# Using critical success factors and Q methodology to discover perspectives on project risk management within a construction organisation

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# USING CRITICAL SUCCESS FACTORS AND Q METHODOLOGY TO DISCOVER PERSPECTIVES ON PROJECT RISK MANAGEMENT WITHIN A CONSTRUCTION ORGANISATION

by

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# PREFACE

Firstly, I would like to thank my TU Delft committee. Thank you to Prof. Hertogh who started as my chairman and to Prof. Bakker who kindly took over. Thank you to Dr. Leijten and Dr. Ökmen for their advice and encouragement during this research project.

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# EXECUTIVE SUMMARY

Risk management is a vital process in the construction of large projects. It is necessary to protect the success of the project, the budget, the project timeline and the reputation of an organisation. Many tools exist to identify, measure and track risks. Risk management processes take place at all phases of a project and require input from employees at all levels of an organisation. Alongside the tools and techniques which exist to support risk management, it is also a process which depends on people's attitudes and decisions, their use of the available tools and how they follow procedures. Risk management is a "philosophy", beyond the quantitative tools and guidelines which exist. Attitude to risk is linked to personal traits such as personality, professional experience, age and gender.

This study sought to identify the perspectives which exist amongst a group of managers from a main contractor organisation with respect to what is important to risk management. Understanding the perspectives on what is important to risk management may help the organisation improve their risk management process as a whole. This research project was conducted at a main contractor organisation based in the Netherlands. Data was collected from managers who had all worked or were currently working on the same project, referred to as 'Project A'.

This project used Q methodology to discover perspectives on what is important to risk management. Q methodology allows the subjective opinions of individuals to be studied and groups of common perspectives to be described. Respondents are asked to do an activity in which they sort and rank a set of statements to illustrate their opinion on a particular topic. One of the first steps of a Q study is to create the Q set, the statements which respondents will rank. It was decided that the Q set would be a list of critical success factors of risk management. Critical success factors are activities which support the overall task of risk management, a literature study was conducted to identify these factors. A variety of factors were found, covering areas such as the organisational strategy, top management, culture, the role of employees, technical tools and resources available and involvement of external parties. A total of 78 items found in literature were narrowed down to a shortlist of 27 using three requirements set by the researcher. Next, these 27 were presented to the risk manager, who advised that five items be removed and three new items added given the characteristics of Project A, resulting in the 25 statements in the Q set.

A total of 15 managers performed the Q sorting question, five from each of three functional teams within the project, the design team, the execution team and the supporting team. The respondents were asked to rank the Q set along a scale, from least important to most important, when considering the sorting instruction, which was: *"In order to perform project risk management it is important to have/do..."*. After the Q sort had been completed, the respondents were interviewed and were asked to motivate the decisions they made when ranking the statements and explain why they considered items to be most or least important.

PQMethod (version 2.35) was used to analyse the quantitative data from the Q sorting activities. Factor analysis and factor rotation are used to develop clusters of respondents who have similar Q sort response charts. A total of three factors, or perspectives, were taken to the next stage of the study, these contained six, five and three of the respondents respectively and one respondent did not belong to any of the perspectives. The cumulative explained variance was 54%.

The interview transcripts were used with the software output to describe and compare the three perspectives. Plots of the Z scores are presented, showing the five most and least important statements for each perspective. Quotes from the interviews were used to enrich the discussion of the results. The three perspectives were named and are summarised below:

> Experience and Belief (Perspective 1) - This perspective values the personal expertise of the individual and that each person believes in the benefits of the risk management process. Other soft skills, such as risk culture and clear and honest communication, are also important to this perspective, along with a clear long-term strategy for the risk management.
>
> Procedures and Leaders (Perspective 2) - This perspective judges the consistent application of procedures, it's integration with other project management activities and the leadership actions of both the risk manager and top management to be the most important features of risk management.
>
> Culture and Communication (Perspective 3) - This perspective sees the risk culture as the cornerstone of risk management. They consider that a healthy risk culture, supported by clear and honest communication, can enable other processes of risk management to be enacted smoothly.

On average, the statements *Project organisation risk culture* and *Integration of risk management with other project management activities* achieved the two highest Z scores. The statements *Shared understanding and acceptance of the key concepts of risk management* and *Regular training to enhance risk management skills* received the lowest average Z scores. The relationship between the perspectives and the functional team to which a respondent belonged was explored, along with the perspectives and the number of years of experience a respondent had. Discussion was provided on two topics which came up frequently in the interviews but did not strictly fall under the scope of the Q sort, namely the complexity of risk management and the documentation of risks.

The results of the research were used to make recommendations to the organisation to improve their risk management. Future research could include repeating the study with a larger and more diverse group of respondents and investigating the links between perspectives and other personal characteristics such as personality type.

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# 1

# INTRODUCTION

## 1.1. AN INTRODUCTION TO RISK MANAGEMENT

Uncertainty can be defined as “the absence of information required for the decision that needs to be taken at a point in time" [1, p.347]. A risk is a foreseeable and quantifiable event [2] which, if it occurs, can cause a plan or project to turn out differently than expected [3]. Risk is “uncertainty that matters", not every uncertainty is a risk but risk is always uncertain [4, p.6]. Risks can be positive or negative meaning they can pose either opportunities or threats to an objective [4–6].

A project is a unique, temporary venture which typically has a fixed time period, cost or scope. Risks are intrinsic to projects due to the uncertainty associated with doing something for the first time [7]. The construction industry is a project based industry, this is what makes risks and risk management so integral to construction. In a construction project, risks can come from any number of aspects, sources could be physical, environmental, design, logistics, financial, legal, political, construction and operation risks [8]. In addition to this, the construction industry is high risk “due to the nature of construction business activities, processes, environment and organization" [8, p.31]. Large projects in particular are “high-stakes games characterized by substantial irreversible commitments, skewed reward structures in case of success, and high probabilities of failure." [3, p.437]. In a construction project, risk is generally defined as any event which could influence the project objectives of time, cost and quality [8]. It is typical for large projects to span decades making it very difficult to foresee some risks and in addition, risks can sometimes combine and snowball causing greater consequences to a project [3].

Project risk management describes the procedures, practices and tools used to manage project risk [2]. Risk management is not about eliminating uncertainty but instead reducing the negative effects of risks [7]. The process typically starts with defining sources of uncertainty, so called risk identification, next the risks are assessed and analysed, enabling the consequences of the risks to be estimated [9]. Risk response strategies are then selected, these can be “one or any combination of risk retention, risk transfer,

risk reduction, and risk avoidance" [8, p.34]. Risk monitoring is necessary to track the risk and check whether the risk has changed in likelihood or if new risk consequences have arisen. This process of identification, analysis, response planning and monitoring should be repeated throughout the project's life cycle to make certain that the project objectives are met [9]. Despite the fact that risk can provide either opportunities or threats, project risk management processes and practices are for the most part focused on threats to objectives [5].

There are a number of reasons why organisations do risk management. Within any organisation, objectives exist at all levels, be it financial, safety, regulatory, portfolio or project level [4]. Since a risk can influence objectives, risk management is relevant to any aspect of an organisation where objectives exist [4]. In reality this means risk management could be applied to all levels of an organisation and all activities which they do, not only technical or project delivery outputs [4]. Nicholas and Steyn [10] go so far as to say that project management itself is fundamentally risk management. Within the construction industry, project risk management is typically aimed towards supporting the client's objectives, but risk management is also vital to the contractor, in terms of limiting professional indemnity costs and protecting their reputation [8]. Furthermore, risk management is "mandated by legislation, industry standards, and internal guidelines" [11, p.731].

In the past, the construction industry's approach to risk management was based on individual intuition, judgement and experience, with few formal risk management techniques being used [8]. The nature of construction projects today makes risk management challenging, especially when compared to the industry a few decades ago, the projects of today are much more complex.

Projects which have one or more of the following features are more likely to require a detailed risk management process: large projects, long planning horizons, substantial resources, significant novelty and complexity [12]. Large construction projects in the modern age often have all of these features. Other aspects which increase the need for an effective risk management process are the competition of the construction market, client requirements and political-economic problems [13]. Kwak [14, p.6] states "As the size and complexity of the project increases, the effort for risk management increases exponentially". This already difficult task is compounded by the fact that a long project duration makes it likely that many aspects relating to the project will change over time, in addition "the scenarios are numerous due to sensitivity of projects to uncontrollable risks stemming from the changes in the macro-environment, existence of high number of parties involved in the project value chain, and one-off nature of the construction process" [9, p.42].

The fact that the construction industry is geared towards a 'just-in-time' delivery to the client impacts upon a contractor's ability to have sufficient time to perform detailed risk analysis, "the more powerful and sophisticated the technique, the more data and time is required" [8, p.37]. Akintoye and Macleod [8] surveyed contractors and project management practices and found that some gave project time constraint as one of the leading reasons for not using risk analysis and management techniques.

Dikmen et al. [15] describe how the major challenges of risk management are caused by poor definition of risk and unclear decisions on how or why risks should be man-

aged in construction projects. They go on to say that risk management is often seen as a process to better quantify risk impacts and perform contingency management but it should also be used to effectively monitor risks, communicate risks between project participants and create a corporate risk memory to enable knowledge sharing on how best to manage risks [15]. Knowledge of risk management is "constantly developing" [7, p.851] and contractors find effective implementation challenging [16]. Wu et al. [7] suggests this could be due to the fragmented and disorganised nature of the construction industry.

The nature of the industry creates challenging conditions to perform risk management, often due to the aforementioned issues of project complexity, project size and tight delivery schedules. Despite this, established construction organisations have the opportunity to learn and develop across their portfolio of projects and risk management is one area in which opportunities for improvement can be explored.

## 1.2. THE RELATION BETWEEN PROJECT RISK MANAGEMENT AND PROJECT SUCCESS

Research has sought to find a link between the use of risk management and the success of a project. A 1997 survey of construction practitioners concluded that risk management was "essential to construction activities in minimizing losses and enhancing profitability" [8, p.31]. More recently in 2006, a study of 60 project management professionals found that risk management is the most important skill required for projects with high uncertainty [17]. Dikmen et al. [9, p.42] describe how a "risk-driven approach" is a critical success factor of construction projects. This view is supported by practitioners in the field, many of whom believe that risk management increases the probability of project success [18]. Wu et al. [7] and Zwikael and Ahn [19] both describe the critical nature of risk management in relation to successfully achieving project objectives . De Bakker et al. [20] found that individual project risk management activities supported the success of IT projects.

In a more general sense, returning to the definition of risk as "uncertainty that matters" [4, p.6], risk is coupled to the attainment of objectives because the aim is to manage risks which could affect project objectives. In turn, "this provides a clear link between risk management and success, delivery, value and benefits. Where risks are effectively managed, the chances of achieving objectives will be optimised" [4, p.6]. Baloi and Price [16] state that there is a direct relationship between effective risk management and the achievement of project success criteria since risks are evaluated by their potential effect on project objectives, Zou et al. [21] found a similar link exists in construction projects.

Looking to industry standards, the ISO 31000, an international standard for risk management, lists the first principle of risk management: "RM creates and protects value" [22]. By protecting value, it can be deduced that projects are likely to be successful, again supporting the link between risk management and project success.

Other research exists which questions the existence of a link between risk management and project success. Besner and Hobbs [2] describe how there is a link between uncertainty and failure, or certainty and success, but the link between risk management and success is not as clear. Voetsch et al. [23] surveyed professionals from a variety of

industries and found that although there existed a high level of visibility and a positive perception or risk management in the organisations where the professionals worked, there seemed to be a gap between the interest for and resource allocation and training to risk management, “a lot of people talk about risk, but not so many do something about it" [2].

Willumsen et al. [11] performed a study of project risk management as a means of creating value. They describe how despite the existence of many guidelines on project risk management, these are not built upon empirical evidence of their link to improving success [11]. This paper goes on to describe the limitations of such research. Finding a link between risk management and project success is problematic given the difficulties associated with determining the effects of risk management, the influence of other factors, the interdependencies between risk management and other processes in the organisation, the opportunity to repeat such studies in a project based industry and the question of how to even define and measure project success [11].

The research of Heravi and Gholami [24] looked into the effects of project risk management maturity and organisational learning on the cost, time, and quality of power plant construction projects. They found that although risk management improved outcomes of cost and quality, it did not reduce the project duration and could increase it. If the risk management process is not efficient or well integrated with other processes, it can have negative effects on project duration.

Despite the doubt in some research as to whether risk management improves project success, the industry has embraced risk management and it is a fundamental process of most construction organisations. For organisations, risk management is necessary to ensure they achieve their goals, therefore efforts made towards making risk management more effective should be welcomed.

## 1.3. PROBLEM DEFINITION

Research has identified inadequate project risk management as a contributory factor to poor performance of construction projects [5]. Despite the existence of detailed risk management procedures, guidelines and organisational processes in the construction industry, these are sometimes not applied consistently or can still be improved [18]. Alongside this, the fact that construction projects are getting larger and more complex adds to the need to seek improvement of their risk management [25].

Risk management is frequently seen as a separate entity from other project management processes such as planning and control, both in practice and in project management standards [2]. Standards describe how risk management has its “own dedicated set of practices and tools" [2, p.231]. Research has outlined the need to move towards a more integrated risk management approach [26, 27]. Jaafari [26, p.90] describes how professionals should not see risk analysis as a stand alone activity but instead appreciate that it “permeates all decisions” and must therefore feed into any decision making process. Jaafari [26, p.89] also explains how risk management is a “philosophy”, it does not only refer to the quantitative tools and guidelines which exist. This philosophical background to the topic is not well defined or understood [9].

One aspect of this philosophy is the way in which people think about risk management including what they consider to be important to successfully perform risk man-

agement. Each manager has their own approach to risk both at work and in their own personal life, "It is obvious that people differ in the way they resolve work-related or personal decisions that involve risk and uncertainty" [28, p.263]. Existing research links an individual's approach to risk to a variety of personal aspects including personality, professional experience, age and gender [29, 30].

Within an organisation, a team of people must work with each other effectively and ultimately follow the organisation's risk management guidelines and procedures but each person will have their own approach to risk and hold their own opinion on risk management. It is not known what different opinions or perspectives exist on the topic of risk management. It is not known which tools, procedures or behaviours managers find to be most important in the implementation of risk management or which aspects managers consider to be less helpful or even redundant.

Understanding the perspectives of managers with respect to risk management could help organisations improve their processes and improve the integration of risk management in practice. Discovering what managers consider to be important in risk management could help risk management implementation.

## 1.4. RESEARCH QUESTION

From the problem definition, the following research question is posed:

> *How can the risk management of an organisation be improved through better understanding of the perspectives on risk management held by managers?*

This question is further divided into three sub-questions:

> *What are the critical success factors of risk management?*
>
> *What perspectives can be derived by asking managers to rank critical success factors of risk management?*
>
> *What recommendations can be made to the organisation to improve their risk management?*

## 1.5. RESEARCH SCOPE

This research project was conducted in collaboration with Ballast Nedam, a large contractor which is well established in the Netherlands and is the 9th largest international contractor in Europe [31]. The data was collected from Ballast Nedam employees who had worked on the same project in the Netherlands, known herein as 'Project A'. Only Ballast Nedam employees were interviewed and the nature of the project and the organisation of Ballast Nedam meant that the scope concerns the Dutch construction industry only. The respondents were asked in their answers to consider the project level risk management only, rather than portfolio risk management or financial risk management. The majority of the employees interviewed were relatively experienced, meaning they would have worked on a variety of projects, not just Project A, it was therefore expected that they would draw upon their knowledge and experience from other projects.

### 1.5.1. FUNCTIONAL TEAMS

Certain teams exist within Project A. Firstly, there is the design team, these are the engineers responsible for designing the structures which will form the new road and tunnel system. Secondly, the execution team or site team is responsible for constructing the engineers' design. Finally, the support team represent the professionals who work on other important aspects of the project, including quality control, obtaining permits, planning and financial control.

Many interdependencies exist between these three teams. The execution team relies on the design team to assist them if something on site prevents them from executing exactly what is specified on the drawings. Complex site conditions sometimes require the design team to produce alternative solutions to keep the construction progressing. The execution team relies on the support team to obtain the relevant permits to enable them to do the construction and to monitor the quality of the build to check that specifications are met. The design team relies on the execution team to inform them of practical limitations of their design, sometimes the order in which structures are built in reality affects their interfaces with other structures.

Managers from each of the three teams were interviewed for this research and the possible relationship between the functional team to which they belong and their perspective on risk management was explored.

## 1.6. RESEARCH METHOD

The research project used Q methodology to study what managers from different functional teams, all of whom had worked on this same project, regard to be the most important success factors of project risk management.

It was decided to perform the research using Q methodology because it "provides a foundation for the systematic study of subjectivity" [32]. The method involves interviewing subjects and asking them to prioritise and group certain items. The results are then quantified by examining which items are prioritised most or least by all subjects. The method aims to analyse the "similarities and differences in subjective viewpoints of individuals" [33].

The reason for using Q methodology is that it allows qualitative data, such as opinions, to be analysed quantitatively in order to typify and group the range of opinions held by the subjects. In this way, certain viewpoints can be identified and defined.

The research is reproducible as it followed the standard steps of Q methodology. The PQMethodology software ensures statistical validity when the factor analysis is used to identify particular typologies of viewpoints. Although conducted within the bounds of one project within one organisation, the fact that the managers interviewed have experience on a range of other projects provided a sound degree of generalisation.

An alternative method which could have been used to research the topic is a survey. This would have produced purely quantitative results and would not have enabled managers to motivate their decisions, making it hard to understand their opinions on the topic. Furthermore, survey research requires many respondents which was not possible to obtain in this project.

Semi-structured interviews is also an alternative method. This would have allowed respondents to explain their opinions in full and would allow freedom for the respondent

to mention anything they thought relevant. The disadvantage of this method is that it is time consuming and produces a large amount of purely qualitative data which must be coded and analysed [34]. The analysis of qualitative data allows subjectivity of the researcher to impact the results.

The first step was to perform a literature review to identify the critical success factors of project risk management. A consultation with the risk manager of the project was then held to verify the critical success factors found by the literature review and identify any which were missing. From these two activities the list of items which was used to perform the Q-sort, the Q set, was derived.

The second step was to perform interviews with managers from different functional teams, namely the design team, the execution team and the support team on Project A. The organisation provided the time of 15 of their employees to this research, each of whom did the Q sort activity and interview. The subjects were asked to perform the Q-sort and in doing so they each ordered the success factors of project risk management from most to least important. Follow up interview questions sought to understand their reasoning and opinions with respect to their personal choices on performing the Q-sort. Interview audio was recorded for use in the analysis phase.

Next, the software PQMethod was used to analyse the Q-sort data and attempt to identify particular viewpoints on what the most important key success factors of risk management are. These viewpoints were 'typified' and the audio from the interviews was used to describe the reasoning behind them.

Finally, the analysis results were examined to see if and how the viewpoints of managers differ. In this way the research question was answered.

## 1.7. Q METHODOLOGY

Q methodolody, or simply 'Q', was created and developed by William Stephenson in the 1930s [35]. Having studied both physics and psychology, Stephenson wanted to bring structure to the study of subjectivity [36].

Every person involved in a particular project or discussion will hold their own opinion. Their viewpoint or opinion is not right or wrong, but can only be described as subjective in that it originates from their own "internal frame of reference" [35]. Q is used to investigate the range of opinions which exist within a population on a certain topic. Q method can be used in any research field where subjectivity is an issue, including attitude measurement [37]. Steven Brown, one of Stephenson's students who made a large contribution to the field of Q, described how "(o)nly subjective opinions are at issue in Q, and although they are typically unprovable, they can nonetheless be shown to have structure and form, and it is the task of Q technique to render this form manifest for purposes of observation and study." [38, p.58].

In a Q study, participants are asked to prioritise a set of statements along a scale to reflect their opinion on a particular topic. These statements may be ranked from 'strongly disagree' to 'strongly agree' or 'least important' to 'most important'. The researcher then processes these rankings using statistical analysis and similarities between individual rankings are able to be quantified. The patterns uncovered by the statistical analysis are used to describe distinct opinions or perspectives on the subject in question. These perspectives can be used to identify consensus and contrasts in views, preferences for a

certain solution or understand conflict among a group [39, 40].

The purpose of Q method is not to identify which variables or statements are the most important overall, but to get insights into why 'statement A' is more important than 'statement B', thus enabling the researcher to describe relative groups of opinion.

Q is a discourse analysis technique, it is one method which exists to analyse texts and uncover patterns or meanings [40]. Q is self-referential, participants are asked to rank statements using their own view on the matter as a benchmark. In Q, the typical set up of a scientific study is inverted, the participants are the 'variables' and the statements which they rank are the 'subjects' [36, 40]. Since the statements are fixed for all participants, the researcher can directly compare their responses, this is an advantage over other forms of qualitative discourse analysis [40]. Q methodology has been applied in a wide variety of research areas including health, education, environmental issues and policy and decision making [33, 40].

The main motivation for selecting Q methodology for this research was the interest in the personal opinions of the managers. Q is ideal for studying such subjectivity. Although other discourse analysis techniques exist, Q has the advantage over them in that every respondent is reacting to the same set of information, in the case of Q this information is the Q set. Since the Q set is constant throughout, the responses can be directly compared in a consistent way [40].

Q is capable of producing results even for low numbers of respondents [41], this is not the case for R type studies such as surveys. Since this research was conducted at a single project, within a single organisation, the number of available respondents was limited. Q could produce interesting insights even though the number of respondents was relatively low. There is no statistical validity of the results as is possible with R studies but the conclusions are still relevant and interesting for the organisation involved.

Initial research indicated that many different aspects feed into risk management, it is a complex issue which relies on both tools in place and human behaviour amongst other things. This was confirmed by the literature study, which uncovered 78 potential critical success factors of risk management. A shortlist of 27 factors was produced and this was further amended to give the final 25 CSFs of risk management which were presented to the respondents for sorting. Q methodology can cope with a large number of factors relating to a topic, unlike semi-structured interviews for example, where it would be very difficult to gather information from one interview on so many issues.

Another reason Q was selected for this research is that it enables information to be presented all at the same time to a respondent, respecting the interdependencies between aspects which relate to the topic. Brouwer [42] explained how this feature helped a respondent express their subjective feelings.

With Q method, collecting both quantitative and qualitative data limits the effect of researcher bias. Semi-structured interviews also require the researcher to have good knowledge of the topic both to lead the interview and perform the analysis of the transcripts [34]. Q method benefits from a researcher who is experienced on the topic, but the method itself is relatively simple to understand [40], and the quantitative data analysis is straightforward.

Appendix A provides a detailed explanation of Q methodology theory. Figure 1.1 shows the basic steps of the process.

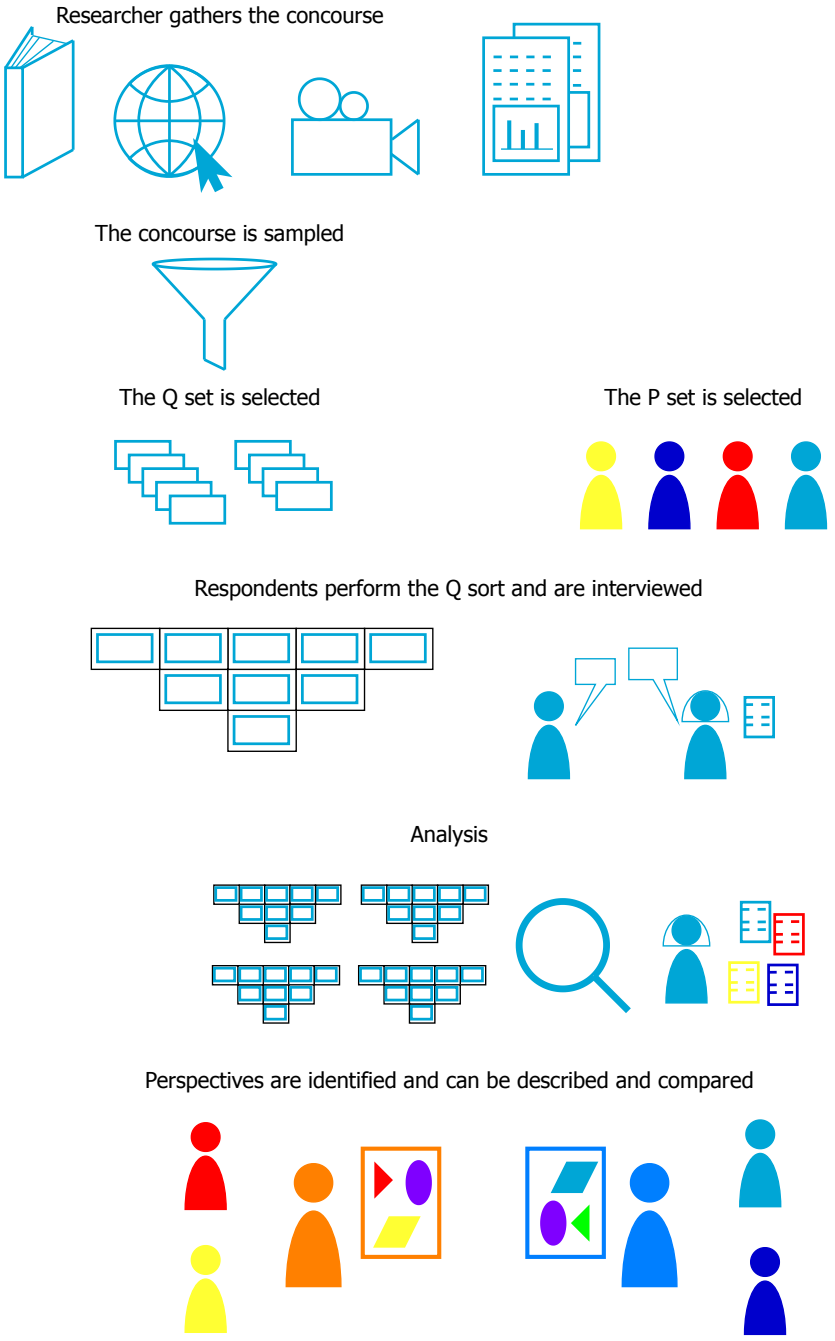



Figure 1.1: The basic steps of Q methodology

# 2

# CRITICAL SUCCESS FACTORS

## 2.1. CRITICAL SUCCESS FACTORS OF RISK MANAGEMENT

The decision was made to explore opinions through the consideration of critical success factors (CSFs) of risk management. Rockhart [43, p.85] describes CSFs as “the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization. They are the few key areas where ‘things must go right’ for the business to flourish."

The reason CSFs were selected as a basis on which to form the Q set was that the CSFs could be found in literature and indicate from theory what issues are important to risk management. What is then interesting to investigate is how managers use these CSFs in practice and which CSFs they consider to be more important in the practical application of risk management.

Two published works exist which have attempted to list the CSFs of risk management [44, 45]. Yaraghi and Langhe [44] present CSFs for risk management systems (RMS), so this work does not relate specifically to the construction industry. Shayan et al. [45] aimed to identify the most CSFs for effective risk management at the execution stage of a construction project. For this research, a literature study was performed to establish CSFs of risk management since neither of these works provided a comprehensive list of CSFs applicable to the scope of this project.

## 2.2. LITERATURE STUDY

A literature study was performed to gather the concourse on the CSFs of risk management. The use of a literature study is an example of ready-made sampling as described in A.1 in Appendix A. The aim of the literature study was to identify CSFs of risk management and by doing so answer the first research sub-question:

*What are the critical success factors of risk management?*

The TU Delft library search engine was used to search for relevant literature, as was Scopus and Google Scholar. Search terms used included:

- improving risk management in construction
- improve risk management in construction
- success factors of risk management
- critical success factors of risk management
- tools for risk management
- improving risk management
- risk management
- successful risk management
- effective risk management
- good practice in risk management

Identifying literature relating to the construction industry was a priority. Some papers were found which had researched a variety of industries, including the construction industry, in which case the references of these papers were examined to search for other papers relating directly to the construction industry.

The scope of the research project meant that thought had to be given as to which sources were appropriate to consider when searching for CSFs. Firstly, only sources which related to project level risk management were included in the study. There are a number of works available on the topic of enterprise risk management, which concerns the risk portfolio of a company including the "strategic, operations, reporting and compliance objectives of a company" [46], but these were not included in the study since they apply to a higher level of risk management within a company and thus fall outside the scope of this project. Secondly, only sources which related to general project risk management or project risk management within the construction industry were considered.

A number of sources were found on the topic of project risk management in the construction industry. Many of these concern techniques or attributes of project risk management or measures of the maturity of the project risk management within a company. In some of the sources used, CSFs of project risk management were explicitly stated. In some sources, principles, guidelines and lessons learned for project risk management were found, it was decided that these items should be listed as CSFs, since the nature of them being principles, guidelines and lessons learned meant that they were intended to improve and advance project risk management. Other sources described activities and practices which could improve or support risk management, it was decided to add these to the list of CSFs. For each CSF found, information was collected as shown in Table 2.1. Some of the factors appeared in more than one source or were very similar to a factor from another source, in which case these factors were grouped together.

Table 2.1: Information collected on each CSF identified in the literature study

| Factor | Origin of factor | Extract from source | Source and source description |
|---|---|---|---|
| *A short description of the CSF* | *Whether the CSF was explicitly mentioned as being a CSF by the source or whether it was interpreted from the text* | *An extract from the source which defines or describes the factor* | *The reference to the source and description of the format of the source (book, journal paper etc.) and the industry to which it relates to (construction, general project management etc.)* |

The use of 'tags' to categorise the factors, decided by the researcher, made finding the same or a similar factor easier amongst the large table produced. It was possible for a factor to fall under two tags but most only related to one, making working with the table and grouping factors easier. The tags used were:

- Organisational - These are items relating to the strategy and procedures which exist in the organisation.
- Management - These are items which describe the actions taken by and expertise of the top management team of an organisation.
- Culture - These are items relating to the culture of the organisation, the work atmosphere and general attitude of the employees.
- Employees - These are items relating to the individual staff in an organisation.
- Technical - These are the tools and specific procedures used to perform risk management.
- Involvement of other parties - These are items which involve a party external to the main organisation under consideration.

From 28 sources, 78 CSFs were identified and recorded in a table. Due to the size of this table it is presented in Appendix B, nevertheless the findings within it are very important to this project as they offer a new contribution to the body of knowledge on CSFs of risk management in the construction industry.

To illustrate the way in which CSFs were collected, an example of one of the CSFs identified by the literature study is presented in Table 2.2. This CSF was found in four different sources. In one case, it was listed explicitly as a CSF of risk management [47] but in the other three cases it was interpreted from the text as something which seeks to improve risk management, hence why these sources were added to the table. This CSF was judged by the researcher to fall under both the 'Organisational' and 'Technical' tags.

Similar information was recorded for the other 77 CSFs, as is shown in Appendix B. For some items, no extract was available in the source to fully explain it, often in cases where the item is simply listed as a CSF of risk management, in most cases these items are self-explanatory from the 'factor' column of the table.

Table 2.2: Information collected on one CSF, taken directly from Appendix B, to illustrate the literature study process

| No. | Tags | Factor description | Origin of factor | Extract from source | Source and source description |
|---|---|---|---|---|---|
| 5 | Organisational & Technical | Recognise that "one size fits all" is the wrong approach | Listed explicitly as a CSF of RM. | “Risk management is not “one size fits all.” While all projects are risky, and risk management is an essential feature of effective project management, there are different ways of putting risk management into practice." | [47] - Book, not specific to the construction industry. |
| | | Recognise that “one size fits all" is the wrong approach | Interpreted from the text given, not explicitly given as a CSF by the author. | “There is evidence that suggests that standardized methods for project management may increase project success (Milosevic and Patanakul, 2005), and it can be argued that standardized processes allow for more accessible and transferable gained experiences and learning in the organization (Perminova et al., 2008). Yet those who maintain a contingency view of project risk question the need for a unifying body of knowledge in risk management. The contingency perspective argues that various project and uncertainty characteristics call for different risk management approaches, and therefore a one-size-fits-all standard risk management practice is not ideal (Teller et al., 2014; Jun et al., 2011; Miterev et al., 2016; Williams, 2005; Thamhain, 2013)." | [27] - This paper presents an empirical investigation and discussion of the eleven principles of the ISO 31000:2009 Risk Management Standard via a large-scale survey of engineering and product development practitioners. |
| | | Adapt RM to each project | Interpreted from the text given, not explicitly given as a CSF by the author. | “Any PRM process must be tailored to the particular circumstances of the project and the organization undertaking it..." | [48] - This article presents a generic project risk management process that has been particularized for construction projects from the point of view of the owner and the consultant who may be assisting the owner. Applied to a project in Spain. |
| | | “One size fits all" approach is not applicable | Interpreted from the text given, not explicitly given as a CSF by the author. | “The same concept applies to risk management: one cannot expect that a single, universal risk management process and its supporting set of tools and techniques would be applicable to all types of projects. Just as there are different types of projects, we should expect to see different kinds of risk management practices." | [49] - General project management. |

## 2.3. SELECTING THE Q SET

The concourse in this research project was the list of 78 CSFs identified by the literature study. The next step was to refine this list down to the Q set, the items which respondents would be asked to prioritise in the Q sorts.

### 2.3.1. NARROWING DOWN THE CONCOURSE

The first stage of reducing the number of items in this list was done by considering the following three requirements, suggested by the researcher:

- The item must appear in at least two sources.
- The item must appear in a source which concerns the construction industry.
- The item must be explicitly mentioned as a CSF of project risk management.

Once these requirements had been applied to the list of 78 CSFs, 21 items met all three and six items met at least two of them, see Appendix C. These 27 CSFs which met at least two of the requirements were taken to the next stage.

### 2.3.2. REVIEWING THE CSFS

Next, the factor descriptions of the 27 CSFs were reviewed. This was especially important for factors which were mentioned in more than one source since the exact description of the factor often differed between sources. The researcher aimed to ensure each factor had a short informative description which captured all the information found in each of the sources referring to it. For example, five sources mentioned communication as a CSF of risk management. Two of these simply stated 'communication', one mentioned 'communication channels' and the other two were more specific, stating that an organisation needed 'open and honest communication' and 'clear and effective communication' to improve risk management. The researcher concluded that 'clear, effective, open and honest communication' be taken forward as the name of the factor. The 27 CSFs, which met at least two of the requirements, are shown in Table 2.3.

Table 2.3: 27 CSFs that met at least two of the requirements. **Number from literature study, see Appendix B*

| No. * | Factor description |
|---|---|
| 1 | Integration of risk management with other project management operations |
| 2 | Well-defined and clearly understood vision, mission, and long-term strategy toward risk management in the organisation |
| 3 | Understanding and defining external context |
| 5 | Adapting risk management to each project |
| 7 | Establishing clear accountability and responsibility of roles for managing risks |
| 9 | Personnel's understanding and belief in the benefits and value of risk management |
| 12 | Availability of adequate resources to support the implementation of risk management |
| 13 | Deciding the appropriate level of risk management (risk thresholds) |

*Table continued on next page*

*Table 2.3 continued*

| No. * | Factor description |
|---|---|
| 30 | Risk management is encouraged and supported by the top management |
| 31 | Clear, effective, open and honest communication |
| 32 | Shared understanding of the key concepts and principles of risk management |
| 37 | Organisational risk culture |
| 38 | Teamwork spirit |
| 43 | Skilled and competent staff |
| 46 | Continuity of risk management across project stages |
| 47 | Detailed documentation and recording of risks |
| 48 | Using external experts and services in risk management |
| 49 | Development and application of a standardised risk management process |
| 50 | Regular (internal or external) training to enhance skills |
| 51 | Suitable contractual framework to support the risk process |
| 53 | Knowledge sharing |
| 55 | Personal and corporate experience, intuition and engineering judgement |
| 70 | Reviewing and monitoring changes and updating approach |
| 71 | Post-project assessment and capturing lessons learned |
| 74 | Use a joint risk register |
| 75 | Teamwork, understanding and cooperation between partnering organisations |
| 76 | An open communication risk management process between partnering organisations |

*End of Table 2.3*

### 2.3.3. INPUT FROM A RISK MANAGER

The second stage of reviewing the list of items was done by way of a discussion with an expert in the field of risk management, namely the risk manager of Project A. The manager was shown the shortlist of 27 items and the intended meaning and relevance of each item was discussed. It was decided that five items be eliminated from the shortlist and some minor changes were made to other items. A summary of the changes to the list of CSFs is shown in Table 2.4, the details of these decisions is shown in Appendix D.

Table 2.4: Result of input from risk manager on the CSFs. **Number from literature study, see Appendix B* Factors highlighted grey were removed from the Q set.

| No. * | Factor description | Action following discussion with risk manager |
|---|---|---|
| 1 | Integration of risk management with other project management operations | |
| 2 | Well-defined and clearly understood vision, mission, and long-term strategy toward risk management in the organisation | Minor rewording |
| 3 | Understanding and defining external context | Minor rewording |
| 5 | Adapting risk management to each project | |
| 7 | Establishing clear accountability and responsibility of roles for managing risks | Rewording to mention 'RACI-matrix' |
| 9 | Personnel's understanding and belief in the benefits and value of risk management | |
| 12 | Availability of adequate resources to support the implementation of risk management | |
| 13 | Deciding the appropriate level of risk management (risk thresholds) | Minor rewording |
| 30 | Risk management is encouraged and supported by the top management | |
| 31 | Clear, effective, open and honest communication | |
| 32 | Shared understanding of the key concepts and principles of risk management | Rewording to mention 'acceptance' |
| 37 | Organisational risk culture | Rewording to make it clear it relates to the project |
| 38 | Teamwork spirit | Rewording to make it clear it relates to the project |
| 43 | Skilled and competent staff | Rewording to make it clear it refers to all staff, not only risk management staff |
| 46 | Continuity of risk management across project stages | |
| 47 | Detailed documentation and recording of risks | |
| 48 | Using external experts and services in risk management | Remove item from list - Risk manager explained that Ballast Nedam does not use external consultancy services. |

*Table continued on next page*

*Table 2.4 continued*

| No. * | Factor description | Action following discussion with risk manager |
|---|---|---|
| 49 | Development and application of a standardised risk management process | |
| 50 | Regular (internal or external) training to enhance skills | |
| 51 | Suitable contractual framework to support the risk process | Remove item from list - Risk manager considers the existence of a suitable contract to be a given, more interesting is to look at contracts with subcontractors. |
| 53 | Knowledge sharing | Minor rewording |
| 55 | Personal and corporate experience, intuition and engineering judgement | Minor rewording |
| 70 | Reviewing and monitoring changes and updating approach | Minor rewording |
| 71 | Post-project assessment and capturing lessons learned | Minor rewording |
| 74 | Use a joint risk register | Remove item from list - From this statement it is not clear whether this meant the risk register is joint internally or externally with other parties. The literature describes this to be the risk register shared between parties, externally shared between organisations. This is not the case for this project, all risk is carried by the contractor. |
| 75 | Teamwork, understanding and cooperation between partnering organisations | Remove item from list - Risk manager judged this was already covered by other statements. |
| 76 | An open communication risk management process between partnering organisations | Remove item from list - Each organisation does their own risk management, this statement does not reflect the reality of Project A. |

*End of Table 2.4*

The discussion with the risk manager led to three items being added to the list of CSFs. These were as follows:

- **A risk manager appointed to the project** - The risk manager felt that it is very important for the team to have an appointed risk manager to look to for guidance on risk management so this was added to the list of CSFs. This item was identified in the literature study but was eliminated in the first stage of narrowing the concourse as it was only mentioned in one source and that source was not specific to the construction industry, see item 28 in Appendix B.
- **Risk management purposes in line with project goals** - The risk manager thought that it was important to mention the link between the project goals and the goals

of the associated risk management strategy for the project, hence this factor was added. This item was identified in the literature study but was eliminated in the first stage of narrowing the concourse since it only appeared in one source and was given as a guideline of risk management rather than a CSF explicitly, see item 18 in Appendix B.

- **Careful management of contracts with subcontractors** - This factor came out of the discussion about the factor 'Suitable contractual framework to support the risk process', see item 51 in Appendix B and Table 2.4. The risk manager thought that this factor was too broad and it is obvious that a contract will exist which details the risk management process. The risk manager did think that contracts held with subcontractors was very important to risk management and was relevant to Project A, since many subcontractors were employed. Many sections of the works are subcontracted out by Ballast Nedam to smaller companies. Ultimately, Ballast Nedam is responsible for the overall construction so must ensure that these parties deliver the work described in the contract and do so safely. Each subcontractor will have their own risk management process and will discuss their risks with Ballast Nedam. The risk management processes of the main contractor and the subcontractors must interface with each other. Careful management of contracts with subcontractors means that these different risk management processes work well together and the works are completed safely, to the specified quality and within time and budget. This factor was added despite the fact it had not been identified in the literature study.

### 2.3.4. THE FINAL Q SET

In this study, a hybrid sampling approach was used to select the final Q set from the concourse of 78 CSFs. The use of a literature study was an example of ready-made sampling, see A.1 in Appendix A. Unstructured sampling was used to reduce the number of CSFs by way of requirements suggested and imposed by the researcher, see A.2 in Appendix A. The discussion with the risk manager was an example of naturalistic sampling, see A.1 in Appendix A.

Before fixing the final Q set, each statement was reviewed and made shorter if possible to make the cards of the Q sort quick and easy to read. The statements were then translated into Dutch, given that the respondents all had Dutch as a first language, see Appendix E for the Dutch translations. Table 2.5 lists the final Q set, which consists of 25 statements. This list was renumbered for simplicity of the application of the Q sorts (see second column, 'No.'). A definition from the literature was provided where possible, other definitions were formulated by the researcher. The three items added following the discussion with the risk manager are highlighted in blue.

Table 2.5: The final Q set. **Number from literature study, see Appendix B.* Q statements highlighted blue were added following the discussion with the risk manager.

| No.* | No. | Q statement | Definition |
|---|---|---|---|
| 1 | 1 | Integration of risk management with other project management activities | "Project risk management does not exist in a vacuum, isolated from other project management processes. Successful project risk management requires the correct execution of the other project management processes." [50] |
| 2 | 2 | A clear long-term strategy towards risk management in the project organisation | "Well-defined and clearly understood vision, mission, and long-term strategy toward risk management in the project organisation." [44] |
| 3 | 3 | Consider the external environment (market, politics, social issues, macro-economic situation) | "External environment in which the organization is performing. It encompasses the effects of market, suppliers, competitors, socio-political systems and also the organization's partnership and joint venture strategies." [44] |
| 5 | 4 | Adapt risk management to each project | "Risk management is not "one size fits all." While all projects are risky, and risk management is an essential feature of effective project management, there are different ways of putting risk management into practice." [47] |
| 7 | 5 | Establish clear responsibility of roles for managing risks (RACI-matrix) | The responsibility of each risk and its management is assigned to a certain person or group of people. This includes use of the RACI-matrix (Responsible, Accountable, Consulted, Informed). |
| 9 | 6 | An understanding and belief in the benefits of risk management from all staff | "Project risk management should be recognised as a value discipline that provides a positive potential return on investment for organisational management, project stakeholders (both internal and external), project management and team members." [50] |
| 12 | 7 | Provision of adequate resources to support risk management | "It is evident that risk management is not a cost-free activity, and the project needs to provide the necessary level of resources if the risk process is to function properly. These resources include people, time and money." [4] |
| 13 | 8 | Decide the appropriate level of risk management for the project | "Project risk management activities should be consistent with the value of the project to the organisation and with its level of project risk, its scale, and other organisational constraints. In particular, the cost of project risk management should be appropriate to its potential value to the project and the organisation." [50] |

*Table continued on next page*

*Table 2.5 continued*

| No.* | No. | Q statement | Definition |
|---|---|---|---|
| 30 | 9 | Top management encouraging and supporting risk management | "There are two things that senior managers can do to maximise the effectiveness of the risk process on their projects. These revolve around demonstrating a visible and consistent commitment to risk management... The first way senior management can show their commitment to the risk process is to appoint a senior manager (who may be called the Corporate Risk Sponsor or similar) who will promote the cause of risk management at the highest levels of the organisation... The second major way in which the senior management of the organisation can demonstrate their commitment to effective risk management across their projects is to use the results of the risk process to support risk-informed decision-making. When project teams can see that their risk information is actually being used to assist senior managers in running the wider business, they will be motivated to provide the best possible outputs from the project risk process." [4] |
| 31 | 10 | Clear and honest communication | "Efficient management of building projects demands clear effective communication and if risk analysis and management is to be used as a tool to assist the management of projects, then it must itself be clearly communicated and understood." [51] |
| 32 | 11 | Shared understanding and acceptance of the key concepts of risk management | Having a shared understanding and acceptance of the key tools and techniques which should be used for risk management means that all staff approach risk management in a similar way and can perform tasks and communicate efficiently. "Effective training creates a shared understanding of the key concepts and principles of risk management." [47] |
| 37 | 12 | Project organisation risk culture | "For risk management to be effective, the culture must be supportive, meaning that individuals' risk attitudes must be understood and managed, and the organization's overall approach must value risk management and commit to making it work." [47] |
| 38 | 13 | Project organisation team spirit | "Existence of developed teams and teamwork spirit within the organization." [44] |
| 43 | 14 | All staff showing competence in the application of risk management | "Project sponsors, project managers, team members, and stakeholders must be trained in applying the process, participating in it, or both." [47] |
| 46 | 15 | Continuity of risk management across project stages | "The management of risk is a continuous process and should span all the phases of the project. Since project risks are dynamic, that is to say they can change continuously, a risk assessment must be carried out at the end of each phase prior to proceeding to the next phase." [52] |
| 47 | 16 | Detailed documentation of risks | The risks associated with each activity are documented along with the management plan for each risk. Data relating to risks is accurate. |
| 49 | 17 | Application of a standardised risk management process | "An efficient procedural framework that supports the process and outlines "what to do" ensures support from the organisation and makes the most of the investment in training, tools, and techniques." [47] |

*Table continued on next page*

*Table 2.5 continued*

| No.* | No. | Q statement | Definition |
|---|---|---|---|
| 50 | 18 | Regular training to enhance risk management skills | "Project sponsors, project managers, team members, and stakeholders must be trained in applying the process, participating in it, or both. Training also needs to be at the right level and depth to suit the role involved... Training should not be viewed as a one-off event carried out when formal risk management is first introduced. It must be a continual process, bringing new members of the organization up to speed as soon as is practical. The end benefit of effective training is skilled and competent staff who contribute effectively to the risk process." [47] |
| 53 | 19 | Knowledge sharing relating to risk management | "Encouraging a knowledge-sharing culture. Central to the success of a knowledge risk management framework, is the concept that values and expectations for ethical behavior need to be communicated widely and effectively throughout the organization. In short, integrity has to become part of the corporate culture. This is best accomplished as part of a formal process of knowledge sharing, of mentoring, and formal ethics training, so that employees at all levels appreciate the importance of good behavior. This means that there needs to be regular and consistent communication on values and on processes that encourage sharing of ideas and early identification of risks." [53] |
| 55 | 20 | Personal experience, intuition and engineering judgement | Drawing on past experiences and your education to make decisions on risks in the present. |
| 70 | 21 | Consistently review and update the risk register | "The risk register should be periodically reviewed, identified risks should be reassessed, project risk information should be updated, and the effectiveness of risk response actions and control measures should be monitored and evaluated." [54] |
| 71 | 22 | Capture and use lessons learned | "For the further development of the risk management system, it is important that stock is taken of the reflection on the progress of the project. In this, relevant questions are: What identified risks have occurred? What problems that have actually occurred in the progress of the project were not identified as risks and why not? These reflections should then be used to inform future decisions on risk management." [6] |
| 28 | 23 | A risk manager appointed to the project | "A proven contributor to maximising risk process efficiency is the use of a skilled and experienced facilitator. This person can have various titles, such as Risk Champion, Risk Coordinator, Risk Process Facilitator, or Risk Manager. More important than their job title however are their personal characteristics. A good Risk Champion will have a combination of technical skills (including both the domain of the project as well as technical risk competences) and people skills (including the ability to understand and manage different types of individuals and groups). These latter soft skills are very useful for keeping energy levels high during the risk process, and a high degree of emotional literacy can be particularly helpful." [4] |
| 18 | 24 | Risk management purposes in line with project goals | The risk management strategy for a project has been tailored so as to align with the goals of that project. |

*Table continued on next page*

*Table 2.5 continued*

| No.* | No. | Q statement | Definition |
|---|---|---|---|
| - | 25 | Careful management of contracts with subcontractors | Appropriate, clear and fair contracts with sub-contractors. “Good contract management can allocate responsibilities and liabilities between parties and therefore avoid conflicts." [55] “Appropriate contract conditions help to meet the specific requirements and objectives of the project. Contract conditions are expected to be clear in order to define the rights and duties of project participants and unequivocally allocate risks (or future uncertainties) to the different contracting parties. Contract conditions are also expected to be fair, so as to allocate these risks in a ‘just’ way, apart from merely following the often applied principle of assigning the risks to those best equipped to deal with them." [56] |

*End of Table 2.5*

# 3

# IDENTIFYING PERSPECTIVES

## 3.1. APPLICATION OF Q METHODOLOGY

Q method was applied in order to answer the second research sub-question:

> *What perspectives can be derived by asking managers to rank critical success factors of risk management?*

The Q set, detailed in the in previous chapter, was presented to 15 respondents who were asked to sort the items considering what they thought important to risk management. They were asked to sort the Q statements considering the sorting instruction:

> *"In order to perform project risk management it is important to have/do..."*

This chapter explains how the Q sort activities and accompanying interviews were performed and how the quantitative results from the completed activities were analysed. The theory followed is explained in Appendix A.

## 3.2. SELECTING THE P SET

A total of 15 respondents performed the Q sort activity and accompanying interview, Table 3.1 shows the description of each of them. Five respondents were found for each of the three functional teams. All the respondents were managers. The experience level of the respondents ranged from five to 30 years. All but one of the respondents were Dutch nationals and all respondents were male.

Table 3.1: The P set

| Respondent | Functional team | Years of experience in the construction industry |
|---|---|---|
| 1 | Supporting | 13 |
| 2 | Supporting | 10 |
| 3 | Supporting | 16 |
| 4 | Supporting | 14 |
| 5 | Supporting | 30 |
| 6 | Design | 25 |
| 7 | Design | 11 |
| 8 | Design | 6 |
| 9 | Design | 15 |
| 10 | Design | 19 |
| 11 | Execution | 12 |
| 12 | Execution | 5 |
| 13 | Execution | 24 |
| 14 | Execution | 30 |
| 15 | Execution | 13 |

## 3.3. CONDUCTING THE Q SORTS

Due to the nationwide restrictions imposed to prevent the spread of the COVID-19 virus, it was not possible to conduct the Q sort activity and accompanying interview face to face. For this reason, the activity and interview were conducted via a Skype call.

Firstly, the researcher presented a series of slides to introduce the research project, explain the Q sort activity and address the confidentiality aspects of the project, see Appendix F. Secondly, the respondent was asked to share their screen with the researcher and open the Q sort activity at *www.qsortware.net*. This is a free to use website where researchers can create their own Q sort activities, respondents simply drag each statement into the column of their choice. The respondent was provided with a list of definitions of the statements to refer to if they were unsure about what a statement meant, see Appendix G. Finally, the researcher asked the respondent questions about their completed Q sort chart.

### 3.3.1. THE RESPONSE CHART

The precise shape of the response chart depends on the number of items in the Q set but is also a “matter of some judgement" on the part of the researcher [40]. Brown [57] recommends the kurtosis of the distribution should depend on the level of controversy of the topic. The distribution should be steeper if the respondents are expected to have a low level of knowledge or interest in the topic, or a small number of the statements are expected to be salient. This means there is “more room for ambiguity, indecisiveness or error in the middle of the distribution" [39, p.6]. The distribution should be flatter if respondents are expected to have strong or well-formed opinions on the topic, it is expected that they will be “generally sensitized to most of the opinions in circulation and are anxious to agree or disagree with most, there being relatively fewer about which

they are neutral" [57, p.200]. A flatter distribution means there is “more room for strong (dis)agreement with statements" [39, p.7] and less space for statements to be placed in the centre.

The response chart used for the Q sort activity is shown in Figure 3.1. It was decided to make the response chart reasonably wide, providing seven columns. The kurtosis of this distribution was chosen because it was anticipated that although all respondents would have a relatively well-formed opinion on the topic, risk management is not their main function. For this reason a balance was struck between providing space for them to rank statements as strongly important or unimportant (columns -3, -2, +2, and +3 holding 40% of statements) but also space for them to rank the majority of statements as salient (columns -1, 0 and +1 holding 60% of statements).

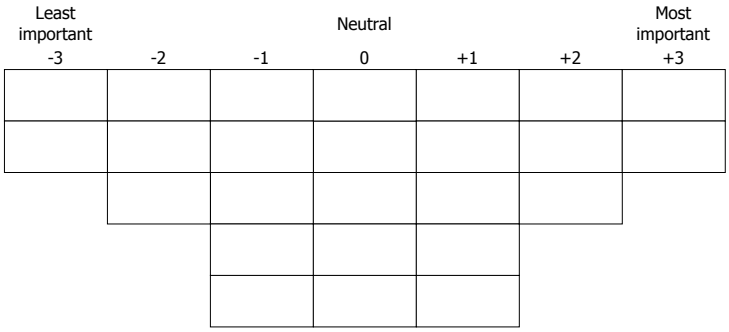



Figure 3.1: Response chart used by respondents to sort the 25 statements

### 3.3.2. THE SORTING INSTRUCTION

The sorting instruction given to the respondents was as follows:

*“In order to perform project risk management it is important to have/do..."*

In addition to this, in the instructional slides presented at the start of the Skype call, see Appendix F, the following points were presented:

- The scope of this project concerns project level risk management only (rather than portfolio, finance or organisational level risk management).
- Please do the activity considering your own opinion rather than answering how Ballast Nedam as an organisation would answer or how you think one of your seniors would like you to answer.
- There is no right or wrong answer.
- The purpose of the chart is to force you to prioritise, please place every item somewhere.
- You can move statements around as much as you want until you are happy with their position.

- Refer to the definitions, provided to you on the email as a pdf, if there are any statements which you don't understand.

### 3.3.3. THE INTERVIEW

Once the respondent had finished the online Q sort activity, the researcher asked them questions about their role and level of experience. Next, they were asked if they thought any statements were missing from the 25 provided. They were then asked about their motivation behind why they had placed certain statements at the extreme ends of their chart, in the +3, +2, -2 and -3 columns. The researcher asked the respondent to reflect on their completed Q sort chart and summarise their opinion on what they thought is important to project risk management. Finally they were asked if they had any comments on the activity or interview. For the full list of interview questions see Appendix H. The audio of the interview was recorded and transcribed to be used in the data analysis.

## 3.4. ANALYSIS

The data analysis was performed using PQMethod (version 2.35), a free software developed for Q method analysis. The 25 statements which make up the Q set were entered into the software along with the 15 completed Q sort charts. The correlation matrix is shown in Appendix I, the highest correlation between any two sorts was 0.66 and the lowest correlation was -0.37. Factor analysis was performed using Principal Component Analysis and factor rotation was performed using the Varimax rotation method.

### 3.4.1. NUMBER OF FACTORS

In order to determine how many factors should be extracted from the analysis, factor rotation was performed six times. The results of each solution were examined and checked against the criteria described below. Brown [57] describes criteria for determining how many factors should be extracted:

1. Each acceptable factor should be defined by at least two significant Q sorts where:
   - A Q sort x is significantly loaded on a factor y at $p < 0.05$ if its factor loading $f_{xy} > 1.96 \cdot SE$, where $SE$ is the standard error, calculated using Equation 3.1

$$SE = \frac{1}{\sqrt{N}} \tag{3.1}$$

     Where:
     $N$ is the number if statements used in the Q sort
   - Its highest square factor loading explains more than half of the common variance, see Equation 3.2

$$f^2 > h^2/2 \tag{3.2}$$

     Where:
     $h^2$ is the sum of the squared factor loadings of a Q sort

2. The cumulative % of explained variance is greater than 50%.

3. Factors are only accepted if they meet Humphrey's rule which states that the cross-product its two highest loadings (ignoring signs) exceeds twice the standard error, *SE*.

   Criterion 1 asks if a factor in a solution has enough people significantly loaded onto it for it to qualify to be taken forward as a factor. Criterion 3 is similar to criterion 1, in that it asks if a factor is sufficiently 'strong' but it is slightly different. Criterion 3 asks if the two strongest loadings are sufficiently high. The difference between these criteria is illustrated in Table 3.2, given each criteria gives different results for the factor solutions in this project.

Webler et al. [40] give four further criteria which can be used to decide between different numbers of factors:

4. **Simplicity** - Fewer factors is preferable because it makes it easier to understand the viewpoints presented however there is a limit to this. The analysis should not oversimplify the viewpoints to the extent that important information about people's difference in opinions is lost.

5. **Clarity** - The best solution for the number of factors is the one for which each respondent loads highly on only one factor. The researcher should try to minimise the number of non-loaders and confounders. If confounders continue to exist it could mean that they hold a hybrid view, a mixture between two or more factors.

6. **Distinctness** - Factors themselves can be highly correlated (given that they are also Q sorts) but lower correlations are preferable as it means factors really express different views. It is not necessarily bad for two factors to be highly correlated, they may share the same view on many issues, but the points on which they disagree are particularly important.

7. **Stability** - Throughout the process of comparing results using different numbers of factors, certain respondents will cluster together. This shows that these people think similarly and these clusters should be preserved.

Table 3.2 shows the results of each factor solution against some of these criteria, the remaining criteria will be discussed in the following paragraphs. Red shading of a cell indicates that the factor solution has not met the criterion.

PQMethod uses a 'pre-flagging algorithm' to flag the Q sorts which meet both parts of criterion 1, this 'flag' is shown as an *X* on the output file from the software. The factor loadings of each solution were examined to check that each factor was defined by at least two significant Q sorts and could therefore be considered an acceptable factor, this is simply done by counting how many *X*s exist for each factor within each factor solution, see Appendix J. The 5, 6 and 7 factor solution all contained factors which did not meet this criterion.

The cumulative explained variance is displayed in the results file, see Appendix J. Criterion 2 specifies that this value must be above 50%, the 2 factor solution does not meet this criterion.

Table 3.2: Criteria for determining the number of acceptable factors. Red shading of a cell indicates that the factor solution has not met the criterion.

| | **Factor solution** | | | | | |
|---|---|---|---|---|---|---|
| | **2** | **3** | **4** | **5** | **6** | **7** |
| Number of acceptable factors (criterion 1.) | 2 | 3 | 4 | 3 | 3 | 4 |
| Cumulative % of explained variance (criterion 2.) | 43% | 54% | 62% | 71% | 78% | 83% |
| Number of acceptable factors (criterion 3.) | 2 | 3 | 4 | 4 | 5 | 5 |
| Number of defining sorts (criterion 5.) | | 14 | 12 | | | |
| Number of non-loaders (criterion 5.) | | 1 | 3 | | | |
| Number of confounders (criterion 5.) | | 0 | 0 | | | |

Humphrey's rule, criterion 3, is checked by hand, see Appendix J. The 5, 6 and 7 factor solution had factors which did not meet this criterion.

Application of criteria 1, 2 and 3 reduced the choice down to either the 3 or 4 factor solution. Criterion 4 considers the simplicity of the factor solution, considering this, the 3 factor solution is preferable. Criterion 5 concerns the clarity of the solution. Neither the 3 or 4 factor solution have any confounders but the 4 factor solution has three non-loaders compared to only one in the 3 factor solution, considering this, the 3 factor solution is preferable. Criterion 6 concerns the distinctness of the factors within the factor solution. Table 3.3 shows the correlation matrix of factors within the 3 factor solution. Table 3.4 shows the correlation matrix for the 4 factor solution.

Table 3.3: Correlation matrix showing the correlation between the three factors in the 3 factor solution. Correlation values taken directly from software output.

| | | **Factor** | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| **Factor** | 1 | | 0.20 | 0.23 |
| | 2 | | | 0.05 |
| | 3 | | | |

Table 3.4: Correlation matrix showing the correlation between the four factors in the 4 factor solution. Correlation values taken directly from software output.

| | | Factor | | | |
|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 |
| Factor | 1 | | 0.24 | 0.15 | 0.38 |
| | 2 | | | -0.004 | -0.12 |
| | 3 | | | | 0.37 |
| | 4 | | | | |

It can be seen that the factors from the 3 factor solution have low correlations. The highest correlation is 0.23 between factors 1 and 3 and the lowest is 0.05 between factors 2 and 3. According to Cohen [58] a correlation value of 0.1 is small, 0.3 is medium and 0.5 is large, therefore all the factors have a small correlation with each other and are distinct. The 4 factor solution has some higher values of correlations, such as 0.37 and 0.38 for the correlations of factors 1 and 3 with factor 4. Examination of Tables 3.3 and 3.4 show the 3 factor solution to be preferable.

Criterion 7 was not considered when deciding between the 3 and 4 factor solutions as examination of criteria 1 to 6 already indicated that the 3 factor solution was preferable.

### 3.4.2. PERSPECTIVE LOADINGS

The 'factors' within the 3 factor solution are herein knows as 'perspectives'. Table 3.5 shows the factor loading values of each respondent onto each perspective. Sufficiently significant factor loadings mean that a respondent belongs to that perspective. Six respondents load onto Perspective 1, five onto Perspective 2 and three onto Perspective 3. Respondent 2 did not have significant factor loadings onto any of the perspectives and is therefore described as a non-loader.

Table 3.5: Factor loadings of each respondent onto each perspective of the 3 factor solution. Blue shading of a cell indicates that respondent loads significantly onto that perspective and therefore belongs to that perspective. Respondent 2 is a non-loader.

| | | **Perspective** | | |
|---|---|---|---|---|
| | | **1** | **2** | **3** |
| **Respondent** | **1** | 0.02 | 0.27 | 0.74 |
| | **2** | 0.30 | 0.17 | 0.10 |
| | **3** | 0.47 | 0.39 | 0.03 |
| | **4** | 0.06 | -0.03 | 0.70 |
| | **5** | 0.50 | 0.46 | 0.13 |
| | **6** | 0.19 | 0.65 | -0.45 |
| | **7** | 0.25 | 0.54 | 0.34 |
| | **8** | 0.66 | 0.06 | 0.13 |
| | **9** | -0.07 | 0.77 | 0.05 |
| | **10** | 0.11 | 0.82 | -0.21 |
| | **11** | 0.31 | -0.15 | 0.61 |
| | **12** | 0.77 | -0.45 | 0.13 |
| | **13** | 0.64 | 0.38 | 0.20 |
| | **14** | 0.21 | 0.61 | 0.31 |
| | **15** | 0.80 | 0.08 | -0.10 |
| **Total** | | 6 | 5 | 3 |

# 4

# RESULTS AND DISCUSSION

In this chapter, the results of the analysis are presented along with discussion of these results. The average Z scores of all the statements by all respondents is presented first, in section 4.1, this gives an indication of the global view of the respondents. Next the statements which some respondents felt were missing from the Q set are discussed in section 4.2. Section 4.3 provides a detailed analysis of each of the three perspectives and quotes from the interview transcripts are used to "bring the perspectives to life". In section 4.4 the perspectives are compared to each other and in section 4.5 the consensus statements are presented. In Section 4.6, the views of respondent 2, the non-loader, are presented. In sections 4.7 and 4.8, the links between the perspectives and other variables are explored. In section 4.9, discussion is presented on two observations which are not a direct result of the application of Q but which the researcher judged to be relevant and interesting to the overall purpose of improving risk management. Section 4.10 explains the more practical observations from the execution of the Q sort activity and the interviews. Section 4.11 lists a summary of the results of the research, these are used to provide recommendations to the organisation, in section 4.12.

## 4.1. MEAN Z SCORES

To investigate the overall rank of the statements across the three perspectives, Figure 4.1 shows the average Z score of the statements from all respondents, see Appendix K for the calculations of these values. *Project organisation risk culture* (12) has the highest average Z score, followed by *Integration of risk management with other project management activities* (1). The statement *Regular training to enhance risk management skills* received the lowest average Z score, with *Shared understanding and acceptance of the key concepts of risk management* (14) falling slightly above.

Understanding the reasoning behind the ranking of these statements is aided by the presentation of the perspectives in section 4.3, where quotes from the respondents along with discussion, will aim to explain why statements were judged to be most or least important. Obviously the views of each perspective differ (as do the views of the non-

loader), but collectively Figure 4.1 is an average of all respondents so the separate perspective descriptions in section 4.3, and in addition section 4.6, are relevant.

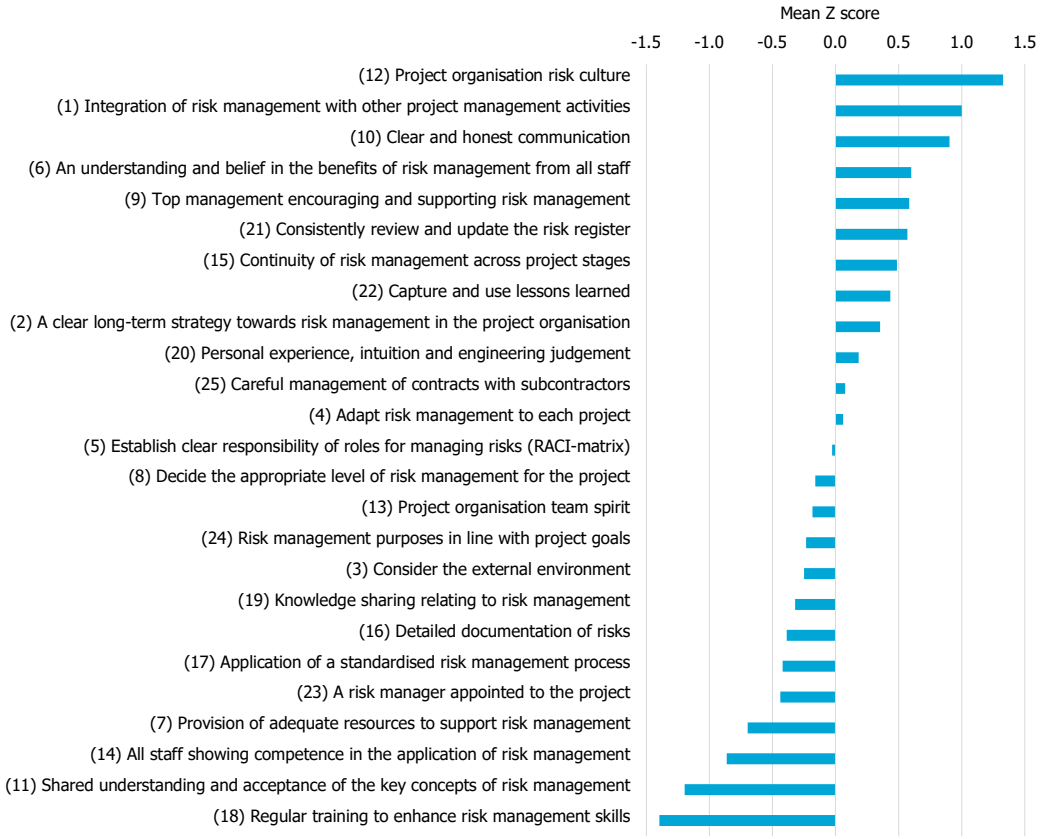



Figure 4.1: Mean Z scores across perspectives, see Appendix K for calculation of mean Z scores.

## 4.2. MISSING STATEMENTS

Every respondent was asked whether they thought any items were missing from the Q set. Seven of the respondents did not think anything was missing from the statements presented to them. The rest of the respondents suggested aspects which they found important to project risk management, which they thought should have been provided as possible statements in the Q set for them to sort, but which were not presented to them. These have been summarised below and all are in answer to the sorting instruction:

*"In order to perform project risk management it is important to have/do..."*

- Opportunity management. Risk management has a positive side too, opportunities can be capitalised upon to improve outcomes for a project.

- A proactive risk manager. It is not enough to simply have a risk manager, as expressed by statement (23), they need to have the right attitude, (mentioned by two different respondents).
- A 'worst case scenario' management strategy prepared at all times. Managers make very many decisions and should always consider what could go wrong and be very well prepared for the eventuality that it does.
- Celebrate successes in risk management.
- Strongly emphasise the responsibility of each person.
- Track the progress of risk measures.
- Risks managed by those closest to them.

Some of these items could be considered to already be included within the Q set, such as 'tracking progress of risk measures' which could be considered to be the same as *Consistently review and update the risk register* (21). Other items were identified in the literature study but were not selected for the Q set as they did not meet the requirements set. Some items suggested were new to the researcher and were not raised by the literature study. One way to minimise the likelihood that a respondent suggests statements are missing from the Q set is to perform an additional step in the research, where people who fit the profile of respondents are asked to review the concourse and help develop the Q set but who are not later asked to do the Q sort. Adding this step obviously requires more time and more people to be found and interviewed.

## 4.3. INTERPRETATION OF PERSPECTIVES

The 3 factor solution was taken forward to the interpretation stage. In this section, the quantitative output from the software analysis was combined with the qualitative interview data to describe the three common perspectives.

For each perspective, the characterising statements are presented, that is the statements which have the five highest and five lowest factor scores or Z scores. These statements would place at the extreme ends of the perspective's idealised Q sort chart (in columns -3, -2, +2 or +3) meaning the perspective judges them to be amongst the most or least important statements. The characterising statements are discussed for each perspective, along with direct quotes from the respondents which motivate their reasoning for how they chose to rank these statements. The statements which received Z scores closer to 0, meaning they would rank in columns -1, 0 and +1 of an idealised Q sort chart, are not included in the plots or the discussions below as they are not as important in terms of describing the perspectives. Statements which were both characterising and distinguishing are useful in describing perspectives, since they indicate a statement which was ranked significantly differently compared to the other perspectives. The theory of Z scores and characterising and distinguishing statements is presented in sections A.5.5 and A.5.6 in Appendix A.

After the discussions of the most and least important statements for each perspective, a conclusion which summarises the opinion of the perspective is given along with

a name for the perspective. The perspective names are only presented after the discussion of the characterising statements. In this way, it is hoped that reader bias is limited, since the reader can first learn what each perspective found to be most and least important and then judge whether the name suggested by the researcher is appropriate. The theory behind whether or not perspectives should be named can be found in A.6 in Appendix A.

This section provides the answer to the second research sub-question:

> *What perspectives can be derived by asking managers to rank critical success factors of risk management?*

### 4.3.1. PERSPECTIVE 1

A total of six respondents share this perspective and it accounts for 19% of the explained variance in the data set. The Z scores for the characterising statements of this perspective is shown in Figure 4.2 and these statements are discussed below.

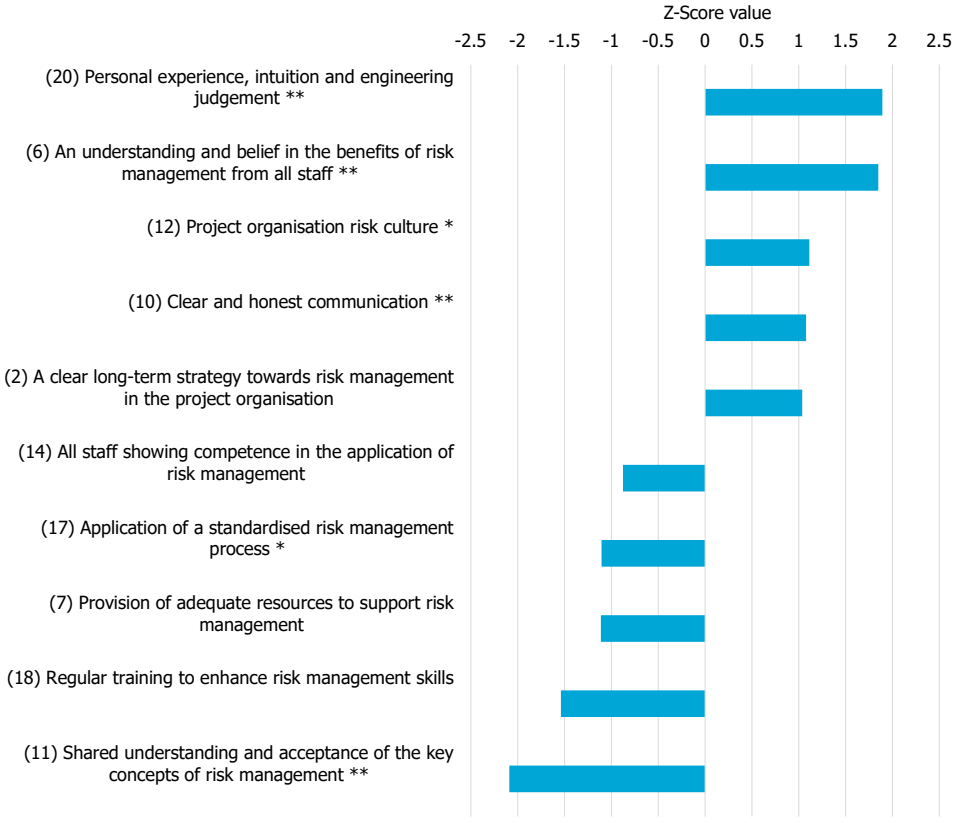



Figure 4.2: Z scores for the characterising statements of Perspective 1. *Note: '**' indicates a distinguishing statement, significant at $p < 0.01$. '*' indicates a distinguishing statement, significant at $p < 0.05$.*

### MOST IMPORTANT STATEMENTS

The two statements ranked highest by this perspective were *An understanding and belief in the benefits of risk management from all staff* (6), with a Z score of 1.85, and *Personal experience, intuition and engineering judgement* (20), with a Z score of 1.89. In addition, both of these statements were distinguishing statements at $p < 0.01$ significance.

Respondents described the importance of personal experience, statement (20), with regards to risk management, in particular in identifying, evaluating and forecasting risks:

> *"I think if it comes to risk evaluation, there's nothing more important than personal experience, intuition and the ability to make some clear judgement, it's incredibly important."*

> *"My opinion is that in construction sites the most valuable asset is experience, and that's also for risks.* [Personal experience is] *mostly to do with validating the risks and forecasting what is going to happen and there you need experience, you can't do that from a textbook."*

Respondents belonging to this perspective described why they found statement (6) to be so important, often highlighting the importance that a belief in risk management should be shared by everyone, otherwise they consider that the whole exercise of risk management will be undermined:

> *"...if no one believes in the safety policy and the risk management policy, it's our common thing to work for, if no one believes in it - it's rubbish, it's not going to be a success, definitely."*

> *"...when you're with a group and half of the group don't believe that the risk management is going to help, then you can stop with your risk management."*

In addition, one respondent linked this belief to the willingness of employees to do their risk management tasks:

> *"If you want to do risk management on the project, the team needs to understand the benefit of it because otherwise no one will do it...if you don't have the belief of everyone then the risk management charts will be half-filled in and then your risks are incomplete."*

The statement *Project organisation risk culture* (12) received a Z score of 1.11 and it was a distinguishing statement at the $p < 0.05$ level. Respondents described how having a healthy risk culture means that people are aware of risks and also means that employees moderate each other with regards to risk taking on the site in particular:

> *"You always have to be aware of risks and you always have to keep an eye on that and be busy with that and not only arranging work and doing those things but also things like being prepared for what can go wrong, "what is my next step if something goes wrong?""*

> *"I think everyone involved in the project should be aware of the risks and you have to be able to talk about it...to have a good discussion from different angles and I think that has to do with the risk culture."*

> *"Sometimes there are situations where you have to convince people that certain situations are not safe, or are taking risks, then it's about culture and whether you can change this as a person, or not..."*

*Clear and honest communication* (10), was a distinguishing statement for this factor at $p < 0.01$ significance and had a Z score of 1.08. Respondents belonging to this perspective described the link between communication and risk management:

> *"...transparency of information is vital and transfer of information can only be valuable if it is clear and transparent."*

> *"First of all, if you don't have transparency in your communication, then nothing is going to work. You must be honest and I think that is the most important thing. When you discuss everything you can challenge if you think the same, you can challenge if you do the same and you can challenge if you understand each other...when that's clear, you're going to be doing the right thing."*

The statement *A clear long-term strategy towards risk management in the project organisation* (2) received a Z score of 1.04. Some respondents described how this strategy provides the basis which unites the organisation and allows it perform. It was also highlighted that projects with long timescales such as Project A must have a long-term strategy to carry the risk management process through the entire project, over many years.

> *"...without a clear strategy at the beginning of the risk management process, of a project or corporate wide, I don't think we can achieve any goal that we are trying to* [achieve]. *Strategy is a kind of starting point, it's a line that we should follow to achieve a proper result for the project. That's the origin of everything regarding the process...that's the zero point which we should start at."*

### LEAST IMPORTANT STATEMENTS

The statement *Shared understanding and acceptance of the key concepts of risk management* (11) was judged to be the least important of all statements by this perspective, with a Z score of -2.09, and this was a distinguishing statement at the $p < 0.01$ level. Respondents considered this statement to mean that people know the definitions of the key concepts of risk management and that they are familiar with the theory. Respondents described how if other processes are in place, particularly clear and honest communication, then having a shared understanding and acceptance of the key concepts of risk management is rendered almost irrelevant:

> "*Well I think when you do the most important thing, you can discard the less important thing* [shared understanding an acceptance of the key concepts of risk management], *you can create that easily in clear and honest communication."*

> *"...you see in all my answers 'the way of doing it' is less important than 'doing it'...so concepts is also a little bit vague...it should be an open discussion, that's the most important thing for risk management."*

*Regular training to enhance risk management skills* (18) received a Z score of -1.54. Respondents had a variety of reasons for this, one described how rather than training to enhance skills, training should aim to increase the awareness of risks to encourage *An understanding and belief in the benefits of risk management from all staff* (6), and that this would reap more benefits for risk management. One respondent described how risk management is not something which you can train people for, it is more a case of having a mindset towards risk management. Another explained that since he had learnt about risk management at university, he now uses that theory in his job and training wouldn't be necessary for or relevant to him.

*Provision of adequate resources to support risk management* (7) received a Z score of -1.11. One respondent described how this statement, along with *Shared understanding and acceptance of the key concepts of risk management* (11) struck them as forms of 'institutionalised risk management'. This respondent in particular thought that risk management was best done by the people working closest to the risks and that making people do paperwork and recording every detail of a risk is a waste of time and effort, they thought it was more about action:

> *"So that's more or less the way everything is divided, so everything that leans slightly towards working with people, skilled colleagues, or a skilled team where you're able to make your own judgements and you know what's right and what's wrong* [I have ranked towards the most important end of the scale]*...and the least important I think are the goals which are 'institutionalised'...that's the ugly side of risk management."*

*Application of a standardised risk management process* (17) obtained a Z score of -1.11 and was a distinguishing statement at the $p < 0.05$ level. Respondents described how each project is unique and a standardised process may not be useful or may even limit the success of the risk management:

> *"I personally don't believe in a standardised approach because every project is different from each other, nature-wise, complexity-wise, magnitude-wise and for all the difficulties-wise so making a process that is standardised I think would limit what we are trying to do ...and also might limit the new approaches"*

> *"It could be helpful, but what I see on every project is another approach, there's not a wrong approach. One system may work better on one project and then another system may work better on another project, it's not a must to standardise it."*

The statement *All staff showing competence in the application of risk management* (14) received a Z score of -0.88. As was the case with *Shared understanding and acceptance of the key concepts of risk management* (11), one respondent thought that if clear

and honest communication was in place, the competence of individuals was less important. Another thought that this was more about how to do something rather than actually putting it into action, they described how all employees can identify risks anyway so their competence is not important.

#### CONCLUSION

By examining the full picture of the way in which statements were ranked by this perspective, it can be concluded that this perspective generally ranks so called 'soft skills' highly and places less importance on the more structured processes surrounding risk management such as training and having a shared understanding of the key concepts. Statements (6), (20), (10) and (12) in particular can be grouped under this umbrella of soft skills, they relate to behaviours, internal thoughts and the interactions between employees rather than the organisational procedures in place. These four statements are also somewhat intangible and immeasurable. In addition, statements (6) and (20) are aspects which are deeply rooted in a person's mindset, their intuition and their belief in the process. These two things are not easy to change, they cannot be quickly addressed through training or changing organisational procedures in the way which other statements can be, for example simply providing more resources or introducing a new set of guidelines.

This perspective judged the more 'institutional' aspects of risk management to be less important, such as statements (7), (17) and (18). It seems that this perspective prefers a bottom-up approach to the risk management, where it is cultivated by the behaviour of individuals rather than a top-down approach which is imposed and measured by rules and processes.

Perspective 1 is herein known as Experience and Belief.

### 4.3.2. PERSPECTIVE 2

Five respondents belong to this perspective and it accounts for 21% of the explained variance in the data set. The Z scores for the characterising statements of this perspective is shown in Figure 4.3 and these statements are discussed below.

#### MOST IMPORTANT STATEMENTS

The most important statements according to this perspective was *Integration of risk management with other project management activities* (1), with a Z score of 1.80. Respondents described how they thought risk management should be a standard activity and is very closely related, or even equivalent, to the project management itself:

> *"It has to do with the long term strategy, if risk management is something which is in your DNA, it's part of the normal agenda of all activities you deploy, not because you have to but because you want to do it, it's normal."*

> *"The project management and the risk management should be the same."*

> *"Risk management is daily business...Risk management should be integrated, it's a way of living, it's a way of working. I think what you should do is, at least maybe 50% of your time, is making sure risks are managed."*

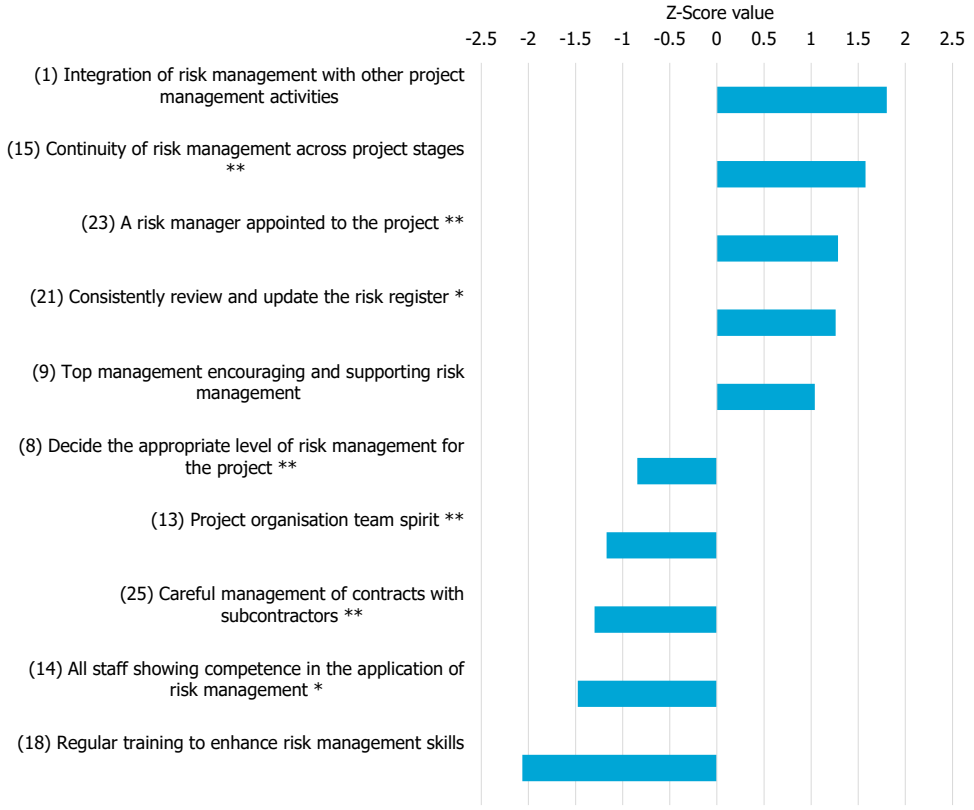



Figure 4.3: Z scores for the characterising statements of Perspective 2. *Note: '**' indicates a distinguishing statement, significant at $p < 0.01$. '*' indicates a distinguishing statement, significant at $p < 0.05$.*

The statement *Continuity of risk management across project stages* (15) obtained a Z score of 1.58, in addition this statement was distinguishing at the $p < 0.01$ level. Respondents explained that for risk management to work, it must traverse all project stages:

> *"To get it right, you have to do it at all the stages"*

This perspective found that *A risk manager appointed to the project* (23) was one of the most important statements, resulting in a Z score of 1.29. This statement was also distinguishing at the $p < 0.01$ level. Respondents described how the risk manager is the advocate for the risk management, their task is to put important risk management items on other's agendas and act as a central point of information:

> *"I think a risk manager is crucial because he's the one who can appoint something on the agenda...if there's something which needs to be done, he's the one who brings attention to it. It's crucial also for the organisation of risk management in a project."*

*Consistently review and update the risk register* (21) received a Z score of 1.26 and was a distinguishing statement at the $p < 0.05$ level. Respondents explained that this process of reviewing and monitoring risks is vital to keep control of the project:

> *"Judging and consistently reviewing and updating the risk register is especially about monitoring if the measures are followed up and are finished because then you're in control, the risk is mitigated and we make more profit. It's simple."*

The statement *Top management encouraging and supporting risk management* (9) obtained a Z score of 1.04. One respondent described how this support from the top ensured that the risk management culture grows. Another thought that the support from the top management is required to ensure that *Continuity of risk management across project stages* (15) is achieved.

### LEAST IMPORTANT STATEMENTS

*Regular training to enhance risk management skills* (18) was ranked the least important, with a Z score of -2.06. Two respondents explained how they thought that if there is a risk manager (ranked as important by this perspective) training is not so necessary:

> *"I think regular training is not that important if the risk manager interviews the teams about the risks they see and explains how it works. It's not necessary to train everyone in risk management."*

> *"...you can also have training on the job, it's important that you have an experienced guy and then you can have training on the job and then it's not that difficult...if you have a system and you have an experienced risk manager, you have enough resources and support, so that's why I did not think it's that important."*

Another described how regular training indicated that the risk management process is too complicated:

> *"If there is training, it means the process is too complicated. The process should not be complicated, it should be accessible and easy to understand."*

This perspective ranked *All staff showing competence in the application of risk management* (14) towards the least important end of the chart, with a Z score of -1.47. One respondent thought that it is the job of the risk manager to lead and instruct others and therefore it is not necessary for all staff to understand the process.

*Careful management of contracts with subcontractors* (25) was regarded to be of less importance by this perspective, with a Z score of -1.30. Two respondents explained that even whilst using subcontractors, the risk management must be performed by the main contractor:

> *"The subcontractors are only interested in their own product, their own part of the project, so they won't have the big picture of the risk management. You*

> *can't expect them to be involved in your risk management of the whole project or the interfaces between other risks so you cannot rely on them for the risk management."*
>
> *"Risks with subcontractors, they should be known by ...the engineers and by everyone involved with the subcontractors. I think the main contractor has to do the risk management."*

This perspective ranked *Project organisation team spirit* (13) towards the least important end of the chart, with a Z score of -1.17. One respondent described how he found this statement to be somewhat irrelevant to the risk management process:

> *"I'm not really a big fan of team building and I don't see how it is important to risk management. We often do team building activities at the start of the project but I don't see the real relevance of them. I prefer to get on with my tasks of producing the design."*

The statement *Decide the appropriate level of risk management for the project* (8) received a Z score of -0.85. One respondent explained that you need to do the same risk management activities for all sizes of projects, the only difference being that less money is involved in the process.

#### CONCLUSION

Considering the overall idealised Q sort chart, it can be concluded that this perspective values consistency and the role of management, both top management and the risk manager, in performing risk management. This perspective thinks that consistency should be applied to many aspects of the risk management process. The application of risk management throughout the project should be consistent, or 'continuous' as is used in statement (15), the risk register should be consistently monitored, statement (21), risk management should be consistent with other project management activities, statement (1), and finally risk management must be consistently raised on the team's agenda through the encouragement of the top management, statement (9), and the presence of a dedicated risk manager, statement (23). This perspective values rules and procedures and the role of management to lead the risk management process.

This perspective attaches less importance to collaboration with the wider team, shown in the low ranking of the statements *Careful management of contracts with subcontractors* (25) and *Project organisation team spirit* (13). This perspective prefers to retain control of the risk management within the main contractor organisation rather than involve subcontractors and it prefers to rely on the individual, rather than collaborate with the wider team and develop relationships which constitute team spirit.

Perspective 2 is herein known as Procedures and Leaders.

### 4.3.3. PERSPECTIVE 3

This perspective accounted for only 13% of the explained variance in the data set and had three respondents loading significantly onto it, the fewest of all the perspectives. Theory suggests that a minimum of four people are required to properly describe a perspective, see A.3.1 in Appendix A. The fact that this perspective has so few respondents

belonging to it makes it difficult to provide clear conclusions as to its position but it is a risk that having such a small P set can result in perspectives with very few respondents belonging to them. There were statements which were ranked very differently by the three respondents, showing contradiction exists within the perspective and it was harder to find evidence in the interview transcripts of the common opinions they share, compared to the analysis of the transcripts of respondents from perspectives 1 and 2. Despite these challenges, discussion of the perspective has been presented since it accounts for 20% of the respondents. The Z scores for the characterising statements of this perspective is shown in Figure 4.4 and discussion of these is presented below.

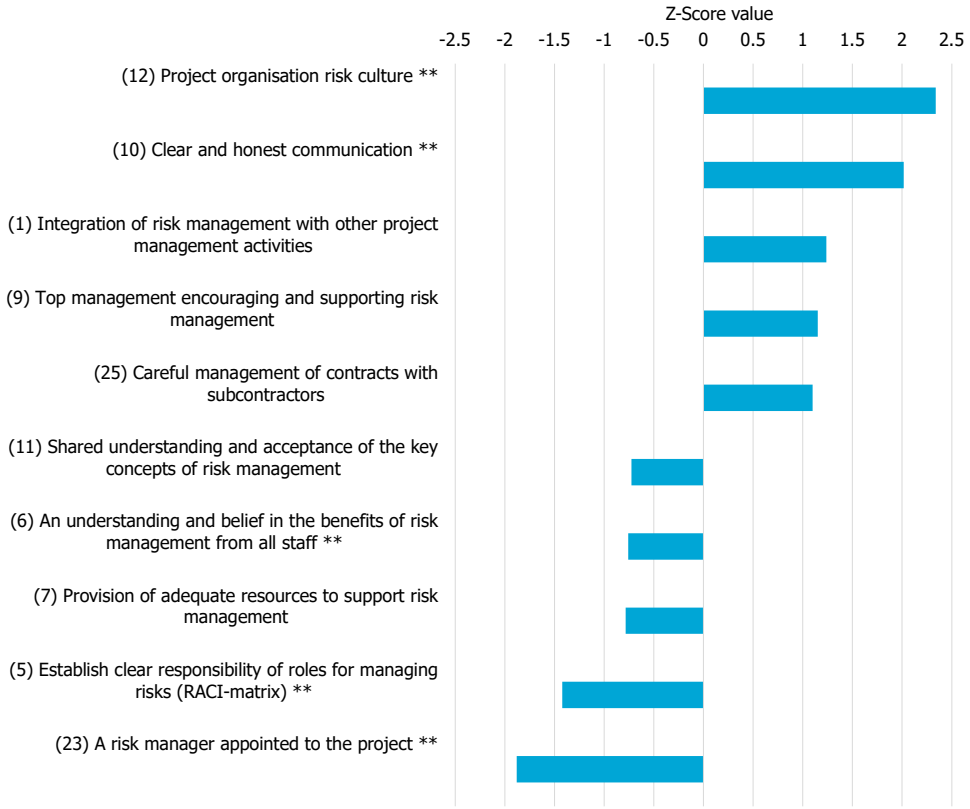



Figure 4.4: Z scores for the characterising statements of Perspective 3. *Note: '**' indicates a distinguishing statement, significant at $p < 0.01$. '*' indicates a distinguishing statement, significant at $p < 0.05$.*

### MOST IMPORTANT STATEMENTS

All three respondents who belong to this perspective ranked *Project organisation risk culture* (12) as the most important statement, giving a Z score of 2.34. This statement was also found to be distinguishing at the $p < 0.01$ level.

> *"You can discuss whether it should be an 'effect of'* [project risk management], *but the culture, there has to be a good culture in the project to make it successful for risk management. If it's forced and there's no common ground for the risk management, then it will be* [unsuccessful]*...you have to believe in it...that's the most important I think, that the right culture is there and everyone who doesn't have that experience is carried with that culture in a project and is affected by that, so that they join risk management."*
>
> [If you want to] *"make sure you're eliminating or containing the risks at the project level, then I think the most important items are that as a team, you are working on that specific*[ally]*, so that's the project organisation risk culture..."*

The statement *Clear and honest communication* (10) received a Z score of 2.02, again this item was distinguishing at the $p < 0.01$ level. Respondents described how the communication channels should flow freely and one described how the positive effects of risk management should be communicated to help build people's belief in the process:

> *"...there should not be any walls or obstacles about discussing the risks."*
>
> *"...being able to communicate and report about information honestly, without any second agendas or political mess around it, and that's also very important."*
>
> *"...if there's a positive effect to be mentioned or communicated then we should do it because then they see "hey this is what happens with my input and this is the benefit for the project", otherwise there are risks occurring and they cost money and there is negative effect.. they hear that as well."*

This perspective ranked *Integration of risk management with other project management activities* (1) towards the most important end of the chart, giving a Z score of 1.24. Respondents described the importance of this integration and one referred to the danger of having a risk manager (covered by statement (23) *A risk manager appointed to the project*, which this perspective found to be one of the least important statements) since this can cause people to assume that the risk management is only the responsibility of the risk manager:

> *"Typically we have some primary processes, engineering, work preparation and realisation, procurement...I look at it as a matrix, on the vertical lines you have our primary processes, risk management is on the horizontal axis, if you only implement risk management for design, what good is that? Having a process which is tailored to each primary process isn't going to work as well I think, because many of those, actually all the primary processes are very much connected and aren't as different as many people think they are."*
>
> *"I think the worst thing you can do is organise it as a* [separate] *department, so there is one person who is the risk manager and he will do the risk management. You have to integrate it or embed it in all the departments, everyone is doing more or less implicit or explicit risk management, it's a way of thinking and not only the tool or the person who has the name 'risk manager'."*

*Top management encouraging and supporting risk management* (9) obtained a Z score of 1.15. One respondent explained that top management must communicate the message behind the risk culture:

> *"I think if everybody wants to make sure that we eliminate the risks or the risks which we cannot eliminate we do the appropriate measures, that's the most benefit you can get from the risk management."*

The statement *Careful management of contracts with subcontractors* (25) received a Z score of 1.10. A respondent explained that the input of subcontractors is important as they know their own section of the project:

> *"If you want to make sure you contain the risks you also need to look at the subcontractors and suppliers and discuss with them the risks which they see or which we can together eliminate."*

### LEAST IMPORTANT STATEMENTS

This perspective judged *A risk manager appointed to the project* (23) as one of the least important statements, it received a Z score of -1.88 and was also found to be distinguishing at the $p < 0.01$ level. Two of the three respondents found that having a designated risk manager is simply less important than other aspects of the risk management, one of whom said:

> *"I think if you have appropriate management which explains the importance of risk management and you create the appropriate culture in the project teams, it shouldn't be necessary to appoint a separate person who says "we need to do something about risks", so it's not personal or anything to risk manager but I think...create a correct culture in the project and* [highlight] *the importance of risk management and you don't need to appoint somebody to be the risk manager."*

Another described how having a risk manager was not enough, it is more about having a risk manager with the right attitude who is proactive and inspires others:

> *"Yeah the risk manager, not per se a risk manager but a proactive, enthusiastic person who helps the implementation and helps the culture which I have put on the most right side of the chart. To have a good risk culture on the project you need, unfortunately still, you need someone who inspires the team on that...and that's what I see as a culture. Just having a risk manager? Well ok, it's not that important."*

The statement *Establish clear responsibility of roles for managing risks* (5) obtained a Z score of -1.42 and was found to be distinguishing at the $p < 0.01$ level. One respondent thought that using a RACI-matrix could restrict the risk management process, since there would be less sharing of ideas on how to solve an issue:

> *"...because then you box off each person's tasks within risk management... The RACI is about which person should have which action during the process in the risk management. But if you want to discuss and find the best solution for risk management, you should all work together...then you shouldn't need a RACI matrix for it, you just need to sit together and discuss the risks and how to eliminate them."*

*Provision of adequate resources* (7) received a Z score of -0.78. Respondents thought that resources are 'nice to have' but it's more about how effective the process is itself and risk management is not something which needs extensive resources:

> *"I see this as a 'nice to have'..of course it helps if you have really nice tooling and the perfect work-instructions and what-not but in the base it should be the process itself...the rest makes it easier but it shouldn't be top priority."*

> *"Having enough resources for risk management, yeah, I was thinking what do you need? You can do it so low profile as possible, you can say having enough coordinators to help the departments or the tools to store all the risks, to record the progress of those risks, but if it's not there you can still do risk management so I thought it's not the most important."*

The statement *An understanding and belief in the benefits of risk management from all staff* (6) had a Z score of -0.76 and was distinguishing at the $p < 0.01$ level. A respondent described how they thought that as long as people follow instructions, they don't need to believe in what they are doing personally:

> *"In these project teams, it isn't a democracy, so if the management or the advisors have decided that a certain process such as risk management is a key process which we should use or follow, then that's that. You shouldn't ask a whole organisation if they can relate to a process and for a lot of staff members...you don't need to tell them 'why', I understand it does help, but it isn't a necessity. The necessity is that they do it correctly and are guided...and have the right tools and organisation to make it work."*

This perspective found *Shared understanding and acceptance of the key concepts of risk management* (11) to be of less importance, with a Z score of -0.72. As for perspective 1, respondents thought this referred to the definitions used in risk management, which they consider to be less important:

> *"The last one is about the definitions used in risk management, that's how I interpreted it in the end and I think as long as you keep the conversation going about risks, it's a little bit less important that you know exactly the definitions in risk management."*

#### CONCLUSION

This perspective values culture and communication most highly and the respondents described how they felt these two aspects are strongly linked to each other. Like Perspective 2, this perspective ranked statements (1) and (9) highly but had an opposing view on

the need for a risk manager, statement (23). Respondents described how the risk culture is more important than having a risk manager, although a proactive risk manager can boost the culture. They judged statement (25) to be one of the most important, valuing the specialist knowledge of subcontractors. They ranked statement (5), *Establish clear responsibility of roles for management risks (RACI-matrix)* to be one of the least important, respondents again described how communication and culture can be used instead of detailed procedures because discussing things openly enables better solutions to be discovered than dividing and allocating risks through the use of a RACI-matrix, for example.

Overall, respondents from this perspective repeatedly described how the risk culture is the overarching aspect which is most important to supporting the risk management. A principal feature of a healthy risk culture is open and honest communication. This perspective thinks that if a healthy risk culture is in place, other things will benefit.

Perspective 3 is herein known as Culture and Communication.

### 4.3.4. SUMMARY OF PERSPECTIVES

Herein the perspectives will be referred to by the following names:

Experience and Belief (Perspective 1) - This perspective values the personal expertise of the individual and that each person believes in the benefits of the risk management process. Other soft skills, such as risk culture and clear and honest communication, are also important to this perspective, along with a clear long-term strategy for the risk management.

Procedures and Leaders (Perspective 2) - This perspective judges the consistent application of procedures, it's integration with other project management activities and the leadership actions of both the risk manager and top management to be the most important features of risk management.

Culture and Communication (Perspective 3) - This perspective sees the risk culture as the cornerstone of risk management. They consider that a healthy risk culture, supported by clear and honest communication, can enable other processes of risk management to be enacted smoothly.

## 4.4. COMPARING PERSPECTIVES

Having examined each perspective individually, the next stage is to investigate how these perspectives differ. PQMethod provides difference scores for all perspectives, see Appendix L. Statements which have a difference score of more than 2 (or -2) have been discussed below as this can indicate a strong difference of opinion on the statement thus enabling a deeper understanding of the ways in which the perspectives differ from one another.

### 4.4.1. COMPARING EXPERIENCE AND BELIEF WITH PROCEDURES AND LEADERS

The statement *Personal experience, intuition and engineering judgement* (20) received a Z score of 1.89 from Experience and Belief and -0.75 from Procedures and Leaders, resulting in a difference score of 2.641. On one hand, Experience and Belief values common sense and personal experience when it comes to dealing with risks:

> *"To emphasise the self-responsibility of people, it's your responsibility to have it safe...I think that's a key to success in risk management. There are risks that are known risks, you know? And there are unknown risks, and especially unknown risks, you only tackle those or help to prevent those when you have this common sense and self-responsibility thing. It's also especially this personal experience and intuition...I think that's most important.*

On the other hand, examining the Z score awarded by Procedures and Leaders, it appears that this perspective places more value on the processes in place and the actions of top management and the risk manager than personal experience at an individual level. This may be why Procedures and Leaders ranks statement (20) towards the least important end of the chart.

The statement *A risk manager appointed to the project* (23) got a Z score of -0.71 from Experience and Belief and in 1.29 from Procedures and Leaders, giving a difference score of 1.99. One respondent who belongs to Experience and Belief described how he considered the risk manager should be responsible for macro risks, whilst leaving micro risks (like daily project risks) to the people who are working directly among and with those risks:

> *"Within the project, we have a specific risk manager and I think it's ok that we have a specific risk manager. I think the risk manager should be responsible and accountable for aligning the macro risks, the risks at a higher abstraction scale. And if you look at the more micro risks... you should put the responsibility and accountability to cope with smaller risks at the lower levels."*

Procedures and Leaders promotes the view that the risk manager is needed to keep risk management on the agenda, to organise the process and act as a central point for sharing information. One respondent from perspective 2 described the risk manager as *"crucial"*, perspectives 1 and 2 see the necessity and role of the risk manager differently.

### 4.4.2. COMPARING EXPERIENCE AND BELIEF WITH CULTURE AND COMMUNICATION

The statement *Establish clear responsibility of roles for managing risks (RACI-matrix)* (5) received a Z score of 0.90 from Experience and Belief and -1.42 from Culture and Communication, with a difference score of 2.323. One respondent from Experience and Belief thought that a risk matrix was vital to ensure that each risk has an owner who will work to manage it:

> *"It's the most important thing and it has to do with ownership. If you have a risk matrix it's very important that every risk has an owner, someone has to feel the responsibility for it otherwise it won't work."*

A respondent from Culture and Communication felt very differently about this statement, saying that the presence of a RACI-matrix would mean the risk management is compartmentalised too much:

> *"The RACI is about which person should have which action during the process in the risk management. But if you want to discuss and find the best solution for risk management, you should all work together...then you shouldn't need a RACI matrix for it, you just need to sit together and discuss the risks and how to eliminate them."*

The statement *An understanding and belief in the benefits of risk management from all staff* (6) received a Z score of 1.85 from Experience and Belief and -0.76 from Culture and Communication, with a difference score of 2.604. One respondent from Experience and Belief described how this belief is important as they think it makes it more likely for a process to be successful if the people involved understand why it is required:

> *"Risk management is a process which is vital for the health and life of a project. If all the parties in the project cannot have a clear understanding of why we are doing it, for what purpose, and what will be the outcome benefit of this process...If they cannot understand it clearly, I don't think it can come to a successful achievement, a successful result."*

Culture and Communication holds a different opinion on this statement, one respondent described how if people are told to do something, they should just do as instructed, they don't need to have a belief in the process:

> *"In these project teams, it isn't a democracy, so if the management or the advisors have decided that a certain process such as risk management is a key process which we should use or follow, then that's that. You shouldn't ask a whole organisation if they can relate to a process sometimes and for a lot of staff members...you don't need to tell them 'why', I understand it does help, but it isn't a necessity."*

The statement *Personal experience, intuition and engineering judgement* (20) received a Z score of 1.89 from Experience and Belief and -0.59 from Culture and Communication, the difference score being 2.483. Unfortunately, there were no quotes available from anyone in Culture and Communication to further investigate this disparity, the reasons why Experience and Belief found this statement so important have been discussed in 4.4.1.

### 4.4.3. COMPARING PROCEDURES AND LEADERS WITH CULTURE AND COMMUNICATION

The statement *Clear and honest communication* (10) received a Z score of -0.39 from Procedures and Leaders and 2.02 from Culture and Communication, the associated difference score being -2.412. None of the respondents from Procedures and Leaders mentioned this statement in their interviews, it was ranked in either the 0 or -1 column by all of them and this indicates they were indifferent to it when looking at the overall picture of relative importance, hence why it was not discussed. All three respondents who

belong to Culture and Communication mentioned this statement and all described how communication is very important to risk management, see 4.3.3 for the quotes on this statement.

The statement *A risk manager appointed to the project* (23) received a Z score of 1.29 from Procedures and Leaders and -1.88 by Culture and Communication, the difference score being 3.165 and the highest difference score for any statement for any of the perspective comparisons. Procedures and Leaders placed importance on this because respondents felt that the risk manager acts as a central point for information sharing and organisation of risk management. Respondents from Culture and Communication thought that it was more important for certain key staff roles to perform effective risk management, rather than having a specified risk manager.

The statement *Careful management of contracts with subcontractors* (25) received a Z score of -1.30 from Procedures and Leaders and 1.10 from Culture and Communication, with a difference score of 2.398. Respondents from Procedures and Leaders described how subcontractors should not be relied upon when it comes to the overall risk management, since they each have their own section of the project and do not fully understand the interfaces between their work and the work of other parties. Only one respondent from Culture and Communication mentioned this statement, they thought that it was important to involve subcontractors and suppliers to discuss risks which they are aware of and what strategy they should use, together with the main contractor, to eliminate the risks.

### 4.4.4. SUMMARY OF COMPARISONS

From the individual descriptions of the perspectives and the above comparisons it is clear that the perspectives see certain statements very differently and have therefore attached very different levels of importance to them when considering project risk management. Experience and Belief places highest importance on the personal experience and initiative of each employee whilst Procedures and Leaders places highest importance on the organisational procedures in place to guide employees. Procedures and Leaders considers a risk manager essential to the organisation of the process whilst Experience and Belief finds it more important to have the power of risk management in the hands of those dealing directly with the risks. Experience and Belief and Culture and Communication seem to disagree on whether a belief in the risk management process is necessary to implement risk management. Culture and Communication values communication highly, both within the organisation and with the management of subcontractors, whilst Procedures and Leaders considers the main contractor should simply lead subcontractors and communication is less important than the procedures in place.

## 4.5. CONSENSUS STATEMENTS

Two consensus statements were found to exist. These were *Consider the external environment* (3), with an average Z score of -0.250, and *Capture and use lessons learned* (22), with an average Z score of 0.433. This means that no consensus statements exist at the extreme ends of the Q sort chart, there were no statements which all perspectives found to be the most or least important (+3 or -3 column of the response chart) at a level

of significance high enough for them to be flagged as consensus statements. The statement *Capture and use lessons learned* (22) was the statement with the most consensus. A respondent from Culture and Communication described how learning lessons is important to the organisation as a whole due to the project nature of the industry and the fact that knowledge is often held in the minds of the staff, rather than being openly available and documented:

> *"I don't believe that you can create a perfect process, it's something which evolves by doing and that's actually one of the hardest things....the learning curve for a project, since we are a project organisation...because the knowledge, most of the time, that knowledge is within the heads of the personnel and firstly it's really difficult to get that knowledge out of those heads and onto paper and then once you succeed in that it's also very hard to transfer it to another project...so capturing and sharing lessons learned, it's very important, because otherwise your learning curve isn't that steep and you keep on making the same mistakes over and over and over."*

Another respondent, from Experience and Belief, thought that lessons learned was an important part of monitoring a project:

> *"...if something goes good or bad you have to learn from that so there should be some lessons learned in risk management...and also we have had this risk management and these major risks and the minor risks and what is the effect on managing those risks?...that's more or less the lessons learned from risk management, "are we doing that ok?", "have we quantified the major risks ok? Have we had enough control measures?" that's also what decides normally the lessons learned."*

## 4.6. THE NON-LOADER

Respondent 2 is described as a non-loader. Their Q sort chart did not correlate strongly enough with any of the perspectives for them to be grouped with other members of the P set, therefore they are considered to be an outlier. Some of the statements which this respondent ranked in the extreme columns (-3, -2, +2 and +3) which have not been discussed in detail in previous sections will be presented, since they show how this respondent differs from the identified perspectives.

The respondent described how they thought the statement *Consider the external environment* (3) was very important to risk management:

> *"In the tender phase you think of all kinds of risks, but none of them were related to having a worldwide corona virus. Now we started up the project and we see "oh no - the corona virus is coming", it's really an external factor but it's causing a lot of problems. It's deteriorating the whole market, we had to send a lot of people home, people are working from home, you're less productive and those kinds of risks you cannot influence, they can have a very very heavy impact on your project and you can do nothing about it. "*

This opinion on the external environment was much stronger than that of any of the other respondents.

This respondent put the statement *Capture and use lessons learned* (22) in the -3 column. They described how they thought that lessons learned were more important for organisational risk management, but had little relevance to project level risk management, since the nature of the projects is that they are always different:

> *"That's for a project, not so interesting, it's more I think from the perspective of a company, it can be, but the probability that you do the same project at the same location with the same stakeholders again is so little that it will barely be useful."*

## 4.7. PERSPECTIVES AND FUNCTIONAL TEAMS

Figure 4.5 shows how the respondents are distributed across the perspectives and the functional team to which each respondent belongs. A statistical analysis was run to investigate whether there was any significance between the functional teams and the perspectives, see Appendix M. It was found to be borderline significant (p=0.0509) that four of the respondents who were members of the design team belong to Procedures and Leaders. There was no significance found between the other perspectives and the teams to which respondents within those perspectives belong.

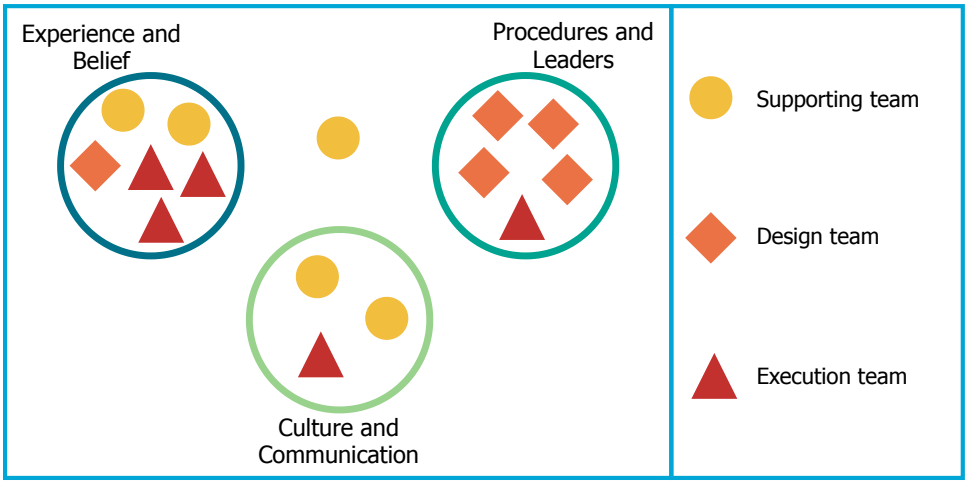



Figure 4.5: Venn diagram in which each respondent is represented by a symbol showing the functional team to which they belong, placed within the perspective in which they belong. Note the non-loader, from the supporting team, not lying within any of the perspectives.

Considering Procedures and Leaders, there are some similarities between what this perspective finds to be important for risk management and the types of people who typically work in the design team of a project. The perspective values procedures and direction from management, people who work in design must follow procedures such as building codes to complete their task. The nature of their work means they are comfort-

able with following rules and procedures and they put trust in these knowing that if they meet the requirements, their design will be a success. In contrast, people who work on the execution team or supporting team may not feel so strongly about the need to rely on procedures, for example execution managers are often required to think on their feet to fix a problem and use their experience for this rather than referring back to codes.

## 4.8. PERSPECTIVES AND LEVEL OF EXPERIENCE

Figure 4.6 plots the level of experience in the construction industry in years for each respondent, against the perspectives. Experience and Belief has an average experience level of 15.7 years, Procedures and Leaders, has the highest average of 20 years and Culture and Communication, has the lowest average of 13 years. Examination of Figure 4.6 shows that a relationship between the years of experience and the perspectives is not clear. Particularly for Experience and Belief and Procedures and Leaders, the data points are scattered across a wide range of experience levels. Although the respondents from Culture and Communication all have a very similar level of experience, there are not enough data points to conclude whether this shows a relationship exists or this is just a coincidence. For this data set, it appears that the level of experience does not impact upon the perspective to which a respondent belongs but further research would be needed, with a larger P set, to investigate the existence of a relationship further.

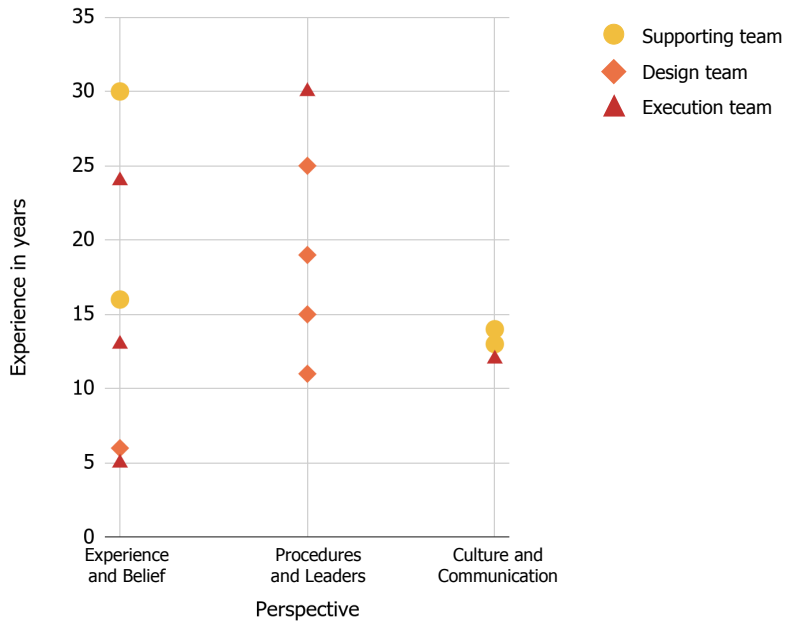



Figure 4.6: Plot showing level of experience in years against perspective. Respondent 2, the non-loader, is not included on this plot.

## 4.9. ADDITIONAL TOPICS FOR DISCUSSION

There were two topics which came up during the interviews which the researcher considers to be worth mentioning in more detail, these were the complexity of risk management and the documentation of risks. These topics were not discussed extensively in the individual perspective descriptions but it was decided to include the discussions from the relevant respondents in this section, as an addition to the main results of the research. These opinions can be considered as 'loose observations' from the interviews and although they do not relate to a perspective in particular and were not included as a goal of the research project, they are relevant and interesting to the research.

### THE COMPLEXITY OF RISK MANAGEMENT

Some respondents expressed their opinions on the overall approach to risk management and the complexity of the process. Firstly, one respondent explained how they felt that by not integrating it well into daily tasks, it actually makes risk management more difficult:

> *"...sometimes I think we make it too difficult to call it 'risk management', just integrate it in the normal way of working and that I think is the most important thing...And don't make it too difficult, you know risk management is not that difficult, because everyone is doing it every day...maybe because we make it a "too hot" topic, so it would be really helpful if the project managers are doing this day by day to give a good example, and try to push it down and on the other hand it can also help if people bottom up are working like this and then it's an easy job for the risk manager."*

Secondly, this respondent described how risk management is appropriate at different levels, and failing to recognise and act on this may negatively affect the risk culture and therefore the risk management as a whole:

> *"...my conclusion is that risk, for me, risk management helps the best on the right level and I think it helps as we do it on Project A with professional tooling and a standardised process and very highly organised and that's not that suitable for the operational day to day risks. But it's very suitable for the more mid-term financial forecasts, giving insights into the financial risks and prognosis and changes in the prognosis especially. On that setting to have the quarterly meetings about the financial forecast supported by good risk management records, in that case, I can use it use it very well but I find it more difficult to let the process to the more operational people who in every decision they make day to day it's about implicit risk analysis in their heads, you won't find anything in the system about that, it's implicit. And I think that's difficult, you can negatively affect that risk culture if you force people too much to register risks in tools and get them to report on them regularly each month and do some quantitative analysis of how big the chance is of occurrence...'do it on the right level' I should say, not automatically to every level."*

Finally, this respondent explained that the process has become so complex, with extensive documentation required, that it begins to miss the point of what it is actually designed for, to save money and keep people safe:

> *[Risk managers] "just bring a lot of paperwork....the least important I think are the goals which are 'institutionalised'...that's the ugly side of risk management...The way it's often implied is that we have this big risk manager and we need to supply them with an incredible amount of paperwork and if you ask someone "well what's the relevance?"..."yeah otherwise we would pay more for our insurance" ...I think least important is the 'forced risk management' you know?* [We have to submit risks to Relatics and write reports] *and then you just generate paper and not save lives or save funds."*

Ballast Nedam must do risk management on all their projects, not only as it is required by their insurance but also as a vital part of their project management, however it is clear that some employees feel that risk management could be done better or differently.

### THE DOCUMENTATION OF RISKS

One respondent, with 25 years of experience in the industry, described the introduction of systems engineering to risk management:

> *''When systems engineering was first introduced to us, everyone wrote down a lot of risks. We wanted to put everything on this big clever system. We put so much information into Relatics or similar softwares and we wrote down hundreds or thousands of risks for a project. But what happens is that a lot of these risks are forgotten about, or the person who wrote them down has left the company...by the end of the project there are still loads of risks which are not "resolved" in Relatics, but we can't delete them because the client has already seen them...so they just sit there and we don't know what to do about them."*

This respondent went on to describe how they feel the risk register is overwhelming:

> *"The risk register on these projects is huge. There are hundreds of risks. It is important that we track risks and update the register, but I think the way the register has become so huge is not the right way to do it. I myself, can probably think about ten risks at a time, on the work that I'm doing in a project, I cannot think about any more than that. But I don't even know how many risks on the risk register I am apparently responsible for, I haven't looked at the register for quite a while. The way the risk register is being done is just wrong to me, it's overwhelming and it doesn't work."*

Another respondent explained that the risk register just didn't work for them and they believe using common sense in their own work is more important than relying on the register:

> *"I'm not into the risk register, it doesn't help me to judge the work, to judge what risks are taken, for me it doesn't help. I think if you are at a high level in the company maybe that would work to make the decisions but for me as an*

*engineer, I don't really put a number behind it and I also don't change my design based on such a criterion...the register is not always covering everything so it's about common sense I think."*

These opinions could indicate that the risk register is not being used as it is intended by some staff which may lead to issues with the risk management as a whole. Clearly a risk register is necessary, there must be evidence of the risk management process and responses and risks should be tracked, but the quotes above show that the risk register is not really working as it should for these staff members and it is possible that this is the case for other employees too.

One respondent said *"I myself, can probably think about ten risks at a time..."*, but it is not feasible or practical to adjust the risk register on the basis of how much the individual team members can think about. Instead solutions can be sought elsewhere, through the use of increasingly advanced software which can handle a very large risk register or risk matrix.

## 4.10. OBSERVATIONS FROM THE DATA COLLECTION

A number of observations were gathered by the researcher through the process of the interviews. These were judged to be observations rather than limitations of the data collection process, hence the fact that limitations are presented in a separate section.

The first observation was that some respondents struggled to select statements to rank in the 'less important' columns of the Q sort chart. These respondents found that all statements in the Q set were, at some level, important to project risk management, therefore flagging any of them as 'less important' proved difficult. This is a typical feature of Q methodology, since it is the relative ranking which is important.

Secondly, some respondents remarked that certain statements were very similar to one another or that one statement included another statement within it, for example *Project organisation risk culture* (12) and *An understanding and belief in the benefits of risk management from all staff* (6). This led to some cases where a respondent ranked one item towards the most important end of the chart then another item towards the least important end because they thought that the second item was similar to or included within the first item.

Thirdly, some comments were made about the fact that the importance of some statements was very dependent on the type of project. This was mentioned a few times in reference to *Consider the external environment* (3), respondents described how this statement would be much more important for a larger project with a longer timescale than a smaller shorter project.

Next, despite the fact that definitions were provided for all of the statements presented, during the discussion following the activity, some respondents said that they had ranked something towards the least important end of the chart (columns -2 or -3) because they didn't understand what it meant.

Another observation was that it proved difficult for some respondents to keep to the consideration of project level risk management. Some respondents described how some statements overlapped with organisational risk management, the way in which Ballast Nedam operates risk management across all their projects, rather than only within Project

A for example. Examination of the Q set shows how the concept of the boundaries of project risk management and organisational risk management are blurred for some of the statements.

At the end of the interview, all respondents were asked for their feedback on the activity and the interview. Many respondents described how they found the Q sort activity useful in terms of challenging their thought process before having the discussion with the researcher. Compared to a traditional interview setting, some respondents mentioned they found the Q activity more enjoyable and easier since it helped 'unlock' their opinion on the topic before being asked more detailed questions.

The final observation was that some respondents struggled to give very long or detailed explanations of their motivation behind how they ranked the statements. In some cases this was due to the language barrier, given the researcher did not speak Dutch and some of the respondents found it hard to express their opinions on the topic with their level of English. The respondents had between five and 30 years of experience in the industry and all of them work with risk management in their role frequently, yet some found it harder than others to set out their way of thinking. This may be because risk management is sometimes treated as an aside to the main processes, or that people are not aware that the tasks they are doing are actually risk management, or because people rely on the risk manager too much and are in fact not fully understanding their risk management responsibilities.

## 4.11. SUMMARY OF RESULTS

A summary of the results of the research project are presented below:

- Three perspectives have been found to exist on the topic of what is important to project risk management within the group of managers who took part in this research. On one hand, a variety of opinions on the topic may make the implementation of risk management within the organisation more challenging. This is because a person's opinion of what they think is most or least important for risk management may impact on how they approach the risk management process in place within the organisation and how they interact with others on the topic of risk management. On the other hand, all perspectives are valuable to the organisation in their own way. A variety of opinions may enrich the conversation on how to best perform risk management and help the organisation ensure the processes in place are robust and reliable.

- The perspective Experience and Belief finds that soft skills are the most important to risk management, statements (6) (10) (12) and (20), which all relate to behaviours, internal thoughts and the interactions between employees rather than the organisational procedures in place. It considers the expertise of the individual and the belief they have in the risk management process to be very important. This perspective places less importance on the more 'institutionalised' aspects of risk management, such as resources and having a standardised process, instead preferring a 'bottom-up' approach based on the expertise of individuals and the relationships between employees.

- The perspective Procedures and Leaders values consistency across many aspects of risk management. This perspective considers consistent rules and procedures, statements (1) (15) and (21), and the role of management, statements (9) and (23), to be most important to successful implementation of risk management. Statements relating to collaboration were ranked towards least important by this perspective, statements (13) and (25), along with statement (14) which relates to the individual competence of staff to apply risk management. This perspective considers that if staff are led effectively by the top management and the risk manager, and procedures are consistently followed, then risk management will be successful, preferring a 'top-down' approach.

- The perspective Culture and Communication places most importance on risk culture and considered this to be strongly supported by clear and honest communication. This perspective also ranked statements (1) and (9) towards the most important end of the chart, as Perspective 2 did, but had an opposing view to Perspective 2 on statement (23), having a risk manager appointed to the project. Statement (5), regarding clearly assigning responsibility of risks to individuals, was placed towards the least important end of the chart by this perspective, respondents described how culture and communication can be used instead of detailed procedures, preferring to discuss responsibilities openly and as a team rather than simply allocating tasks. All in all, this perspective considered risk culture to be the overarching force behind risk management.

In addition to the discovery of the perspectives, other results are presented below:

- Section 4.1 presented the overall average scores given each item in the Q set, across all respondents. *Project organisation risk culture* (12) and *Integration of risk management with other project management activities* (1) achieved the two highest average Z scores. In general, the employees consider the risk culture to be very important to risk management and they think that risk management should be well integrated with other streams of the project. Statement (10), *Clear and honest communication* received the third highest Z score, some respondents described how this supports the risk culture. The statements *Shared understanding and acceptance of the key concepts of risk management* (11), *Regular training to enhance risk management skills* (18) and *All staff showing competence in the application of risk management* (14) were on average ranked with the least importance across all the respondents. Statement (18) was ranked as least important both perspectives 1 and 2.

- It was found to be borderline significant that four out of five of the respondents from the design team belong to Procedures and Leaders. This could indicate a link between the functional team to which employees belong and their perspective on risk management. Further research is required to establish whether being a member of a certain functional team is linked to the perspective of an individual.

- The level of experience in the construction industry of an individual was found to be unrelated to the perspective to which they belong for this data set. Further

research is required to establish whether this finding is accurate and this would require a larger P set.

- Two loose observations were made following the interviews, namely concerning the complexity of risk management and the documentation of risks. Some of the points raised by the respondents on these topics indicate room for improvement in terms of how these people see the risk management working and how they interact with the risk management process. It may be that software can offer some solutions to the points raised as it is capable of dealing with complex interdependencies between risks which people struggle to track.

## 4.12. RECOMMENDATIONS FOR THE ORGANISATION

One thing to consider when making recommendations to the organisation based on the results of this research is that the respondents each have statements which they judged to be, relatively, the least and most important. In practice, it is hard to make assumptions about what being the least or most important statement actually means for how the respondent engages with or does the activity described in the statement. For example, if a person ranks statement (5), *Establish clear responsibility of roles for managing risks (RACI-matrix)*, as least important, it does not mean that they do not use the RACI-matrix and complete all the tasks assigned to them by this tool, only that they found other statements to be more important. Likewise, a person who judges *Project organisation team spirit* (13) to be the most important is not necessarily the best 'team player' or the most supportive colleague.

The recommendations aim to give a holistic view of the results to reflect the fact that the Q sorts show the relative importance of each statement, from a set of statements which were all judged to be important to risk management at some level in the first place. The recommendations apply to the organisation as a whole, rather than any of the perspectives or any projects in particular.

This section provides the answer to the third research sub-question:

> *What recommendations can be made to the organisation to improve their risk management?*

The statements *Project organisation risk culture* (12) and *Clear and honest communication* (10) were ranked as the top and the third most important statements across all the respondents, respectively. Respondents described how the risk culture is linked to people's risk awareness, how it helps moderate potentially risky behaviour and how it makes sure that even those with less experience are guided to do the right thing in terms of risk management. Respondents felt very strongly about the need for transparency in communication, describing how it protects the value of shared information and how it helps people openly challenge each other's thinking. A recommendation is to make use of a Project Charter specifically aimed the risk management culture within a project. The risk culture is experienced and influenced by the individuals in the project team and because it was judged to be one of the most important factors, it makes sense for the organisation to formalise it to a degree. A Project Charter is a document which sets out the scope, objectives and participants in a project, it acts as a common point of reference

by which team members can be held accountable. A Project Charter for risk management would set out the expectations of the organisation and encourage adherence from all staff to the same basic set of principles. This could help improve overall awareness of risks, integration of new employees, trust within the team and the risk management process as a whole. Principles such as clear and honest communication, support from top management and belief in the benefits of risk management could be listed on the charter, reflecting the other statements which were ranked amongst the most important on average.

The statement *Integration of risk management with other project management activities* (1) was ranked as the second most important across all the respondents. Respondents explained how risk management should be daily business and how integrating it into other activities helps it to become a normal part of people's tasks. A recommendation is to facilitate this integration as much as possible from the side of the organisation. For example, risk management is relevant to activities such as design, estimating, planning, logistics, cost analysis, quality assurance, schedule analysis, stakeholder management, contract management and many more. For each of these activities, the necessary risk management tasks should be clear to those involved and it should be clear what needs to be recorded or reported to the risk manager. A well integrated process offers more opportunities for employees to engage with risk management compared to treating it as a separate entity.

*Regular training to enhance risk management skills* (18) was ranked as the least important on average across all the respondents. The respondents gave a variety of reasons for this including how risk management was more about mindset which is something you can't train, how as long as the risk manager is advising people then training is not that important and how the existence of training proves that the risk management process is too complicated. Employees attitude to training may impact on how they engage with it. Should any changes be made to the risk management strategy or procedures of the organisation, it is likely that employees will receive training on the new methods. Therefore, a recommendation is to begin any training session on the topic of risk management with a clear explanation of the exact motivation for the training and what the desired effect of the training is on the risk management. At the end of the session, feedback could be collected to investigate if the attendees understood the purpose of the training and this can be used to ensure that training is successful and people are engaged, motivated and that training is achieving its purpose.

There were some respondents who described some concerning opinions regarding the risk register. Project A was an extremely large project, resulting in a very complex and large risk register. Some respondents described how they found the risk register to be overwhelming, how they haven't looked at the risk register for a while, how they can only think about and deal with a fixed number of risks at any one time and how some risks no longer have anyone responsible for them since the responsible person has left the company. A recommendation is for the organisation to consider how they expect their employees to use the risk register and to instruct them clearly as to what these expectations are. It may be that they can offer guidance on how frequently people are expected to update the risk register, how to ensure risks are handed over when the responsible person leaves the company and how to better prepare people for working

with a large number of risks. Software may offer some solutions to these issues too.

Finally, it is recommended that the organisation reviews the results of this research themselves and considers how they might affect their existing and future strategies for risk management.

# 5

# CONCLUSIONS AND RECOMMENDATIONS

## 5.1. CONCLUSIONS

The aim of this research project was to improve the risk management strategy of an organisation through gaining a better understanding of the different perspectives on risk management held by the managers. This was achieved by answering three research sub-questions, the answers to which are presented below:

### WHAT ARE THE CRITICAL SUCCESS FACTORS OF RISK MANAGEMENT?

Since there was no existing list of CSFs of risk management in the construction industry, a literature study was performed. A total of 78 CSFs were identified from a number of sources relating both to general risk management and the construction industry. The CSFs found covered a variety of topics, for example the technical tools used by an organisation and the cultural aspects of the organisation's environment.

The researcher set three requirements to narrow down the list of CSFs to the statements taken forward to form the Q set. The researcher checked that the CSF appeared in at least two sources, that it was mentioned in a source concerning the construction industry and that it was explicitly cited as a CSF of risk management. The 27 CSFs which met at least two of these requirements were presented to the risk manager, who considered five of these to be irrelevant to the organisation or project and asked that three other CSFs be added to the list (two of which had been identified by the literature study). The 25 CSFs which were used as the Q set for the application of Q method are shown in Table 5.1.

Table 5.1: 25 CSFs of risk management - The Q set

| No. | Q statement |
|---|---|
| 1 | Integration of risk management with other project management activities |
| 2 | A clear long-term strategy towards risk management in the project organisation |
| 3 | Consider the external environment (market, politics, social issues, macro-economic situation) |
| 4 | Adapt risk management to each project |
| 5 | Establish clear responsibility of roles for managing risks (Responsible, accountable, consented, informed (RACI)-matrix) |
| 6 | An understanding and belief in the benefits of risk management from all staff |
| 7 | Provision of adequate resources to support risk management |
| 8 | Decide the appropriate level of risk management for the project |
| 9 | Top management encouraging and supporting risk management |
| 10 | Clear and honest communication |
| 11 | Shared understanding and acceptance of the key concepts of risk management |
| 12 | Project organisation risk culture |
| 13 | Project organisation team spirit |
| 14 | All staff showing competence in the application of risk management |
| 15 | Continuity of risk management across project stages |
| 16 | Detailed documentation of risks |
| 17 | Application of a standardised risk management process |
| 18 | Regular training to enhance risk management skills |
| 19 | Knowledge sharing relating to risk management |
| 20 | Personal experience, intuition and engineering judgement |
| 21 | Consistently review and update the risk register |
| 22 | Capture and use lessons learned |
| 23 | A risk manager appointed to the project |
| 24 | Risk management purposes in line with project goals |
| 25 | Careful management of contracts with subcontractors |

### WHAT PERSPECTIVES CAN BE DERIVED BY ASKING MANAGERS TO RANK CRITICAL SUCCESS FACTORS OF RISK MANAGEMENT?

This study used Q methodology to investigate the perspectives which exist on risk management within a main contractor organisation. A total of 15 managers were interviewed, all of whom had worked or were currently working on the same project. Three perspectives were found to exist through asking the managers to rank the 25 CSFs, these perspectives are known as Experience and Belief, Procedures and Leaders and Culture and Communication.

The perspective Experience and Belief represents a 'bottom up' view of risk management. People belonging to this perspective value the personal experience of individuals in dealing with risks and the individual's belief in the risk management process as a whole. This perspective considers 'soft skills' to be important in the implementation of risk management, namely clear and honest communication and the organisational risk culture. Experience and Belief judged the more 'institutionalised' side of risk manage-

ment to be less important, it finds that risk management rules, guidelines and processes are not as important as the behaviour and skills of the staff and the communication and culture between them.

Procedures and Leaders represents a 'top down' approach to risk management. This perspective considers consistency across the application of risk management and the roles of both top management and the risk manager to be the most important. Procedures and Leaders thinks that top management and the risk manager should lead the team through the process and that procedures should be consistently followed, the risk register should be consistently updated and the whole risk management process should be well integrated with other activities. This perspective judged team spirit and collaboration with subcontractors to be less important.

Both Experience and Belief and Procedures and Leaders ranked the statements relating to training to improve risk management skills and all staff being competent in the application of risk management towards the least important end of the Q chart.

Culture and Communication considers the risk culture to be the cornerstone of risk management. It also values clear and honest communication and describes how this supports the risk culture. Like Procedures and Leaders, this perspective found integration of risk management with other project management activities and the role of top management in supporting and encouraging risk management to be important but it had an opposing view of the importance of the appointment of a risk manager and the management of contracts with subcontractors. They ranked statement (5), *Establish clear responsibility of roles for management risks (RACI-matrix)* to be one of the least important, respondents again how communication and culture can be used instead of detailed procedures because discussing things openly enables better solutions to be discovered than dividing and allocating risks through the use of a RACI-matrix, for example.

### WHAT RECOMMENDATIONS CAN BE MADE TO THE ORGANISATION TO IMPROVE THEIR RISK MANAGEMENT?

The results of this research have enabled a number of recommendations to be made to the organisation:

- Make use of a Project Charter specifically aimed the risk management culture within a project which would set out the expectations of the organisation and encourage adherence from all staff to the same basic set of principles. This could help improve overall awareness of risks, integration of new employees, trust within the team and the risk management process as a whole. Principles such as clear and honest communication, support from top management and belief in the benefits of risk management could be listed.

- Facilitate the integration of risk management with other project management activities as much as possible from the side of the organisation. For each project management activity, the necessary risk management tasks should be clear to those involved and it should be clear what needs to be recorded or reported to the risk manager. A well integrated process offers more opportunities for employees to engage with risk management compared to treating it as a separate entity.

- Begin any training session on the topic of risk management with a clear explanation of the exact motivation for the training and what the desired effect of the training is on the risk management. At the end of the session, feedback could be collected to investigate if the attendees understood the purpose of the training and this can be used to ensure that training is successful and people are engaged, motivated and that training is achieving its purpose.
- Consider how they expect their employees to use the risk register and to instruct them clearly as to what these expectations are. It may be that they can offer guidance on how frequently people are expected to update the risk register, how to ensure risks are handed over when the responsible person leaves the company and how to better prepare people for working with a large number of risks. Software may offer some solutions to these issues too.
- Review the results of this research themselves and consider how they might affect their existing and future strategies for risk management.

## 5.2. LIMITATIONS OF THE RESEARCH

Limitations exist within this project, both due to the inherent limitations of using Q methodology and also from the way in which the data had to be collected. A detailed explanation of the limitations of Q method is presented in A.7.2.

The P set lacked variety, given all the respondents were male and all but one were Dutch. The construction industry lacks gender balance worldwide so it is not surprising that it was not possible to find any female staff to interview. The homogeneous nature of the P set limits the possibility of uncovering the full extent of the opinions which exist on the topic of risk management.

Another limitation of the P set was its size, unfortunately only 15 respondents were found and interviewed. If more respondents had been surveyed it may have been possible to explain the perspectives more fully, to find other perspectives and to explore the relation between the perspectives and functional teams further. The effect of this is illustrated by the fact that conclusions which could be made about Culture and Communication were limited, since only three respondents loaded onto it. If the P set were larger, it may have enabled Culture and Communication to be explored more deeply and led to a better understanding of this perspective.

The Q set statements were selected from the list of 78 CSFs using requirements set by the researcher and consultation with one risk manager. If time and resources had allowed, it would be preferable to present the full list of CSFs to a number of professionals who are knowledgeable on the topic and ask them which statements should form the Q set and if any items were missing which should be added.

The researcher does not speak Dutch so all the interviews were conducted in English. The Q set statements were presented in both Dutch and English, given that most the respondents work primarily in Dutch. There were some interviews where it was noticeable that the language barrier limited the extent to which respondents could explain their thinking. These respondents probably would have been able to express themselves much more clearly and in a more detailed way in Dutch. Webler et al. [40] describes

language and culture as potential barriers to performing successful Q studies. For most respondents this was not a problem and the quality of the qualitative data was good.

A website was used to set up the Q sort activity. One drawback of this website is that it did not allow the Q set to be shuffled for each respondent, the statements were presented one by one, always in the same order. In a traditional face-to-face Q sort, it is recommended that respondents are able to read all the statements before they do the Q sort and that the cards are shuffled between respondents. Since respondents did the pre-sort and the main sort, they had the opportunity to read every statement twice before deciding on a final position on the chart, so it is unlikely that the order in which they first saw the Q set would have an effect on their final charts.

The website had quite a dated appearance and did not allow any changes in the size of certain panels on the screen, this meant that once the respondent started sorting in the main sort stage, they had to scroll down some panels quite far in order to read all the statements. This limited the ability of the respondents to easily find and read all the statements in the main sorting stage.

All the respondents were friendly and willing to be part of the project, however there is something about video calls which makes interactions more challenging. Screen sharing to show the Q sort activity meant that the video of both people was minimised, thus losing the chance to communicate anything through facial expressions. There were some cases where the researcher attempted to press a respondent for a more detailed answer but the respondent did not pick up on this, this is much easier to do in a face-to-face interview since you can use non-verbal communication.

As explained in A.7.1 in Appendix A, the perspectives discovered in this research cannot be generalised to the rest of the population of the organisation or the managers in the Dutch construction industry, for example. But, given that the research was undertaken at a typical large construction company and the respondents represented a typical group of managers within that industry, it can be postulated that a similar study conducted at another organisation would discover similar perspectives on what is important to risk management. This is why general recommendations for the organisation have been produced.

## 5.3. RECOMMENDATIONS FOR FURTHER RESEARCH

Following the conclusion of this research project, a number of recommendations for further work are presented below.

The list of 78 CSFs which were identified in the literature study could be researched further. The CSFs could be presented to professionals from the industry to gain their insight on which of these factors are relevant to construction. The implementation of these factors could be measured in practice, enabling a definitive list of the CSFs of risk management in construction to be created, as exists for other industries.

The P set of this Q study was relatively homogeneous. Further research could seek to involve a much more diverse group of respondents in terms of nationality and gender. This would help improve the likelihood that all perspectives on the issue could be well understood and could be compared to each other. In addition, the P set was relatively small. Performing the same research with more respondents would enable more to be learnt about Culture and Communication. Repeating the same Q study with a more

diverse or larger P set might give a completely different set of perspectives to those discovered in this research.

Further investigation could be done into the link between other characteristics of respondents and their attitude to risk management, for example educational background, gender and personality type. This would require the diversity of the P set to be adjusted to obtain results from a variety of people and possibly another series of tests to collect the data on personality types, for example. Although a link was found between Procedures and Leaders and one of the functional teams, more data is required to see if the other functional teams are also more likely to belong to a certain perspective. No relationship was found between the level of experience and the perspective to which a person belongs, a larger study would be required to verify whether this is the case or if the experience level does impact on a person's opinions of risk management.

Given that three perspectives have been identified, further research could look into which of these perspectives are actually more successful at managing risks in practice. This would require risk management capabilities at a personal level to be described and quantified so that the actions of an individual could be measured.

## 5.4. PERSONAL REFLECTION

This is the second masters thesis which I have written and I have found this research project to be very different from my research on laminated glass in 2015. This is not only due to the subjects, there I was sitting alone in a lab measuring failure loads and examining fracture patterns and here I have talked to 15 respondents and worked with a large amount of qualitative data, but to the whole graduation process set out by TU Delft and the 'process' sprung on me (and everyone else in the world) by COVID-19.

I only spent three days in the Ballast Nedam office before I was forced to work from home. I am grateful that I was still able to continue my project, largely as planned, but I was not able to develop the insights into the company and their risk management processes that I had hoped. Meeting a variety of employees, experiencing the company culture and having informal conversations with people about your research all offer opportunities to enrich your research and tailor it to the organisation. I think the fact I did not have the chance to do this has limited my ability to make recommendations which are truly sensitive to the personality and nature of Ballast Nedam.

I think the design of the thesis process at TU Delft strongly encourages students to take charge of their own research and I think this set-up, along with the necessity for me to perform the vast majority of my project from home, has helped me to develop skills of independent working. The input of my committee members was of course invaluable and their expertise was needed at times to set me on the right course but ultimately I feel, as I'm sure all students who have worked on their thesis during 2020, that circumstances have forced me to show another level of independence and ownership for my project.

When developing my data collection method, I received advice from a PhD student who had successfully implemented Q methodology using a website. I played around and tried out a number of websites which allow Q sorts to be sent out to collect data remotely and I even tried developing my own simpler version of a Q sort in Microsoft Excel. I think the data collection method I settled on, using a simple website and talking each respondent through how to do the Q sort, could have been improved. I only had 45 minutes

to conduct each of the interviews and explaining the website was quite time consuming and some of the respondents struggled to follow exactly how the Q sort worked. I'm sure there was room for improvement in the explanation I gave using my slides but I think, had it been possible, a demonstration of the Q sort process using some cards laid out on a table would have made for a much more successful explanation.

I had some time between the end of my literature research and the start of my data collection. I decided to use this time to learn how to use PQMethod, to help ensure I could execute my quantitative analysis as quickly and smoothly as possible. I reached out to Dr Suprapto, who did his PhD at TU Delft and published a paper using Q. He kindly shared his data with me, enabling me to practise using the software by comparing my results to those in his paper. PQMethod is easy to use, but this step of my project really helped me to understand how many factors should be taken forward and which outputs would be most relevant to my results. I also signed up to the Q method discussion board managed by Kent State University [59]. This was a valuable resource for learning about the pitfalls of Q and responses to questions are often provided by Steven Brown, one of the leading experts in the world of Q. Exploring this discussion board and reading how other researchers, of all levels, do their analysis was very interesting. The choice to perform these two activities, practising using the software and learning about how you should actually use (or not use) the results of Q, was driven by my desire to be accurate and produce a clear report. This mindset is helpful, it was certainly necessary for my experimental research in 2011, but what I feel it distracted me from in this project was the requirement for sensitive consideration of the results of this research and how the discovery of the perspectives could actually be used practically. Although I have produced recommendations, in hindsight I would have set aside more time for preparing these and discussing them with my committee and less time on producing such a comprehensive explanation and detailed display of the results.

To finish, there are a number of things I will take away from this experience. The importance of being flexible and resilient, given that I was appointed a new chair of my committee halfway through my project and that I, like everyone else, had to adjust to the circumstances of 2020. Increased confidence, given I had to approach the respondents and interview them with the added challenge of never actually meeting any of them in person. Finally, a small insight into the complexities of doing research, in particular with a company, and the importance of asking 'What does this actually mean in practice? How can this be used?', something which I hope I have answered in part, but I feel I have at least gained an appreciation for.

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# A

# Q METHODOLOGY THEORY

## A.1. GATHERING THE CONCOURSE

It is not always easy for people to articulate their opinion on a topic [60]. In a Q study, this problem is avoided by presenting participants with a fixed set of statements, known as the Q set. In order to determine what these statements should be, the first step of a Q study is to gather the concourse on the topic in question.

The concourse is described as "the flow of communicability surrounding any topic" [32]. The concourse is often text, but can also include photographs, artwork or even music [32], and should represent the "universe of subjective viewpoints around a topic" [60]. The concourse can be collected from literature, the media or interviews with the participants who will later perform the Q sort [40]. The form of the concourse is typically defined by the nature of the research question [60]. In the common situation where text statements are used as Q set items, they are presented as multiple possible answers to a given umbrella question [61].

McKeown and Thomas [35] describe the different ways in which a concourse can be gathered. They describe how the researcher can choose between naturalistic and ready-made sampling. In naturalistic sampling, statements are collected from people who have knowledge of the topic, possibly the participants who will later perform the Q sorts, this can be done through written surveys or interviews. Naturalistic sampling can also be done by taking statements from the media, in newspapers or other recorded interviews "...since items are taken from real-world communication contexts." Ready-made sampling is where statements are taken from any sources which are not the participants of the study, for example by way of a literature review.

## A.2. THE Q SET

The Q set, sometimes called the Q sample, is the sample of statements taken from the concourse which represents everything that can be said on the topic in question [60]. The Q set should cover all the key issues, but for simplicity and ease of the Q sort, there should be no overlap between statements. The Q set is taken forward to the next stage

of the study and the statements which make up the Q set are what the participants rank in the Q sort. The Q set can consist of anything between 20 and 60 statements and the number of statements will affect how a participant conducts the Q sort [40]. Too few statements could mean the participant struggles to fully express their opinion, too many statements could overwhelm the participant and they could lose patience with the activity or place statements unthinkingly [40].

In addition to naturalistic and ready-made sampling as options for gathering the concourse, McKeown and Thomas [35] describe the ways in which statements can be selected from the concourse to create the Q set. The researcher can choose between structured or unstructured sampling. Structured sampling is done by first dividing the statements in the concourse into categories, these categories can emerge organically through the process or can be defined by the theory surrounding the topic [40]. A set number of statements are then selected from each category to from the Q set, this helps to ensure that all categories are covered and the Q set does not favour one aspect of the topic over another [36]. Unstructured sampling is when the researcher selects the items from the concourse, which they themselves deem relevant, to form the Q set. No consideration is given as to whether all aspects of the topic have been covered, which could prove problematic later on if participants miss certain items when doing the Q sort. Furthermore, this method enables the bias of the researcher to be introduced into the study.

It is possible to combine the above sampling methods and create a hybrid approach. In such a case, a few experts on the topic being studied can be shown the proposed Q set and interviewed. In this way statements may be eliminated or combined, text can be adjusted or new statements can be added based on expert input.

Statements in the Q set should be short, 'stand alone' sentences which are easy to read and understand, and which participants are likely to have an opinion about [40]. Unlike in other surveys where people are asked to rank or rate items, it is not necessary for statements in the Q set to be "revised and rewritten so as to reduce ambiguities" [57]. This is because the nature of Q is such that statements can and should contain a certain amount of "excess meaning" [40]. This allows for flexibility in the interpretation of the statement by the participants. Too much "excess meaning" may cause confusion later on in the study, if there is a large disparity between the participants interpretation of a particular statement. For this reason statements from the concourse are edited where necessary [39], but the researcher need not write out each statement so explicitly as to lose the potential for this personal interpretation later on.

## A.3. THE P SET

### A.3.1. NUMBER OF RESPONDENTS

The P set describes the population of respondents who perform the Q sort activity.

In a traditional survey, the researcher may want to find out how the population are distributed across certain variables but in a Q study the researcher wants to identify which perspectives (also called factors) exist and why. This means that the principle of studying large numbers of people, as is traditional in survey research, does not apply to Q [32].

Brown [57, p.192] explains "all that is required are enough subjects to establish the

existence of a factor for purposes of comparing one factor with another." He goes on to liken surveying increasing numbers of respondents to the law of diminishing returns, this is because once a perspective has been identified and the reasoning behind it is understood, finding more respondents who share this perspective does not add any further validation to the study [57].

In a Q study the 'observations' are the statements in the Q set and the 'variables' are the Q sorts performed by the respondents, which is inverted compared to a traditional survey [40]. It is recommended to have more observations than variables therefore the P set is typically smaller than the Q set [42]. Literature states that anywhere between eight [39] and 50 [32] respondents should form the P set.

The number of respondents needed is linked to the number of perspectives which are expected to be identified. Van Exel and de Graaf [39] recommend four or five respondents defining each perspective and estimate a Q study will typically identify between two and four perspectives and rarely more than six. In the early stages of a research project, it is impossible to know how many perspectives will be discovered, therefore determining the number of respondents required is not a simple task, for this reason it is prudent to plan for excess respondents [40].

### A.3.2. VARIETY OF RESPONDENTS

Respondents are selected purposefully, much like in qualitative methods, rather than by taking a random sample of the population as in traditional quantitative surveys [57]. The aim of the P set is to cover the full breadth of opinions which exist on a topic, not their distribution [40]. This means that the P set should include a wide variety of respondents. It is important to select people who will likely bring different points of view [60] but a certain level of overlap is desirable [40]. Brown describes how "P sets, as in the case of Q samples (sets), provide breadth and comprehensiveness so as to maximize confidence that the major factors at issue have been manifested using a particular set of persons and a particular set of Q statements" [57, p.194].

Brown [57] explains how the P set can be given explicit structure or geometry, thus enabling the researcher to ensure all people who are relevant to the problem can be included. For a given research topic, the people who are relevant to potentially include in the P set will differ on certain 'main effects'. A 'main effect' could be gender, geographical location, profession, educational background or any number of other aspects. Each 'main effect' has a number of levels, for example the educational levels could be HBO, Bachelor, Master and PhD. Assuming no more than three 'main effects' are chosen to differentiate members of the potential P set, the P set geometry can be represented graphically, see Figure A.1. In this way, the researcher can ensure that at least one P set member represents each smaller cube of the P set geometry, and therefore it can be concluded that the P set is sufficiently broad.

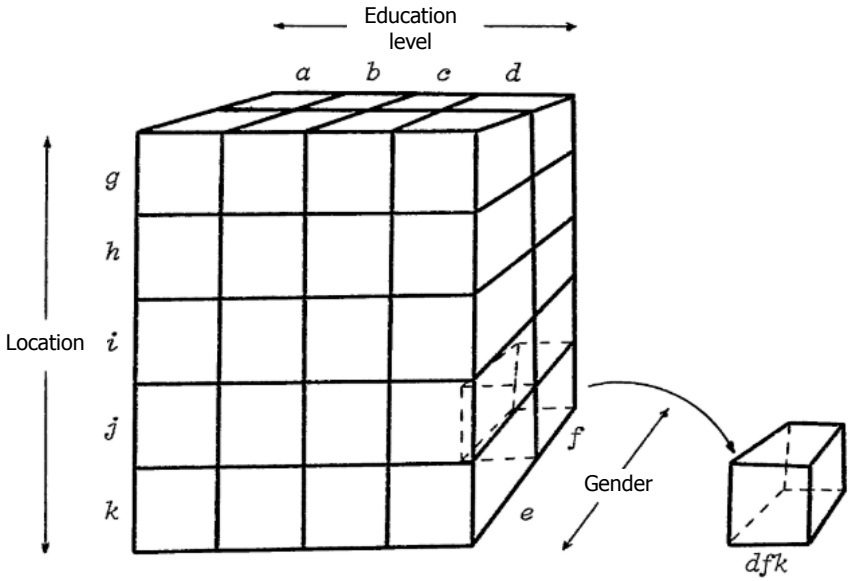



Figure A.1: The geometry of the P set expressed graphically, an adaptation of the image from [57, p.193]

### A.3.3. PROFILE OF RESPONDENTS

When creating the P set, the researcher should select respondents who are knowledgeable about and have experience in the topic and who are expected to have a clear perspective on it [40], [57]. Respondents who fit this profile will likely find it easier to perform the Q sort and elaborate on their opinion than respondents who are new to or unfamiliar with the topic.

## A.4. CONDUCTING THE Q SORT

Once the Q set and the P set have been decided, the Q sort is conducted. Each Q set statement is placed on a card and the participant is asked to read all the statements. If the respondent does not understand a statement, a definition can be provided. The researcher then gives the sorting instruction, this is the question which the respondent should answer through the execution of the Q sort. Next, the respondent is asked to perform a preliminary sort in answer to the question by separating the cards into three piles, typically ‘agree’, ‘disagree’, ‘neutral’ or ‘important’, ‘not important’, ‘neutral’. The main Q sort is then conducted where the respondent is asked to arrange the cards onto the Q chart. Starting with the cards in the ‘agree’ or ‘important’ pile, the respondent places these on the far end of the Q chart. They then do the same with the ‘disagree’ or ‘not important’ pile and the opposite end of the chart. Finally, the cards from the ‘neutral’ pile are arranged in the middle of the chart. Each respondent “uses (their) own subjective criteria to evaluate the relative agreement on each statement" [33]. Figure A.2 illustrates the basic steps of the Q sort activity.

Q sorts are typically performed individually. They are usually done face to face in an interview setting, with the Q statements and response chart printed out, but can also be done remotely, either by posting each respondent their own set of cards and response chart or by creating an online environment so that the respondent can sort the cards on a computer.

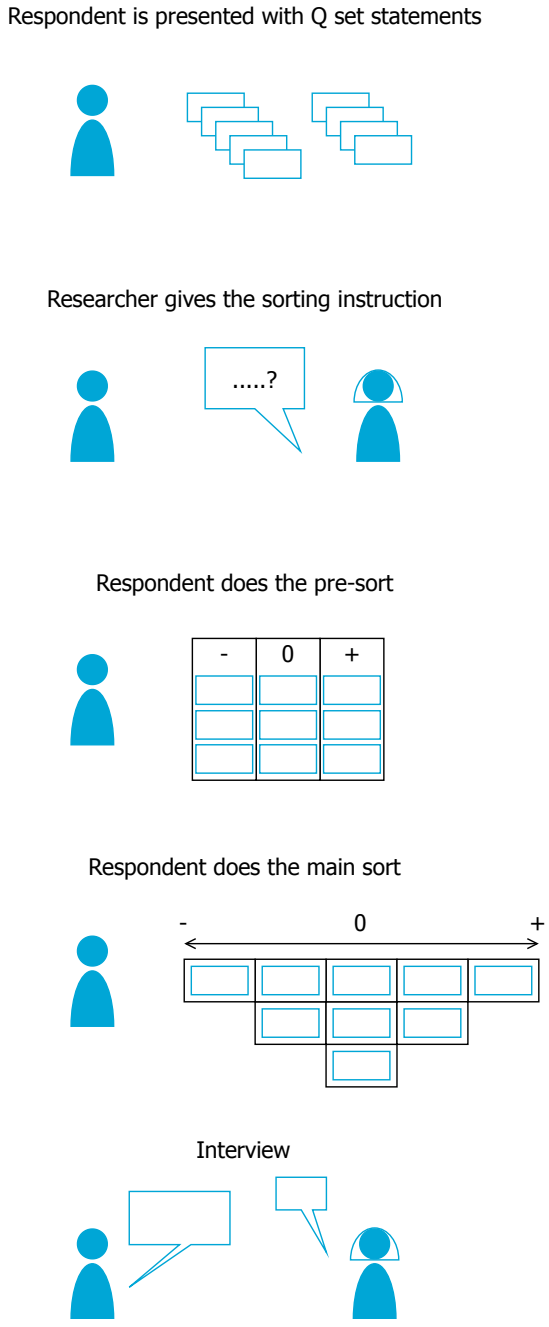



Figure A.2: Conducting the Q sort

### A.4.1. DESIGNING THE RESPONSE CHART

In a Q study, every respondent is given the same chart on which to arrange the Q set. The response chart is typically in the shape of a quasi-Normal distribution [33], with a scale of 'not important' to 'important' or 'disagree' to agree' running from left to right across the columns. The order of the Q statements down the rows does not have any meaning, only their column position is important. Without this response chart, if respondents were able to assign the statements any ranking, some respondents would simply divide the Q set into two groups (for example 'agree' and 'disagree') which would not enable a very deep understanding of their perspective on the topic [40]. The purpose of providing the respondent with a chart on which to arrange the Q set is to encourage them to consider the Q set statements thoughtfully and then force them to prioritise them [40]. If a respondent finds it very difficult to arrange the Q set on the response chart, the researcher can allow them to put more or fewer statements in some columns but it is important that the respondent uses the full width of the chart and that every statement in the Q set is placed somewhere [40].

The theory behind the shape and kurtosis of the response chart is explained in the main body of the report, in 3.3.1.

It is possible to conduct a Q study without a specified response chart [62]. This means that respondents are able to sort the cards into any distribution shape they choose based on their feelings towards the issue at hand. Respondents find this method easier than using a prescribed response chart but it will likely increase the number of responses the researcher receives.

### A.4.2. THE SORTING INSTRUCTION

The sorting instruction describes the guidance which the researcher gives the respondent to prepare them to execute the Q sort. This mainly concerns the question which respondents should answer or sometimes the sentence which they should finish, either should be based on the research question which the study concerns [40]. The researcher should explain the Q sort method and what they want to learn from the respondent [40]. It is also important to explain to the respondent how you want them to answer the question. In a professional context some respondents may be tempted to answer based on the perspective of their organisation, the researcher should make clear to the respondent if they want to indeed learn about this perspective or in fact the respondent's personal perspective [40]. Since Q studies subjectivity, it may also be helpful to remind the respondent that there is no 'right' or 'wrong' answer and the purpose of the Q sort is only to uncover their opinion rather than test them on their knowledge or familiarity with the topic.

### A.4.3. THE INTERVIEW

It is recommended to follow the Q sort activity with a short interview [32]. This is because an interview can help the researcher later in the study, when they must interpret the results of the Q sort analysis and describe perspectives [39].

In this interview the researcher can first ask the respondent some questions on their personal profile, for example their profession or their age. This information should be gathered so that the researcher can check that the P set has enough variety of respon-

dents, namely that every cube of the P set geometry has an equivalent respondent profile (see A.3.2).

In the interview, the researcher can ask the respondent if they think anything is missing from the Q set which they deem relevant or important to the topic in question. These 'missing' items should be noted but should not be added to that respondent's Q sort or the Q set available to future respondents. If it is discovered that many respondents are missing a particular aspect of a topic from the Q set, the selection of the Q set has not been successful and it may be necessary to restart the process.

The researcher can then have a discussion with the respondent about their completed Q sort chart. The presence of the completed Q sort "provides focus" [32, p.106] to the interview. The researcher can ask why the respondent has placed a statement in a certain column with the statements at the extremes of the chart being of the highest interest. Once individual statements have been discussed, it is useful to ask the respondent to interpret their own Q sort and try to sum up their opinion, again this is useful information to review when the researcher comes to describing perspectives [40, 60].

## A.5. ANALYSIS OF THE Q SORTS

The completed Q sorts act as the data input for the quantitative part of the analysis. This analysis is an entirely technical and objective procedure "and is therefore sometimes referred to as the scientific base of Q" [39, p.8]. The analysis is essentially a data reduction exercise in which the aim is to reduce the Q sort data to a small number of synthetic Q sorts which each represent a shared viewpoint [63]. Given that the Q set is fixed for all respondents, the analysis can easily use quantitative methods to find patterns between the Q sorts [33]. The viewpoints identified should explain most of the variety in the respondents of the Q sort activity [63]. In traditional survey research, minority views are often deemed insignificant but this is not the case in Q. In Q methodology, views from all respondents hold equal standing [64].

A number of software packages exist to perform the analysis stage of a Q study. This project used PQMethod software which was developed in 1992 and last updated in 2014 [65]. PQMethod is very popular despite its basic interface. It is a functional program and plenty of guidance exists in literature on how to perform the whole anaylsis using PQMethod such as Donner [66] and Webler et al. [40].

### A.5.1. CORRELATION MATRIX

The first step of the analysis is to calculate the correlation matrix. Consider two respondents, A and B who have performed a Q sort of four statements and have arranged them onto this simple Q chart shown below in Figure A.3.

The correlation, r, between the Q sorts of respondents A and B, is then calculated using the following equation:

$$r = 1 - \frac{\sum D^2}{\sum {S_A}^2 + \sum {S_B}^2} \tag{A.1}$$

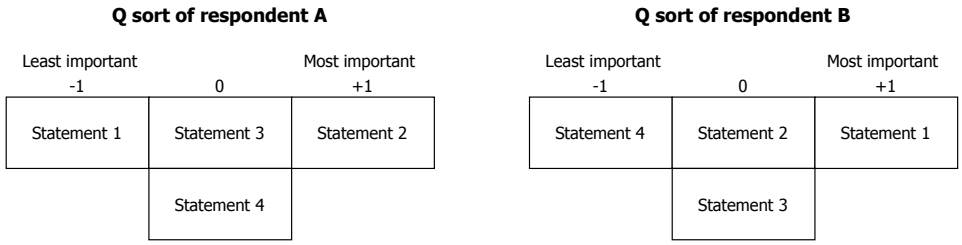



Figure A.3: Q sorts of respondents A and B

| Statement | $S_A$ | $S_A^2$ | $S_B$ | $S_B^2$ | D (=$S_A$ - $S_B$) | $D^2$ |
|---|---|---|---|---|---|---|
| 1 | -1 | 1 | +1 | 1 | -2 | 4 |
| 2 | +1 | 1 | 0 | 0 | 1 | 1 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | -1 | 1 | 1 | 1 |
| Sum | 0 | 2 | 0 | 2 | 0 | 6 |

Table A.1: Calculation of correlation between respondents A and B. S is the score given to a statement by a respondent. D is the difference between the scores of the respondents for a given statement.

For the example presented, this would therefore be:

$$r = 1 - \frac{6}{2+2}$$

$$r = -0.5$$

The correlation value r ranges between -1 and +1, with +1 showing perfect positive correlation (the Q sorts of two respondents are identical to one another) and -1 showing perfect negative correlation (the Q sorts of two respondents are the mirror image of one another).

Using Table A.1, a correlation matrix is produced to show the correlations between all the Q sorts in the study. This matrix represents the level of agreement between the individual Q sorts and therefore the level of agreement between the individuals in the P set [39].

### A.5.2. FACTOR ANALYSIS

The second step of the analysis process is the factor analysis. Factor analysis is a statistical method which reduces a large number of variables to a smaller number of factors. In Q, the variables are the Q sorts and the factors are the shared perspectives or viewpoints which exist on the topic.

Factor analysis uses the correlation matrix to examine how many basically different Q sorts exist [32]. Q sorts which have a high positive correlation are grouped together. The

'families' of similar Q sorts are known as factors. A factor is "a dimension or construct which is a condensed statement of the relationships between a set of variables." [67, p.5]. Factors are also Q sorts, but can be thought of as synthetic or 'idealised' sorts [40] since they are created by the software rather than a respondent.

The number of factors found is 'purely empirical' [32, p.111] as it depends on the variability in the Q sorts collected [39]. It is recommended to retain more than the number of factors that is anticipated in the next phase, factor rotation, so as to maintain variance in the data [39], "[e]xperience has indicated that 'the magic number 7' is generally suitable" [57, p.223].

Each Q sort will have a factor loading $f$ for each of the factors produced by the analysis. This factor loading lies between -1 and +1 and expresses the extent to which each Q sort is associated to each factor [32].

PQMethod software has two types of factor analysis available, Centroid Analysis or Principal Component Analysis (PCA). They differ in the way in which they use 'individual specificity' of Q sorts when constructing factors [40, p.29]. Centroid analysis only uses the commonality among Q sorts and ignores the specificity of individual sorts whilst PCA uses both commonality and specificity [40]. PCA is more commonly used but Centroid is preferable to researchers who want to use hand rotation [40].

But some individuals' views will be closer to the social perspective than others'. People whose individual views most closely match a social perspective are said to "define the perspective." This means that, in the numerical analysis, their Q sorts were closer to the social perspective than other people's. The degree of this similarity can be computed into what are called factor loadings. People with a high factor loading for a given perspective, are said to "define" that perspective. To avoid the social perspective being driven too strongly by one person, it is desirable to have several people with high factor loadings on each perspective. In general, it is important to avoid having a factor defined by only one person, since it is mathematically impossible to distinguish the social narrative (communality) from the individual perspective (specificity) [40].

### A.5.3. FACTOR ROTATION

The third step is factor rotation. Brown [32, p.112] describes how factor analysis, the previous step, is "is usually of little immediate interest and only provides the raw materials for probing these subjective relationships from vantagepoints that might interest us." He goes on to explain that it is factor rotation which allows the researcher to take advantage of the initial positive correlations, possibly alongside any underlying guesses or hypotheses as to which factors exist, to find the shared perspectives within the population.

In factor rotation, the original factors found in the factor analysis phase are rotated to reach a final set of factors [39]. Consider a simple graph with two factors representing the two axes where the Q sorts are plotted according to their factor loadings onto these two factors, see Figure A.4. Two particular Q sorts, from respondents A and B are labelled.

The factors can be rotated until factor 1 extends through the centre of gravity between the points which represent respondents A and B so as to highlight the connection between the views of these two respondents [32]. In this example, this would mean rotating the factors (or axes) by approximately 70 degrees clockwise, see Figure A.5, resulting

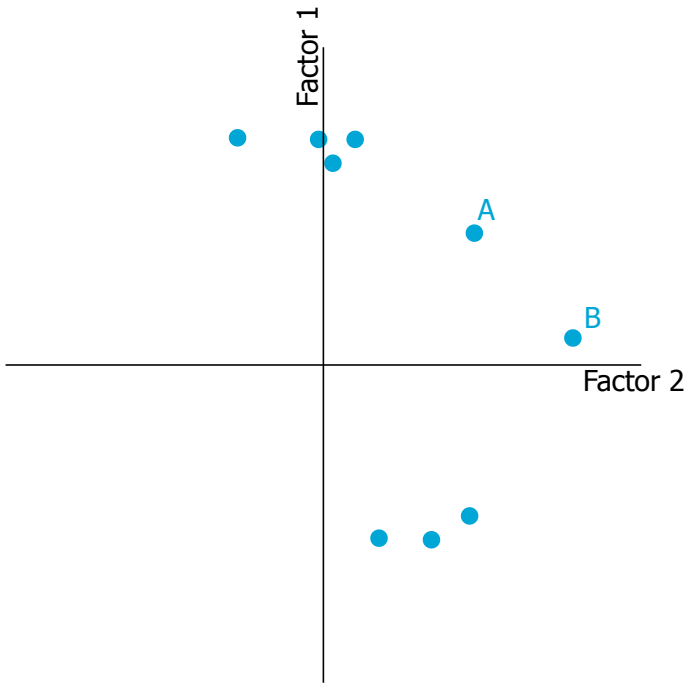



Figure A.4: Plot of Q sorts (indicated by blue dots) onto axes of original factors 1 and 2, based on an image from [32, p.112]

in new rotated factors 1' and 2'.

This rotated plot enables respondents A and B to be focused onto factor 1' whilst also focusing the other respondents onto the opposing poles of factor 2'. The factor loadings of each Q sort are then updated according to these new rotated factors. There is an infinite number of ways to rotate the factors [32]. The process of factor rotation enables the researcher to look at the results from different angles but it does not affect the consistency of meaning within each Q sort or the relationships between Q sorts [39]. "Each resulting final factor represents a group of individual points of view that are highly correlated with each other and uncorrelated with others" [39, p.9].

Respondents who do not belong to any of the extracted factors are known as *non-loaders*. Respondents who belong to more than one extracted factor are known as *confounders*.

Factor rotation can be performed in two ways. The researcher can follow a statistical principle, such as the varimax algorithm in the PQMethod software, or rotate the factors manually. Manual rotation allows the researcher to make guesses or test hypotheses they have about what factors may exist based on their own or other people's knowledge of the topic [32, 39]. The varimax algorithm attempts to rotate the factors so that individual respondents are likely only highly loaded onto only one factor [40].

According to Kline (1994:62), the varimax factor rotation, devised by Kaiser (1958;

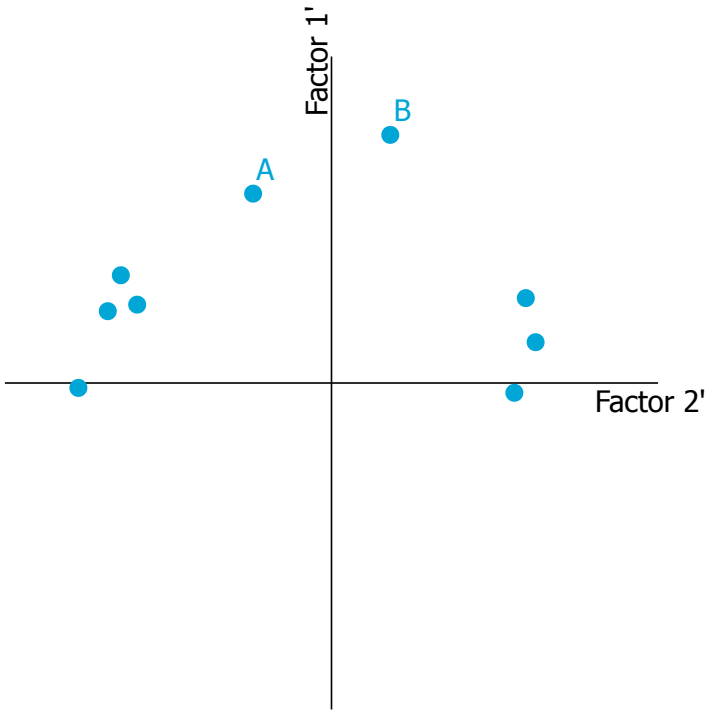



Figure A.5: Plot of Q sorts (indicated by blue dots) onto axes of rotated factors, based on an image from [32, p.113]

1959), is strictly mathematical and provides an orthogonal solution. This means that factors are rotated in such a way that they are always at right angles to each other, that is, the factors are uncorrelated. Through an "iterative" 83 process, variance is distributed across the factor structure in such a way that each sort has the highest degree of association with only one factor, all sorts and all factors being taken into consideration (Stricklin & Almeida 1999).The purpose is to maximise "the purity of saturation" of as many Q sorts as possible on one or the other of the number of factors extracted initially" (McKeown & Thomas 1988:52). [62]

### A.5.4. NUMBER OF FACTORS

The fourth step requires the researcher to determine how many factors will be taken to the interpretation phase of the project. A set of criteria is used to decide how many factors to take forward, these criteria are presented in the main body of the report in 3.4.1. The criteria are checked for a number of factor solutions (for example for solutions which have between two and seven factors) and the researcher must decide which factor solution best fits the criteria.

### A.5.5. FACTOR SCORES

Although a factor is defined by a number of Q sorts which are said to belong to the same family as explained in A.5.2, some respondents Q sorts are closer to the factor to which they belong than others. This is taken into account by calculating the weight $w$ of a Q sort, see Equation A.2.

$$w = \frac{f}{1 - f^2} \tag{A.2}$$

Where:

$f$ is the factor loading of the Q sort

This weight $w$ is used to calculate the factor score $Z$ of a statement, "[a] statement's factor score is the normalised weighted average statement score (Z score) of respondents that define that factor" [39], see Equation A.3.

$$Z_{\mathrm{m}} = \sum (w_{\mathrm{n}} * S_{\mathrm{n}}) \tag{A.3}$$

Where:

$w$ is the weight of the Q sort

$S$ is the score of statement of statement m

$n$ is the Q sort which is loaded onto the factor

The transformation from the weight $w$ to the factor score $Z$ allows for easy comparison across factors. The Z scores can be used to create an idealised Q sort for each factor, this is the Q sort chart which shows how a respondent with a 100% loading onto that factor would choose to rank the statements [39].

### A.5.6. CHARACTERISING STATEMENTS, DIFFERENCE SCORES, DISTINGUISHING STATEMENTS AND CONSENSUS STATEMENTS

Characterising statements are those which have the lowest and highest Z score values, meaning they are found at the extreme ends of the idealised Q sort charts for each factor. These are usually the first statements to look at to get an initial idea of what this factor finds to be extremely important or unimportant.

The difference score expresses the difference between a statement's Z scores on any two factors that is required for it to be statistically significant [39]. A large difference score shows that two factors have very different views about the statement in question. When a statement's score on two factors exceeds this difference score, it is known as a distinguishing statement [39]. Conversely, a statement which is not distinguishing for any of the factors is known as a consensus statement, it represents a common view held by all respondents. The examination of the distinguishing and consensus statements enable the identified factors to be compared.

### A.5.7. OUTPUT FROM THE QUANTITATIVE ANALYSIS

The outputs of a PQMethod analysis are as follows [33, 40, 66]:

- The factors, in the discussion phase these are known as perspectives. These are the distinct subgroups of respondents within the P set who have a similar pattern of responses on their Q sorts and thus are considered to share a perspective on the issue.
- The normalised factor $Z$ scores for each perspective. Practically, the Z scores are used to create the synthetic or idealised Q sorts which express each perspective.
- The idealised Q sort which expresses each perspective. This is the Q sort chart which represents the perspective, it is 'synthetic' in that it is an average of the Q sort charts of the respondents who belong to the perspective.
- The factor loading of each respondent onto each perspective. This is the extent to which each respondent is similar to each perspective.
- The difference scores for each statement. These show the difference between how perspectives have ranked statements.
- The correlations between factor scores, meaning the extent to which perspectives are similar to other perspectives.
- The consensus statements. These are the statements which are generally rated at the same level by most respondents, meaning everyone in the P set rates them with a similar importance. These show consensus across the perspectives.
- The distinguishing statements. These are the statements which are important to some respondents but considered unimportant by others. These show the differences between the perspectives.

## A.6. INTERPRETATION OF PERSPECTIVES

Once the quantitative analysis is complete and the factors have been extracted, the qualitative analysis can begin. This involves interpreting the factors by combining the data outputs from the PQMethod software with the discussions from the interviews with the respondents. In this way, the researcher can describe the perspectives and then compare them to each other.

The statements which have a high $Z$ score and in particular the distinguishing statements can be used to explain what is most important to a perspective. The researcher can start be investigating these primary elements before moving to secondary elements, being those statements with a lower $Z$ score [40].

Some respondents Q sorts will lie closer to the factor than others, expressed by the factor loading $f$. These respondents are said to "define the perspective" [40]. The researcher can examine the interview from these respondents to help them compose the narrative to describe the perspective as these respondents best describe the perspective. Interview respondents can be directly quoted to best describe a perspective, "sometimes a single quotation says it all" [39, p.10].

The researcher must try to uncover the "underlying rationale which explains the story beneath all of these themes" [40]. The results of the Q study is the distinct perspectives which exist and these should tell a "convincing narrative" about the topic [40].

There is division amongst the Q methodology community as to whether the factors discovered should be named or should simply be given labels such as factors 'A', 'B' and 'C' etc. This discussion seems to frequently come up on the Kent State University Q methodology discussion board [59], a useful forum for researchers of all levels to discuss Q. On one hand, some academics think that giving a perspective a descriptive name is helpful to the reader as it can give an initial impression of what the perspective thinks and can 'personify' the perspective. On the other hand, other academics describe how naming perspectives can immediately add bias to the results and this bias is troubling as perspectives are then only referred to by this given name. They explain how naming perspectives distracts from the actual description of the perspective and the reader no longer appreciates the details of the perspective description. The names which perspectives are given can, unintentionally, attach other connotations to the perspective description.

The final step of the analysis is to compare perspectives. The researcher should start by looking at the consensus statements to understand what all respondents generally agree on, however this should be done carefully as both consensus statements and distinguishing statements can hide differences in understandings [40]. This is where the presence of the researcher at the Q sort becomes very useful, they can refer back to their notes and the interview transcript with a respondent to check their interpretation of a statement. Next, the researcher can look at the distinguishing statements. During this comparison exercise when examining the $Z$ scores, it is important to remember that the statements were sorted relative to each other, so simply comparing $Z$ scores is not in alignment with the method of Q [40]. The researcher should consider the statements within the context of the overall factors rather than picking them out individually [40].

## A.7. RELIABILITY, VALIDITY AND LIMITATIONS OF Q METHODOLOGY

### A.7.1. RELIABILITY AND VALIDITY

Reliability and validity are important elements of any type of R methodology study [68]. The most important type of reliability in Q is replicability, this concerns a situation in which if the same sorting instruction were given to a different P set who were presented with a similarly structured yet different Q set, whether similar perspectives on the topic be uncovered compared to the original study [39]. Brown [57] states that an important aspect of Q is the concept that only a limited number of perspectives exist on any given topic. This means that any well-structured Q set will uncover these perspectives, in addition to this Thomas and Baas [69] concluded that any doubts surrounding this type of reliability is unwarranted [39].

Another way to address validity and reliability is to ask the same respondent to sort the same Q set more than once, so they do two Q sorts some time apart and the researcher can observe any changes [68]. For this test-retest situation, Brown suggests the reliability coefficient (the extent to which a respondent will agree with themselves in the past) to lie between 0.8 and 0.9 [57].

Q methodology does not claim to have external validity. The results of a Q study cannot be generalised to the rest of the population (those who have not performed the

Q sort) but given the purpose of Q is to discover perspectives rather than work out how many people hold each perspective, generalisation is judged to hold little importance [39].

The other two types of validity, in addition to external validity, are measurement validity, which is whether the method measures what it is supposed to measure, and internal validity, which is whether the findings within a sample can be trusted [70]. Brown [57, pp.174-175] argues that "the concept of validity has very little status since there is no outside criterion for a person's own point of view" however more recent critiques of the method such as the work by Kampen and Tamás [70] have given extensive consideration to the measurement and internal validity of Q. Kampen and Tamás [70] studied 71 articles published in 2010 which used Q and used their review of these to present their findings on the validity aspects on Q. Some of these aspects will be examined in the following section which details the limitations of various parts of Q method.

### A.7.2. LIMITATIONS

The following section will discuss some of the limitations mentioned in literature and the effects these have on validity. Section 5.2 details the efforts made in this study to counteract the impact of some of these limitations on the results and discusses the limitations for which the impact could not be reduced.

The first limitation encountered by a researcher undertaking a Q study is the fact that the concourse can never be fully known [71]. Kampen and Tamás explain how there exists no clear instructions on how to gather a sound concourse and "no formal procedure to test its completeness" [70, p.3120]. This in turn affects the Q set, which should be a representative sample of the concourse. A concourse may not exist as a countable finite set of statements or may not exist at all, in which case taking the Q set from it as a representative sample becomes "meaningless" [70, p.3120].

The next limitation concerns whether or how to verify that the P set is sufficiently diverse. The researcher selects respondents purposively, as explained in A.3.2, but Kampen and Tamás found that none of the articles they studied "provided a test by which they could ascertain whether there was adequate diversity among respondents to support inference from the factors derived from sorts to the concourse from which sort items derive" [70, p.3117]. They found that Q researchers describe how the diversity of the P set is important, but are unable to verify this in practice. If the P set is not sufficiently diverse, it is possible that perspectives could be overlooked, therefore endangering internal validity. The geometry of the P set is one way to check the diversity of the respondents but there is no way of knowing whether another dimension or 'main effect' exists which is important to the problem and how the selected respondents differ on this.

The use of a set response chart for all respondents decreases variance in the results. This in turn increases correlation and therefore increases the "amenability" of the data to clustering in the factor analysis stage [70, p.3120]. Kampen and Tamás argue that although the use of a forced sort helps produce better clusters, it cannot be known whether this clustering is due to the design of the response chart or from the true perspectives of the respondents [70].

Q method asks respondents to confront a particular topic and express their opinion on it and from this, deduces perspectives which exist within a population. In a Q sort,

the researcher asks a respondent to consciously consider the topic in question but it is possible that a respondent does not exhibit this consciousness to the topic in their daily life [70] and thus the measurement validity is at risk. For a researcher to be able to conclude that the perspectives uncovered are truly in existence they must assume that respondents are exhibiting this consciousness towards the topic in their daily life, which in reality is impossible to check.

Kampen and Tamás [70] describe the limitation which exists regarding the number of factors or perspectives which can be identified in a Q study. They explain how even if the selected P set are sufficiently representative of the whole population “the mathematics dictate that we are impotent to find all the factors (groups, clusters)" [70, p.3133]. The constraints imposed by the mathematics behind factor analysis are what causes this threat to validity. The fact that PQMethod software is limited to identify a maximum of eight factors further compounds this issue.

The Q methodology process has a number of opportunities in which the researcher is able to introduce bias. The first stage in which bias can be introduced is through the composition of the Q set. The researcher chooses where to draw items for the concourse from, how to word the statements (assuming a study in which text statements are used as items in the concourse and Q set) and finally which items make the final Q set [70]. The researcher chooses who will be selected for the P set, giving the opportunity to introduce bias. The instructions given by the researcher during the Q sort activity and the discussion they have with the respondent can also introduce bias, along with the setting in which the Q sort is actually conducted (for example a private room or in small groups with other respondents).

Kampen and Tamás [70] explain that bias can enter the project when the researcher makes decisions regarding the thresholds at which items are considered to be distinguishing or consensus statements. PQMethod uses the base threshold of $p<0.05$ to flag distinguishing and consensus statements and additionally adds a second flag to indicate items which are significant at the $p<0.01$ level.

Bias can enter the study during the analysis stage. Factor analysis and factor rotation both require a level of judgement on the part of the researcher [40], for factor analysis “considerable subjective judgement" is inevitable [70]. The researcher can choose how many factors to rotate and also the extent to which they are rotated. In PQMethodology software, the varimax rotation procedure rotates the factors following a standard algorithm which is not necessarily better than any other method but it is widely used due to the fact it makes the analysis “straightforward and transparent" [40].

Finally, bias can enter the study through the descriptions composed by the researcher to set out the different perspectives identified. Kampen and Tamás describe how, when writing the perspective descriptions, researchers may “cherry-pick" quotes from the interviews which strongly support the factors which the analysis has identified [70, p.3119]. This means that discussions from the interviews which contradict the identified perspectives or offer other subtleties on the topic may be disregarded by the researcher.

There are some general practicalities of conducting a Q study which are worth discussing. Q is an “intensive process" in which the researcher must put in significant effort in all phases [39]. The methodology itself is not a difficult concept but subtleties in the analysis can make that part of the study challenging [40]. Conducting the Q sort activ-

ity is time consuming [35], the method and the sorting instructions must be explained to each respondent. The advantage of having the researcher present during the Q sort activity is that the data collected is “highly reliable" [62] since the respondent can be observed and explanations provided to help them understand the process. It is possible to conduct the Q sorts with small groups of respondents, this is more time efficient since the explanation can be given once to many people but the issue with this is that a researcher may miss seeing a respondent struggling with the activity, meaning data could become less reliable and the follow up interviews with each respondent are still advisable. The relatively small number of respondents needed for a Q study means that it is cost-effective compared to large scale survey methods [72] but the time required for each respondent to do the Q sort activity and then be interviewed could limit the advantage provided by this.

# B

# LITERATURE STUDY

Table B: 78 CSFs identified in the literature study

| No. | Tags | Factor description | Origin of factor | Extract from source | Source and source description |
|---|---|---|---|---|---|
| 1 | Organisational | Integration of risk management with other project management operations | Interpreted from the text given, not explicitly given as a CSF by the author. | "In particular, management of risks and uncertainties should be seen as a continuous real time operation integrated with other project management operations." | [26] - Paper, not stated as being specific to construction but author works in Dept of Civil Engineering. |
| | | Integration of risk management into total project management | Listed explicitly as a CSF of RM | "Having decided on tools and templates, attention must be given to how these will integrate into other systems and processes, particularly those used for routine project management. It is important for risk management to be a fully integrated part of how projects are managed. The interfaces between the risk infrastructure and the rest of the project support system largely determine how successfully this is achieved." | [47] - Book, not specific to the construction industry |
| | | Integrate with project management | Listed explicitly as a CSF of RM. | "Project risk management does not exist in a vacuum, isolated from other project management processes. Successful project risk management requires the correct execution of the other project management processes." | [50] - Book, not specific to the construction industry. |
| | | Integrated with project management | Interpreted from the text given, not explicitly given as a CSF by the author. | "The necessity to install a risk management system as early as possible results from the fact that risk potentials exist, at least in a rudimentary form, already before or at the start of the project and are recognizable, however their effects and damage only come to light in the subsequent progress of the project. For this reason, the risk management process should be established and integrated into the entire project process as a permanent (sub-) task of the project management." | [6] - Paper explains the risk management process in construction projects. |
| | | Integration between risk management and other key processes | Interpreted from the text given, not explicitly given as a CSF by the author. | "The ineffective implementations of risk management are often caused by...poor integration between risk management and other key processes, including design, estimating, planning, production, logistics, cost analysis, manufacturing, quality assurance, reliability, schedule analysis, support (e.g. maintainability), and test and evaluation;" | [55] - Paper concerning the Chinese construction industry. |
| | | Integration of risk management with other project management processes | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper specific to the construction industry |

| No. | Tags | Factor description | Origin of factor | Extract from source | Source and source description |
|---|---|---|---|---|---|
| 2 | Organisational | Strategy (for risk management) | Listed explicitly as a CSF of RM. | "Well-defined and clearly understood vision, mission, and long-term strategy toward risk management in the organization." | [44] - Interview data collected from Swedish corporations (not specifically construction industry). Case study on a company in New York. |
| | | Clear objectives for risk management | Listed explicitly as a CSF of RM. | "A supportive organization behaves in such a way that it is seen to be fully behind risk management and all it entails. The organization “walks the talk.”" | [47] - Book, not specific to the construction industry. |
| 3 | Organisational & Involvement of other parties | Environment | Listed explicitly as a CSF of RM. | "External environment in which the organization is performing. It encompasses the effects of market, suppliers, competitors, socio-political systems and also the organization's partnership and joint venture strategies." | [44] - Interview data collected from Swedish corporations (not specifically construction industry). Case study on a company in New York. |
| | | External risk (finance, politics and national cultures) | Interpreted from the text given, not explicitly given as a CSF by the author. | "External risk management is especially important also because the firm's operations are now exposed to a dynamic environment influenced by macro-economic, political and social factors." and "Establishing an external risk management task group ensures that adequate time and effort is put into this area, to minimise possible losses for the company." and "...risk and external risk management are essentially good practices that all construction firms should employ when both undertaking construction projects and expanding their operations into foreign host countries." | [73] - Survey looking at how Chinese construction companies deal with external risks when they operate abroad. |
| | | Understand and define external context | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry |
| 4 | Organisational & Technical | Accept the need to change in response to risk management | Listed explicitly as a CSF of RM. | "These organizations also accept the need to change in response to risk, and, where appropriate, provide a suitable contractual framework to facilitate the process." | [47] - Book, not specific to the construction industry. |

| No. | Tags | Factor description | Origin of factor | Extract from source | Source and source description |
|---|---|---|---|---|---|
| 5 | Organisational & Technical | Recognise that "one size fits all" is the wrong approach | Listed explicitly as a CSF of RM. | "Risk management is not “one size fits all.” While all projects are risky, and risk management is an essential feature of effective project management, there are different ways of putting risk management into practice." | [47] - Book, not specific to the construction industry. |
| | | Recognise that "one size fits all" is the wrong approach | Interpreted from the text given, not explicitly given as a CSF by the author. | "There is evidence that suggests that standardized methods for project management may increase project success (Milosevic and Patanakul, 2005), and it can be argued that standardized processes allow for more accessible and transferable gained experiences and learning in the organization (Perminova et al., 2008). Yet those who maintain a contingency view of project risk question the need for a unifying body of knowledge in risk management. The contingency perspective argues that various project and uncertainty characteristics call for different risk management approaches, and therefore a one-size-fits-all standard risk management practice is not ideal (Teller et al., 2014; Jun et al., 2011; Miterev et al., 2016; Williams, 2005; Thamhain, 2013)." | [27] - This paper presents an empirical investigation and discussion of the eleven principles of the ISO 31000:2009 Risk Management Standard via a large-scale survey of engineering and product development practitioners. |
| | | Adapt RM to each project | Interpreted from the text given, not explicitly given as a CSF by the author. | "Any PRM process must be tailored to the particular circumstances of the project and the organization undertaking it.... The aim of this article is not to persuade readers that a particular, rigid approach to PRM should be adopted, but to present a flexible methodology to be adapted to the project and organization circumstances and to stimulate reflection on the ways to develop the different PRM tasks in different environments (projects, companies, and so on)." | [48] - This article presents a generic project risk management process that has been particularized for construction projects from the point of view of the owner and the consultant who may be assisting the owner. Applied to a project in Spain. |
| | | "One size fits all" approach is not applicable | Interpreted from the text given, not explicitly given as a CSF by the author. | "The same concept applies to risk management: one cannot expect that a single, universal risk management process and its supporting set of tools and techniques would be applicable to all types of projects. Just as there are different types of projects, we should expect to see different kinds of risk management practices." | [49] - General project management. |

| No. | Tags | Factor description | Origin of factor | Extract from source | Source and source description |
|---|---|---|---|---|---|
| 6 | Organisational & Employees | Responsibility | Listed explicitly as a CSF of RM. | "Job design and descriptions and also level of employee involvement in RMS." | [44] - Interview data collected from Swedish corporations (not specifically construction industry). Case study on a company in New York. |
| | | Individual commitment/ responsibility | Listed explicitly as a CSF of RM. | "Project participants and stakeholders should all accept responsibility for undertaking risk-related activities as required. Risk management is everybody's responsibility." | [50] - Book, not specific to the construction industry. |
| | | Establishing clear accountability and responsibility of roles for managing risks | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| 7 | Organisational & Involvement of other parties | Buy-in from all stakeholders | Listed explicitly as a CSF of RM. | "It ensures that there are clear objectives for risk management and that these objectives are bought into by all stakeholders, who also contribute inputs and commit to using the outputs of the process." | [47] - Book, not specific to the construction industry. |
| 8 | Organisational | Organisational infrastructure | Listed explicitly as a CSF of RM. | "The organisation is responsible for ensuring that each project has the necessary infrastructure to support the various activities and processes of the project. This is usually provided as a generic organisational capability into which each individual project taps." | [4] - Book, not specific to the construction industry. |

| No. | Tags | Factor description | Origin of factor | Extract from source | Source and source description |
|---|---|---|---|---|---|
| 9 | Organisational & Culture | Recognise the value of risk management | Listed explicitly as a CSF of RM. | "Project risk management should be recognised as a value discipline that provides a positive potential return on investment for organisational management, project stakeholders (both internal and external), project management and team members." | [50] - Book, not specific to the construction industry. |
| | | Personnel's understanding and belief in the benefits of risk management | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| 10 | Organisational | Organisational learning | Interpreted from the text given, not explicitly given as a CSF by the author. | "Organizational learning should be a crucial part of an integrated risk management process. The organizational learning of risk management is a learning framework designed to help Chinese contractors improve their knowledge and performance of risk management." | [55] - Paper concerning the Chinese construction industry. |
| 11 | Organisational | Understand and define internal context | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |

| No. | Tags | Factor description | Origin of factor | Extract from source | Source and source description |
|---|---|---|---|---|---|
| 12 | Organisational | Resources | Listed explicitly as a CSF of RM. | "Availability of all kinds of resources and infrastructure including human resources, organizational validity, and technical validity. Cost and time are also included in this category." | [44] - Interview data collected from Swedish corporations (not specifically construction industry). Case study on a company in New York. |
| | | Availability of adequate resources | Listed explicitly as a CSF of RM | "The organization allows time in the schedule for risk management, and it ensures that risk management occurs as early as possible in the project life cycle. The organization also provides the necessary resources and funding to carry it out. Supportive organizations recognize that the extra work identified to manage risks is fundamental to ensuring project success and needs to be adequately resourced." | [47] - Book, not specific to the construction industry. |
| | | Required level of infrastructure and software tools to support appropriate level of implementation | Listed explicitly as a CSF of RM | "Different organizations may implement risk management in varying levels of detail, depending on the type of risk challenge they face. The decision about implementation level may also be driven by organizational risk appetite—the overall willingness or hunger to expose the organization to risk—and by the availability of funds, resources, and expertise to invest in risk management. The objective is for each organization to determine a level of risk management implementation that is appropriate and affordable. Having chosen this level, the organization then needs to provide the necessary infrastructure to support it." | [47] - Book, not specific to the construction industry. |
| | | Adequate resources | Listed explicitly as a CSF of RM | "It is evident that risk management is not a cost-free activity, and the project needs to provide the necessary level of resources if the risk process is to function properly. These resources include people, time and money." | [4] - Book, not specific to the construction industry. |
| | | Organisation commit resources for risk management | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| | | Organisation structure | Listed explicitly as a CSF of RM. | "Organization's design, allocation of authorities, and responsibilities." | [44] - Interview data collected from Swedish corporations (not specifically construction industry). Case study on a company in New York. |

| No. | Tags | Factor description | Origin of factor | Extract from source | Source and source description |
|---|---|---|---|---|---|
| 13 | Organisational | Decide the appropriate level of risk management (risk thresholds) | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| | | Scale risk effort to project | Listed explicitly as a CSF of RM. | "Project risk management activities should be consistent with the value of the project to the organisation and with its level of project risk, its scale, and other organisational constraints. In particular, the cost of project risk management should be appropriate to its potential value to the project and the organisation." | [50] - Book, not specific to the construction industry. |
| 14 | Organisational & Involvement of other parties | Appropriate mechanisms for sharing risks amongst those best placed to manage them | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| 15 | Organisational | Define risk management tools and techniques | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| 16 | Organisational | Availability process for deciding the project reserve | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| 17 | Organisational | Availability of a clear mechanism for external/internal communication and reporting | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| 18 | Organisational | Risk management purposes in line with organisation / project purposes | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |

| No. | Tags | Factor description | Origin of factor | Extract from source | Source and source description |
|---|---|---|---|---|---|
| 19 | Organisational | Organisational commitment | Listed explicitly as a CSF of RM. | "Organisational commitment can only be established if risk management is aligned with the organization's goals and values. Project Risk Management may require a higher level of managerial support than other project management disciplines because handling some of the risks will require approval of or responses from others at levels above the project manager." | [50] - Book, not specific to the construction industry. |
| 20 | Management | The manager's knowledge and personal experience | Interpreted from the text given, not explicitly given as a CSF by the author. | "The author has observed that on many projects classed as successful projects, the project managers tend to apply the above key success factors somewhat intuitively. Each manager tends to build his or her own's mental model of the project and its challenges, albeit based on his or her experience and professional judgement. This model is the basis for formulation of stratgies, evaluation of project status and making of decisions, which will secure a successful outcome in the end. The entire process is experimental in the sense that the manager will try to see what will work. It is normally based on the manager's reference framework (knowledge and personal experience) and his or her ability to apply reflective thinking." | [26] - Paper, not stated as being specific to construction but author works in Dept of Civil Engineering. |
| 21 | Management | Top management reviews risk management reports actively to make decisions | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. Only found in one guidelines source, (Managing successful projects with PRINCE2). | [18] - Paper, specific to the construction industry. |
| 22 | Management | Availability of a risk management plan | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| 23 | Management | Top management communication of goals and strategies of risk management | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |

| No. | Tags | Factor description | Origin of factor | Extract from source | Source and source description |
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| 24 | Management | Management (people and leadership) capability in relation to risk | An attribute used by the paper to measure the risk maturity of a company. Not sure if it can be used as a CSF. | "Effective and efficient management is always necessary in order to manage people and make decisions." and "Upper management actively takes part in risk activities, supports and encourages risk management • How often are the risk management capabilities assessments held within the organization • To what extent is risk management information distributed and communicated to all project participants within the organization • To what extent is risk management tools and techniques integrated and used in projects • To what extent are resources dedicated to projects in accordance to the severity of risk events identified" | [74] - Paper explains development of model to measure risk capability or risk maturity of construction companies. Tested model in Australia. |
| 25 | Management | General management skills | Listed explicitly as a CSF of RM. | "General management skills including problem-solving, negotiating, communication, and influencing the organization." | [44] - Interview data collected from Swedish corporations (not specifically construction industry). Case study on a company in New York. |
| 26 | Management | Leadership | Listed explicitly as a CSF of RM. | "Leadership characteristics of risk and top managers. This factor is excluded from general management skills due to its importance and attention that it has gained from risk management researchers and practitioners." | [44] - Interview data collected from Swedish corporations (not specifically construction industry). Case study on a company in New York. |
| 27 | Management | Project management skills | Listed explicitly as a CSF of RM. | "Maturity of the organization's project management capabilities." | [44] - Interview data collected from Swedish corporations (not specifically construction industry). Case study on a company in New York. |
| 28 | Management | Risk champion appointed | Listed explicitly as a CSF of RM. | "A proven contributor to maximising risk process efficiency is the use of a skilled and experienced facilitator. This person can have various titles, such as Risk Champion, Risk Coordinator, Risk Process Facilitator, or Risk Manager. More important than their job title however are their personal characteristics. A good Risk Champion will have a combination of technical skills (including both the domain of the project as well as technical risk competences) and people skills (including the ability to understand and manage different types of individuals and groups). These latter soft skills are very useful for keeping energy levels high during the risk process, and a high degree of emotional literacy can be particularly helpful." | [4] - Book, not specific to the construction industry. |

| No. | Tags | Factor description | Origin of factor | Extract from source | Source and source description |
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| 29 | Management | Regularly communicating and reporting relevant risk information to the organisational management | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| 30 | Management | Top management support | Listed explicitly as a CSF of RM. | "Level of top management support of RMS practices." | [44] - Interview data collected from Swedish corporations (not specifically construction industry). Case study on a company in New York. |
| | | Management support | Listed explicitly as a CSF of RM. | "...there are other things that senior managers can do to maximise the effectiveness of the risk process on their projects. These revolve around demonstrating a visible and consistent commitment to risk management, with two particular aspects.....The first way senior management can show their commitment to the risk process is to appoint a senior manager (who may be called the Corporate Risk Sponsor or similar) who will promote the cause of risk management at the highest levels of the organisation. This role is ideally filled by a Board member, responsible to the CEO and the Board for setting risk policy for the entire organisation, creating a 'pull' for risk management from the lower levels of the business.....The second major way in which the senior management of the organisation can demonstrate their commitment to effective risk management across their projects is to use the results of the risk process to support risk-informed decision-making. When project teams can see that their risk information is actually being used to assist senior managers in running the wider business, they will be motivated to provide the best possible outputs from the project risk process." | [4] - Book, not specific to the construction industry. |
| | | Top management support | Interpreted from the text given, not explicitly given as a CSF by the author. | "Sometimes, a project system's capacity to cope with risk impacts is constrained by certain conditions. For instance, a project organization may not obtain sufficient resources such as people, money, and equipment due to lack of the top management's support. Thus, in the event of risk events, this organization would be unable to adopt sufficient measures to reduce risk impacts." | [75] - Paper, not specific to construction, but paper studies a few PFI projects, of which some are construction. Examples are related to the construction industry. |
| | | Risk management is encouraged and supported by the top management | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |

| No. | Tags | Factor description | Origin of factor | Extract from source | Source and source description |
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| 31 | Culture | Clear and effective communication | Interpreted from the text given, not explicitly given as a CSF by the author. | "Efficient management of building projects demands clear effective communication and if risk analysis and management is to be used as a tool to assist the management of projects, then it must itself be clearly communicated and understood." | [51] - This paper examines the steps involved in conducting the risk identification and assessment process and how they may influence the effectiveness of risk analysis, specific to construction. |
| | | Communication | Listed explicitly as a CSF of RM. | "Communication system which is used in the organization and its hardware infrastructure and software capabilities design. It also includes data analysis systems and non- official and emotional communications within the organization." | [44] - Interview data collected from Swedish corporations (not specifically construction industry). Case study on a company in New York. |
| | | Open and honest communication | Listed explicitly as a CSF of RM. | "Everyone should be involved in the Project Risk Management process. Any actions or attitudes that hinder communication about project risk reduce the effectiveness of Project Risk Management in terms of proactive approaches and effective decision-making." | [50] - Book, not specific to the construction industry. |
| | | Communication channels | Interpreted from the text given, not explicitly given as a CSF by the author. | "For this, however, it is necessary that a high quality of the status of information is always available in order to make determinations on the basis of useable and comprehensive information. Risk management can therefore only be implemented and enforced effectively if communication channels in the enterprise are created, which guarantee the direction of the information to the places concerned in each case." | [6] - Paper explains the risk management process in construction projects. |
| | | Communication | Listed explicitly as a CSF of RM. | "The ineffective implementations of risk management are often caused by...a lack of interaction among different parties, including clients, contractors, insurers, and suppliers" | [55] - Paper concerning the Chinese construction industry. |
| 32 | Culture | Shared acceptance of proposed risk assessment measures between all team members/ across all project employees | Interpreted from the text given, not explicitly given as a CSF by the author. | "A key component of the Presentation Step is to elicit from the core team or obtain conformation of acceptance of proposed measures of the likelihood of occurrence and impact, to ensure consistency of assessment. Without these measures, any assessment would be seriously impaired." | [51] - This paper examines the steps involved in conducting the risk identification and assessment process and how they may influence the effectiveness of risk analysis, specific to construction. |
| | | Shared understanding of the key concepts and principles of risk management | Listed explicitly as a CSF of RM. | "Effective training creates a shared understanding of the key concepts and principles of risk management." | [47] - - Book, not specific to the construction industry. |

| No. | Tags | Factor description | Origin of factor | Extract from source | Source and source description |
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| 33 | Culture | Attitude | Interpreted from the text given, not explicitly given as a CSF by the author. | "There is a general reluctance to implement risk management in China's construction industry because of the lack of experience and expertise demonstrated by the results of the survey. Without knowledge and expertise, contractors cannot recognise the importance and benefits of risk management. The low perception of risks can only be improved by changing the enterprise culture. It is necessary that Chinese contractors accept the concept of risk management and implement the techniques of risk management. Practitioners' attitude is the most important factor influencing the development of risk management in China's construction industry." | [55] - Paper concerning the Chinese construction industry. |
| 34 | Culture | (Personnel) commitment | Interpreted from the text given, not explicitly given as a CSF by the author. | "A risk and control culture borne and experienced by all parties involved in the project has the effect of a connecting bracket that can safeguard the effectiveness of the structural and organizational measures of risk management. The key to this is the parties involved in risk management. Effective risk management requires commitment as well as the risk- conscious behaviour of each individual. The motivation as well as the interplay of the parties involved in the project in the end determines the quality of the work and thus the success of the project." | [6] - Paper explains the risk management process in construction projects. |
| 35 | Culture | Organisational culture | Listed explicitly as a CSF of RM. | Staff morale and commitment. Adaption to change and respect to external management consultants. | [44] - Interview data collected from Swedish corporations (not specifically construction industry). Case study on a company in New York. |
| 36 | Culture | No blame culture and accepting that people make mistakes | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |

| No. | Tags | Factor description | Origin of factor | Extract from source | Source and source description |
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| 37 | Culture | A culture that recognises that uncertainty is inevitable | Listed explicitly as a CSF of RM. | "In the same way that individuals have an attitude to risk that affects their participation in the risk process, organizations also have a “risk culture” that reflects their preferred approach to dealing with uncertainty." and " Project managers and their teams are rewarded for managing risks appropriately, with the recognition that some unwelcome risks occur in even the best-managed project." and "For risk management to be effective, the culture must be supportive, meaning that individuals’ risk attitudes must be understood and managed, and the organization's overall approach must value risk management and commit to making it work." | [47] - Book, not specific to the construction industry. |
| | | Organisational risk culture | An attribute used by the paper to measure the risk maturity of a company. Not sure if it can be used as a CSF. | "The construction industry is an industry that relies heavily on human interaction. This means that having a good cultural environment plays a significant role in the morale and productivity within the organization." | [74] - Paper explains development of model to measure risk capability or risk maturity of construction companies. Tested model in Australia. |
| | | Organisational risk culture | Listed explicitly as a CSF of RM. | "Here we will concentrate on those elements of organisational risk culture that contribute towards effective risk management. Perhaps the most important of these is a culture which is risk-aware, recognising the existence of risk both within the business and in the external environment, as well as intrinsically present in the projects being undertaken by the organisation....A second characteristic of appropriate organisational risk culture is to be risk- mature. This describes a culture which has a well-developed approach to risk at all levels, which is not surprised when risk is encountered, and which is able to take risk in its stride....A last element of risk culture that has a significant influence on whether the project risk process is effective or not is the way risk-taking is regarded. The organisation (and particularly its senior management) should encourage and reward appropriate risk-taking, and will celebrate successes when projects and their teams demonstrate an effective approach to managing risk." | [4] - Book, not specific to the construction industry. |

| No. | Tags | Factor description | Origin of factor | Extract from source | Source and source description |
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| 38 | Culture | Team-building | Listed explicitly as a CSF of RM. | "Existence of developed teams and teamwork spirit within the organization." | [44] - Interview data collected from Swedish corporations (not specifically construction industry). Case study on a company in New York. |
| | | (Strong) teamwork (with internal and external partners) | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| 39 | Culture | A common language and agreement of key risk management terms | Listed explicitly as a CSF of RM. | "It (training) enables the establishment of a common language and agreement on key risk management terms." | [47] - Book, not specific to the construction industry. |
| 40 | Culture | Alignment of risk management attitude and goals of personnel with the organisation | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| 41 | Culture & Involvement of other parties | Team members trust and openness in reporting risks to internal and external stakeholders | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| 42 | Culture & Involvement of other parties | Socio-cultural forces | Interpreted from the text given, not explicitly given as a CSF by the author but Shayan et al (2019) lists this as a CSF. | "Cultural influence is unavoidable in construction projects and a clear understanding of it is vital for successful risk management." AND "The findings show that national culture plays a more important role in contractor's risk management." AND "Risks are fewer and easier to manage where the host culture is similar to the contractor's than when the host culture is different." | [55] - Paper concerning the Chinese construction industry. |

| No. | Tags | Factor description | Origin of factor | Extract from source | Source and source description |
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| 43 | Employees | Skilled and competent staff | Listed explicitly as a CSF of RM. | "Project sponsors, project managers, team members, and stakeholders must be trained in applying the process, participating in it, or both." | [47] - Book, not specific to the construction industry. |
| | | Involved staff exhibit an appropriate level of competence in application of risk management | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| | | Combination of theoretical knowledge, effective behaviours, and appropriate attitudes | Listed explicitly as a CSF of RM. | "Attention should also be paid to ongoing competence development, with on-the-job training, job rotation, mentoring, and coaching, in addition to focused formal training courses. The aim is to develop practical skills as well as theoretical knowledge, encouraging effective behaviors and appropriate attitudes." | [47] - Book, not specific to the construction industry. |
| 44 | Employees | Availability of experienced team responsible for risk management | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| 45 | Employees | Reward and recognition system | Listed explicitly as a CSF of RM. | "Availability of reward and recognition system schemes in organisations." | [44] - Interview data collected from Swedish corporations (not specifically construction industry). Case study on a company in New York. |
| 46 | Technical | Continuity of risk management across project stages | Interpreted from the text given, not explicitly given as a CSF by the author. | "The ineffective implementations of risk management are often caused by... a lack of continuity of risk management in the different stages in the project life cycle, including conceive, design, plan, allocate, execute, deliver, review and support" | [55] - Paper concerning the Chinese construction industry. |
| | | Continuity of risk management across project stages | Interpreted from the text given, not explicitly given as a CSF by the author. | "It is believed that RM should be a continuous activity throughout the project. Thus, the risks and related factors should be entered and assessed at each stage." | [9] - Paper, specific to construction projects, a tool to improve knowledge management and risk management. |
| | | Risk management spans all project phases | Interpreted from the text given, not explicitly given as a CSF by the author. | "At the end of each phase an appraisal can be made and assessment of the risk involved in proceeding with the project. The management of risk is therefore a continuous process and should span all the phases of the project. Since project risks are dynamic, that is to say they can change continuously, a risk assessment must be carried out at the end of each phase prior to proceeding to the next phase." | [52] - Book, specific to construction. |

| No. | Tags | Factor description | Origin of factor | Extract from source | Source and source description |
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| 47 | Technical | Detailed documentation and recording of risks | Interpreted from the text given, not explicitly given as a CSF by the author. | "The third step in assessing risk involves identifying as exhaustively as practicable, the risks associated with each activity and documenting what is involved." | [51] - This paper examines the steps involved in conducting the risk identification and assessment process and how they may influence the effectiveness of risk analysis, specific to construction. |
| | | Documentation | Listed explicitly as a CSF of RM. | "Documentation system which is used in the organization and its hardware infrastructure and software capabilities design. It also includes the data accuracy level in the organization." | [44] - Interview data collected from Swedish corporations (not specifically construction industry). Case study on a company in New York. |
| | | A documented process | Listed explicitly as a CSF of RM. | "A simple to use, scalable, and documented process ensures that each project does not have to work out the best way to apply risk management in its situation." | [47] - Book, not specific to construction industry. |
| | | The whole process is documented | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| 48 | Technical | Use of specialised consultants | Listed explicitly as a CSF of RM. | "Utilization of management consultancy services in organization". | [44] - Interview data collected from Swedish corporations (not specifically construction industry). Case study on a company in New York. |
| | | Use of external experts and services in risk management | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |

| No. | Tags | Factor description | Origin of factor | Extract from source | Source and source description |
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| 49 | Technical | Development and application of standardised risk management process | An attribute used by the paper to measure the risk maturity of a company. Not sure if it can be used as a CSF. | "Risks are consistently identified, analyzed, responded, and continuously monitored throughout the project life cycle • The flow of risk management information is passed on and communicated throughout the entire project life cycle • Risk management process is woven into daily business processes of the organization • A standardized risk management process is applied to all projects within the organization • How often is risk management process reviewed to ensure the process is effective" | [74] - Paper explains development of model to measure risk capability or risk maturity of construction companies. Tested model in Australia. |
| | | Process design | Listed explicitly as a CSF of RM. | Detailed and clear process design and availability of documented process ownerships for the organization's internal processes. | [44] - Interview data collected from Swedish corporations (not specifically construction industry). Case study on a company in New York. |
| | | Efficient procedural framework | Listed explicitly as a CSF of RM. | "At the simplest level is an informal risk process in which all the phases are undertaken, but with a very light touch. In this informal setting, the risk process might be implemented as a set of simple questions. At the other extreme is a fully detailed risk process that uses a range of tools and techniques to support the various phases." | [47] - Book, not specific to construction industry. |
| | | Clear instruction on "what to do" | Listed explicitly as a CSF of RM. | "An efficient procedural framework that supports the process and outlines "what to do" ensures support from the organization and makes the most of the investment in training, tools, and techniques." | [47] - Book, not specific to construction industry. |
| | | Formal risk management systems | Interpreted from the text given, not explicitly given as a CSF by the author. | "The risk management systems applied in the industry tend to be informal, which are inadequate to manage project risks;" | [76] - This paper reports the findings of an empirical Chinese industry survey on the importance of project risks, application of risk management techniques, status of the risk management system, and the barriers to risk management. |
| | | Thoughtful process design | Listed explicitly as a CSF of RM. | "This barrier can be overcome by thoughtful process design, seeking to maximise efficiency and reduce the overhead associated with running the risk process, while not cutting any essential corners." | [4] - Book, not specific to construction industry. |
| | | A documented framework of risk management processes | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |

| No. | Tags | Factor description | Origin of factor | Extract from source | Source and source description |
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| 50 | Technical | Education | Listed explicitly as a CSF of RM. | Competence, awareness, training, and education of the organization's personnel, including risk management staff about RMS, its processes, tools, and applications. | [44] - Interview data collected from Swedish corporations (not specifically construction industry). Case study on a company in New York. |
| | | In house training and experience | Maybe not a CSF, only identified as a technique. | "Respondents indicated that the most beneficial risk management training that they had received was by way of in-house training and experience..." | [77] - This paper provides the results of a survey of senior management involved in the Queensland engineering construction industry, concerning the usage of risk management techniques. |
| | | Recognise the need for continuous training of staff | Listed explicitly as a CSF of RM. | "Project sponsors, project managers, team members, and stakeholders must be trained in applying the process, participating in it, or both. Training also needs to be at the right level and depth to suit the role involved." and "Training should not be viewed as a one-off event carried out when formal risk management is first introduced. It must be a continual process, bringing new members of the organization up to speed as soon as is practical. The end benefit of effective training is skilled and competent staff who contribute effectively to the risk process." | [47] - Book, not specific to construction industry. |
| | | Training in the selected methods, tools and techniques | Listed explicitly as a CSF of RM. | "Having selected the level of implementation, providing the required level of infrastructure to support the risk process is then possible. This might include choosing techniques, buying or developing software tools, allocating resources, providing training in both knowledge and skills, developing procedures that integrate with other business and project processes, producing templates for various elements of the risk process, and considering the need for support from external specialists. The required level for each of these factors will be different depending on the chosen implementation level." | [47] - Book, not specific to construction industry. |
| | | Regular (internal or external) training to enhance skills | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |

| No. | Tags | Factor description | Origin of factor | Extract from source | Source and source description |
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| 51 | Technical & Involvement of other parties | Suitable contractual framework to support the risk process | Listed explicitly as a CSF of RM. | "These organizations also accept the need to change in response to risk, and, where appropriate, provide a suitable contractual framework to facilitate the process." | [47] - Book, not specific to construction industry. |
| | | Good contract management | Interpreted from the text given, not explicitly given as a CSF by the author. | "Risk management is not separated from other knowledge. Of respondents, 48.57 percent highlight contract management as the most important factor. It means that Chinese practitioners have realised that risks can be defined and shared in contract. And good contract management can allocate responsibilities and liabilities among parties and therefore avoid conflicts." | [55] - Paper concerning the Chinese construction industry. |
| | | Contract | Interpreted from the text given, not explicitly given as a CSF by the author. | "A project system's capacity to cope with risk events could also be constrained by project contract and even regulation or law." | [75] - Paper, not specific to construction, but paper studies a few PFI projects, of which some are construction. Examples are related to the construction industry. |
| | | Contract | Interpreted from the text given, not explicitly given as a CSF by the author. | "Appropriate, clear and equitable conditions of contract are commonly considered to be invaluable for successful projects. Appropriate contract conditions help to meet the specific requirements and objectives of the project. Contract conditions are expected to be clear in order to define the rights and duties of project participants and unequivocally allocate risks (or future uncertainties) to the different contracting parties. Contract conditions are also expected to be equitable, so as to allocate these risks in a 'just' way, apart from merely following the often espoused principle of assigning the risks to those best equipped to deal with them." | [56] - Paper, presents a study into using joint risk management and relational contracting in construction. |
| 52 | Technical | Integrated toolkit, both internally coherent and interfacing with project management and business tools | Listed explicitly as a CSF of RM. | "This might include choosing techniques, buying or developing software tools, allocating resources, providing training in both knowledge and skills, developing procedures that integrate with other business and project processes, producing templates for various elements of the risk process, and considering the need for support from external specialists." | [47] - Book, not specific to construction industry. |

| No. | Tags | Factor description | Origin of factor | Extract from source | Source and source description |
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| 53 | Technical | Knowledge sharing | Interpreted from the text given, not explicitly given as a CSF by the author. | "Encouraging a knowledge-sharing culture. Central to the success of a KRM framework, is the concept that values and expectations for ethical behavior need to be communicated widely and effectively throughout the organization. In short, integrity has to become part of the corporate culture. This is best accomplished as part of a formal process of knowledge sharing, of mentoring, and formal ethics training, so that employees at all levels appreciate the importance of good behavior... This process of formal, company-advocated knowledge sharing sends the important message to employees throughout the organization that they have responsibility and authority to voice concerns and act on ethical, legal or safety issues that might harm the company." | [53] - This is mainly a paper about knowledge management, so not sure how applicable it can be here. Not specific to the construction industry. |
| | | Database for collecting historical information about risk management | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| 54 | Technical | Level of risk management knowledge and techniques | Interpreted from the text given, not explicitly given as a CSF by the author. The opposite of a barrier could be considered to be a CSF. | ""Lack of joint risk management mechanisms by parties" "shortage of knowledge/techniques on risk management," and "different recognition of risk control strategies" are the top three barriers to risk management" | [76] - This paper reports the findings of an empirical Chinese industry survey on the importance of project risks, application of risk management techniques, status of the risk management system, and the barriers to risk management. |
| 55 | Technical & Employees | Personal and corporate experience and engineering judgement | Interpreted from the text given, not explicitly given as a CSF by the author. | "In Table 1, the top two methods, from both the amount of usage and their success, are personal and corporate experience and engineering judgement. Experience and engineering judgement have always been realised as qualities important to both industries and not just in risk anlaysis." | [78] - Survey of most successful qualitative and quantitative risk analysis tools in construction and Oil and Gas industries, direct survey of workers in those industries. |
| | | Intuition, judgement and experience | Maybe not a CSF, only identified as a technique. | "Among the risk assessment techniques available, intuition, judgement and experience are the most frequently used, which is consistent with Akintoye and MacLeod's [6] findings. This result is also consistent with Fayek and Rolla's [10] conclusion that 'experience, judgement, and subjective assessment are the main tools used' in their own and Ahmad and Minkarah [3], Shash and Abdul- Hadi [4], Shash [5], Hegazy and Moselhi [8], Ting and Mills [9] and Uher and Toakley's [11] surveys." | [77] - This paper provides the results of a survey of senior management involved in the Queensland engineering construction industry, concerning the usage of risk management techniques. |

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| 56 | Technical | Dividing risks based on different classification | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| 57 | Technical | Risks and opportunities are identified proactively based on different objectives and methods | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| 58 | Technical | Define the frequency of monitor, reviewing and reporting | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| 59 | Technical | Nominate risk owner with authority and responsibility for each risk | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| 60 | Technical | Check actual progress against risk treatment plan and update of risk treatment plan | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| 61 | Technical | Routine and consistent application of risk management | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| 62 | Technical | Selection of an appropriate risk strategy for each risk | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |

| No. | Tags | Factor description | Origin of factor | Extract from source | Source and source description |
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| 63 | Technical | Identify list of potential responses | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| 64 | Technical | Comparing the estimated risk against risk criteria and prioritising risks | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| 65 | Technical | Considering residual and secondary risks | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| 66 | Technical | Implications of planned risk responses | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| 67 | Technical | Preparing risk treatment plan | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| 68 | Technical | Qualitative and quantitative risk analysis | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| 69 | Technical | Regular evaluating and improving of the risk management process | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |

| No. | Tags | Factor description | Origin of factor | Extract from source | Source and source description |
|---|---|---|---|---|---|
| 70 | Technical | Reviewing and monitoring changes | Interpreted from the text given, not explicitly given as a CSF by the author. | "The risk register should be periodically reviewed, identified risks should be reassessed, project risk information should be updated, and the effectiveness of risk response actions and control measures should be monitored and evaluated." | [54] - Specific PMBOK for construction. |
| | | Monitoring and control | Interpreted from the text given, not explicitly given as a CSF by the author. | "Every project needs to be updated periodically; in large projects, about once a month or even weekly, through monitoring and control. If it is true that EVA analyzes past performance, it also looks for risk occurrence or absence, and to what extent the risk was avoided or mitigated, or if, for whatever reasons, the risk nonetheless materialized. If the risk did not materialize and prevention measures were, in reality, unnecessary, there could possibly be a surplus in time, cost or both, which, in the case of time, can be subtracted at the end of the project, but will count as a loss in the case of cost, if it cannot be recovered." | [79] - Book, specific to engineering projects. |
| | | Perfomance reporting | Listed explicitly as a CSF of RM. | "Short- and long-term performance measurement, monitoring and feedback." | [44] - Interview data collected from Swedish corporations (not specifically construction industry). Case study on a company in New York. |
| | | RM as a continuous process with feedback | Interpreted from the text given, not explicitly given as a CSF by the author. | "There may be “static” risks, which will maintain their characteristics during their period of existence, but many risks are “dynamic” and can change their probability and impact during the project life cycle. Moreover, there are risks with a single or normal uncertainty (weather phenomena), and other risks (Soros 1999) with other components of uncertainty caused by their inter- active character (social, political, and economic phenomena). These are the reasons why PRM must be a continuous process" | [48] - This article presents a generic project risk management process for construction projects from the point of view of the owner. Applied to a project in Spain. |
| | | Regularly assess risks and update approach | Interpreted from the text given, not explicitly given as a CSF by the author. | "Risks may also change during a phase. Should this be significant then a complete reappraisal may need to be performed. On long duration projects where the phases themselves may span several months or even years, regular risk assessments and updates must be carried out. This is an essential prerequisite of efficient management and effective decision-making," | [52] - Book, specific to construction. |
| | | Dynamic risk management | Interpreted from the text given, not explicitly given as a CSF by the author. | "But not all information required to handle future uncertainties properly are discernible, and not all risks are identifiable and quantifiable at the planning stage. Thus a totally comprehensive contract is impossible to achieve, while even the more comprehensive ones are expensive and time-consuming to formulate. The alternative is to make provision for some gaps in the contract provisions and provide adequate procedures to address them as and when those risks materialize during the process of construction...This requires joint and dynamic risk management, under the canopy of flexible contract conditions with provisions for amicable adjustment processes and rapid co-ordinated multi-party responses to emerging problem scenarios." | [56] - Study into using joint risk management and relational contracting in construction. |

| No. | Tags | Factor description | Origin of factor | Extract from source | Source and source description |
|---|---|---|---|---|---|
| 71 | Technical | Reflection on project | Interpreted from the text given, not explicitly given as a CSF by the author. | "For the further development of the risk management system, it is important that stock is taken of the reflection on the progress of the project. In this, relevant questions are: What identified risks have occurred? What problems that have actually occurred in the progress of the project were not identified as risks and why not?" | [6] - Paper explains the risk management process in construction projects. |
| | | Post-project assessment and capturing lessons learned | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| 72 | Technical & Involvement of other parties | Sharing risks (both internally and externally) | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| 73 | Technical & Involvement of other parties | Key external stakeholders as well as company professionals participate in risk identification | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| 74 | Technical & Involvement of other parties | Existence of joint risk management mechanisms by parties | Interpreted from the text given, not explicitly given as a CSF by the author. The opposite of a barrier could be considered to be a CSF. | ""Lack of joint risk management mechanisms by parties" "shortage of knowledge/techniques on risk management," and "different recognition of risk control strategies" are the top three barriers to risk management" This relates also to partnering between organisations, as well as within an organisation. | [76] - This paper reports the findings of an empirical Chinese industry survey on the importance of project risks, application of risk management techniques, status of the risk management system, and the barriers to risk management. |
| | | Joint risk register | Interpreted from the text given, not explicitly given as a CSF by the author.. | "A shared or joint risk register may be used to ensure that parties share the project risk identification process and provide the basis for a collaborative assessment of risks. A shared risk register helps to avoid different perspectives on shared project risks and offers the collaborative parties or integrated project team an opportunity to agree on risk ownership allocation, responsibilities, responses, unified terminology and language, and a definition of risk metrics to measure the effectiveness of collaborative project risk management." | [54] - Specific PMBOK for construction. |

| No. | Tags | Factor description | Origin of factor | Extract from source | Source and source description |
|---|---|---|---|---|---|
| 75 | Culture & Involvement of other parties | Attitudinal factors - partnering under EPC contract | Listed explicitly as a CSF of RM. | "Commitments, mutual objectives, equity, trust, attitude." | [80] - This research outlines the statuses on contractors' risk management, application of partnering, and their organizational capability. |
| | | Teamwork, understanding and cooperation between parties | Interpreted from the text given, not explicitly given as a CSF by the author. | "...JRM at the post-contract stage needs non-adversarial teamwork, where better relations, mutual understanding, strong co-operation among the contracting parties and an appreciation of the situation are preconditions." and "This in turn requires a revamping of attitudes towards co-operative teamwork and risk anticipation and response/mitigation on the part of every individual, as well as of all contracting parties in the project team. In other words this calls for a veritable 'cultural revolution' in terms of project culture. Diverse interests of contracting parties need to be addressed through better relationships, co-operative teamwork and proper restorational techniques, as and when anticipated uncertainties occur. The possibility of any potential problems needs to be considered as a normal part of relationships among the contracting parties." | [56] - Study into using joint risk management and relational contracting in construction. |
| | | Good understanding and interaction among clients, contractors, and insurers | Interpreted from the text given, not explicitly given as a CSF by the author. | "The improved understanding and interaction among clients, contractors, and insurers will help in the effective management of risks that will benefit the construction industry (Choy et al., 2006; Liu and Flanagan, 2005)." | [55] - Paper concerning the Chinese construction industry. |
| | | Better relationships and co-operative teamwork between parties | Interpreted from the text given, not explicitly given as a CSF by the author. | "Given the nature of today's construction industry as a very high risk, complex, multiparty business, conflicts between the diverse participants need to be minimized through better relationships and co-operative teamwork (Dissanayaka and Kumaraswamy, 1999), where the motivation and attitudes of the project participants are critical." | [56] - Study into using joint risk management and relational contracting in construction. |

| No. | Tags | Factor description | Origin of factor | Extract from source | Source and source description |
|---|---|---|---|---|---|
| 76 | Culture & Involvement of other parties | Open communication factors - partnering under EPC contract | Listed explicitly as a CSF of RM. | "Effective communication, openness, team building, problem resolution, timely responsiveness." | [80] - This research outlines the statuses on contractors' risk management, application of partnering, and their organizational capability. |
| | | Open communication risk management process between partnering organisations | Interpreted from the text given, not explicitly given as a CSF by the author. | "Open communication allows an organization to measure its risk management system against relevant organizations, which may provide comparative information and peer review feedback; external organizations also frequently provide valuable information on the functioning of an organization's risk management system, the implications of which can be important for an organization to take appropriate corrective actions (COSO 2004). Thus, organizations should spend more effort up front to put a foundation for improving communication, resolving conflicts, and making process improvements among participants (Jiang et al. 2002)....Establishing such an open communication risk management process is difficult because of the need to consider the concerns of different organizations and balance the interests of all project participants; parties need to become more collaborative and integrated, and data processing and data management often become a shared responsibility of multiple organizations, in which information comes from internal and external sources to facilitate response to changing conditions (COSO 2004)" | [76] - This paper reports the findings of an empirical Chinese industry survey on the importance of project risks, application of risk management techniques, status of the risk management system, and the barriers to risk management. |
| | | Communication in collaborative construction project arrangements | Interpreted from the text given, not explicitly given as a CSF by the author. | "Project communications between project stakeholders throughout the project life cycle are of major consideration and critical to minimize the impact of risks." | [54] - Specific PMBOK for construction. |
| | | Regularly communicating and reporting relevant risk information to the key stakeholders | Cited as a guideline from other sources, guidelines exist to improve RM, therefore taken as a CSF. | Listed only, no extract available. | [18] - Paper, specific to the construction industry. |
| | | Communication between project groups and other stakeholder groups | Interpreted from the text given, not explicitly given as a CSF by the author. | "Our findings suggest that it is not enough to have a formal risk management system in place; one must also pay attention to the way people discuss risks, specifically how different groups in a project talk about risks in relation to the other stakeholder groups. The time and energy spent on external attribution of responsibility, conflict, and withholding information, is likely to damage the efficiency of a project, which could add to the problems of delays and escalating costs that we touched upon in the introduction. It is therefore important to be aware of these processes and to act upon them whenever possible." | [81] - This paper explores the role of social identity threat in risk discourse in an infrastructure project, and the consequences risk discourse has for cooperation between stakeholders. |

| No. | Tags | Factor description | Origin of factor | Extract from source | Source and source description |
|---|---|---|---|---|---|
| 77 | Involvement of other parties | Expert risk analysis before tendering a PPP | Interpreted from the text given, not explicitly given as a CSF by the author. | "Expert risk analysis is required for a successful design of contractual arrangements made prior to competitive tendering and that allocate risk burdens appropriately." | [54] - Specific PMBOK for construction. |
| 78 | Involvement of other parties | Early involvement in a PPP | Interpreted from the text given, not explicitly given as a CSF by the author. | "The early involvement of the parties on the project in a collaborative relationship provides advantages in planning and can reduce overall project risk." | [54] - Specific PMBOK for construction. |

# C

# NARROWING THE CONCOURSE

Table C: Narrowing down the concourse. **Number from literature study, see Appendix B*

| No.* | Factor description | Requirement 1: Is the factor mentioned in at least two sources? | Requirement 2: Is the factor mentioned in a source concerning the construction industry? | Requirement 3: Is the factor explicitly mentioned as a CSF of project risk management? | Are at least two of the requirements met, meaning the factor is taken to the next stage? |
|---|---|---|---|---|---|
| 1 | Integration of risk management with other project management operations | ✓ | ✓ | ✓ | ✓ |
| 2 | Well-defined and clearly understood vision, mission, and long-term strategy toward risk management in the organisation | ✓ | ✗ | ✓ | ✓ |
| 3 | Understanding and defining external context | ✓ | ✓ | ✓ | ✓ |
| 4 | Accept the need to change in response to risk management | ✗ | ✗ | ✓ | ✗ |

*Table continued on next page*

*Table C continued*

| No.* | Factor description | Requirement 1: Is the factor mentioned in at least two sources? | Requirement 2: Is the factor mentioned in a source concerning the construction industry? | Requirement 3: Is the factor explicitly mentioned as a CSF of project risk management? | Are at least two of the requirements met, meaning the factor is taken to the next stage? |
|---|---|---|---|---|---|
| 5 | Adapting risk management to each project | ✓ | ✓ | ✓ | ✓ |
| 6 | Organisational structure | ✗ | ✗ | ✓ | ✗ |
| 7 | Establishing clear accountability and responsibility of roles for managing risks | ✓ | ✓ | ✓ | ✓ |
| 8 | Buy-in from all stakeholders | ✗ | ✗ | ✓ | ✗ |
| 9 | Personnel's understanding and belief in the benefits and value of risk management | ✓ | ✓ | ✓ | ✓ |
| 10 | Organisational learning | ✗ | ✓ | ✗ | ✗ |
| 11 | Understand and define internal context | ✗ | ✓ | ✗ | ✗ |
| 12 | Availability of adequate resources to support the implementation of risk management | ✓ | ✓ | ✓ | ✓ |
| 13 | Deciding the appropriate level of risk management (risk thresholds) | ✓ | ✓ | ✓ | ✓ |
| 14 | Appropriate mechanisms for sharing risks amongst those best placed to manage them | ✗ | ✓ | ✗ | ✗ |
| 15 | Define risk management tools and techniques | ✗ | ✓ | ✗ | ✗ |

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*Table C continued*

| No.* | Factor description | Requirement 1: Is the factor mentioned in at least two sources? | Requirement 2: Is the factor mentioned in a source concerning the construction industry? | Requirement 3: Is the factor explicitly mentioned as a CSF of project risk management? | Are at least two of the requirements met, meaning the factor is taken to the next stage? |
|---|---|---|---|---|---|
| 16 | Availability process for deciding the project reserve | ✗ | ✓ | ✗ | ✗ |
| 17 | Availability of a clear mechanism for external/internal communication and reporting | ✗ | ✓ | ✗ | ✗ |
| 18 | Risk management purposes in line with organisation / project purposes | ✗ | ✓ | ✗ | ✗ |
| 19 | Organisational commitment | ✗ | ✗ | ✓ | ✗ |
| 20 | The manager's knowledge and personal experience | ✗ | ✓ | ✗ | ✗ |
| 21 | Top management reviews risk management reports actively to make decisions | ✗ | ✓ | ✗ | ✗ |
| 22 | Availability of a risk management plan | ✗ | ✓ | ✗ | ✗ |
| 23 | Top management communication of goals and strategies of risk management | ✗ | ✓ | ✗ | ✗ |
| 24 | Management (people and leadership) capability in relation to risk | ✗ | ✓ | ✗ | ✗ |
| 25 | General management skills | ✗ | ✗ | ✓ | ✗ |
| 26 | Leadership | ✗ | ✗ | ✓ | ✗ |
| 27 | Project management skills | ✗ | ✗ | ✓ | ✗ |

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*Table C continued*

| No.* | Factor description | Requirement 1: Is the factor mentioned in at least two sources? | Requirement 2: Is the factor mentioned in a source concerning the construction industry? | Requirement 3: Is the factor explicitly mentioned as a CSF of project risk management? | Are at least two of the requirements met, meaning the factor is taken to the next stage? |
|---|---|---|---|---|---|
| 28 | Risk champion appointed | ✗ | ✗ | ✓ | ✗ |
| 29 | Regularly communicating and reporting relevant risk information to the organisational management | ✗ | ✓ | ✗ | ✗ |
| 30 | Risk management is encouraged and supported by the top management | ✓ | ✓ | ✓ | ✓ |
| 31 | Clear, effective, open and honest communication | ✓ | ✓ | ✓ | ✓ |
| 32 | Shared understanding of the key concepts and principles of risk management | ✓ | ✓ | ✓ | ✓ |
| 33 | Attitude | ✗ | ✓ | ✗ | ✗ |
| 34 | Personnel commitment | ✗ | ✓ | ✗ | ✗ |
| 35 | General organisational culture | ✗ | ✗ | ✓ | ✗ |
| 36 | No blame culture and accepting that people make mistakes | ✗ | ✓ | ✗ | ✗ |
| 37 | Organisational risk culture | ✓ | ✓ | ✓ | ✓ |
| 38 | Teamwork spirit | ✓ | ✓ | ✓ | ✓ |
| 39 | A common language and agreement of key risk management terms | ✗ | ✗ | ✓ | ✗ |

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*Table C continued*

| No.* | Factor description | Requirement 1: Is the factor mentioned in at least two sources? | Requirement 2: Is the factor mentioned in a source concerning the construction industry? | Requirement 3: Is the factor explicitly mentioned as a CSF of project risk management? | Are at least two of the requirements met, meaning the factor is taken to the next stage? |
|---|---|---|---|---|---|
| 40 | Alignment of risk management attitude and goals of personnel with the organisation | ✗ | ✓ | ✗ | ✗ |
| 41 | Team members trust and openness in reporting risks to internal and external stakeholders | ✗ | ✓ | ✗ | ✗ |
| 42 | Socio-cultural forces (national cultural differences between partnering organisations) | ✗ | ✓ | ✗ | ✗ |
| 43 | Skilled and competent staff | ✓ | ✓ | ✓ | ✓ |
| 44 | Availability of experienced team responsible for risk management | ✗ | ✓ | ✗ | ✗ |
| 45 | Reward and recognition system | ✗ | ✗ | ✓ | ✗ |
| 46 | Continuity of risk management across project stages | ✓ | ✓ | ✗ | ✓ |
| 47 | Detailed documentation and recording of risks | ✓ | ✓ | ✓ | ✓ |
| 48 | Using external experts and services in risk management | ✓ | ✓ | ✓ | ✓ |

*Table continued on next page*

*Table C continued*

| No.* | Factor description | Requirement 1: Is the factor mentioned in at least two sources? | Requirement 2: Is the factor mentioned in a source concerning the construction industry? | Requirement 3: Is the factor explicitly mentioned as a CSF of project risk management? | Are at least two of the requirements met, meaning the factor is taken to the next stage? |
|---|---|---|---|---|---|
| 49 | Development and application of a standardised risk management process | ✓ | ✓ | ✓ | ✓ |
| 50 | Regular (internal or external) training to enhance skills | ✓ | ✓ | ✓ | ✓ |
| 51 | Suitable contractual framework to support the risk process | ✓ | ✓ | ✓ | ✓ |
| 52 | Integrated toolkit, both internally coherent and interfacing with project management and business tools | ✗ | ✗ | ✓ | ✗ |
| 53 | Knowledge sharing | ✓ | ✓ | ✗ | ✓ |
| 54 | Level of risk management knowledge and techniques | ✗ | ✓ | ✗ | ✗ |
| 55 | Personal and corporate experience and engineering judgement | ✓ | ✓ | ✗ | ✓ |
| 56 | Dividing risks based on different classification | ✗ | ✓ | ✗ | ✗ |
| 57 | Risks and opportunities are identified proactively based on different objectives and methods | ✗ | ✓ | ✗ | ✗ |

*Table continued on next page*

*Table C continued*

| No.* | Factor description | Requirement 1: Is the factor mentioned in at least two sources? | Requirement 2: Is the factor mentioned in a source concerning the construction industry? | Requirement 3: Is the factor explicitly mentioned as a CSF of project risk management? | Are at least two of the requirements met, meaning the factor is taken to the next stage? |
|---|---|---|---|---|---|
| 58 | Define the frequency of monitor, reviewing and reporting | ✗ | ✓ | ✗ | ✗ |
| 59 | Nominate risk owner with authority and responsibility for each risk | ✗ | ✓ | ✗ | ✗ |
| 60 | Check actual progress against risk treatment plan and update of risk treatment plan | ✗ | ✓ | ✗ | ✗ |
| 61 | Routine and consistent application of risk management | ✗ | ✓ | ✗ | ✗ |
| 62 | Selection of an appropriate risk strategy for each risk | ✗ | ✓ | ✗ | ✗ |
| 63 | Identify list of potential responses | ✗ | ✓ | ✗ | ✗ |
| 64 | Comparing the estimated risk against risk criteria and prioritising risks | ✗ | ✓ | ✗ | ✗ |
| 65 | Considering residual and secondary risks | ✗ | ✓ | ✗ | ✗ |
| 66 | Implications of planned risk responses | ✗ | ✓ | ✗ | ✗ |
| 67 | Preparing risk treatment plan | ✗ | ✓ | ✗ | ✗ |

*Table continued on next page*

*Table C continued*

| No.* | Factor description | Requirement 1: Is the factor mentioned in at least two sources? | Requirement 2: Is the factor mentioned in a source concerning the construction industry? | Requirement 3: Is the factor explicitly mentioned as a CSF of project risk management? | Are at least two of the requirements met, meaning the factor is taken to the next stage? |
|---|---|---|---|---|---|
| 68 | Qualitative and quantitative risk analysis | ✗ | ✓ | ✗ | ✗ |
| 69 | Regular evaluating and improving of the risk management process | ✗ | ✓ | ✗ | ✗ |
| 70 | Reviewing and monitoring changes and updating approach | ✓ | ✓ | ✓ | ✓ |
| 71 | Post-project assessment and capturing lessons learned | ✓ | ✓ | ✗ | ✓ |
| 72 | Sharing risks (both internally and externally) | ✗ | ✓ | ✗ | ✗ |
| 73 | Key external stakeholders as well as company professionals participate in risk identification | ✗ | ✓ | ✗ | ✗ |
| 74 | Using a joint risk register | ✓ | ✓ | ✗ | ✓ |
| 75 | Teamwork, understanding and cooperation between partnering organisations | ✓ | ✓ | ✓ | ✓ |
| 76 | An open communication risk management process between partnering organisations | ✓ | ✓ | ✓ | ✓ |

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*Table C continued*

| No.* | Factor description | Requirement 1: Is the factor mentioned in at least two sources? | Requirement 2: Is the factor mentioned in a source concerning the construction industry? | Requirement 3: Is the factor explicitly mentioned as a CSF of project risk management? | Are at least two of the requirements met, meaning the factor is taken to the next stage? |
|---|---|---|---|---|---|
| 77 | Expert risk analysis before tendering a PPP | ✗ | ✓ | ✗ | ✗ |
| 78 | Early involvement in a PPP | ✗ | ✓ | ✗ | ✗ |

*End of Table C*

# D

# INPUT FROM RISK MANAGER

Table D: Input from the risk manager on determining the Q set **Number from literature study, see Appendix B*

| No.* | Factor description | Comment from risk manager (paraphrased) | Response from/ action for researcher | Amended factor if required |
|---|---|---|---|---|
| 1 | Integration of risk management with other project management operations | 'Does this relate to organisational or process?' | Process is covered by item 18 | |
| 2 | Well-defined and clearly understood vision, mission, and long-term strategy toward risk management in the organisation | 'Is there potentially a critical success factor which could relate to aligning risk management with project goals? Does this relate to the organisation as a whole or the project organisation more specifically?' | Look into literature again for a CSF about aligning risk management with project goals. Amend this CSF to make it specific to the project organisation. | A clear long-term strategy towards risk management in the project organisation |
| 3 | Understanding and defining external context | 'What does this mean? Can you reword this item to explain it more fully?' | | Considering the external environment (market, suppliers, competitors, politics, social issues, macro-economic situation) |
| 5 | Adapting risk management to each project | | | |
| 7 | Establishing clear accountability and responsibility of roles for managing risks | 'Mention the RACI matrix (responsible, accountable, consulted, informed) as this is what is used by us in the project' | | Establish clear responsibility of roles for managing risks (RACI-matrix) |
| 9 | Personnel's understanding and belief in the benefits and value of risk management | | | |
| 12 | Availability of adequate resources to support the implementation of risk management | | | |

*Table continued on next page*

*Table D continued*

| No.* | Factor description | Comment from risk manager (paraphrased) | Response from/ action for researcher | Amended factor if required |
|---|---|---|---|---|
| 13 | Deciding the appropriate level of risk management (risk thresholds) | 'Include that this is for the project' | | Decide the appropriate level of risk management for the project |
| 30 | Risk management is encouraged and supported by the top management | | | |
| 31 | Clear, effective, open and honest communication | | | |
| 32 | Shared understanding of the key concepts and principles of risk management | 'Include *"acceptance"* in this description too' | | Shared understanding and acceptance of the key concepts and principles of risk management |
| 37 | Organisational risk culture | 'Which organisation does this refer to? Ballast Nedam or Project A?' | This refers to the organisational risk culture of Project A so reword factor | Project organisation risk culture |
| 38 | Teamwork spirit | 'Which team does this refer to? Ballast Nedam as a whole or the Project A team?' | The Project A team, so reword factor | Project organisation team spirit |
| 43 | Skilled and competent staff | 'Does this relate to risk staff or all staff?' | All staff | All staff show competence in application of risk management |
| 46 | Continuity of risk management across project stages | | | |
| 47 | Detailed documentation and recording of risks | | | |

*Table continued on next page*

*Table D continued*

| No.* | Factor description | Comment from risk manager (paraphrased) | Response from/ action for researcher | Amended factor if required |
|---|---|---|---|---|
| 48 | Using external experts and services in risk management | 'This is not applicable to Ballast Nedam, we do not use external management consultancy services or similar, there is no commitment from these services to the long term risk management strategies within our company' | Remove item from list | |
| 49 | Development and application of a standardised risk management process | | | |
| 50 | Regular (internal or external) training to enhance skills | | | |
| 51 | Suitable contractual framework to support the risk process | 'A contract is a standard condition needed to start the project. This item is a bit *"yes/no"*. Which contract is this for? What might be more useful is to include a CSF about subcontracting contracts. Subcontracting is very typical to our projects. Some subcontractors do their own risk management but their work must be integrated into the Ballast Nedam risk management process.' | Remove this item as it is and include a new CSF relating to the management of subcontracts | |
| 53 | Knowledge sharing | 'The meaning of this is unclear, is this about knowledge on risk management?' | Yes, reword this item | Sharing knowledge relating to risk management |

*Table continued on next page*

*Table D continued*

| No.* | Factor description | Comment from risk manager (paraphrased) | Response from/ action for researcher | Amended factor if required |
|---|---|---|---|---|
| 55 | Personal and corporate experience, intuition and engineering judgement | 'The word *"corporate"* is perhaps not important here.' | Reword to remove 'corporate' | Personal experience, intuition and engineering judgement |
| 70 | Reviewing and monitoring changes and updating approach | 'The meaning of this is unclear, can you refer to the use of the risk register?' | Refer back to definitions from literature to look for a better wording which refers to 'risk register' | Reviewing, assessing and updating the risk register |
| 71 | Post-project assessment and capturing lessons learned | 'Can you also mention *"using the lessons learned"*?' | Reword | Post-project assessment and capturing and using lessons learned |
| 74 | Using a joint risk register | 'Using a joint risk register with whom? The client and other collaborating organisations or internally? | The literature highlights this as being between collaborating parties, rather than internally, so this CSF will be removed as it is not reflected by the reality of the project and contract type in use. Remove item from list. | |
| 75 | Teamwork, understanding and cooperation between partnering organisations | 'This seems to have been covered already by other items, in addition the length of the contract on Project A means that the partnering organisations are very blended already.' | Remove item from list | |

*Table continued on next page*

*Table D continued*

| No.* | Factor description | Comment from risk manager (paraphrased) | Response from/ action for researcher | Amended factor if required |
|---|---|---|---|---|
| 76 | An open communication risk management process between partnering organisations | 'Each organisation within the partnership does their own analysis and interpretation of risk management and these are not communicated between organisations. This item doesn't really fit with the reality of the risk management at the project.' | Remove item from list | |

*End of Table D*

# E

# THE FINAL Q SET WITH DUTCH TRANSLATIONS

Table E: The final Q set with Dutch translations. **Number from literature study, see Appendix B*

| No.* | Statement | Q statement | Dutch translation |
|---|---|---|---|
| 1 | 1 | Integration of risk management with other project management activities | Integratie van risicomanagement in andere projectmanagement activiteiten |
| 2 | 2 | A clear long-term strategy towards risk management in the project organisation | Een duidelijke langetermijnstrategie voor risicomanagement in de projectorganisatie |
| 3 | 3 | Consider the external environment (market, politics, social issues, macro-economic situation) | Rekening houden met de externe omgeving (markt, politiek, sociale problemen, macro-economische situatie) |
| 5 | 4 | Adapt risk management to each project | Risicomanagement project-specifiek maken |
| 7 | 5 | Establish clear responsibility of roles for managing risks (RACI-matrix) | Duidelijke verantwoordelijkheden bepalen voor rollen in risicomanagement (RACI-matrix) |
| 9 | 6 | An understanding and belief in the benefits of risk management from all staff | Begrip voor en geloof in de voordelen van risicomanagement bij het gehele personeel |

*Table continued on next page*

*Table E continued*

| No.* | Statement | Q statement | Dutch translation |
|---|---|---|---|
| 12 | 7 | Provision of adequate resources to support risk management | Beschikbaarheid van voldoende middelen ter ondersteuning van risicomanagement |
| 13 | 8 | Decide the appropriate level of risk management for the project | Het passende niveau van risicomanagement bepalen in het project |
| 30 | 9 | Top management encouraging and supporting risk management | Vanuit het top management aanmoediging en ondersteuning van risicomanagement |
| 31 | 10 | Clear and honest communication | Duidelijke en eerlijke communicatie |
| 32 | 11 | Shared understanding and acceptance of the key concepts of risk management | Gedeeld begrip en aanvaarding van de sleutelbegrippen van risicomanagement |
| 37 | 12 | Project organisation risk culture | Risicocultuur binnen de projectorganisatie |
| 38 | 13 | Project organisation team spirit | Teamgeest binnen de projectorganisatie |
| 43 | 14 | All staff showing competence in the application of risk management | Bekwaamheid van het personeel in het toepassen van risicomanagement |
| 46 | 15 | Continuity of risk management across project stages | Continuïteit van risicomanagement over verschillende projectfasen |
| 47 | 16 | Detailed documentation of risks | Een gedetailleerde documentatie van risico's |
| 49 | 17 | Application of a standardised risk management process | Gebruik van een gestandaardiseerd risicomanagementproces |
| 50 | 18 | Regular training to enhance risk management skills | Regelmatige trainingen voor het verbeteren van risicomanagementvaardigheden |
| 53 | 19 | Knowledge sharing relating to risk management | Kennis delen met betrekking tot risicomanagement |
| 55 | 20 | Personal experience, intuition and engineering judgement | Persoonlijke ervaring, intuïtie en vermogen tot technische oordeelsvorming |
| 70 | 21 | Consistently review and update the risk register | Het risicoregister consequent beoordelen en bijwerken |
| 71 | 22 | Capture and use lessons learned | Lessons learned vastleggen en benutten |
| 28 | 23 | A risk manager appointed to the project | Een risicomanager aangesteld in het project |
| 18 | 24 | Risk management purposes in line with project goals | Risicomanagementdoeleinden in lijn met projectdoelstellingen |

*Table continued on next page*

*Table E continued*

| No.* | Statement | Q statement | Dutch translation |
|---|---|---|---|
| - | 25 | Careful management of contracts with subcontractors | Zorgvuldig management van contracten met onderaannemers |

*End of Table E*

# F

# SLIDES TO EXPLAIN Q SORT ACTIVITY

# Instructions for Q sort activity and interview

Thea Stratton

1

## About my project

- Research into attitudes and opinions towards project risk management.
- Interviewing BN employees from a variety of teams within the project.
- Supervised by Maarten Ruesink.

2

## The purpose of this interview

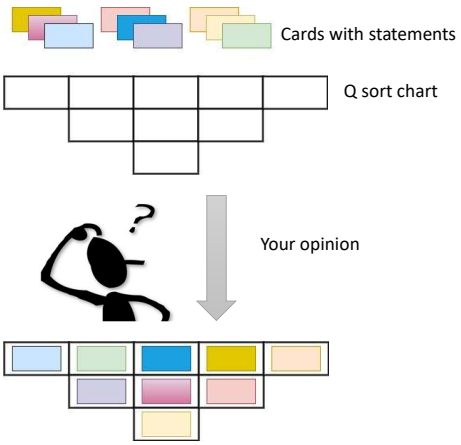
- Discuss your opinions on project risk management.
- Perform a Q sort activity to aid this discussion.
- Follow up questions on the activity.



3

## What is Q methodology?

- Developed to help researchers understand the opinions held on a given topic.
- Participants prioritise statements by organising cards on a chart.
- Participants are asked some short questions on their finished Q chart.
- Researcher uses statistical analysis to investigate similarities and differences in the way cards have been placed by all respondents and uses the interviews with participants to explain the opinions that have been discovered.

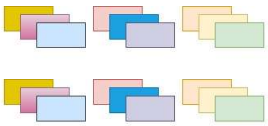



4

## Q sort activity instructions – Step 1 of 3 – Setting up

- You will open the link to the website where the activity is and share your screen with me via Skype.
- You will be presented with 25 statements which you will organise on the chart.
- Definitions of the statements are available on the separate PDF provided to you in the email.

25 cards showing written statements



5

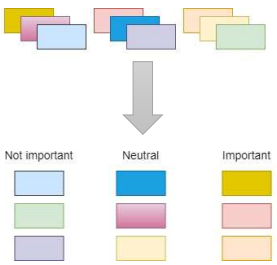
## Q sort activity instructions – Step 2 of 3 – Pre-sort

- For the pre-sort activity, consider the following sentence:

*In order to perform project risk management it is important to have/do...*

*Om projectrisicomanagement uit te voeren, is het belangrijk om ... (te hebben / toe te passen)*

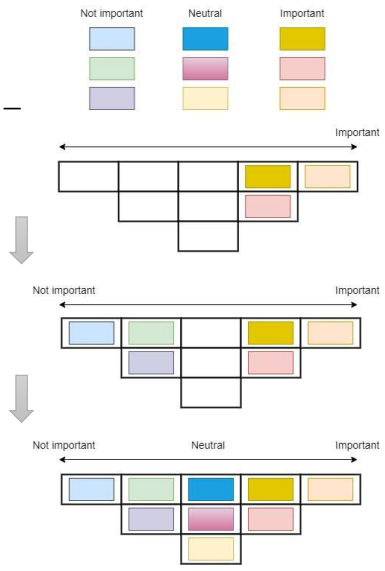
- You are asked to sort the statements into **three** categories according to the above sentence: 'not important', 'neutral' and 'important'.




6

## Q sort activity instructions – Step 3 of 3 – Main sort

- You will then place the statements onto the Q sort chart, this is the main sorting activity, using the same sentence as before. This time there are **seven** categories.
- Start by sorting the statements you have put in the 'important' column and arrange these onto the right hand side of the chart.
- Next sort the statements you have put in the 'not important' column and arrange these onto the left hand side of the chart.
- Finally arrange the statements you have put in the neutral column.
- **Important: The rows of the chart do not have any meaning, only the column position is important.**




7

## Things to remember as you do the Q sort activity:

- The scope of my project concerns **project level risk management only** (rather than portfolio, finance or organisational level risk management).
- Please do the activity considering **your own opinion** rather than answering how Ballast Nedam as an organisation would answer or how you think one of your seniors would like you to answer.
- There is **no right or wrong answer.**
- The purpose of the chart is to force you to prioritise, please place every item somewhere.
- You can move statements around as much as you want until you are happy with their position.
- Refer to the definitions if there are any statements you don't understand.

8

## Interview

When you have finished the sorting activity, I will ask you a few questions about:

- Your job role and experience.
- If you think any statements are missing from the cards presented to you.
- How you have organised statements on the Q sort chart.
- Your comments on the interview and the Q sort activity.

9

## Confidentiality

- Record interview - I will only record the audio, not your camera or screen.
- Recordings will not be shared or published, they will be only be used by me for the data analysis. I will delete them at the end of my project.
- Collect information on your job role and your experience level.
- Quotes from interview may be used with information on your personal profile but **your name will not be included**, for example:

*"Respondent 4 (5 years experience) said `The risk register is very important for risk management'"*

- Let me know if you have any objections to the above points.

10

# G

# THE FINAL Q SET WITH DEFINITIONS

Table G: The final Q set with definitions for interviews. As far as possible these were taken directly from the literature study, in cases where no clear definition was available, the researcher devised one.

| Statement (EN) | Statement (NL) | Definition |
|---|---|---|
| Integration of risk management with other project management activities | Integratie van risicomanagement in andere projectmanagement activiteiten | Project risk management does not exist in a vacuum, isolated from other project management processes. Successful project risk management requires the correct execution of the other project management processes. |
| A clear long-term strategy towards risk management in the project organisation | Een duidelijke langetermijnstrategie voor risicomanagement in de projectorganisatie | Well-defined and clearly understood vision, mission, and long-term strategy toward risk management in the project organisation |
| Consider the external environment (market, politics, social issues, macro-economic situation) | Rekening houden met de externe omgeving (markt, politiek, sociale problemen, macro-economische situatie) | External environment in which the organization is performing. It encompasses the effects of market, suppliers, competitors, socio-political systems and also the organization's partnership and joint venture strategies. |

*Table continued on next page*

*Table G continued*

| Statement (EN) | Statement (NL) | Definition |
|---|---|---|
| Adapt risk management to each project | Risicomanagement project-specifiek maken | Risk management is not “one size fits all.” While all projects are risky, and risk management is an essential feature of effective project management, there are different ways of putting risk management into practice. |
| Establish clear responsibility of roles for managing risks (RACI-matrix) | Duidelijke verantwoordelijkheden bepalen voor rollen in risicomanagement (RACI-matrix) | The responsibility of each risk and its management is assigned to a certain person or group of people. This includes use of the RACI-matrix (Responsible, Accountable, Consulted, Informed). |
| An understanding and belief in the benefits of risk management from all staff | Begrip voor en geloof in de voordelen van risicomanagement bij het gehele personeel | Project risk management should be recognised as a value discipline that provides a positive potential return on investment for organisational management, project stakeholders (both internal and external), project management and team members. |
| Provision of adequate resources to support risk management | Beschikbaarheid van voldoende middelen ter ondersteuning van risicomanagement | It is evident that risk management is not a cost-free activity, and the project needs to provide the necessary level of resources if the risk process is to function properly. These resources include people, time and money." |
| Decide the appropriate level of risk management for the project | Het passende niveau van risicomanagement bepalen in het project | Project risk management activities should be consistent with the value of the project to the organisation and with its level of project risk, its scale, and other organisational constraints. In particular, the cost of project risk management should be appropriate to its potential value to the project and the organisation. |

*Table continued on next page*

*Table G continued*

| Statement (EN) | Statement (NL) | Definition |
|---|---|---|
| Top management encouraging and supporting risk management | Vanuit het top management aanmoediging en ondersteuning van risicomanagement | There are two things that senior managers can do to maximise the effectiveness of the risk process on their projects. These revolve around demonstrating a visible and consistent commitment to risk management... The first way senior management can show their commitment to the risk process is to appoint a senior manager (who may be called the Corporate Risk Sponsor or similar) who will promote the cause of risk management at the highest levels of the organisation... The second major way in which the senior management of the organisation can demonstrate their commitment to effective risk management across their projects is to use the results of the risk process to support risk-informed decision-making. When project teams can see that their risk information is actually being used to assist senior managers in running the wider business, they will be motivated to provide the best possible outputs from the project risk process. |
| Clear and honest communication | Duidelijke en eerlijke communicatie | Efficient management of building projects demands clear effective communication and if risk analysis and management is to be used as a tool to assist the management of projects, then it must itself be clearly communicated and understood. |
| Shared understanding and acceptance of the key concepts of risk management | Gedeeld begrip en aanvaarding van de sleutelbegrippen van risicomanagement | Having a shared understanding and acceptance of the key tools and techniques which should be used for risk management means that all staff approach risk management in a similar way and can perform tasks and communicate efficiently. Effective training creates a shared understanding of the key concepts and principles of risk management. |
| Project organisation risk culture | Risicocultuur binnen de projectorganisatie | For risk management to be effective, the culture must be supportive, meaning that individuals' risk attitudes must be understood and managed, and the organization's overall approach must value risk management and commit to making it work. |
| Project organisation team spirit | Teamgeest binnen de projectorganisatie | Existence of developed teams and teamwork spirit within the organization. |
| All staff showing competence in the application of risk management | Bekwaamheid van het personeel in het toepassen van risicomanagement | Project sponsors, project managers, team members, and stakeholders must be trained in applying the process, participating in it, or both. |

*Table continued on next page*

*Table G continued*

| Statement (EN) | Statement (NL) | Definition |
|---|---|---|
| Continuity of risk management across project stages | Continuïteit van risicomanagement over verschillende projectfasen | The management of risk is a continuous process and should span all the phases of the project. Since project risks are dynamic, that is to say they can change continuously, a risk assessment must be carried out at the end of each phase prior to proceeding to the next phase. |
| Detailed documentation of risks | Een gedetailleerde documentatie van risico's | The risks associated with each activity are documented along with the management plan for each risk. Data relating to risks is accurate. |
| Application of a standardised risk management process | Gebruik van een gestandaardiseerd risicomanagementproces | An efficient procedural framework that supports the process and outlines "what to do" ensures support from the organisation and makes the most of the investment in training, tools, and techniques. |
| Regular training to enhance risk management skills | Regelmatige trainingen voor het verbeteren van risicomanagement-vaardigheden | Project sponsors, project managers, team members, and stakeholders must be trained in applying the process, participating in it, or both. Training also needs to be at the right level and depth to suit the role involved... Training should not be viewed as a one-off event carried out when formal risk management is first introduced. It must be a continual process, bringing new members of the organization up to speed as soon as is practical. The end benefit of effective training is skilled and competent staff who contribute effectively to the risk process. |
| Knowledge sharing relating to risk management | Kennis delen met betrekking tot risicomanagement | Encouraging a knowledge-sharing culture. Central to the success of a knowledge risk management framework, is the concept that values and expectations for ethical behavior need to be communicated widely and effectively throughout the organization. In short, integrity has to become part of the corporate culture. This is best accomplished as part of a formal process of knowledge sharing, of mentoring, and formal ethics training, so that employees at all levels appreciate the importance of good behavior. This means that there needs to be regular and consistent communication on values and on processes that encourage sharing of ideas and early identification of risks. |
| Personal experience, intuition and engineering judgement | Persoonlijke ervaring, intuïtie en vermogen tot technische oordeelsvorming | Drawing on past experiences and your education to make decisions on risks in the present. |

*Table continued on next page*

*Table G continued*

| Statement (EN) | Statement (NL) | Definition |
|---|---|---|
| Consistently review and update the risk register | Het risicoregister consequent beoordelen en bijwerken | The risk register should be periodically reviewed, identified risks should be reassessed, project risk information should be updated, and the effectiveness of risk response actions and control measures should be monitored and evaluated. |
| Capture and use lessons learned | Lessons learned vastleggen en benutten | For the further development of the risk management system, it is important that stock is taken of the reflection on the progress of the project. In this, relevant questions are: What identified risks have occurred? What problems that have actually occurred in the progress of the project were not identified as risks and why not? These reflections should then be used to inform future decisions on risk management. |
| A risk manager appointed to the project | Een risicomanager aangesteld in het project | A proven contributor to maximising risk process efficiency is the use of a skilled and experienced facilitator. This person can have various titles, such as Risk Champion, Risk Coordinator, Risk Process Facilitator, or Risk Manager. More important than their job title however are their personal characteristics. A good Risk Champion will have a combination of technical skills (including both the domain of the project as well as technical risk competences) and people skills (including the ability to understand and manage different types of individuals and groups). These latter soft skills are very useful for keeping energy levels high during the risk process, and a high degree of emotional literacy can be particularly helpful. |
| Risk management purposes in line with project goals | Risicomanage-mentdoeleinden in lijn met projectdoel-stellingen | The risk management strategy for a project has been tailored so as to align with the goals of that project. |

*Table continued on next page*

*Table G continued*

| Statement (EN) | Statement (NL) | Definition |
|---|---|---|
| Careful management of contracts with subcontractors | Zorgvuldig management van contracten met onderaan-nemers | Appropriate, clear and fair contracts with sub-contractors. Good contract management can allocate responsibilities and liabilities between parties and therefore avoid conflicts. Appropriate contract conditions help to meet the specific requirements and objectives of the project. Contract conditions are expected to be clear in order to define the rights and duties of project participants and unequivocally allocate risks (or future uncertainties) to the different contracting parties. Contract conditions are also expected to be fair, so as to allocate these risks in a 'just' way, apart from merely following the often applied principle of assigning the risks to those best equipped to deal with them. |

*End of Table G*

# H

# INTERVIEW QUESTIONS

## INTERVIEW QUESTIONS

Following the completion of the Q sort activity, the researcher asked the respondent the following questions:

- What is your job role?
- How many years of experience do you have in the construction industry?
- In your opinion, is there anything missing from the statements given which you consider to be important to project risk management?
- Why did you put the statements in the +3 column of the chart in this position?
- Why did you put the statements in the +2 column of the chart in this position?
- Why did you put the statements in the -2 column of the chart in this position?
- Why did you put the statements in the -3 column of the chart in this position?
- As you look at the way you have organised the statements on this chart, how would you sum up your opinion on what is important to project risk management?
- Do you have any comments on this interview or the Q sort activity?

# I

# CORRELATION MATRIX

Table I: Correlation matrix

| | | Respondent | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** |
| **Respondent** | 1 | | 0.27 | 0.20 | 0.39 | 0.21 | -0.06 | 0.20 | 0.13 | 0.13 | 0.10 | 0.33 | 0.01 | 0.26 | 0.33 | -0.04 |
| | **2** | | | 0.17 | 0.13 | 0.21 | 0.30 | 0.04 | 0.20 | 0.16 | 0.19 | 0.11 | 0.27 | 0.06 | 0.03 | 0.10 |
| | **3** | | | | -0.06 | 0.21 | 0.39 | 0.29 | 0.41 | 0.16 | 0.23 | 0.11 | 0.16 | 0.40 | 0.44 | 0.19 |
| | **4** | | | | | 0.16 | -0.13 | 0.37 | 0.14 | 0.00 | -0.16 | 0.24 | 0.19 | 0.00 | 0.04 | 0.09 |
| | **5** | | | | | | 0.33 | 0.39 | 0.41 | 0.30 | 0.40 | 0.10 | 0.23 | 0.40 | 0.36 | 0.33 |
| | **6** | | | | | | | 0.21 | -0.04 | 0.31 | 0.61 | -0.37 | -0.10 | 0.23 | 0.21 | 0.17 |
| | **7** | | | | | | | | 0.27 | 0.27 | 0.29 | 0.04 | -0.10 | 0.34 | 0.51 | 0.36 |
| | **8** | | | | | | | | | 0.07 | -0.04 | 0.04 | 0.31 | 0.23 | 0.29 | 0.50 |
| | **9** | | | | | | | | | | 0.66 | 0.03 | -0.34 | 0.34 | 0.33 | 0.01 |
| | **10** | | | | | | | | | | | -0.01 | -0.30 | 0.37 | 0.30 | 0.30 |
| | **11** | | | | | | | | | | | | 0.40 | 0.44 | 0.07 | 0.16 |
| | **12** | | | | | | | | | | | | | 0.40 | -0.06 | 0.47 |
| | **13** | | | | | | | | | | | | | | 0.46 | 0.53 |
| | **14** | | | | | | | | | | | | | | | 0.10 |
| | **15** | | | | | | | | | | | | | | | |

# J

# CRITERIA CHECKS

Output from PQMethod:

- Cumulative explained variance for all factor solutions.
- The factor matrix of each individual factor solution with checks of criteria 1 and 3.
- Standard error = 1 / √N = 1/ √25 = 1/5 = 0.2
- Criteria 1 checked by counting how many 'X's exist for each factor which indicates a defining sort.
- Criteria 3 checked by hand. The two highest factor loadings for each factor are highlighted red. This value must exceed twice standard error, 2 x 0.2 = 0.4
- Non-loaders highlighted yellow for 3 and 4 factor solutions.

Cumulative Communalities Matrix

| SORTS | Factors 1 Thru .... 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 1 1Sup13 | 0.1529 | 0.2015 | 0.6238 | 0.6613 | 0.6851 | 0.7359 | 0.7360 | 0.7477 |
| 2 2Sup10 | 0.1189 | 0.1271 | 0.1285 | 0.3983 | 0.8214 | 0.8341 | 0.8424 | 0.8673 |
| 3 3Sup16 | 0.3545 | 0.3546 | 0.3756 | 0.3876 | 0.3877 | 0.7860 | 0.8124 | 0.8644 |
| 4 4Sup14 | 0.0391 | 0.2168 | 0.5005 | 0.5208 | 0.6567 | 0.7970 | 0.8529 | 0.8629 |
| 5 5Sup30 | 0.4775 | 0.4778 | 0.4818 | 0.4829 | 0.5099 | 0.5583 | 0.6110 | 0.9169 |
| 6 6Des25 | 0.2219 | 0.5586 | 0.6669 | 0.6879 | 0.7802 | 0.7813 | 0.9255 | 0.9330 |
| 7 7Des11 | 0.3984 | 0.4018 | 0.4701 | 0.6995 | 0.7005 | 0.7609 | 0.8207 | 0.8423 |
| 8 8Des6 | 0.2618 | 0.3979 | 0.4519 | 0.6185 | 0.6707 | 0.6901 | 0.9364 | 0.9587 |
| 9 9Des15 | 0.2597 | 0.5352 | 0.5959 | 0.6359 | 0.6536 | 0.6794 | 0.8137 | 0.8506 |
| 10 10Des19 | 0.3595 | 0.7325 | 0.7347 | 0.8154 | 0.8273 | 0.8790 | 0.8796 | 0.8854 |
| 11 11Exe12 | 0.0669 | 0.4033 | 0.4900 | 0.6756 | 0.8446 | 0.8447 | 0.8455 | 0.8593 |
| 12 12Exe5 | 0.0546 | 0.6491 | 0.8167 | 0.8622 | 0.8644 | 0.8645 | 0.8830 | 0.9085 |
| 13 13Exe24 | 0.5539 | 0.5855 | 0.5964 | 0.6299 | 0.8558 | 0.8558 | 0.8739 | 0.8775 |
| 14 14Exe30 | 0.4185 | 0.4379 | 0.5081 | 0.6045 | 0.6372 | 0.7542 | 0.7548 | 0.7950 |
| 15 15Exe13 | 0.3201 | 0.4170 | 0.6608 | 0.6735 | 0.6840 | 0.8296 | 0.8313 | 0.8792 |
| cum% expl.Var. | 27 | 43 | 54 | 62 | 71 | 78 | 83 | 87 |

Cumulative explained variance for all factor solutions

Factor Matrix with an X Indicating a Defining Sort **2 factor solution**

| QSORT | Loadings 1 | 2 |
|---|---|---|
| 1 1Sup13 | 0.1893 | 0.4071X |
| 2 2Sup10 | 0.2275 | 0.2744 |
| 3 3Sup16 | 0.4903X | 0.3379 |
| 4 4Sup14 | -0.0848 | 0.4579X |
| 5 5Sup30 | 0.5511X | 0.4173 |
| 6 6Des25 | 0.7209X | -0.1973 |
| 7 7Des11 | 0.5472X | 0.3199 |
| 8 8Des6 | 0.2009 | 0.5980X |
| 9 9Des15 | 0.7200X | -0.1298 |
| 10 10Des19 | 0.8431X | -0.1472 |
| 11 11Exe12 | -0.1276 | 0.6221X |
| 12 12Exe5 | -0.2593 | 0.7628X |
| 13 13Exe24 | 0.5015 | 0.5780X |
| 14 14Exe30 | 0.6069X | 0.2636 |
| 15 15Exe13 | 0.2786 | 0.5825X |
| % expl.Var. | 23 | 20 |

Criteria 1:
1 7 defining sorts - factor is acceptable
2 7 defining sorts - factor is acceptable

Criteria 3:
1 0.7209 * 0.8431 = 0.608 > 0.4 - factor is acceptable
2 0.6221 * 0.7628 = 0.475 > 0.4 - factor is acceptable

Factor Matrix with an X Indicating a Defining Sort **3 factor solution**

Respondent 2 is a non-loader

| QSORT | Loadings 1 | 2 | 3 |
|---|---|---|---|
| 1 1Sup13 | 0.0229 | 0.2682 | 0.7426X |
| 2 2Sup10 | 0.2961 | 0.1732 | 0.1039 |
| 3 3Sup16 | 0.4682X | 0.3946 | 0.0264 |
| 4 4Sup14 | 0.0618 | -0.0292 | 0.7041X |
| 5 5Sup30 | 0.5025X | 0.4602 | 0.1324 |
| 6 6Des25 | 0.1906 | 0.6518X | -0.4536 |
| 7 7Des11 | 0.2479 | 0.5410X | 0.3404 |
| 8 8Des6 | 0.6561X | 0.0597 | 0.1339 |
| 9 9Des15 | -0.0658 | 0.7673X | 0.0529 |
| 10 10Des19 | 0.1080 | 0.8245X | -0.2079 |
| 11 11Exe12 | 0.3127 | -0.1456 | 0.6091X |
| 12 12Exe5 | 0.7748X | -0.4464 | 0.1310 |
| 13 13Exe24 | 0.6427X | 0.3808 | 0.1959 |
| 14 14Exe30 | 0.2148 | 0.6073X | 0.3051 |
| 15 15Exe13 | 0.8033X | 0.0798 | -0.0955 |
| % expl.Var. | 19 | 21 | 13 |

Criteria 1:
1 6 defining sorts - factor is acceptable
2 5 defining sorts - factor is acceptable
3 3 defining sorts - factor is acceptable

Criteria 3:
1 0.7748 * 0.8033 = 0.622 > 0.4 - factor is acceptable
2 0.7673 * 0.8245 = 0.633 > 0.4 - factor is acceptable
3 0.7426 * 0.7041 = 0.523 > 0.4 - factor is acceptable

Factor Matrix with an X Indicating a Defining Sort

## 4 factor solution

| QSORT | Loadings 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 1Sup13 | 0.0002 | 0.1751 | 0.7544X | 0.2480 |
| 2 2Sup10 | 0.0583 | 0.2767 | 0.0573 | 0.5613X |
| 3 3Sup16 | 0.5385X | 0.2998 | 0.0623 | 0.0623 |
| 4 4Sup14 | 0.1231 | -0.1986 | 0.6818X | 0.0375 |
| 5 5Sup30 | 0.5494X | 0.3622 | 0.1679 | 0.1472 |
| 6 6Des25 | 0.2294 | 0.7201X | -0.3416 | 0.0079 |
| 7 7Des11 | 0.5517 | 0.2872 | 0.4531 | -0.3276 |
| 8 8Des6 | 0.7679X | -0.1342 | 0.1035 | -0.0126 |
| 9 9Des15 | 0.0149 | 0.7727X | 0.1966 | -0.0055 |
| 10 10Des19 | 0.1350 | 0.8851X | -0.0714 | 0.0927 |
| 11 11Exe12 | 0.0537 | -0.1386 | 0.4881 | 0.6444X |
| 12 12Exe5 | 0.4814 | -0.4321 | -0.0692 | 0.6625X |
| 13 13Exe24 | 0.5563 | 0.3811 | 0.1787 | 0.4230 |
| 14 14Exe30 | 0.4599 | 0.4077 | 0.4214 | -0.2219 |
| 15 15Exe13 | 0.7617X | 0.0023 | -0.1570 | 0.2622 |
| % expl.Var. | 19 | 19 | 13 | 11 |

Criteria 1:
1 4 defining sorts - factor is acceptable
2 3 defining sorts - factor is acceptable
3 2 defining sorts - factor is acceptable
4 3 defining sorts - factor is acceptable

Criteria 3:

| | | |
|---|---|---|
| 1 | 0.7679 * 0.7617 = 0.585 | > 0.4 - factor is acceptable |
| 2 | 0.7727 * 0.8851 = 0.684 | > 0.4 - factor is acceptable |
| 3 | 0.7544 * 0.6818 = 0.514 | > 0.4 - factor is acceptable |
| 4 | 0.6444 * 0.6625 = 0.427 | > 0.4 - factor is acceptable |

Respondents 7,13 and 14 are non-loaders

Factor Matrix with an X Indicating a Defining Sort

## 5 factor solution

| QSORT | Loadings 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1 1Sup13 | -0.0176 | 0.1912 | 0.7364X | 0.1424 | 0.2927 |
| 2 2Sup10 | 0.1201 | 0.1596 | 0.2376 | 0.8512X | 0.0229 |
| 3 3Sup16 | 0.5344X | 0.3061 | 0.0620 | 0.0365 | 0.0572 |
| 4 4Sup14 | 0.1239 | -0.2075 | 0.7660X | 0.1029 | 0.0302 |
| 5 5Sup30 | 0.5549X | 0.3483 | 0.2074 | 0.1863 | 0.0542 |
| 6 6Des25 | 0.2690 | 0.6426X | -0.2140 | 0.3744 | -0.3300 |
| 7 7Des11 | 0.5250 | 0.3270 | 0.4647 | -0.2918 | -0.1302 |
| 8 8Des6 | 0.7791X | -0.1465 | 0.1898 | 0.0483 | -0.0622 |
| 9 9Des15 | -0.0072 | 0.7952X | 0.1306 | -0.0258 | 0.0584 |
| 10 10Des19 | 0.1282 | 0.8842X | -0.1178 | 0.1179 | 0.0356 |
| 11 11Exe12 | 0.0062 | -0.0554 | 0.2599 | 0.0155 | 0.8796X |
| 12 12Exe5 | 0.4978 | -0.4459 | -0.0905 | 0.3853 | 0.5110 |
| 13 13Exe24 | 0.5106 | 0.4122 | -0.0304 | -0.0847 | 0.6458 |
| 14 14Exe30 | 0.4182 | 0.4725 | 0.3492 | -0.3386 | 0.0493 |
| 15 15Exe13 | 0.7606X | 0.0155 | -0.1929 | 0.0739 | 0.2503 |
| % expl.Var. | 19 | 19 | 12 | 9 | 12 |

Criteria 1:
1 4 defining sorts - factor is acceptable
2 3 defining sorts - factor is acceptable
3 2 defining sorts - factor is acceptable
4 only one defining sort - factor is not acceptable
5 only one defining sort - factor is not acceptable

3 acceptable factors according to this criteria

Criteria 3:

| | | |
|---|---|---|
| 1 | 0.7791 * 0.7606 = 0.593 | > 0.4 - factor is acceptable |
| 2 | 0.7952 * 0.8842 = 0.703 | > 0.4 - factor is acceptable |
| 3 | 0.7364 * 0.7660 = 0.564 | > 0.4 - factor is acceptable |
| 4 | 0.8512 * 0.3853 = 0.328 | < 0.4 - factor is not acceptable |
| 5 | 0.8796 * 0.6458 = 0.568 | > 0.4 - factor is acceptable |

4 acceptable factors according to this criteria

Factor Matrix with an X Indicating a Defining Sort

## 6 factor solution

| QSORT | Loadings 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 1 1Sup13 | -0.2582 | 0.0774 | 0.4999 | 0.3112 | 0.4460 | 0.3429 |
| 2 2Sup10 | 0.0871 | 0.1348 | 0.1181 | 0.8893X | 0.0411 | 0.0428 |
| 3 3Sup16 | 0.1863 | 0.0959 | -0.1534 | 0.2088 | 0.0454 | 0.8265X |
| 4 4Sup14 | 0.0853 | -0.1200 | 0.8541X | 0.1310 | 0.1345 | -0.1029 |
| 5 5Sup30 | 0.4707 | 0.3876 | 0.3079 | 0.1861 | 0.0118 | 0.2216 |
| 6 6Des25 | 0.1572 | 0.6221 | -0.1889 | 0.3721 | -0.3915 | 0.2053 |
| 7 7Des11 | 0.2855 | 0.3498 | 0.5982 | -0.2336 | -0.1011 | 0.3668 |
| 8 8Des6 | 0.5610 | -0.1874 | 0.2408 | 0.1145 | -0.1163 | 0.5056 |
| 9 9Des15 | -0.0973 | 0.7959X | 0.1151 | -0.0035 | 0.0899 | 0.1232 |
| 10 10Des19 | 0.1114 | 0.9213X | -0.0719 | 0.0851 | -0.0048 | 0.0731 |
| 11 11Exe12 | 0.1201 | -0.0519 | 0.1175 | 0.0355 | 0.9014X | 0.0050 |
| 12 12Exe5 | 0.6588X | -0.3963 | -0.0750 | 0.3330 | 0.3960 | 0.0130 |
| 13 13Exe24 | 0.4837 | 0.4004 | -0.0700 | -0.0713 | 0.5667 | 0.3613 |
| 14 14Exe30 | 0.0109 | 0.3119 | 0.2126 | -0.1627 | 0.1047 | 0.7577X |
| 15 15Exe13 | 0.8903X | 0.1558 | 0.0496 | -0.0405 | 0.0829 | 0.0408 |
| % expl.Var. | 15 | 18 | 11 | 9 | 11 | 13 |

Criteria 1:
1 two defining sorts - factor is acceptable
2 two defining sorts - factor is acceptable
3 only one defining sort - factor is not acceptable
4 only one defining sort - factor is not acceptable
5 only one defining sort - factor is not acceptable
6 two defining sorts - factor is acceptable

3 acceptable factors according to this criteria

Criteria 3:

| | | |
|---|---|---|
| 1 | 0.6588 * 0.8903 = 0.587 | > 0.4 - factor is acceptable |
| 2 | 0.7959 * 0.9213 = 0.733 | > 0.4 - factor is acceptable |
| 3 | 0.8541 * 0.5982 = 0.511 | > 0.4 - factor is acceptable |
| 4 | 0.8893 * 0.3721 = 0.331 | < 0.4 - factor is not acceptable |
| 5 | 0.9014 * 0.5667 = 0.511 | > 0.4 - factor is acceptable |
| 6 | 0.8265 * 0.7577 = 0.626 | > 0.4 - factor is acceptable |

5 acceptable factors according to this criteria

Factor Matrix with an X Indicating a Defining Sort **7 factor solution**

| | | Loadings | | | | | | |
|---|---|---|---|---|---|---|---|---|
| QSORT | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | 1Sup13 | 0.1027 | -0.2598 | 0.5016 | 0.4393 | 0.3284 | 0.3214 | 0.0475 |
| 2 | 2Sup10 | 0.1218 | 0.0527 | 0.0375 | 0.0650 | 0.8976X | 0.0294 | 0.1119 |
| 3 | 3Sup16 | 0.0154 | 0.1466 | -0.0199 | -0.0840 | 0.1933 | 0.8536X | 0.1314 |
| 4 | 4Sup14 | -0.1367 | 0.0354 | 0.1803 | 0.8717X | 0.1540 | -0.1221 | 0.0446 |
| 5 | 5Sup30 | 0.4443 | 0.3496 | 0.0040 | 0.2507 | 0.2103 | 0.1391 | 0.4061 |
| 6 | 6Des25 | 0.4345 | 0.2422 | -0.5573 | -0.0083 | 0.3812 | 0.3695 | -0.2928 |
| 7 | 7Des11 | 0.2921 | 0.2207 | -0.1354 | 0.6854X | -0.2091 | 0.3720 | 0.1283 |
| 8 | 8Des6 | -0.0460 | 0.2696 | -0.0132 | 0.0782 | 0.1073 | 0.2574 | 0.8821X |
| 9 | 9Des15 | 0.8754X | -0.1224 | 0.0962 | 0.0156 | 0.0344 | 0.0873 | 0.1182 |
| 10 | 10Des19 | 0.8747X | 0.1873 | -0.1187 | -0.0261 | 0.1205 | 0.1658 | -0.1804 |
| 11 | 11Exe12 | -0.0026 | 0.2393 | 0.8803X | 0.0780 | 0.0488 | 0.0364 | -0.0595 |
| 12 | 12Exe5 | -0.4316 | 0.6870X | 0.3223 | -0.0285 | 0.3188 | 0.0327 | 0.1320 |
| 13 | 13Exe24 | 0.3517 | 0.5972 | 0.4279 | 0.0119 | -0.0555 | 0.4541 | -0.0330 |
| 14 | 14Exe30 | 0.3034 | -0.0392 | 0.0988 | 0.2244 | -0.1550 | 0.7335X | 0.1976 |
| 15 | 15Exe13 | 0.1284 | 0.8555X | -0.0242 | 0.1164 | -0.0308 | 0.0427 | 0.2569 |
| % expl.Var. | | 16 | 14 | 11 | 10 | 9 | 13 | 8 |

Criteria 1:
1 two defining sorts - factor is acceptable
2 two defining sorts - factor is acceptable
3 only one defining sort - factor is not acceptable
4 two defining sorts - factor is acceptable
5 only one defining sort - factor is not acceptable
6 two defining sorts - factor is acceptable
7 only one defining sort - factor is not acceptable

4 acceptable factors according to this criteria

Criteria 3:

| | | |
|---|---|---|
| 1 | 0.8754 * 0.8747 = 0.766 | > 0.4 - factor is acceptable |
| 2 | 0.6870 * 0.8555 = 0.588 | > 0.4 - factor is acceptable |
| 3 | 0.5573 * 0.8803 = 0.491 | > 0.4 - factor is acceptable |
| 4 | 0.8717 * 0.6854 = 0.597 | > 0.4 - factor is acceptable |
| 5 | 0.8976 * 0.3812 = 0.342 | < 0.4 - factor is not acceptable |
| 6 | 0.8536 * 0.7335 = 0.626 | > 0.4 - factor is acceptable |
| 7 | 0.4061 * 0.8821 = 0.358 | < 0.4 - factor is not acceptable |

5 acceptable factors according to this criteria

# K

# Q SET AND CORRESPONDING FACTOR SCORES

Table K: Q-set, corresponding factor scores (Z-SC), Q sort values (Q-SV) and mean factor scores . *Note: '**' indicates a distinguishing statement, significant at p<0.01. '*' indicates a distinguishing statement, significant at p<0.05. '#' indicates a consensus statement.*

| | | Factor 1 | | Factor 2 | | Factor 3 | | |
|---|---|---|---|---|---|---|---|---|
| **No.** | **Statement** | **Z-SC** | **Q-SV** | **Z-SC** | **Q-SV** | **Z-SC** | **Q-SV** | **Mean Z-SC** |
| 1 | Integration of risk management with other project management activities | -0.04 | 0** | 1.80 | 3 | 1.24 | 2 | 1.000 |
| 2 | A clear long-term strategy towards risk management in the project organisation | 1.04 | 2 | 0.67 | 1 | -0.65 | -1** | 0.353 |
| 3 | Consider the external environment (market, politics, social issues, macro-economic situation) | 0.20 | 0# | -0.33 | -1# | -0.62 | -1# | -0.250 |
| 4 | Adapt risk management to each project | 0.53 | 1 | 0.21 | 0 | -0.56 | 0* | 0.060 |
| 5 | Establish clear responsibility of roles for managing risks (RACI-matrix) | 0.90 | 1 | 0.44 | 1 | -1.42 | -3** | -0.027 |
| 6 | An understanding and belief in the benefits of risk management from all staff | 1.85 | 3** | 0.71 | 1** | -0.76 | -2** | 0.600 |
| 7 | Provision of adequate resources to support risk management | -1.11 | -2 | -0.20 | 0 | -0.78 | -2 | -0.697 |
| 8 | Decide the appropriate level of risk management for the project | 0.20 | 0 | -0.85 | -2** | 0.17 | 1 | -0.160 |
| 9 | Top management encouraging and supporting risk management | -0.44 | -1** | 1.04 | 2 | 1.15 | 2 | 0.583 |
| 10 | Clear and honest communication | 1.08 | 2** | -0.39 | -1** | 2.02 | 3** | 0.903 |
| 11 | Shared understanding and acceptance of the key concepts of risk management | -2.09 | -3** | -0.78 | -1 | -0.72 | -2 | -1.197 |
| 12 | Project organisation risk culture | 1.11 | 2* | 0.53 | 1* | 2.34 | 3** | 1.327 |
| 13 | Project organisation team spirit | 0.29 | 1 | -1.17 | -2** | 0.33 | 1 | -0.183 |
| 14 | All staff showing competence in the application of risk management | -0.88 | -2 | -1.47 | -3* | -0.24 | 0 | -0.863 |
| 15 | Continuity of risk management across project stages | -0.25 | 0 | 1.58 | 3** | 0.13 | 0 | 0.487 |

Table K continued: Q-set, corresponding factor scores (Z-SC), Q sort values (Q-SV) and mean factor scores. *Note: '**' indicates a distinguishing statement, significant at p<0.01. '*' indicates a distinguishing statement, significant at p<0.05. '#' indicates a consensus statement.*

| | | Factor 1 | | Factor 2 | | Factor 3 | | |
|---|---|---|---|---|---|---|---|---|
| **No.** | **Statement** | **Z-SC** | **Q-SV** | **Z-SC** | **Q-SV** | **Z-SC** | **Q-SV** | **Mean Z-SC** |
| 16 | Detailed documentation of risks | -0.64 | -1 | 0.12 | 0* | -0.64 | -1 | -0.387 |
| 17 | Application of a standardised risk management process | -1.11 | -2* | 0.14 | 0 | -0.29 | 0 | -0.420 |
| 18 | Regular training to enhance risk management skills | -1.54 | -3 | -2.06 | -3 | -0.59 | -1** | -1.397 |
| 19 | Knowledge sharing relating to risk management | -0.46 | -1 | -0.82 | -1 | 0.32 | 1* | -0.320 |
| 20 | Personal experience, intuition and engineering judgement | 1.89 | 3** | -0.75 | -1 | -0.59 | -1 | 0.183 |
| 21 | Consistently review and update the risk register | -0.00 | 0 | 1.26 | 2* | 0.45 | 1 | 0.570 |
| 22 | Capture and use lessons learned | 0.48 | 1# | 0.28 | 1# | 0.54 | 1# | 0.433 |
| 23 | A risk manager appointed to the project | -0.71 | -1** | 1.29 | 2** | -1.88 | -3** | -0.437 |
| 24 | Risk management purposes in line with project goals | -0.73 | -1* | 0.06 | 0 | -0.03 | 0 | -0.233 |
| 25 | Careful management of contracts with subcontractors | 0.43 | 1 | -1.30 | -2** | 1.10 | 2 | 0.077 |

# L

# DIFFERENCE SCORES

# Output from PQMethod: Differences between Z scores

Descending Array of Differences Between Factors 1 and 2

| No. | Statement | No. | Type 1 | Type 2 | Difference |
|---|---|---|---|---|---|
| 20 | Personal experience, intuition and engineering judgement | 20 | 1.891 | -0.750 | 2.641 |
| 25 | Careful management of contracts with subcontractors | 25 | 0.433 | -1.298 | 1.730 |
| 10 | Clear and honest communication | 10 | 1.077 | -0.394 | 1.471 |
| 13 | Project organisation team spirit | 13 | 0.285 | -1.171 | 1.456 |
| 6 | An understanding and belief in the benefits of risk manageme | 6 | 1.847 | 0.713 | 1.134 |
| 8 | Decide the appropriate level of risk management for the proj | 8 | 0.197 | -0.845 | 1.042 |
| 14 | All staff showing competence in the application of risk mana | 14 | -0.876 | -1.475 | 0.599 |
| 12 | Project organisation risk culture | 12 | 1.112 | 0.527 | 0.585 |
| 3 | Consider the external environment | 3 | 0.196 | -0.331 | 0.526 |
| 18 | Regular training to enhance risk management skills | 18 | -1.539 | -2.065 | 0.526 |
| 5 | Establish clear responsibility of roles for managing risks ( | 5 | 0.902 | 0.437 | 0.465 |
| 2 | A clear long-term strategy towards risk management in the pr | 2 | 1.036 | 0.672 | 0.364 |
| 19 | Knowledge sharing relating to risk management | 19 | -0.457 | -0.819 | 0.361 |
| 4 | Adapt risk management to each project | 4 | 0.533 | 0.214 | 0.319 |
| 22 | Capture and use lessons learned | 22 | 0.482 | 0.277 | 0.205 |
| 16 | Detailed documentation of risks | 16 | -0.645 | 0.123 | -0.768 |
| 24 | Risk management purposes in line with project goals | 24 | -0.731 | 0.063 | -0.794 |
| 7 | Provision of adequate resources to support risk management | 7 | -1.112 | -0.205 | -0.908 |
| 17 | Application of a standardised risk management process | 17 | -1.105 | 0.138 | -1.243 |
| 21 | Consistently review and update the risk register | 21 | -0.004 | 1.261 | -1.265 |
| 11 | Shared understanding and acceptance of the key concepts of r | 11 | -2.089 | -0.777 | -1.312 |
| 9 | Top management encouraging and supporting risk management | 9 | -0.435 | 1.038 | -1.473 |
| 15 | Continuity of risk management across project stages | 15 | -0.254 | 1.578 | -1.832 |
| 1 | Integration of risk management with other project management | 1 | -0.037 | 1.803 | -1.840 |
| 23 | A risk manager appointed to the project | 23 | -0.705 | 1.285 | -1.990 |

Descending Array of Differences Between Factors 1 and 3

| No. | Statement | No. | Type 1 | Type 3 | Difference |
|---|---|---|---|---|---|
| 6 | An understanding and belief in the benefits of risk manageme | 6 | 1.847 | -0.758 | 2.604 |
| 20 | Personal experience, intuition and engineering judgement | 20 | 1.891 | -0.592 | 2.483 |
| 5 | Establish clear responsibility of roles for managing risks ( | 5 | 0.902 | -1.421 | 2.323 |
| 2 | A clear long-term strategy towards risk management in the pr | 2 | 1.036 | -0.646 | 1.682 |
| 23 | A risk manager appointed to the project | 23 | -0.705 | -1.880 | 1.175 |
| 4 | Adapt risk management to each project | 4 | 0.533 | -0.559 | 1.092 |
| 3 | Consider the external environment | 3 | 0.196 | -0.624 | 0.820 |
| 8 | Decide the appropriate level of risk management for the proj | 8 | 0.197 | 0.166 | 0.031 |
| 16 | Detailed documentation of risks | 16 | -0.645 | -0.642 | -0.003 |
| 13 | Project organisation team spirit | 13 | 0.285 | 0.325 | -0.040 |
| 22 | Capture and use lessons learned | 22 | 0.482 | 0.541 | -0.059 |
| 7 | Provision of adequate resources to support risk management | 7 | -1.112 | -0.784 | -0.329 |
| 15 | Continuity of risk management across project stages | 15 | -0.254 | 0.133 | -0.388 |
| 21 | Consistently review and update the risk register | 21 | -0.004 | 0.454 | -0.458 |
| 14 | All staff showing competence in the application of risk mana | 14 | -0.876 | -0.238 | -0.638 |
| 25 | Careful management of contracts with subcontractors | 25 | 0.433 | 1.100 | -0.668 |
| 24 | Risk management purposes in line with project goals | 24 | -0.731 | -0.033 | -0.699 |
| 19 | Knowledge sharing relating to risk management | 19 | -0.457 | 0.321 | -0.778 |
| 17 | Application of a standardised risk management process | 17 | -1.105 | -0.293 | -0.813 |
| 10 | Clear and honest communication | 10 | 1.077 | 2.017 | -0.941 |
| 18 | Regular training to enhance risk management skills | 18 | -1.539 | -0.592 | -0.947 |
| 12 | Project organisation risk culture | 12 | 1.112 | 2.338 | -1.227 |
| 1 | Integration of risk management with other project management | 1 | -0.037 | 1.238 | -1.275 |
| 11 | Shared understanding and acceptance of the key concepts of r | 11 | -2.089 | -0.725 | -1.364 |
| 9 | Top management encouraging and supporting risk management | 9 | -0.435 | 1.151 | -1.586 |

Descending Array of Differences Between Factors 2 and 3

| No. | Statement | No. | Type 2 | Type 3 | Difference |
|---|---|---|---|---|---|
| 23 | A risk manager appointed to the project | 23 | 1.285 | -1.880 | 3.165 |
| 5 | Establish clear responsibility of roles for managing risks ( | 5 | 0.437 | -1.421 | 1.858 |
| 6 | An understanding and belief in the benefits of risk manageme | 6 | 0.713 | -0.758 | 1.471 |
| 15 | Continuity of risk management across project stages | 15 | 1.578 | 0.133 | 1.445 |
| 2 | A clear long-term strategy towards risk management in the pr | 2 | 0.672 | -0.646 | 1.318 |
| 21 | Consistently review and update the risk register | 21 | 1.261 | 0.454 | 0.807 |
| 4 | Adapt risk management to each project | 4 | 0.214 | -0.559 | 0.773 |
| 16 | Detailed documentation of risks | 16 | 0.123 | -0.642 | 0.765 |
| 7 | Provision of adequate resources to support risk management | 7 | -0.205 | -0.784 | 0.579 |
| 1 | Integration of risk management with other project management | 1 | 1.803 | 1.238 | 0.565 |
| 17 | Application of a standardised risk management process | 17 | 0.138 | -0.293 | 0.431 |
| 3 | Consider the external environment | 3 | -0.331 | -0.624 | 0.294 |
| 24 | Risk management purposes in line with project goals | 24 | 0.063 | -0.033 | 0.095 |
| 11 | Shared understanding and acceptance of the key concepts of r | 11 | -0.777 | -0.725 | -0.052 |
| 9 | Top management encouraging and supporting risk management | 9 | 1.038 | 1.151 | -0.112 |
| 20 | Personal experience, intuition and engineering judgement | 20 | -0.750 | -0.592 | -0.158 |
| 22 | Capture and use lessons learned | 22 | 0.277 | 0.541 | -0.264 |
| 8 | Decide the appropriate level of risk management for the proj | 8 | -0.845 | 0.166 | -1.011 |
| 19 | Knowledge sharing relating to risk management | 19 | -0.819 | 0.321 | -1.140 |
| 14 | All staff showing competence in the application of risk mana | 14 | -1.475 | -0.238 | -1.237 |
| 18 | Regular training to enhance risk management skills | 18 | -2.065 | -0.592 | -1.473 |
| 13 | Project organisation team spirit | 13 | -1.171 | 0.325 | -1.496 |
| 12 | Project organisation risk culture | 12 | 0.527 | 2.338 | -1.812 |
| 25 | Careful management of contracts with subcontractors | 25 | -1.298 | 1.100 | -2.398 |
| 10 | Clear and honest communication | 10 | -0.394 | 2.017 | -2.412 |

# M

# STATISTICAL TEST FOR FUNCTIONAL TEAMS

The SAS System
The FREQ Procedure

**Table of team by factor 1**

| team | factor 1 | | |
|---|---|---|---|
| | **0** | **1** | **Total** |
| **design** | 4 | 1 | 5 |
| | 26.67 | 6.67 | 33.33 |
| | 80.00 | 20.00 | |
| | 44.44 | 16.67 | |
| **site** | 2 | 3 | 5 |
| | 13.33 | 20.00 | 33.33 |
| | 40.00 | 60.00 | |
| | 22.22 | 50.00 | |
| **supp** | 3 | 2 | 5 |
| | 20.00 | 13.33 | 33.33 |
| | 60.00 | 40.00 | |
| | 33.33 | 33.33 | |
| **Total** | 9 | 6 | 15 |
| | 60.00 | 40.00 | 100.00 |

**Frequency**
**Percent**
**Row Pct**
**Col Pct**

Statistics for Table of team by factor1

| Statistic | DF | Value | Prob |
|---|---|---|---|
| **Chi-Square** | 2 | 1.6667 | 0.4346 |
| **Likelihood Ratio Chi-Square** | 2 | 1.7261 | 0.4219 |
| **Mantel-Haenszel Chi-Square** | 1 | 0.3889 | 0.5329 |
| **Phi Coefficient** | | 0.3333 | |
| **Contingency Coefficient** | | 0.3162 | |
| **Cramer's V** | | 0.3333 | |

**WARNING: 100% of the cells have expected counts less than 5. Chi-Square may not be a valid test.**

**Fisher's Exact Test**

| | |
|---|---|
| **Table Probability (P)** | 0.0999 |
| **Pr <= P** | 0.8002 |

Sample Size = 15

**Table of team by factor2**

| team | factor2 0 | factor2 1 | Total |
|---|---|---|---|
| design | 1 | 4 | 5 |
| | 6.67 | 26.67 | 33.33 |
| | 20.00 | 80.00 | |
| | 10.00 | 80.00 | |
| site | 4 | 1 | 5 |
| | 26.67 | 6.67 | 33.33 |
| | 80.00 | 20.00 | |
| | 40.00 | 20.00 | |
| supp | 5 | 0 | 5 |
| | 33.33 | 0.00 | 33.33 |
| | 100.00 | 0.00 | |
| | 50.00 | 0.00 | |
| Total | 10 | 5 | 15 |
| | 66.67 | 33.33 | 100.00 |

**Frequency**
**Percent**
**Row Pct**
**Col Pct**

Statistics for Table of team by factor2

| Statistic | DF | Value | Prob |
|---|---|---|---|
| Chi-Square | 2 | 7.8000 | 0.0202 |
| Likelihood Ratio Chi-Square | 2 | 9.0874 | 0.0106 |
| Mantel-Haenszel Chi-Square | 1 | 6.7200 | 0.0095 |
| Phi Coefficient | | 0.7211 | |
| Contingency Coefficient | | 0.5849 | |
| Cramer's V | | 0.7211 | |

**WARNING: 100% of the cells have expected counts less than 5. Chi-Square may not be a valid test.**

**Fisher's Exact Test**

| | |
|---|---|
| **Table Probability (P)** | 0.0083 |
| **Pr <= P** | 0.0509 |

Sample Size = 15

**Table of team by factor3**

| team | factor3 0 | factor3 1 | Total |
|---|---|---|---|
| design | 5 | 0 | 5 |
| | 33.33 | 0.00 | 33.33 |
| | 100.00 | 0.00 | |
| | 41.67 | 0.00 | |
| site | 4 | 1 | 5 |
| | 26.67 | 6.67 | 33.33 |
| | 80.00 | 20.00 | |
| | 33.33 | 33.33 | |
| supp | 3 | 2 | 5 |
| | 20.00 | 13.33 | 33.33 |
| | 60.00 | 40.00 | |
| | 25.00 | 66.67 | |
| Total | 12 | 3 | 15 |
| | 80.00 | 20.00 | 100.00 |

Frequency
Percent
Row Pct
Col Pct

Statistics for Table of team by factor3

| Statistic | DF | Value | Prob |
|---|---|---|---|
| Chi-Square | 2 | 2.5000 | 0.2865 |
| Likelihood Ratio Chi-Square | 2 | 3.2779 | 0.1942 |
| Mantel-Haenszel Chi-Square | 1 | 2.3333 | 0.1266 |
| Phi Coefficient | | 0.4082 | |
| Contingency Coefficient | | 0.3780 | |
| Cramer's V | | 0.4082 | |

**WARNING: 100% of the cells have expected counts less than 5. Chi-Square may not be a valid test.**

**Fisher's Exact Test**

| | |
|---|---|
| **Table Probability (P)** | 0.1099 |
| **Pr <= P** | 0.7253 |

Sample Size = 15

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