria	Comments	Suggestions
Is the roadmap understandable	The roadmap is understandable but some clarifications can be added.	In the first block (the stimulator factors), the connection between the moment in the project timeline and the types of opportunities is missing. It can be added as an 8th factor.
Does the roadmap provide a clear goal?	The roadmap provides a clear goal of planning how opportunities will be identified and managed.	---

Is the roadmap appropriate to follow?	The roadmap is appropriate to follow for how to start with identifying opportunities, but further considerations should be included.	It is important to extend the roadmap and focus on the opportunity session, how the opportunities are then realized and the decision process on how to go for an opportunity or not. A step could be added which is to evaluate the opportunities that were realized to see what effect they actually had and whether they met the expectations of the project team. It's also important to consider opportunities from previous projects and share them in the new project. An implementation guideline can help in applying the roadmap

Table 19: Criteria for evaluation of the roadmap

Appendix I: Implementation Guideline for the CDOIT

The Complexity-Driven Opportunity Identification Technique (CDOIT) is composed of 3 major steps: 1) Assessment of the project complexity using the TOE framework, 2) Identifying the requirements needed to exploit the complexities, and 3) Identifying the opportunities that result from each complexity element. A guideline on how to complete every step is provided in this appendix. As a reminder, these steps could be repeated at least at the beginning of every phase, as suggested by the CDOIT.

Step 1: Assessing project complexity by the project team using the TOE framework

At the beginning of the project phase, the complexity of the project should be assessed by the members of the project team to account for the subjective character of complexity. The average scores are then calculated to determine the complexity elements that can highly contribute the project's complexity. The focus would be on exploiting these elements since they are considered most critical and can affect the project in a negative way. Scoring the complexity elements of the TOE framework can be done by following the instructions in the attached Excel template (double click on the Excel icon):

TOE_assessment_file.xlsm

The team can make a list of the technical, organizational and external complexity elements that scored 3 or higher (elements that have some to high potential of contributing to project complexity):

Technical (T)	Organizational (O)	External E
T1	O1	E1
T2	O2	E2
…	…	…

Step 2: Identifying the requirements needed to exploit the complexities

Four main requirements should be identified based on this study:

- Strengths and weaknesses of the project team or organization with regard to the project at hand.
- External weaknesses related to the client, the contractor, the stakeholders or the contract.
- Available (different types of) resources in the organization that could benefit the project or get some benefits as a result of being deployed in the project.
- Project's scope specifics with the goals of all stakeholders

Internal Strengths	Internal Weaknesses	External Weaknesses
1.	1.	1.
2.	2.	2.
…	…	…

Human resources	Intellectual resources	Other types of resources	…
1.	1.	1.	1.
2.	2.	2.	2.
…	…	…	…

Detailed scope of the project:

_____

_____

Stakeholders	Requirements
1.	1. 2. …
2.	1. 2. …
…	…

<u>Step 3:</u> Identifying the opportunities that result from each complexity elements

For this step, 3 main inputs are needed:

1) The complexity elements identified in step 1 and listed in the table according to every category (Technical, Organizational and External).
2) The requirements identified in step 2.
3) The project objectives that the team should have identified at the beginning of the project (as proposed by the roadmap). Five project objectives are listed as examples, and more should be identified based on the project at hand.

Project objectives
1. Reduce cost
2. Reduce time
3. Improve quality
4. Improve company recognition/reputation
5. Increase stakeholders' satisfaction/support
6. …
…

Opportunities can next be identified for every complexity category using the risk metalanguage in the following form:

As a result of <**complexity element *x***>,

<**opportunity**> may occur,

which would lead to <**one or more positive effects on objective(s**)>

and by considering the five suggested possibilities:

1. Exploiting complexities using internal strengths:

Complexity + strength (internal) → opportunity → positive impact (s)

2. Exploiting complexities by taking advantage of external weaknesses combined with internal strengths:

Complexity + weakness (external) + strength (internal) → opportunity → positive impact(s)

3. Exploiting complexities by aiming to turn internal weaknesses to strengths:

Complexity + weakness (internal) → opportunity → weakness become strength + positive impact(s)

4. Exploiting complexities through a better use of available resources:

Complexity + better use of resources → opportunity → positive impact(s)

5. Exploiting complexities by increasing the scope of the project:

Complexity → increase in scope (opportunity) → positive impact(s)

The procedure that should be followed:

1) Select the complexity element to be exploited (technical, organizational or external).
2) Identify the opportunities that can result using the 5 suggested possibilities.
3) Determine the positive impact on the project objective (s).

Technical Complexities (Facts)	Opportunities	Positive impact on objective(s) (Consequence)
T1	…	Objective *x*, *y* …
T2	…	Objective *x*, *y* …
…	…	…

Organizational Complexities (Facts)	Opportunities	Positive impact on objective(s) (Consequence)
O1	…	Objective *x*, *y* …
O2	…	Objective *x*, *y* …
…	…	…

External Complexities (Facts)	Opportunities	Positive impact on objective(s) (Consequence)
E1	…	Objective *x*, *y* …
E2	…	Objective *x*, *y* …
…	…	…

Appendix J: Implementation guideline for the proposed roadmap

The implementation of opportunity management in practice follows the same process as risk management (managing threats and opportunities). The most important aspects to consider based on this study (stimulating factors) are highlighted in the planning and identification phases (1 and 2). Also, identifying and managing opportunities starts by having a common risk language in the organization. The definition of opportunity as a risk along with the risk metalanguage which separates the opportunity from its cause and consequence are presented. This foundation with the 5 stages of opportunity management is necessary to guide the implementation of opportunity management, as shown in Figure 34:

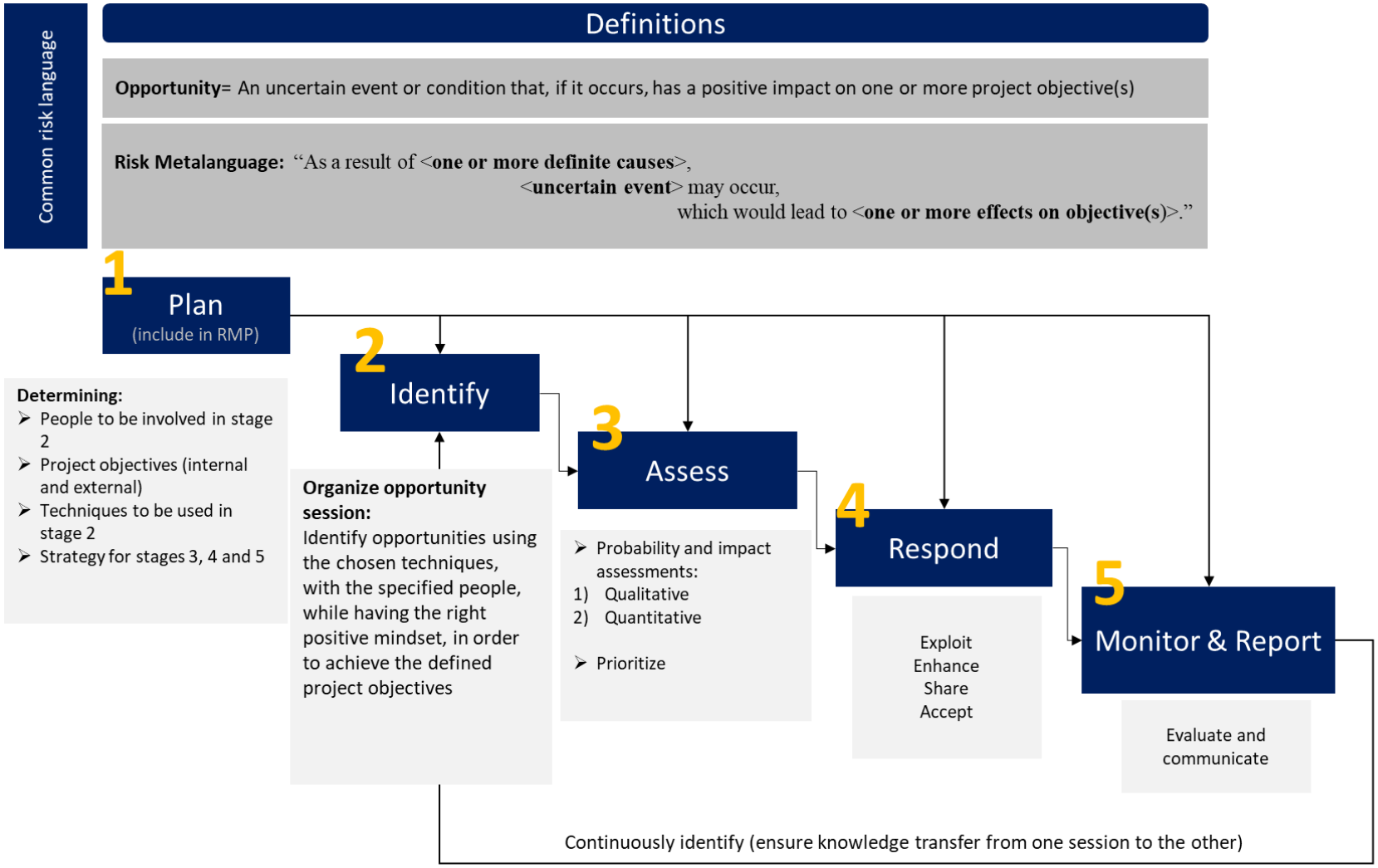


Figure 34: Implementing Opportunity Management