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Developing a generic risk maturity model (GRMM) for evaluating risk management in construction projects

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ABSTRACT

The literature on risk management acknowledges a growing number of Risk Maturity Models (RMM). However, for the construction sector, there is no validated RMM that is based on both theory and experts' opinions. In this article, a Generic RMM (GRMM), inspired by the EFQM model, is developed and validated to remedy this shortcoming. The GRMM uses a list of statements extracted from risk management literature by means of qualitative content analysis. The statements and the model are both validated by means of two focus group sessions, based on which the statements and the model are improved. According to the experts, the GRMM is easy to use and provides projects with a clear picture of potential improvements regarding risk management. Project managers can use the GRMM for planning and improving risk management, as well as for cross-project analysis for learning purposes. Further research on application of the GRMM in real projects is recommended.

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1. Introduction

The occurrence of risks, either positive (opportunity) or negative (threat), is unavoidable in projects because projects are surrounded with uncertainties (Murray 2009). Many researchers and practitioners believe that risk management increases the possibility of project success (Ren and Yeo 2004; Schwindt and Zimmermann 2015; Yeo and Ren 2009; Global 2004; Olechowski et al. 2016; Chapman and Ward 2003; Flyvbjerg, Bruzelius, and Rothengatter 2003; Hillson 2006; Holzmann and Spiegler 2011; Cagliano, Grimaldi, and Rafele 2015). Over the past decades, risk management has increasingly received attention (Raz and Hillson 2005; Hillson 2006; Yaraghi and Langhe 2011; Verbano and Venturini 2011). Despite this, risk management practices are either not implemented thoroughly, or can still be improved in several ways (Olechowski et al. 2016; Dyer 2016; Mu et al. 2014; Yaraghi and Langhe 2011). Those organizations that have tried to integrate risk management into their business processes have reported various degrees of success (Bosler 2002).

Organizations wishing to implement a formal approach to risk management (or to improve their existing approaches) require a clear definition of objectives, proper planning and resourcing, and effective monitoring and control. Additionally, these organizations need a tool that can help them to identify the areas of improvement and to measure the progress in improving risk management (Bosler 2002; Yeo and Ren 2009). A risk maturity model (RMM) is such a tool that can be used for this purpose.

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An RMM aims to measure the maturity of risk management in projects and/or organizations. Maturity in terms of risk management means an evolution towards the full development of risk management processes (RIMS). RMMs help to improve the risk management processes in projects (Schiller and Prpich 2014). A major benefit of an RMM is the possibility to identify the areas of strengths and weaknesses in risk management (Yeo and Ren 2009; Bosler 2002; Zou 2010; Strutt et al. 2006; Macgillivray et al. 2007; Loosemore et al. 2006; Wendler 2012). Yeo and Ren (2009) state that there is a close link between risk management maturity and success of projects. Identifying the maturity of risk management can contribute to minimizing costs and improving profitability (Zou 2010; Oliva 2016).

Despite the suggested capabilities of RMMs, the development of RMMs is still subject of discussion (Jia et al. 2013). Wendler (2012) studied 237 articles in maturity models in more than 20 domains. The results reveal that, despite the increasing number of maturity models, most models are not empirically validated. A similar conclusion is drawn by Tarhan, Turetken, and Reijers (2016). Furthermore, Wendler (2012) mentions that the theoretical reflections of the maturity models are mostly missing. Therefore, there is a need for an RMM that is based on sound theoretical and empirical foundations. Such an RMM is presented in this article and its applicability and approach are validated.

This article is structured as follows. Section 2 discusses the research background and formulates the research objectives. In Section 3, a description of the methods used in the research is given. Next, in Section 4, the development of a new RMM for the construction projects is presented. Section 5 explains the validation of the model based on two focus group sessions. Next, in Section 6, the improved model is discussed and compared with other models. Finally, in Section 7, conclusions are drawn, and in Section 8, recommendations are given for further research and the use of the model in practice.

2. Research background and problem formulation

The term *maturity* for a project is known as a measurement concept that demonstrates progress in development (RIM; Loosemore et al. 2006; Cienfuegos Spikin 2013; Öngel 2009). Maturity in terms of risk management indicates an evolution towards full development and application of the risk management process. Linked closely with continuous improvement, risk management maturity expresses the degree of formality and application of risk management activities (RIM).

The concept of maturity models is rooted in the field of quality management and can be traced back to the quality revolution of the 1970s (Macgillivray et al. 2007; Wendler 2012; Strutt et al. 2006). Two early maturity models are Nolan's model and Crosby's Quality Management Maturity Grid (QMMG) (Wendler 2012; Mu et al. 2014). During the last decade, several maturity models were expanded to other domains (Wendler 2012; Kwak et al. 2015). The European Foundation for Quality Management (EFQM), the INK (the Dutch version of the EFQM) model, and the Project Excellence Model (Westerveld 2003) are some examples of maturity models.

The past decade also saw the development of several RMMs. Table 1 compares 13 RMMs in terms of type and number of the maturity levels. Despite the differences among the available RMMs, they all consist of two common components. First, RMMs define a set of levels that describe the evolvement of a project in risk management. These levels present sequential and hierarchical progression, which are connected. A project achieves a new level of maturity when a new system of practices, not present at lower levels of maturity, has been established. The second component refers to the measured objects: the capabilities or attributes. This means RMMs have to define criteria for measurement such as conditions, processes, and application targets (Wendler 2012; Cienfuegos Spikin 2013).

The models in Table 1 contain either four or five levels of maturity. The models are either in the form of an attributes-maturity level matrix, a questionnaire or a combination of an

Table 1. List of risk maturity models.

Source	Maturity levels	Type
Risk Maturity Model (Hillson 1997)	Four	Attributes-maturity level matrix
Project Management Maturity Model (Crawford 2006b)	Five	Attributes-maturity level matrix
Risk Management Maturity Model (RMMM) (Bosler 2002)	Four	Attributes-maturity level matrix
IACCM Business Risk Management Maturity Model (IACCM 2003)	Four	Questionnaire and attributes-maturity level matrix
Risk Management Capability Maturity Model (Yeo and Ren 2009)	Five	Questionnaire
PMI's Risk Management Maturity Model (Loosemore et al. 2006)	Four	Attributes-maturity level matrix
Project Risk Maturity Model (Hopkinson 2012)	Four	Questionnaire
Risk Management Capability Maturity Model (Macgillivray et al. 2007)	Five	Attributes-maturity level matrix
Risk Management Maturity Model (Zou 2010)	Four	Questionnaire
Construction Risk Management Maturity Model (Öngel 2009)	Four	Questionnaire
The Alarm National Performance Model for Risk Management in the Public Services (ALARM 2009)	Five	Questionnaire and attributes-maturity level matrix
Risk Maturity Model for Dutch municipalities (Cienfuegos Spikin 2013)	Five	Questionnaire
RIMS Risk Maturity Model for ERM (RIMS 2015b)	Five	Questionnaire

attributes-maturity level matrix and a questionnaire. The attributes-maturity models are in the form of a table in which the attributes are presented in the first column and the levels in the first row. The table provides explanations for each attribute in each level. The user can select a level of maturity based on the explanations provided for each attribute. A project achieves a certain level if all processes have reached or exceeded a certain level (Schiller and Prpich 2014).

The models with questionnaires request detailed questions to be answered. The user can select a score between 1 to 4 or 1 to 5, depending on the level of maturity. In the combined models, the attributes-maturity level matrix is used to better score the questions in the questionnaire. The more mature a project is in risk management, the more steps of risk management are implemented (Cagliano, Grimaldi, and Rafele 2015).

Most of the RMMs examined in this research do not clarify in which industry the model should be used. Among the studied models in Table 1, only three models explicitly mention the sector in which the model may be used; the models by Öngel (2009), Loosemore et al. (2006) and Zou, Chen, and Chan (2010) were designed specifically for construction projects. In addition, the origin of the statements or the aspects used in the models in Table 1 is indistinct. Most of the available RMMs are merely based on the experience of the authors and suffer from a lack of theoretical background (Wendler 2012). Some RMMs do not cover all risk management steps. This is an important shortfall of the RMMs, as they are supposed to check the extent to which risk management is applied in projects. Furthermore, as also addressed by Wendler (2012) and Tarhan, Turetken, and Reijers (2016), most RMMs are not validated. Together, this results in weaknesses in these models, which in turn could result in a skewed picture of a project's risk maturity. To overcome these shortcomings, this research develops a Generic RMM (GRMM) for the construction sector, based on sound theoretical and empirical bases. Furthermore, expert opinions from those involved in construction projects are used to validate the model. The objective of this study is twofold:

1. To develop a generic RMM on solid theoretical and empirical bases, covering the most important activities of risk management.
2. To have the model and its benefits validated by risk management experts.

The research aims to answer the following research question:

What are the validated elements of a Generic Risk Maturity Model for construction projects?

This research contributes to the current literature by developing an RMM that addresses the shortcomings of other models. It covers all relevant activities of risk management and adopts a more holistic view on risk management. The practitioners can use the GRMM for improving risk management and cross-project analysis for learning purposes.

3. Method

To achieve the research objectives, the research was performed in two parts: a theoretical part consisting of Qualitative Content Analysis (QCA) on selected literature and an empirical part by means of focus groups. The theoretical part deals with the first research objective while the empirical part deals with the second one. The results of the theoretical part are inputs for the empirical part. The overall research design is presented in Figure 1.

In the theoretical part of the research, 12 risk management guidelines (RMG), 13 RMMs, and 5 articles dealing with lessons learned (LL) about applying risk management were examined. By using QCA, the risk management statements mentioned by most of these sources are extracted. QCA is a method, which describes the meaning of qualitative data systematically. The method is performed by breaking the qualitative data down to coding frames which cover the features of the qualitative data (Schreier 2014). Next, the GRMM was developed as an interactive Excel file using the extracted statements from the literature.

In the empirical part of the research, the statements as well as the GRMM were tested by performing two focus group sessions. In the first focus group, only the statements extracted from the literature in the theoretical part were tested. In the second focus group, in addition to evaluating the statements, the experts were asked to evaluate the model design. The purpose of performing focus groups is to check the extent to which the statements in the GRMM cover the reality of risk management practice. A focus group is a research approach in which attitudes, opinions or perceptions towards a matter are tested on the interaction within a group (Langford and McDonagh 2003; Asbury 1995). A focus group is chosen because it enables the gathering of rich qualitative data.

The focus group sessions were held in the Netherlands with participants from diverse groups of experts. Morgan (1993) discerns two group definition characteristics: 1. *break* characteristics, those that differentiate groups from each other and 2. *control* characteristics, those that groups have in common (Morgan 1993). To fulfill the *control* characteristic, the participants for both

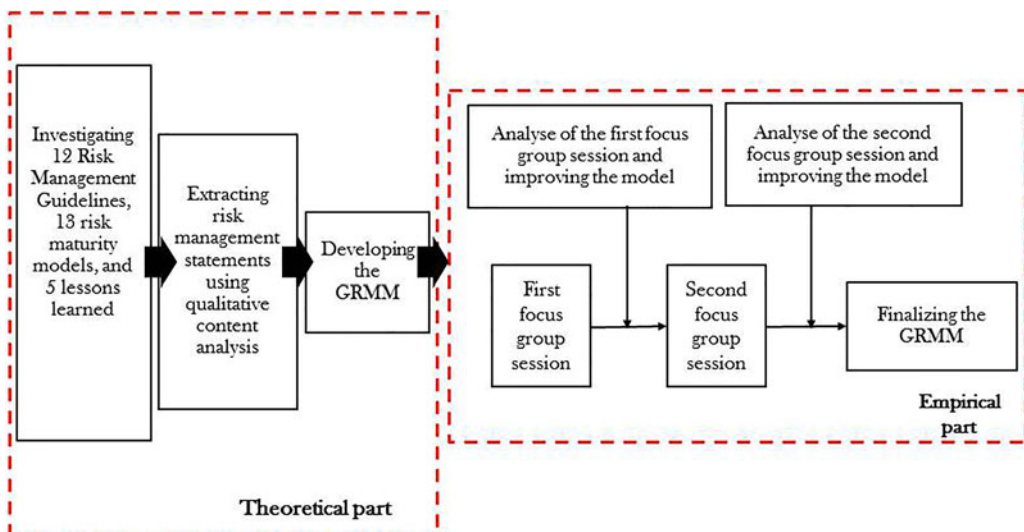


Figure 1. Research design.

focus groups are selected based on their familiarity with risk management in projects. For the first focus group session, the researchers contacted a group of experts in the Netherlands known as the Special Interest Group in Probabilistic Risk Analysis (SIGPRA). The experts in this group work in both public and private companies and meet regularly to discuss the experiences and developments in risk management. The participants in the first focus group session were selected from both clients and contractors to fulfill the *break* characteristic of the group. For the second focus group session, the participants are selected among the risk managers of a consultant company, which provides risk management services to both client and contractor companies (and hence are familiar with the requirements of both groups regarding risk management).

In the first focus group session, the experts' opinions were asked about the *clarity* and *completeness* of the statements in the GRMM. The experts were provided with printed statements of the models in two forms: *Individual* and *Group* forms. The experts were asked to work individually first and give their comments in the *Individual* form about the statements they felt were unclear or should be removed. In addition, the experts were asked to add statements if needed in the space provided on the *Individual* forms. In this way, statements which the experts felt were missing could be added. Next, the experts were divided into sub-groups of three persons and asked to select a list of the most important statements they felt should be added or removed, and write them down in the *Group* form. In this way, the experts had to argue within their groups as to why a statement should be added or removed. This step was followed by a plenary session during which the experts were asked to discuss the comments they had written down on the *Group* forms. Each sub-group read the list of selected statements, followed by discussions between the sub-groups about their comments on the statements.

The second focus group session included the same steps as the first focus group session, and in addition, the experts were provided with the GRMM Excel file. The experts were asked to work individually with the GRMM in Excel. They were asked to score a recent project in which they were involved and, while doing so, to examine the model with regard to clarity and completeness of the statements as well as convenience and ease of use. The experts were given the *Individual* form so they could provide their opinion about the clarity and completeness of the statements. In addition, they were given the *Group* form so they could decide for each sub-group whether a statement should be added or removed. This process had also been used in the first focus group. In addition, a list of questions was provided to each expert, based on criteria defined by Kolfshoten (2007), to check the GRMM for completeness, usefulness, understandability, ease of use, willingness to use GRMM again, and need for improvement. At the end, plenary discussions were held and the experts' opinions were gathered about the statements and the model.

For both sessions, the experts were informed beforehand that they were supposed to examine an RMM, without being provided with further information. Both sessions started with a short presentation about risk management maturity and RMMs in general, followed by a brief introduction about the newly developed GRMM. In both presentations, only the framework of the model was provided; the statements were not explained. Afterwards, the experts were instructed how to examine the model. Each focus group session took about 1 hour, with two facilitators present for each session. The first focus group session was held with nine experts and the second one with seven experts. During the first session, one of the facilitators wrote down the important discussion points. During the second session, besides taking notes, the session was also recorded (audio only). All forms (i.e. *Individual* form, *Group* form, and the list of questions), notes, and audio recording were analyzed afterwards.

4. Theoretical part: model development

First, the development of the GRMM is explained. Next, the selection of the statements is explained. Finally, the proposed application of the GRMM is discussed.

4.1. Developing the generic risk maturity model (GRMM)

The GRMM is inspired by the European Foundation of Quality Management (EFQM). The EFQM model is established to assess a project organization's progress towards excellence (Qureshi, Warraich, and Hijazi 2009). The EFQM model has the same intention as RMMs, despite their different focus areas. Several scholars have shown that the EFQM can also be adjusted for projects (Westerveld 2003; Westerveld and Walters 2001; Bryde 2003). Moreover, the EFQM follows the Plan, Do, Check and Act (PDCA) cycle, which insists on repeatable implementation of the model. This characteristic is comparable to the continuous application and improvement characteristic of risk management.

Figure 2 presents a schematic model for the GRMM, which is a customized model of the EFQM. Risk management literature shows that two conditions should be in place in order to successfully apply risk management in a project. The first condition addresses any activities that ensure that risk management can be performed in a project (e.g. training, culture, policy and strategy and commitment towards risk management) (ISO, ISO31000 2009; BSI and IEC 2001). These activities fall under the *Organizational* category in the GRMM. The second condition addresses the activities related to applying risk management (e.g. identifying risks, applying control measures, monitor and review). These activities are addressed by the *Application and Process* category in the GRMM. The *Organizational* category in the GRMM is comparable to the *Enablers* area in the EFQM. Activities in this category are the steps a project needs to take in order to implement risk management. The *Application and Process* category is comparable to the *Results* area of the EFQM model since it measures the results of risk management application.

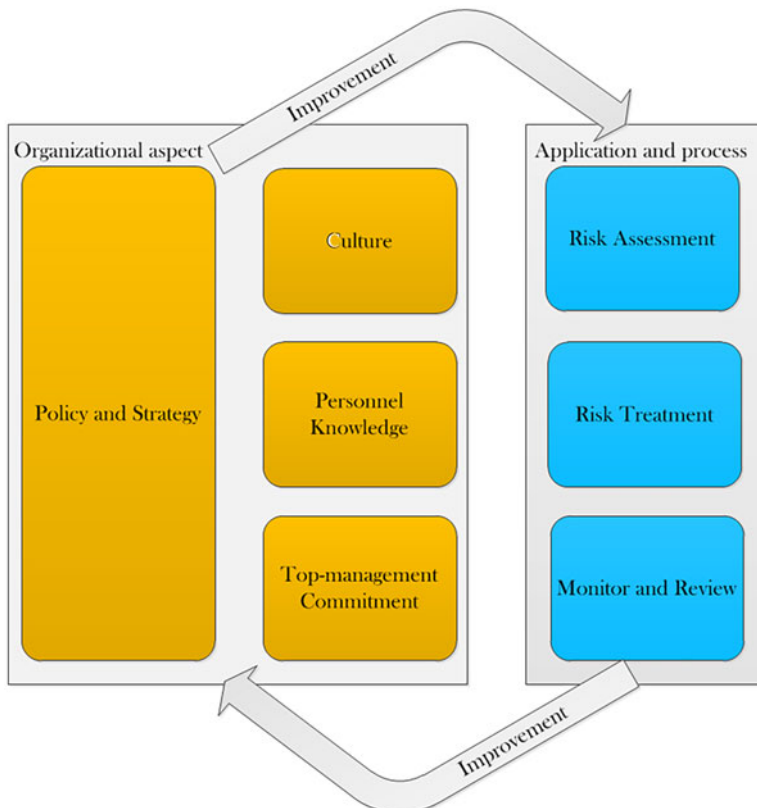


Figure 2. The GRMM framework.

On a deeper level, the *Organizational* category of the GRMM contains four aspects, adjusted from the EFQM model:

1. *Policy and Strategy*, which is comparable to *Strategy* aspect in the EFQM model. The aspect focuses on the availability of a risk management policy in a project. This enables effective implementation of risk management. Risk management policy specifies the processes, methods, and tools to be used for managing risks (ISO, ISO31000 2009; Global 2004).
2. *Culture*, which can be compared to *Partnership and Resources* in the EFQM. The aspect emphasizes building a risk-aware culture within a project and by all the stakeholders (FERMA 2002). Hillson and Simon (2007) mention the individuals' attitudes toward risks, organization risk culture, and combination of theoretical knowledge, and effective behaviors and attitudes as success factors for risk management.
3. *Personnel Knowledge*, comparable to the *People* aspect in the EFQM. This aspect focuses on the availability of skilled and competent staff, training, and allocation of appropriate resources (COSO 2004; BSI and IEC 2001; Van Well-Stam, Lindenaar, and van Kinderen 2004).
4. *Top-management Commitment*, comparable to the *Leadership* aspect in the EFQM. This aspect highlights the role of top-management in the introduction of risk management and ensuring its on-going effectiveness (Loosemore et al. 2006; ISO, ISO31000 2009; Hillson and Simon 2007).

These four aspects cover the 19 risk management success criteria as mentioned by Yaraghi and Langhe (2011).

The *Application and Process* category contains the steps of the risk management process as mentioned by several standards and guidelines (PMI 2013; ISO, ISO31000 2009). This category checks the application of risk management given the availability of the aspects in the *Organizational* category. This category has three aspects:

1. *Risk Assessment*. This aspect covers all activities related to identifying, quantifying, formulating, and prioritizing risks etc.
2. *Risk treatment*. This aspect contains activities such as selecting a response strategy, implementing the control measures, considering residual and secondary risks etc.
3. *Monitor and Review*. This aspect is about controlling previous steps, identifying new risks and updating the status of risks, and control measures.

The feedback loops between the two categories in the GRMM reflect on the continuous improvements based on the result of the GRMM application in both categories (*Organizational and Application and Process*).

4.2. Extracting the statements for the GRMM

A list of RMGs was selected to extract the important statements in risk management (Table 2). These resources are well-known RMGs, selected based on studies by Raz and Hillson (2005), Koutsoukis (2010) and RIMS (2011), who compared several RMGs. Furthermore, a list of articles dealing with LL of successfully applying risk management in construction projects was selected through a scan of recent literature (Table 2). The LLs are investigated to extract the activities that can lead to successful application of risk management. In addition to these resources, the RMMs provided in Table 1 are further examined to extract the statements, in case any were not mentioned in RMGs and LLs.

By means of QCA, the statements mentioned by most of these references were selected. Table 3 provides the statements with their reference to the literature. Table 4 and Table 5

Table 2. List of 12 RMP sources and 5 LL sources selected.

RMG sources	LL sources
(PMI 2013)	(Marcelino-Sádaba et al. 2014)
(ISO, ISO31000 2009)	(Hertogh et al. 2008)
(FERMA 2002)	(Greiman 2013)
(COSO 2004)	(Staveren 2009)
(Hillson and Simon 2007)	(Staal-Ong et al. 2016)
(Van Well-Stam, Lindenaar, and van Kinderen 2004)	
(Chapman 1997)	
(Murray 2009)	
(Canadian Standards Association 1997)	
(Global 2004)	
(BSI 2000)	
(BSI and IEC 2001)	

provide the list of risk management statements for each aspect. To remove some duplications and to resolve ambiguity, the formulation of the statements was adjusted. The GRMM consists of 58 statements in total.

4.3. The GRMM application

The GRMM is presented as an interactive Excel document, with a separate sheet for each of the aspects (Policy and Strategy, Culture, etc.). The extracted statements for each aspect (as shown in Table 3 and Table 4) are linked to the corresponding aspects. The user scores the statements in each aspect by awarding it a score of 10, 7, 4, or 1. The final score of a specific aspect is equal to the average of the scores of the statement in each aspect.

There is a long discussion in literature regarding the optimal number of response categories or scale points. A key consideration in the number of response categories is whether the scale should be odd or even (Darbyshire and McDonald 2004). Garland (1991) shows that presenting a midpoint in the Likert Scale causes distortion since the respondents have a tendency to select this middle point. Earlier, Matell and Jacoby (1972) advised on minimizing the usage of a mid-point category and propose to either not include it at all or use scales with many points so respondents feel less inclined to choose the middle point. Following Matell and Jacoby, we propose an even point scale avoiding a middle point for the GRMM.

The nature of responses in a scale can be divided to *agreement*, *evaluation*, and *frequency* (Spector 1992). The statements in the GRMM fall under the category *evaluation*. For evaluating the risk management implementation, four response choices were selected in this study. Each statement in risk management can be evaluated by applying one of the following descriptions: *not applied*, *limitedly applied*, *to a large extent applied*, or *totally applied*. Having fewer than four response choices does not cover risk management implementation completely, whereas more than four does not have sufficient added value. These response choices are used to make a verbal four-point scale with the above possibilities as the definition of each score. A verbal scale prevents ambiguity with regard to the actual meaning of each point (Spector 1976).

For assigning values to the four-point scale, two criteria are considered. Spector (1976) shows that in a Likert Scale, response categories with equal intervals should be used (criterion 1). The second criterion is that if the information is gathered at the interval level of measurement, a two-sided, balanced scale must be used (either with or without a mid-point), so that the negative points on the scale mirror positive points on the scale (Spector 1976). We decided to show the score of the statements in the GRMM between 1 and 10 in a verbal four-point scale. To fulfill the criteria, the scale of 1 to 10 is divided into three equal intervals, with the negative points mirroring the positive points as follows: 1 (not applied), 4 (limitedly applied), 7 (to a large extent applied), 10 (totally applied).

Table 3. List of the statement extracted based on RMMs and RMGs, and LLS.

Aspect	Extracted statements	References
Policy and strategy	Understand and define internal context	1*2*3*4*5*6*7*8*9*10*11*1**
	Understand and define external context	1*2*3*4*5*6*7*8*9*10*11*12*1**
	Organization Commit resources for Risk Management	1,3,4,7,8,9,10,11,12,1*2*3*4*5*6*7*8*9*10*11*12*1**3**4**
	Risk management purposes in line with organization/ project purposes	4,7,13,12*3*3*5*6*7*8*10*11*12*1**3**
	Decide the appropriate level of RM (risk thresholds)	4,8,11,12,1*2*3*4*5*7*8*10*12*1**3**
	Appropriate mechanisms for sharing risk amongst those best placed to manage them	7,11*2*2**4**
	A documented framework of risk management processes	2,3,5,6,7,8,9,10,11,13,1*2*5*6*7*8*10*11*12*1**5**
	Define RM tools and techniques	3,12,1*2*5*6*7*8*12*4**
	Availability of a clear mechanism for external/ internal communication and reporting	3,1*2*3*4*5*6*8*10*11*12*1**3**4**
	Availability process for deciding the project reserve	2,10,11*3*7*8*9*10*11*12*2*3**5**
Top-management commitment	Database for collecting historical information about risk management	2,10,1*2*10*11*12*2*5**
	Define the frequency of monitor, reviewed and reporting	7,9,1*2*3*4*5*6*8*10*12*1**
	Risk Management is encouraged and supported by the top management	1,3,4,5,6,7,9,10,11,12,13,3*4*8*10*11*2**4**5**
	Communication of goals and strategies of risk management	4,13,1*10*
	Top management reviews risk management reports actively to make decisions	2,3,6,7,9,10,11,12,8*
	Establishing clear accountability and responsibility of roles for managing risks	11,13,1*2*3*4*5*6*7*8*10*11*12*2**4**
	Availability of a Risk management plan	7,1*2*5*6*7*9*10*11*12*1**3**
	Integration of risk management with other project management processes	2,4,6,7,10,11*2*3*4*5*6*7*10*11*12*2**3**5**
	Regular (internal or external) training to enhance skills	1,3,4,5,6,7,10,11,12,2*3*4*10*11*3**4**
	Availability of experienced team responsible for risk management	1,3,4,10,12,2*4*9*10*11*12*2**
Personnel knowledge	Use of external experts and services in risk management	1,3,6,8,10,12,4*9*11*
	Involved staff exhibit an appropriate level of competence in application of risk management	3,4,8,9,2*4*7*9*10*11*12*4**
	Personnel's understand and belief in the benefits of risk management	1,3,4,5,6,9,10,11,3*4*4**5**
	Project is flexible and willing to change	1,3,5,6
	No blame culture and accepting that people make mistakes	3,6,11,10*11*2**
	Team members trust and openness in reporting risks to internal and external stakeholders	6,7,9,1*10*12*2**3**4**5**
	Alignment of risk management attitude and goals of personnel with the organization	4,1*3*
	(Strong) teamwork (with internal and external partners)	2,3,5,6,7,8,9,10,11,12,13,1*2*3*4*6*7*8*9*10*11*12*2**3**4**
	Risks and opportunities are identified proactively based on different objectives and methods	2,3,5,6,7,8,9,10,11,12,1*2*3*4*5*6*7*8*9*10*11*12*1**2**3**4**
	Dividing risks based on different classification	1*3*5*6*7*8*9*11*12*2**
Risk assessment	Key external stakeholders as well as company professionals participate in risk identification	3,5,6,8,9,10,12,13,1*2*3*4*5*6*7*8*9*10*11*12*1**2**3**5**
	Qualitative and quantitative risk analysis	2,6,9,11*2*3*4*5*6*7*8*9*10*11*12*2**5**
	Comparing the estimated risk against risk criteria and prioritizing risks	1*3*4*5*6*7*8*9*10*11*12*1**3**
	Identify list of potential responses	2,4,7,11,12,1*2*3*4*5*6*7*8*9*10*11*12*1**2**3**
	Selection of an appropriate risk strategy for each risk	2,5,6,7,9,11,13,1*2*3*4*5*6*7*8*9*10*11*12*1**2**5**
	Nominate risk owner with authority and responsibility for each risk	4,5,6,1*2*4*8*10*11*12*2**3**5**
	Sharing risks (both internally and externally)	7,1*2*4*5*6*7*8*9*10*11*12*1**3**
	Preparing risk treatment plan	7,1*2*4*5*6*7*8*9*10*11*12*1**4**
	Implications of planned risk responses	7,1*2*3*4*5*6*7*8*9*10*11*12*1**2**
	Considering residual and secondary risks	

(continued)

Table 3. Continued.

Aspect	Extracted statements	References
Monitor and review	Regular evaluating and improving Risk management process Post- project assessment and Capturing lesson learned Routine and consistent application of risk management Check actual progress against risk treatment plan and update of risk management plan The whole process is documented Regularly communicating and reporting relevant risk information to the key stakeholders Regularly communicating and reporting relevant risk information to the organization management	1,3,5,6,7,8,9,11,12,1*2*3*4*5*6*7*8*9*11*12*3** 2,4,5,6,7,11,1*2*3*4*5*6*7*8*10*11*12*1**3**4** 1,3,7,9,11,13,1*2*3*4*5*6*7*8*9*10*11*12*1**2**3** 1,2,3,7,9,10,11,12,1*2*3*4*5*6*7*8*9*10*11*12*1**2**4** 1,2,4,5,7,11,12,13,1*2*3*4*5*6*7*8*9*10*11*12*1**2**3**4** 1,2,3,4,6,7,9,10,11,13,1*2*3*4*5*6*7*8*9*10*11*12*1**2**3** 1,3,4,6,7,9,10,11,13,1*2*3*4*5*6*7*8*9*10*11*12*1**2**3**
RMM sources:	1 = (Hillson 1997), 2 = (Crawford 2006b), 3 = (Bosler 2002), 4 = (IACCM 2003), 5 = (Yeo and Ren 2009), 6 = (Loosemore et al. 2006), 7 = (Hopkinson 2012), 8 = (Macgillivray et al. 2007), 9 = (Zou 2010), 10 = (Öngel 2009), 11 = (ALARM 2009), 12 = (Cienfuegos Spikin 2013), 13 = (RIMS 2015b).	
RMG sources:	1* = (PMI 2013), 2* = (ISO, ISO31000, 2009), 3* = (FERMA, 2002), 4* = (COSO 2004; Moeller, 2007), 5* = (Hillson and Simon 2007), 6* = (Van Well-Stam 2004), 7* = (Chapman 1997), 8* = (OGC, 2009), 9* = (Canadian Standards Association 1997), 10* = (Global 2004), 11* = (BSI 2000), 12* = (BSI and IEC, 2001).	
LL sources:	1** = (Marcelino-Sádaba et al. (2014), 2** = (Hertogh et al. 2008), 3** = Greiman (2013), 4** = Staveren (2009).	

Table 4. Extracted statements for the category organizational.

Aspect	Statements
Policy and Strategy	Understand and define internal context Understand and define external context Project organization Commit resources for Risk Management Risk management purposes in line with organization/ project purposes Decide the appropriate level of RM (risk thresholds) Appropriate mechanisms for sharing risk amongst those best placed to manage them A documented framework of risk management processes Define RM tools and techniques Availability of a clear mechanism for external/ internal communication and reporting Availability process for deciding the project reserve Database for collecting historical information about risk management Define the frequency of monitor, reviewed and reporting
Top-management Commitment	Risk Management is encouraged and supported by the top management Communication of goals and strategies of risk management Top management reviews risk management reports actively to make decisions Establishing clear accountability and responsibility of roles for managing risks Availability of a Risk management plan Integration of risk management with other project management processes
Personnel Knowledge	Regular (internal or external) training to enhance skills Availability of experienced team responsible for risk management Use of external experts and services in risk management Involved staff exhibit an appropriate level of competence in application of risk management
Culture	Personnel's understand and belief in the benefits of risk management project is flexible and willing to change No blame culture and accepting that people make mistakes Team members trust and openness in reporting risks to internal and external stakeholders Alignment of risk management attitude and goals of personnel with the organization (Strong) teamwork (with internal and external partners)

5. Empirical part: GRMM validation

This section describes the results of the empirical part of the research, which is the validation of the GRMM. This section elaborates on the results of each focus group session, the experts' remarks and the consequent improvements in the GRMM.

5.1. Analysis of the first focus group

In the first focus group session, the statements of the GRMM were validated with nine experts. Details about the experts are provided in Appendix, [Table A1](#). First, the comments provided in the *Individual* forms, filled by each participant, were examined and the remarks and feedback were recorded. Next, the *Group* forms were analyzed and the comments recorded, and afterwards, the comments made during the plenary discussion were reviewed. If the experts indicated a statement should be removed while that statement was mentioned in several pieces of literature, we did not apply the experts' comments.

Based on the comments received, the experts agreed with most of the statements. Only some of the statements were modified and a few were removed. An example of a removed statement is 'risks are shared with external parties' from the *Risk Treatment* aspect, which received the most comments; six out of nine experts stated that this statement was not necessary. Examples of remarks among the comments are '*depends on the goal of your risk management*' or '*[it] depends on the contract [and] not always possible*'. During the plenary session, the contractor group explicitly mentioned that they will not share their risks with other parties: '*we will share top 5 or top 10 risks, but not all of the risks*'. However, the client groups had no problems in sharing the risks. This statement was replaced with the statement 'the risk register containing the risks related to the project is shared between client and contractor' (see [Table 5](#)).

Table 5. Extracted statements for the category application and process.

Aspect	Statements
Risk Assessment	Risks and opportunities are identified proactively based on different objectives and methods Dividing risks based on different classification Key external stakeholders as well as company professionals participate in risk identification Qualitative and quantitative risk analysis Comparing the estimated risk against risk criteria and prioritizing risks
Risk Treatment	Identify list of potential responses Selection of an appropriate risk strategy for each risk Nominate risk owner with authority and responsibility for each risk Sharing risks (both internally and externally) Preparing risk treatment plan Implications of planned risk responses Considering residual and secondary risks
Monitor and Review	Regular evaluating and improving Risk management process Post- project assessment and Capturing lesson learned Routine and consistent application of risk management Check actual progress against risk treatment plan and update of risk management plan The whole process is documented Regularly communicating and reporting relevant risk information to the key stakeholders Regularly communicating and reporting relevant risk information to the organization management

Table 6. List of added statements to the model.

Aspect	Added statements
Policy and Strategy	The organization/ project has a defined risk matrix for quantifying probability and consequence of risks (in time, cost, quality)
Risk Treatment and Mitigation	The cost/ time of the most important rest risks (after applying the control measures) are considered as cost/ time contingency A cost/ time contingency is assigned for the unforeseen risks based on the complexity and size of the project The risk register containing the risks related to the project is shared between client and contractor
Monitor and Review	Cost/schedule documents are updated based on the status of risks Probability and consequences of active risks are updated based on the risk matrix of the organization

Some of the statements were modified based on the first focus group. For example, with regard to the statement 'the risk appetite of the organization/project is communicated to the external and internal stakeholders', both the client and the contractor participants indicated that they would not share their risk appetite with other parties. Treasury (2004, p. 49) defines risk appetite as 'the amount of risk that an organization is prepared to accept, tolerate or be exposed to at any point in time'. One participant responded, 'internally [sharing the risk appetite] yes, but externally sharing is not necessary' or 'I do not know if I would tell my contractors about my risks appetite'. Therefore, this statement was modified to '... communicated internally'. Similarly, regarding the statement 'there is an internal or/and external training to enhance skills', one of the experts said: 'not as necessary, though external input is often refreshing' or 'it does not need to be external per se and it can be internal as well'. Based on the comments, this statement was adjusted to 'the personnel receive training for enhancing risk management skills'. Some comments were also made with regard to the statement 'risk and opportunities are identified'. One expert stated: 'Whether or not this is needed, depends on your definition of risk management. Strictly, thus, it is not needed'. PMI (2013) indicates that risk can be both positive (opportunity) and negative (threat). To clarify this statement, the word 'opportunity' was removed and instead, we mentioned in the introduction sheet of the model that the model focuses on negative (threat) as well as positive (opportunity) risks.

Besides these changes, six statements were added to the model based on the experts' inputs (Table 6).

In addition to the statements, the experts were also asked (in both the Individual and Group forms) whether an aspect needed to be removed or changed. The only comment about the

aspects was about *Risk Treatment*. One of the experts suggested that this aspect should be changed to *Risk Treatment and Mitigation*. This comment was applied, since the combination of ‘treatment and mitigation’ reflects the statements in this aspect better. The experts recognized all aspects in the GRMM without further remarks. During the plenary session, the experts confirmed that the GRMM seems helpful in improving risk management.

5.2. Analysis of the second focus group

During the second focus group session, seven participants tested the statements – which had been revised based on the first focus group session – as well as the GRMM. Details about the experts are provided in Appendix. The comments regarding the statements and the model were analyzed separately following the same procedure as was used for the analysis of the first focus group session.

Compared to the first focus group session, the experts provided few comments about the statements, mainly about clarity and certainty of a few statements. No suggestions were done to remove a statement. Like the first focus group, the experts did not provide any remarks regarding the two categories, and as such, no remarks regarding the aspects in each category. Only the statement ‘the project is flexible and willing to change’ received some comments. The experts felt that the words ‘flexible’ and ‘change’ are ambiguous, and a project might not be flexible but could nevertheless perform well in applying risk management. This statement was removed from the final list. Table 7 provides the validated statements of the GRMM after the two focus group sessions. The final number of statements is 51.

Regarding the use of the GRMM, we received positive feedback and some experts began discussing the scores they had awarded to the same project. Based on the answers to the questions about the method and use of the model, most of the experts acknowledged that the GRMM is easy to work with. Moreover, the experts mentioned that the GRMM provides a good picture of the status of risk management in a project. Most of the experts confirmed that the model helps with better application and improvement of risk management. One of the experts stated ‘*[the GRMM] provides insight about where the possibilities are to improve in [risk management] maturity*’. One of the experts declared that ‘*the model opens the subject for discussion*’. Another participant stated that ‘*[the GRMM] quickly provides an insight [with regard to risk management] and helps with steering [risks]*’. Similarly, another participant said that ‘*[the GRMM] provides possibilities for discussion and suggestions for improvement*’.

We also asked the experts about the system of scoring, and most of them agreed that the scoring accurately expresses the situation of risk management application in a project. The experts indicated that they would be willing to implement the model in their projects.

In addition to the positive comments, the experts provided two additional remarks regarding weight factors and ambition in risk management improvement. In both focus group sessions, experts mentioned that the importance of the statements should not be considered equally, since not all statements are equally important for all projects. To address this concern, a column called *Importance* was added to the model. The user can select the importance of each statement for the project using the same scoring method as for the evaluating the maturity of the statements (10 (very important), 7 (important), 4 (less important), and 1 (not important)). The score of importance adds a weight factor to each statement: the statements with a higher importance have more impact on the final score of each aspect in the GRMM. The following formula is used to calculate the maturity score for each aspect (Equations 1 and 2).

$$N = \sum_{i=1}^j \text{importance}_i \quad (1)$$

$$\text{Total maturity score} = \sum_{i=1}^j \text{Score}_i \times \frac{\text{importance}_i}{N} \quad (2)$$

Table 7. Validated statements of the generic risk maturity model.

Aspect	Statements after the focus group sessions
Strategy and policy	<p>The project commits resources (tools, personnel, training, etc.) to risk management</p> <p>Risk management objectives are defined and documented</p> <p>Risk management objectives are in line with project objectives</p> <p>The risk appetite of the project is defined and documented</p> <p>The risk appetite document of the project is internally communicated and available</p> <p>The project has a documented process for risk management</p> <p>The risk management tools and techniques to be used in the project are defined and documented</p> <p>The project has procedures to report risk management to external and internal stakeholders</p> <p>The project has a database for collecting the information about risk management</p> <p>The project has a defined risk matrix for quantifying probability and consequence of risks (in time, cost, quality, etc.)</p> <p>Risk management is integrated in project management approach of the project</p> <p>There is a procedure for deciding risk reservation in the project</p> <p>The procedure for deciding risk reservation is based on the defined risk appetite of the project</p>
Top-management commitment	<p>Management encourages and supports risk management within the project</p> <p>Management communicates goals and strategies of risk management within the project</p> <p>Management asks for risk management information and reports</p> <p>Management uses risk management reports to make decisions</p> <p>Management defines roles (with authority and accountability) to perform risk management process within the project</p>
Culture and personnel knowledge	<p>The project team understands the necessity of risk management (risk management is not seen as an additional burden)</p> <p>There is no blame culture and the project organization accepts that people make mistakes</p> <p>The project team has trust and openness in reporting risks</p> <p>The project team is aware of his risk attitude</p> <p>The personnel receive training (if needed) to improve risk management skills</p> <p>There is an experienced team/person responsible for risk management</p>
Risk assessment	<p>Risks are identified and the type, cause, possible consequences and phase of the risks are described in the risk register</p> <p>Key external stakeholders (besides the key internal stakeholders) participate in risk identification</p> <p>Probability and consequences of identified risks are quantified based on the risk matrix of the project</p> <p>Quantitative risk analysis (for both time and cost) is performed</p> <p>There is a risk owner (either internally or externally) for each risk who is responsible for that risk</p> <p>Important risks for treatment and mitigation are identified based on the risk appetite of the project</p> <p>The entire risk assessment process is performed based on the project risk management process</p> <p>The risk assessment outcome is documented and communicated to internal and (if needed) external stakeholders</p>
Risk treatment and mitigation	<p>Per risk a control measure based on different strategies (reduce, avoid, transfer, and accept) is defined</p> <p>Secondary risks after applying control measures are considered</p> <p>The costs of control measures are considered in the project costs</p> <p>The time of control measures are considered in the project schedule</p> <p>Residual risks after applying control measures are quantified and considered</p> <p>The cost/ time of the most important residual risks are considered as cost/ time contingency</p> <p>A cost/ time contingency is assigned for the unforeseen risks based on the complexity and size of the project</p> <p>Control measures are applied</p> <p>The whole risk treatment and mitigation process is based on the project risk management process</p>

(continued)

Table 7. Continued.

Aspect	Statements after the focus group sessions
Monitor and review	The risk treatment outcome is documented and communicated to internal and (if needed) external stakeholders
	The contractor risks, identified by the client, are communicated to the relevant contractors
	Status of the control measures are updated (in progress, applied, not applied yet)
	Status of risks are updated in the risk register (active, managed, occurred)
	New risks are added to the risk register and the previous steps are repeated for the new risks
	Cost/schedule documents are updated based on the status of risks
	Probability and consequences of active risks are updated based on the risk matrix of the organization
	Lessons learned (occurred risks, performing risk management, etc.) are recorded
	The entire monitor and review process is based on the project risk management process
	The outcome of monitor and review process is documented and communicated to internal and (if needed) external stakeholders

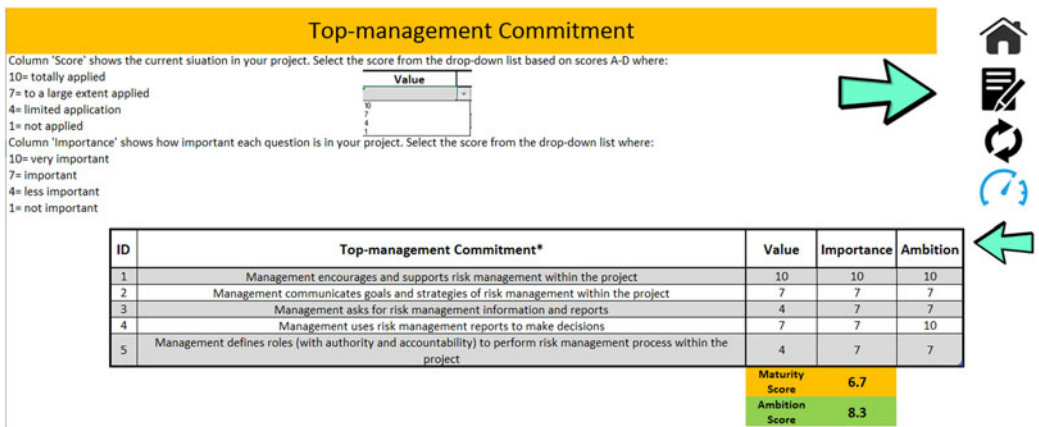


Figure 3. Appearance of the GRMM.

Where N represents the summation of the score for the importance, j is the number of statements. The score_i looks at the maturity score of statement i .

Another comment that was made, related to the ambition of a project in improving risk management. The expert mentioned that the model only looks at the current situation of risk management, while the ambition of a project to improve in risk management is overlooked. To address this concern, a column named *Ambition* was added to the model, again to be scored with 1, 4, 7 or 10 (with higher scores reflecting more ambition). In this way, the GRMM can also measure the ambition level of risk management in a project, in addition to the current level. The ambition score of each aspect is calculated in the same way as explained in Equations 1 and 2 with the score_i showing the ambition score of statement i .

As an example, Figure 3 shows an overview of the GRMM for the aspect *Top-management Commitment*. Some symbols are provided on all pages of the model to help the user to navigate through the model. The home symbol takes the user back to the starting page, where an explanation about the model is provided. The dashboard symbol takes the user to the results of the model and the green arrows can be used for navigating to the previous and following pages.

6. Discussion

The GRMM presented in this article aims to help practitioners in construction projects by evaluating and improving risk management. In addition, it can be used for cross-project analysis for learning purposes. The results of both focus group sessions confirmed that the GRMM provides insight about the current situation of risks management in a project. In addition, it facilitates a discussion about risk management improvement between the project members.

The GRMM covers the limitations of other RMMs, that is, the lack of theoretical and/or practical background and the lack of validation of the models. Because of the weight factors per statement, the GRMM is suitable for use in all types of construction projects regardless of their size. The GRMM measures the ambition of projects in risk management application. This feature enables projects to create a clear picture about their desired risk management status, in addition to understanding the current situation of risk management. This way, by evaluating and benchmarking risk management, the projects' ability to plan for improvements is enhanced. In addition, the GRMM focuses explicitly on both positive and negative risks. These features make the GRMM a generic RMM.

The GRMM contains risk management statements extracted from 12 RMGs, 13 RMMs and 5 LLs, and the opinions of practitioners are considered in its development as well. This is a clear difference with the existing RMMs examined in this article, which do not mention the origin of their statements. Wendler (2012) indicates that not all models have a theoretical background and the attributes decided on for these models are based on the experiences of their developers. Bosler (2002) states that an RMM should appreciate the nature of the risk management process. Some of the examined models (e.g. model number 1, 3, 4, 6, 7 and 8 in Table 1), however, only consider parts of the risk management process. Therefore, these models cannot thoroughly identify weaknesses and strengths of applying risk management in projects.

Furthermore, the current RMM models do not present a realistic picture of the implementation of risk management. For example, the aspects considered in the highest level of maturity in the attributes-maturity models do not contain exactly the aspects in the lower levels (e.g. in the model by Bosler (2002), the concern of 'risk budget allocation' is considered in level three but not in level four). It seems that there is an unwritten rule applied in these models that a higher maturity level can only be achieved when the lower levels have already been achieved (only model no. 7 explicitly mentions this concern). With this 'rule', it is difficult for the projects to find their position in these maturity models, which complicates the real situation of risk management application. A similar argument is applicable to the models that use a questionnaire. In these models, again, hidden 'rule' applies and, hence, the user is not provided with a valid picture of risk management application. In addition, the results in these models are not always an integer number. Usually, the models come with another unwritten rule to round off the non-integer number and provide the user with a level of maturity that does not fully reflect the project's true situation. In fact, in both types of the models, the model's make-up presents the user with a level of maturity that the user is forced to choose a level of maturity that might not reflect the reality of a project.

Many models try to specify a set of fixed situations for each level and explain the situation of all projects based on these specific descriptions. But: projects are unique, and the same situation might not be applicable to all projects. Since the main goal of an RMM is aiding projects in identifying their strong and weak areas of performing risk management, we argue that the existence of a specific level does not add value. Instead, the projects need to know their current risk management situation and compare it to the desired situation for continuous improvement. Therefore, unlike other models, the GRMM, does not have any maturity level, and instead uses an explicit scoring system. Hence, the GRMM does not limit the user to one of four or five levels of maturity. Instead, the maturity score can be any number between 1 and 10. Based on the

maturity and ambition scores gained for each aspect, the user decides whether the score is considered sufficient, and whether or not an improvement is required.

The examined RMMs in this paper consider all statements as being equally important. However, not all of the statements may be applicable to a project, or some may be more important than others given the context of the project. Hillson and Simon (2007) mention that not all projects require the same level of risk management and a 'one size fits all' approach does not apply to all projects. This concern was explicitly mentioned during the first focus group session where the client and contractor expressed different opinions about a number of statements. Therefore, GRMM uses an adjustable weighting factor so that the user can decide which statement is more important and applicable to a particular project. This capability of the GRMM makes it a generic model applicable in small, medium and large construction projects.

It is important for a project to know where it stands regarding risk management, but it is also important to know what it wants to reach. The GRMM's ability of measuring ambition is another point that distinguishes it from other models. Crawford (2006a) explains that the final level of maturity is not desired for every project. Each project needs to determine the minimum level of maturity at which the desired value is achieved and determine the value associated with achieving the next level (Crawford 2006a). The same situation is applicable to the GRMM. Before implementing the model in a project, the appropriate score for that particular project should be decided upon. The project team should decide where they want to be in risk management by filling out the ambition score in the GRMM, and next, they should strive for continuous improvement until the desired goal is reached. Selecting a specific score as the goal of a project is crucial, because a project cannot come up with proper improvement measures if it does not have a goal.

7. Conclusion

This article presents the development and validation of a GRMM for the construction industry that can help projects gain a full, realistic picture of their risk management application. This research has contributed to the available literature by bridging the research gap in the field of RMM: there was a lack of an RMM based on both theory and experts' opinions, validated on the statement level as well as the overall model level.

With regard to answering the research question, the statements for the GRMM were extracted by means of QCA, from different risk management resources. These statements have been divided into two main categories of *Organizational* and *Application and Process*. The *Organizational* category contains four aspects of *Policy and Strategy*, *Top-management Commitment*, *Culture and Personnel Knowledge*. The category *Application and Process* contains the aspects of *Risk Assessment*, *Risk Treatment and Mitigation*, and *Monitor and Review*. The aspects, the statements, and the model were tested in two focus group sessions. The aspects (*Policy and Strategy*, *Top-management Commitment*, etc.) and the statements are elements of a generic RMM. Experts stated that the GRMM helps project by identifying strong and weak areas of risk management, and felt it provided a realistic picture of risk management in a project. They also indicated that it facilitates discussion about improvement of risk management in a project. The firm theoretical background of the GRMM and inclusion of the practitioners' views make it different from other, currently available RMMs.

8. Recommendation for future research

The research creates need for future research. A limitation of this study is the fact that only the opinions of professionals in the construction industry of the Netherlands have been considered, therefore, expanding the research to cover an international scope could be considered. Another

recommendation for future research is the application of the GRMM in real construction projects and to compare the risk management improvement areas across different projects.

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Appendix

Table A1. Details about the experts who took part in the focus groups.

First focus group session		Second focus group session	
Role	Years of experience	Role	Years of experience
Senior adviser risk manager	18	Risk manager	20
Functional project control	9	Risk manager	3
Manager cost Engineer	40	Risk manager Senior adviser	12
Senior contract manager	10	Risk manager	8
Risk manager	5	Risk manager	13
Cost Engineer/ business analyst	2	Risk manager adviser	2.5
Risk manager	16	Risk management adviser	5
Cost Engineer	17		
Cost manager	30		