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LIMITED DIVERSITY IN RISK TREATMENT SELECTION IN PUBLIC INFRASTRUCTURE PROJECTS: A RATIONAL RESPONSE?

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ABSTRACT

In public infrastructure projects, risks can emerge quickly due to its external uncertainties and interdependencies among a large number of stakeholders. Scholars still debate whether the current approach of risk management is dynamic enough to safeguard project objectives in such public environments. Because of little empirical evidence that explains how and why Project Management Teams (PMTs) select a specific risk treatment, we aim to characterize risk treatment selection by PMTs in public infrastructure projects. Based on document reviews and semi-structured interviews with PMT members and their executives of a Dutch project-oriented public infrastructure agency, it was found that the diversity in risk treatment selection is limited and risk treatment in public infrastructure projects focuses on controlling risk predominantly through preventive control measures. Although PMTs also intentionally control risk through preventive measures, the decision to do so is often implicitly taken and constitutes an unwitting routine that PMTs seem to have developed due to a risk-averse organizational culture. We conclude with providing directions to improve risk management practices and enable more diversity in risk treatment selection by PMTs in public infrastructure projects.

KEYWORDS

Risk management; risk treatment; risk aversion; public infrastructure projects; project-oriented organizations.

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INTRODUCTION

Public infrastructure projects are often characterized as complex, nonlinear, and dynamic processes that include specific uncertainties and interdependencies among a large number of stakeholders (Khan et al. 2016). In a VUCA – volatile, uncertain, complex, and ambiguous – world (Bennett and Lemoine 2014; Saleh and Watson 2017), unexpected events are the norm rather than an exception. This renders public infrastructure projects highly uncertain and difficult to predict (Floricel et al. 2011). Moreover, public sector projects, in contrast to private or non-profit sector projects, may experience public scrutiny (Chen and Bozeman 2012). The level of uncertainty in public infrastructure projects and the importance of well-functioning infrastructure facilities underline the relevance of *risk management* in such projects (Dyer 2017) – in this study defined as "coordinated activities to direct and control an organization with regard to risk" (ISO 2009). Scholars still debate whether the current approach of risk management is dynamic enough to safeguard project objectives in such public environments (see e.g., Dyer 2017; Farooq et al. 2018; Mikes 2011; Power 2009; Rydmark et al. 2020; van Staveren 2018; Walpole and Wilson 2020; Zhang, 2016). In practice, Project Management Teams (PMTs), that comprise several individuals who are responsible for the management of a project and its team members, have to actually cope with *risk* – to be perceived as an "effect of uncertainty on objectives" (ISO 2009). This involves selecting a specific *risk treatment* – to be understood as the "process to modify risk" (ISO 2009) – for each risk.

Unfortunately, there is little empirical evidence that explains how and why PMTs select a specific risk treatment. Therefore, in this study we aim to characterize risk treatment selection by PMTs in public infrastructure projects. To this end, we conducted an in-depth case study of a public infrastructure agency that uses risk management to support the achievement of their projects' goals. In this paper, we reflect on the results of our study about risk treatment selection, pinpoint how risk aversion seems to hamper efficient use of public resources, and we provide directions for improvement of risk management practices in general.

THEORETICAL BACKGROUND: RISK TREATMENT SELECTION

Risk Treatment in Public Infrastructure Projects

Risk management is seen as an essential component of the management of infrastructure projects (El-Sayegh 2014; Farooq et al. 2018; Zhang 2016) and is part of the Project Management Body of Knowledge (PMBOK) by the Project Management Institute. This led to international standards, such as COSO-ERM – Enterprise Risk Management – and ISO 31000 – risk management –, that provide the basis for the interpretation of risk management (Aven 2016). Many organizations integrated such standards into their management systems, which ensures appropriate risk management in projects (Sanchez et al. 2009).

There is consensus in the literature that the *risk management process* generally consists of setting goals, identifying risks, classifying risks, treating risks,

evaluating risks, and communicating risks (Van Staveren 2018). It is a cyclical process that is repeated several times during the lifecycle of a project. After *setting the goals* of a project and *identifying risks* that can affect the achievement of the project goals, risks are *classified*. During classification, quantifications of risks are developed. The PMT estimates the size of each risk in terms of the likelihood of occurrence and the effects when a risk materializes. The result of this step is a risk file that contains a ranking based on the quantifications of all risks that the PMT has identified. Subsequently, the PMT selects a specific *risk treatment* for each of the risks, namely to *transfer, avoid, accept,* or *control* a risk.

A risk can be *transferred* to the party that is best capable to control that risk. For example, in public infrastructure projects, a part of the risks is transferred to the contractor. *Avoiding* a risk can be done by, for example, adjusting the design so that the risk can no longer occur. *Acceptance* refers to a risk remaining unaffected, although that risk can be monitored. *Controlling* implies that the size of a risk is reduced by *preventive* measures aimed at reducing the likelihood of occurrence or *corrective* measures aimed at reducing the effects of a risk that materializes (Claassen 2009; ISO 2009). Although preventive and corrective measures contribute to risk mitigation, often a risk cannot be fully reduced, and residual risk remains. During *evaluation,* the effectiveness of measures is discussed and PMTs decide on additional measures, if necessary. This process requires up-to-date documentation of risks in a risk file and continuous *communication of risks*.

Risk management standards like COSO-ERM and ISO 31000 point out the importance of PMT decision making on risk treatment (Aven 2016). In this light, there is consensus in the literature that a balance between controlling and accepting risk calls for a centralized approach that sets out a clear view on how risks should be managed throughout the organization (Gordon et al. 2009; Liu et al. 2013; Wu and Olson 2010). A term closely linked to risk treatment is *risk attitude*. Risk attitude is defined by ISO (2009) as: "an organization's approach to assess and eventually pursue, retain, take, or turn away from risk". Hillson and Murray-Webster (2007) add that risk attitude is not restricted to the organizational level, but individuals or PMTs can also adopt a risk attitude towards a particular risk. Studies that describe risk attitude provide insight into what affects the selection of a risk treatment. Most of these studies use the spectrum of Hillson and Murray-Webster (2007) that distinguishes five risk attitudes: risk paranoid, risk averse, risk tolerant, risk seeking, and risk addicted.

Project Management Teams (PMTs) are groups that consist of individuals and manage projects based on assignments from the parent organization. Risk treatment selection, thus, involves interaction within PMTs and between PMTs and their parent organization. Risk management literature provides several concepts that can help to understand which factors affect the selection of a specific risk treatment. In this study we focus on human behavior in organizations and distinguish between factors that are attributable to the PMTs themselves and factors that are related to the parent organization. We identified

four main risk treatment factors from risk management literature that are relevant for public infrastructure projects: *individual influence* and *group dynamics* – attributable to the PMT – and *governance* and *organizational culture* – attributable to the parent organization. These selection factors are explained in the following sections.

Factors Affecting Risk Treatment Selection in Public Infrastructure Projects

Selection Factors Attributable to the Project Management Team

Risk attitude at an *individual* level is strongly associated with *risk perception*. Risk perception is described as the subjective judgement that people make about the characteristics and severity of a risk (Slovic 2000). People generally prefer known risk over unknown risk where the likelihood and consequences cannot be determined (Ellsberg 1961). This *preference for certainty* is especially relevant in the context of public infrastructure projects where, as aforementioned, uncertainty can be high. Van Staveren (2018) states that a person's risk attitude determines how someone will handle a risk based on his or her risk perception. Many studies examined the risk *perception of individuals*. For example, Lidén and Olofsson (2020) showed variations in risk perception based on the place of origin and gender, and Mao et al. (2020) revealed a positive correlation between risk perception and an individual's education and income. The key message from previous studies is that risk perceptions of PMT members can be very different. These differences can lead to varying preferences towards risk treatment.

In a project, risk treatment is set by the PMT as a *collective* rather than on an individual basis. The PMT must agree on their collective risk treatment. *Group dynamics* play an important role in the decision-making process that leads to a particular risk treatment (Vugt and Schaller 2008). Studies into group decision-making processes vary and describe different effects in different group settings. One effect that is acknowledged to play an important role in group dynamics is *groupthink* (Janis 1982). According to Janis (1982), groupthink occurs if the drive for consensus overrides a realistic appraisal of decision alternatives. To improve decision making, it is necessary to create an environment that allows criticism and challenging of each other's perceptions, while ensuring that this criticism is not at the expense of group cohesion (Janis 1982). Another well-known effect is *evaluation apprehension*, which is not daring to contribute to a group out of fear of being judged by the group (Cottrell et al. 1968). The *role of a leader* who gives direction to the group process is also frequently mentioned (Fox et al. 2000). A lack of guidance increases the likelihood of conflicts within a group. From this perspective, the role of a risk manager who directs a risk management session seems important. While these are just a few studies describing some known effects regarding group dynamics, it can be concluded that the group process can have a significant effect on the risk treatment selection by PMTs.

In sum, risk treatment factors attributable to PMTs seem to comprise 1) *individual influence*, which is affected by *individual risk perception* and

preference for certainty, and 2) *group dynamics*, which is affected by *groupthink*, *evaluation apprehension*, and the *role of a group leader*.

Selection Factors Attributable to the Parent Organization

Public infrastructure agencies often manage by projects. That is, they initiate projects (temporary organizations) to provide adequate infrastructure facilities instead of, or besides, ongoing processes and activities managed by departments. Müller (2009) illustrated that a parent organization can organize the monitoring of project progress and results in different ways in his model for *project governance*. In this model, a distinction is made between outcome control and behavior control. Outcome control means that the PMT is assessed by the parent organization on the actual results or milestones in terms of time and money. Behavior control focuses on the way that the PMT fulfils its tasks. Müller and Lecoeuvre (2014) showed that there are significant differences in how project progress is monitored depending on project size, project type, and country. Further research by Joslin and Müller (2016) indicates no correlation between control mechanisms and project success; one approach is not necessarily superior to the other. Output control seems to be a form of project governance that aligns with the conventional methods of COSO-ERM and ISO-31000, in which risks are quantified in terms of time and money so that they can be incorporated into the project budget and planning (Claassen 2009).

The body of knowledge that describes the risk attitude of organizations is extensive. Some studies show differences in risk attitude between organizational types, e.g. between public and non-profit organizations (Chen and Bozeman 2012). Public organizations may experience public scrutiny and tend to have a more risk-averse attitude, which is often visible among public employees in their risk decision making but also at organizational level in, for example, policymaking (Chen and Bozeman 2012; Paape and Speklé 2012). According to Torugsa and Arundel (2017), in the public sector the downside of risk is typically stressed, i.e. the potential losses from risk are given more weight than the potential gains. A risk-averse attitude entails that fewer risks are taken, and the benefits are probably lower. As a result, public organizations are lagging behind private organizations that take more risks (Kim 2010). Kim (2010) and Clark (2016) argue for more entrepreneurship in the public sector. In fact, enhancing risk-taking is considered key in New Public Management (Chen and Bozeman 2012). However, the political environment is often identified as a leading cause for limited risk-taking behavior. Top officials are more easily held *accountable* for incidents such as a risk that materializes, where shareholders in the private sector assess their directors more on long-term performance (Chen and Bozeman 2012). This debate about differences in risk attitudes between the public and private sector shows the importance of accountability and measuring results of risk management.

Another recurring aspect regarding factors that are attributable to the parent organization is *organizational culture* (see e.g., Chen and Bozeman 2012; Dressel 2015; Wang and Yuan 2011). Three decades after the appearance of the

first edition of 'Organizational Culture and Leadership', Schein and Schein (2017, 14) summarize that for arriving at a definition of an abstract concept as culture it is useful "to think in dynamic evolutionary terms, to think of culture as what the group has learned in its efforts to survive, grow, deal with its external environment, and organize itself". Wang and Yuan (2011) illustrated that the organizational *understanding of value* – i.e. "the collective conviction of what is right and wrong" (Wang and Yuan 2011, 212) – is part of the organizational culture and affects risk attitude in projects. Furthermore, *psychological safety*, referring to the extent to which individuals feel free to give criticism and the area to which negative feedback can be expressed without having personal consequences (Cheung et al. 2011), influences risk attitude. If there are no direct personal consequences, then individuals can think critically about what matters for the organization rather than what impact it has on themselves. The open *sharing of information* is also often mentioned as part of the organizational culture, involving the degree of open mutual communication between the PMT and the parent organization in which sensitive information is shared. This openness prevents internal tensions and increases decisiveness on the project (Karlsen 2010; Khattak et al. 2020). A supportive culture with open mutual communication is vital to avoid surprises for directors of the parent organization. It should be noted that organizational culture is a broad concept that has many components. What the aforementioned studies show is that the organizational culture affects decision making in PMTs and, therefore, the selection of a specific risk treatment.

In sum, risk treatment factors attributable to the parent organization appear to comprise 3) *governance*, which is affected by *project governance* and *accountability*, and *4) organizational culture*, which is affected by *understanding of value*, *psychological safety*, and *sharing of information*.

RESEARCH APPROACH AND METHODS

This study aims to characterize risk treatment selection by PMTs in public infrastructure projects. It answers the question: Which risk treatments are (predominantly) selected in infrastructure projects and why? There is little empirical evidence that explains the process of risk evaluation in PMTs in public infrastructure projects and why PMTs select a specific risk treatment. Therefore, an exploratory qualitative research approach was chosen. We chose Rijkswaterstaat – the executive agency for the Ministry of Infrastructure and Water Management in The Netherlands – to collect the data because of its responsibility for maintenance, reconstruction, and renewal of main road and water infrastructure facilities, the use of projects in fulfilling this responsibility, and because this organization was wondering how risk management could be improved (Rijkswaterstaat 2020). This Dutch public infrastructure agency has embedded risk management in their projects, where the process is based on established standards such as the COSO-ERM and ISO 31000 risk management frameworks. PMTs within this organization generally consist of five members: a project manager, technical

manager, contract manager, stakeholder manager and a project control manager. These PMT members are formally employed in separate departments in the parent organization.

First, we conducted a document review as this is an efficient and effective way to gather initial data (Bowen 2009). To access the data, we consulted the organization's risk management advisors. The collective of advisors organizes monthly meetings to share experiences from their activities in projects and to improve risk management practices. We examined research reports on the implementation of risk management within the organization, supplemented with internal strategies, frameworks and guidelines describing the risk management process. Furthermore, we analyzed the full risk files of 13 different projects to identify selected risk treatments. We used the purposeful sampling strategy of maximum variation to obtain an overall impression (Patton 2015). The dataset consisted of large water and road projects spread across multiple regions in the Netherlands. The projects were also in different phases of their lifecycle; some projects were still in the planning phase, while others were already nearly completed. The risk files did not have a specific column for the selected risk treatment, but they did show the allocation of risks, in this case whether risks were controlled by the organization itself or transferred to a contractor.

Second, we selected three out of the 13 projects for semi-structured interviews with all PMT members (see Table 1). We used semi-structured interviews to strengthen the data obtained from the document review and to collect additional data about how the factors identified in the theoretical framework affect the risk treatment selection. The selected projects concerned large water and road projects and were part of different organizational divisions to ensure a rich view on risk treatment throughout this Dutch public infrastructure agency. We interviewed the project manager, technical manager, contract manager, stakeholder manager, and project control manager of each of the three selected projects and questioned them on the four risk treatment factors as identified in the theoretical framework. A total of 15 PMT interviews (Interviewees 1 until 15) were executed in May and June 2020. All interviews were conducted through an online video connection and lasted 30 to 45 minutes. The interviews were recorded and transcribed. The interview transcripts were coded using factors from the framework as codes (see Figure 1) and analyzed using Atlas.ti.

Third, we focused on and enrichments of the findings by conducting semi-structured interviews with executives in the parent organization (see Table 1). We interviewed these senior managers of the departments of technical management and project control, a portfolio manager, and two directors responsible for part of the selected projects on the confrontation of the project perspective with the perspective of the parent organization. These five interviews (Interviewees 16 until 20) with the executives in the parent organization were conducted in July 2020 through an online video connection, lasted 30 to 45 minutes. The interviews were recorded, and the interview transcripts were coded using factors from the framework as codes (see Figure 1) and analyzed using Atlas.ti.

Table 1: Overview of interviews

ID	Function	Date	Entity
	Project manager	13-5-2020	Project: dike reinforcement
	Project control manager	20-5-2020	
	Contract manager	19-5-2020	
	Stakeholder manager	15-5-2020	
	Technical manager	26-5-2020	
	Project manager	28-5-2020	Project: expansion of a highway intersection
	Project control manager	15-5-2020	
	Contract manager	18-5-2020	
	Stakeholder manager	13-5-2020	
	Technical manager	26-5-2020	
	Project manager	18-5-2020	Project: expansion of a highway trajectory including intersections, railway viaducts, and a bridge
	Project control manager	20-5-2020	
	Contract manager	15-5-2020	
	Stakeholder manager	20-5-2020	
	Technical manager	29-5-2020	
	Director Production and Project Management	30-6-2020	Parent organization
	Head of department Project Control	2-7-2020	
	Advisor Project Control	2-7-2020	
	Head of department Technical Management	3-7-2020	
	Director Network Development	3-7-2020	

Fourth, we presented the preliminary findings of our study to the collective of risk management advisors as mentioned in step 1 in an online meeting in August 2020. We invited these advisors to discuss our preliminary findings to nuance and corroborate them. This largely validated the analysis of the risk treatment process, confirmed the preliminary conclusions on the limited diversity of risk treatment selection and led to the finalization of the results as presented below.

RESULTS: PREDOMINANCE OF CONTROLLING RISK THROUGH PREVENTIVE MEASURES

Risk Treatment in Public Infrastructure Projects

The document analysis showed that the full risk files of the 13 selected projects contained a total of 1836 risks. The majority of the risks, 58% to be precise, was *controlled*. A common remark in the first interview set in relation to these projects was that "we are actually mainly trying to reduce the likelihood of occurrence and consequences of a risk", which confirms the focus on controlling risk. Subsequently, we examined the

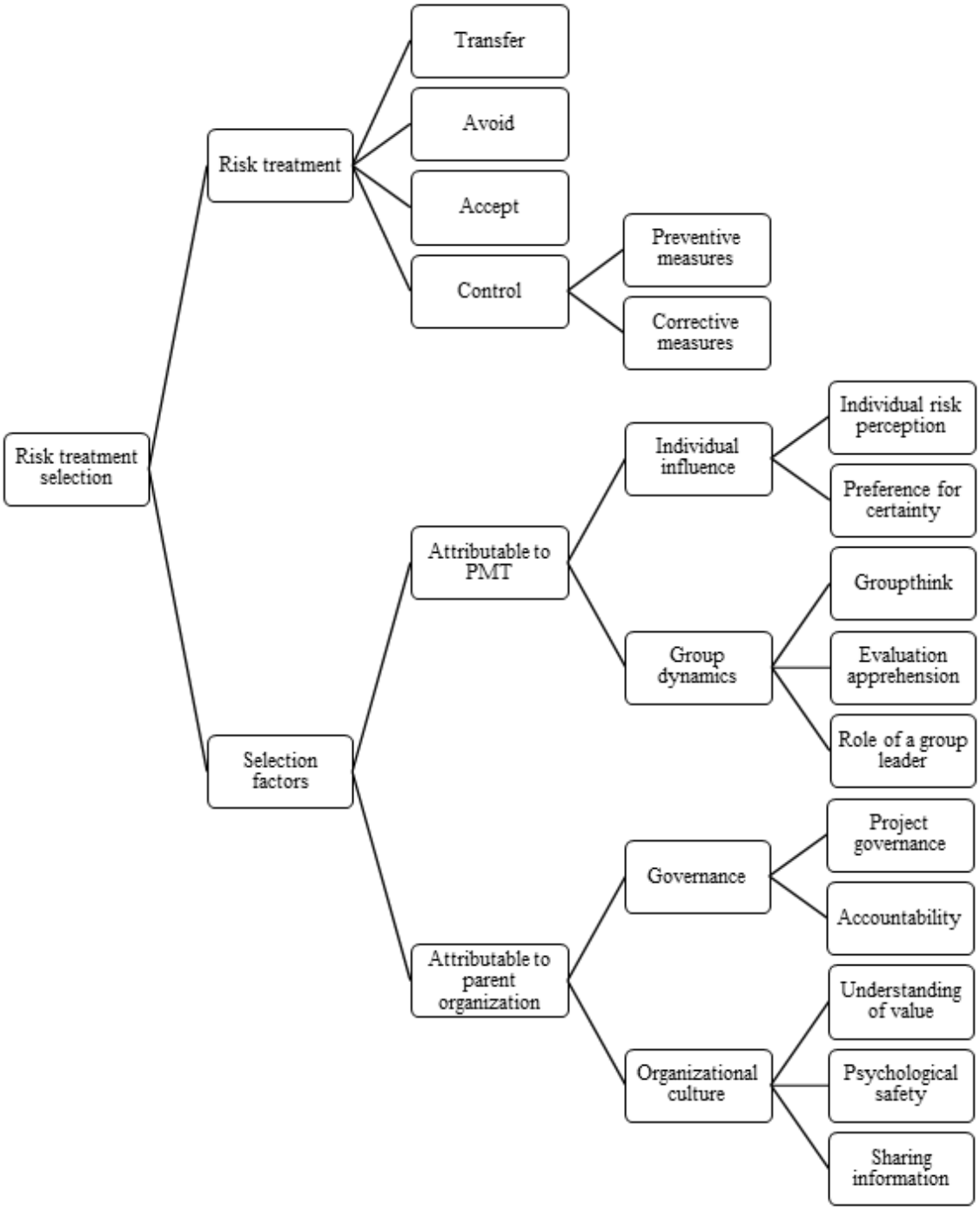

Figure 1: Code tree

balance between *preventive* – reducing likelihood – and *corrective* control measures – reducing consequences. The risk files revealed that 90% of all control

measures focused on reducing the likelihood of risks materializing. These findings from the risk files were corroborated by the interviews with the PMT members of these projects: 12 out of 15 interviewees expressed a preference for preventive control measures. Interviewee 13 argued that "prevention is better than the cure". Other interviewees gave similar motivations or argued that taking preventive measures was a routine rather than a deliberate decision.

The other 42% of the risks was *transferred* to a contractor or intended to be transferred in projects that were still in the preparation phase. Although risks can be transferred, this does not always mean that they cannot affect the client organization anymore. For example, to case that all possible control measures have been taken and that a risk is still present; we then accept this residual risk".

Regarding the process of risk treatment selection Interviewee 4 stated that "the choice between the four management strategies is not an explicit decision in our team". In line with the findings regarding the selection of preventive control measures, other interviewees from PMTs here too indicated that they did not always deliberately select a specific risk treatment. Some interviewees even argued that they were not aware of the different risk treatments at all. A seemingly unwitting routine to control risk resulted in risk files that often contained one or more control measures per risk. In large projects with many risks, this sometimes resulted in an overwhelming amount of control measures that had to be implemented and monitored. Maintaining an overview compensate poor cost estimates, a contractor can limit personnel, which can affect stakeholder management and subsequently result in claims from stakeholders towards the client organization. Of the transferred risks, 90% was considered to still possibly affect the studied client organization. Therefore, PMTs continued to monitor these risks once they were transferred.

We did not find any risks that were registered as *avoided*. We did find examples that indicated *accepting* risk. However, this concerned *residual risks*, not initial risks. Interviewee 12, but also interviewee 7 and 8, stated that "in the planning phase you do not really want to accept risks. In the realization phase, it may well be the

seemed complicated and "it is difficult to keep everybody engaged with a very large risk file with many control measures." (Interviewee 11).

In sum, risk treatment in the practice of public infrastructure projects in our study predominantly concerned controlling risk with a clear preference for preventive measures above corrective measures. The findings indicate that this preferred treatment was generally chosen without a deliberate decision to do so. Even if risks were transferred, they were still generally considered to possibly affect the organization and therefore continued to be monitored by the parent organization.

Factors Affecting Risk Treatment Selection in Public Infrastructure Projects

Selection Factors Attributable to the Project Management Team

During the interviews with PMT members, *differences in perceptions* towards risk became visible. For example, some interviewees indicated to be quite willing to accept risks, while other interviewees indicated a strong need to control risk as much as possible. PMTs seemed to be aware of these differences as multiple interviewees stated that there were often discussions about the size of risks and how the risks should be handled. Representing the view of multiple interviewees, Interviewee 2 argued that "we appreciate our collective risk sessions because they make it possible to enter into dialogue and where necessary there is also room for criticism." Interviewee 12 added that "if a risk owner scales a risk high in terms of chance and consequence, then this risk owner is challenged to justify to the group why 'his risk' has to score this high". Group sessions in which all participants engaged constructively were considered a valuable instrument for nuancing individual over- and underestimation of risk. Hence, the results of the interviews show that in these public infrastructure PMTs differences in risk perception are recognized and embraced. *Groupthink* and *evaluation apprehension* did not seem to be an issue. This also indicates that the role of a *group leader* is relevant, especially in guiding the discussion as the aforementioned project control manager, for example, did during a risk session.

Interestingly, the perception towards risk seemed to vary across different types of risk. Interviewees appeared to be more inclined to see *technical risks* as controllable. For example, Interviewee 15 argued that "technical risks are generally not assessed as exogenous, they often relate to issues that the PMT can affect. This is different with stakeholder risks, where the influence is sometimes minimal". This notion recurred more often in the data, especially with regard to technical risks, such as risks relating to soil and underground infrastructure. Interviewees, for example, indicated that further soil investigation often reduces the risk considerably because additional information enables a more reliable design and execution plans, and thereby reduces the likelihood of risk materializing. This tendency to act on risks that are considered controllable by taking preventive measures does underline the *preference for certainty*.

In sum, PMTs seem to recognize and embrace different perceptions towards risk within their teams as this was considered to improve risk evaluation. Additionally, there seems to be a tendency to view technical risks as more controllable than, for example, stakeholder risk.

Selection Factors Attributable to the Parent Organization

Multiple interviewees from both PMTs and the parent organization explicitly stated that the focus to control risk is part of the *organizational culture*. Several explanations were given. Interviewee 19, for example, stated that the organization "must guarantee the water safety of the Netherlands and takes little risk in doing

so. This philosophy is deeply rooted and culturally embedded. As a result, the project team wants to be in control as much as possible". Interviewee 1 added that "it is unpleasant to accept as a PMT that you are not in control, accepting risks does not fit in this image". Additionally, Interviewees 16, 19, and 20 mentioned an intrinsic drive within the organization to "make the most of it" and accepting risk, or doing nothing to reduce risk, does not seem to correspond to this *understanding of value*. Opposing the current understanding of value is experienced by many PMT interviewees as precarious: not experiencing *psychological safety* seems to hamper *sharing of information*. Hence, these results seem to demonstrate that the organizational culture strongly affects risk treatment selection by PMTs. In the case of the studied public infrastructure agency, this resulted in a preference for controlling risks instead of avoiding, accepting or transferring them.

Regarding *project governance*, the risk file plays an essential role in how the project's progress is monitored. "The risk file is a means of communication that is often used during interactions with the parent organization, as well as with the environment of the project" as Interviewee 11 stated. Moreover, the risk file is an input document for project planning and budget, which necessitates the expression of risk in terms of time and money. Although multiple interviewees in the PMTs stated that it can be difficult to quantify risk due to uncertainty and unpredictability, much effort was paid to providing quantifications because it enhanced project control. From the perspective of the parent organization, this allowed project progress to be monitored and facilitated comparisons among projects. An interviewee in the parent organization added that these quantified risks are used in the preparation of contracts, which indicates that the risk file containing quantified risks is also used as a steering tool for various other applications. The importance of the risk file also makes it essential to keep it properly organized and up-to-date, at least regarding the top risks. Interviewee 2 stated that "as a PMT, you want to show that you are fully engaged with these top risks".

The feeling that PMTs have to show active control of risk is strengthened by the *accountability* sentiment that was often mentioned by interviewees in the context of being a public organization. All related projects are financed with public governmental funds. "The fact that you deal with taxpayers' money means that you always have to be able to justify yourself" (Interviewee 18), implying a moral and political imperative to use public resources responsibly. Interviewees stated that this makes it difficult to accept a risk that has financial consequences when it materializes. For example, "if a risk is taken and this risk materializes, parliamentary questions might be raised on what the costs were" as Interviewee 18 argued. The majority of the interviewees mentioned that this public accountability aspect definitely plays a significant role in the risk treatment selection by PMTs.

In sum, because of the history of the studied public infrastructure agency in ensuring water safety, controlling risk is deeply rooted in the organizational culture of this Dutch parent organization. Correspondingly, the project governance

in this public project-oriented organization appears to be focused on being in control. Such a project governance is additionally fed by the perceived accountability for adequately spending governmental funds which seemed to direct risk treatment towards controlling risk.

DISCUSSION: ENABLING MORE DIVERSITY IN RISK TREATMENT SELECTION IN PUBLIC INFRASTRUCTURE PROJECTS

The results from our study imply that risk treatment in public infrastructure projects focusses on controlling risks predominantly through preventive control measures. As far as risks are transferred, they are generally considered to still possibly affect the parent organization and therefore continue to be monitored. *Accountability* and *understanding of value* seem important factors for this focus on controlling risk. These factors affect *individual risk perception* and subsequently the aggregated risk perception of PMTs. As such, our study confirms earlier studies that public organizations are often risk averse (Chen and Bozeman 2012; Paape and Speklé 2012). Although PMTs also intentionally control risk through preventive measures, the decision to do so is often implicitly taken and seems to be an involuntary manifestation of risk aversion rather than a deliberate choice. Hence, based on our insights on the factors that influenced these risk management practices, we conclude that PMTs seem to have developed an unwitting routine to control risk due to a risk-averse organizational culture. In this section we discuss four implications of these results and provide suggestions - thresholds for risk acceptance, balancing risk methods, addressing public concerns more explicitly and discussing the efficiency of public funds - to enable more diversity in risk treatment selection in practice and future research.

Thresholds for Risk Acceptance

As stated in the theoretical section, there is consensus in the literature that a balance between controlling and accepting risk calls for a centralized approach that sets out a clear view on how risks should be managed throughout the organization (Gordon et al. 2009; Liu et al. 2013; Wu and Olson 2010). In this light, the absence of guidelines for risk-taking behavior and the present credo "better safe than sorry" within the studied organization possibly explains the tendency to control risk. The COSO-ERM framework provides guidelines on how risk management can be structured throughout an organization (Wu and Olson 2010). In the financial industry, where frameworks such as COSO-ERM have a firm foothold, the trade-off between controlling and accepting risk is predominated by risk thresholds (Mikes 2011). These risk thresholds are derived from a risk appetite statement, which is entirely qualitative and formulated by the board of the organization, indicating the amount of risk an organization is willing to accept in its pursuit of value (COSO 2012). Here, risks are quantified using models and then examined to see whether they exceed the threshold. Risks below the threshold are accepted and risks that exceed the threshold are controlled. Hallowell et al. (2013) showed that in several state transportation departments COSO-ERM

allowed risk throughout the organization to be managed more efficiently and consistently. We suggest further research into the contribution of such standards to balance between controlling and accepting risk in public sector organizations through a more explicit understanding of value and its relationship with individual preference for certainty and accountability.

Balancing Qualitative and Quantitative Risk Management

The Achilles' heel of using quantitative approaches in risk management is the need for reliable and 'complete' data (Zhao et al. 2015) and adequate methods that capture "the true picture of risk quantification" (Farooq et al. 2018, 425). Our insights on this similar issue align with the findings of Van Staveren (2018) and Perminova et al. (2008), pointing out that quantification is difficult when there is a large amount of uncertainty. Moreover, Van Winsen et al. (2016) underlined the importance of the attitude towards risk in guiding risk management over the amount of risk faced. Several scholars (e.g., Dyer 2017; van Staveren 2018) therefore call for a more qualitative form of risk management with less attention towards quantification and more room for recognition of uncertainties. This, however, conflicts with the risk-averse attitude of the studied organization and its employees. We also found that for a substantial part of the risks, the current risk management approach seems to work well. For example, the opportunities to monitor project progress, compare projects, and its use in contract preparations were appreciated and the studied PMTs did not seem to experience issues with groupthink and evaluation apprehension. Further research into an approach that balances qualitative and quantitative risk management by preserving project steering information and at the same time allowing to cope with risks that are difficult to quantify would be valuable.

Taking Public Concern into Account on an Organizational Level

Risk management standards like COSO-ERM and ISO 31000 point out the importance of PMT decision making on risk treatment (Aven 2016). Our study shows various factors influence PMT decision making and that especially the accountability sentiment is important in public organizations. As an aggregate of individual risk perceptions, PMTs assume that they need to extensively control risk to ensure that, in case something goes wrong, managers and politicians can justify that everything has been done to prevent risk from materializing. In line with Hinna et al. (2020, 125), risk management "is not creating the conditions for 'protecting and justifying' possible errors of public organizations", rather risk management is used to give an account of the measures taken to mitigate risk. This seems to originate from an organizational culture of risk aversion. However, organizational culture affects individuals as much as it is constructed by individuals themselves (Dressel 2015; Chen and Bozeman 2012). Since projects are temporary, task-oriented constructs (Gemünden et al. 2018), the parent organization seems to be the entity that has to break the vicious circle of individuals and organizational culture affecting each other, for example by introducing guidelines for risk-taking behavior throughout the organization.

This could enable PMTs to deliberately choose the optimal risk treatment in correspondence to the explicit risk attitude of the organization. Such entrepreneurial public organizations should be transparent about risks, i.e. recognize and communicate that risks are sometimes poorly controllable, and, as Kim (2010) suggested, occasionally take losses without having immediate political consequences. Moreover, Fellenor et al. (2020) argued that considering public concern as a homogenous object, thereby neglecting its multifaceted nature, results in inadequate policies. Being more specific in recognizing and addressing public concern could also be beneficial to choosing the optimal risk treatment.

Efficient Use of Public Resources

Accepting risks may requires hardly any action but entails uncertainty for achieving the predefined results within the set conditions, because these risks may still materialize (ISO, 2009; Van Staveren, 2018). Corrective measures are prepared before a risk materializes, but are only effectuated once risk materializes (Van Staveren, 2018). Hence, both accepting risk and taking corrective measure may initially take little project management resources. Contrastingly, taking preventive measures does always consume project management resources either with or without a risk, partially or completely, materializing (Van Staveren, 2018). Moreover, a focus on controlling risk can result in risk files that expand to a point where the file becomes hard to oversee due to the number of control measures as our study shows. This effect shows similarities with over-management as described by Power (2009) and Van Staveren (2018) and reduces the efficient use of project management resources. According to Ward (1999), the control potential must always be taken into account when managing risk because, even when a risk is high, trying to control risk is a waste of project management resources if there is no control potential, especially in the complex setting where public infrastructure projects take place. Relating to the issue of accountability, this raises the question whether it is an efficient use of public resources to invest in, possibly an overload of, preventive measures or to reserve resources for risks that occasionally materialize. It would be worthwhile to investigate this further.

CONCLUSIONS

In our study, we aimed to characterize risk treatment selection by Project Management Teams (PMTs) in public infrastructure projects. We found that the diversity in risk treatment selection is limited. Risk treatment in public infrastructure projects focusses on *controlling risk* predominantly through *preventive* control measures. As far as risks are *transferred*, they are generally considered to still possibly affect the organization and therefore continue to be *monitored*. Furthermore, we analyzed how various factors attributed to the PMTs (*individual influence* and *group dynamics*) and their parent organization (*organizational culture* and *governance*), influence the risk treatment selection in practice. Whereas literature generally suggests a deliberate consideration of different risk treatments, our study shows that the limited diversity in risk treatment selection seems to be an involuntary manifestation of risk aversion rather than

a deliberate choice.

Although PMTs of public infrastructure projects also intentionally control risk through preventive measures, the results show that the decision to do so is often implicitly taken and constitutes an unwitting routine that PMTs seem to have developed due to a risk-averse organizational culture. Professionals in public infrastructure projects experience hardly any space for mistakes or risk-taking behavior and feel the need to be in full control. They want to do things right. Consequently, PMTs appeared to hardly consider and discuss other risk treatments that could be more efficient. Paradoxically, the intention to optimally use public resources may actually result in suboptimal use of public resources.

Our study contributes to the literature on risk management in projects by giving prominence to an unwitting routine of PMTs of public infrastructure projects to control risk predominantly through preventive measures. As our study was limited to one particular infrastructure organization in the Netherlands, we recommend further research on risk treatment selection in similar organizations to be able to generalize findings. Further research in other types of organizations or in sectors other than construction would contribute to providing insight in the completeness and importance of the particular factors affecting risk treatment selection by PMTs.

Our study indicates particular challenges that public project-oriented organizations need to overcome, the most important being issues with an organizational culture of risk aversion. This paper provides suggestions to cope with such challenges based on literature and directions for further research. Explicit guidelines for risk-taking behavior and a more diverse and balanced approach towards risk treatments seem useful for risk management practices that connect to the dynamic and complex environment of public infrastructure projects.

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