Suggestions for Implementing Geotechnical Risk Management

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ABSTRACT: Without doubt, geotechnical engineering is a key success factor for most construction projects. Currently, risk management gets more and more attention in these projects. Nevertheless, with geotechnical risk *analysis* becoming common practice, the routine application or implementation of geotechnical risk *management* still is an unexplored area. After numerous debates over the last years, about *why applying* geotechnical risk management in construction projects, a new major question emerges within the geotechnical community: *How implementing* geotechnical risk management effectively, efficiently, and persistently in construction projects?

The Dutch Delft Cluster Research Programme *Implementing Risk Management* investigates the hurdles and conditions for successfully implementing risk management in organizations. First, by theory, data and investigator triangulation, these hurdles and conditions have been identified, analyzed, clustered and synthesized into seven key hurdles and ten key conditions for effectively *applying* geotechnical risk management. The result triggered another research question: Are these key hurdles and key conditions also appropriate for actually *implementing* geotechnical risk management within organizations?

Therefore, the next research phase consisted of identifying, selecting, and combining innovation management variables and theories with those of risk management. The key hurdles and key conditions for geotechnical risk management have been synthesized and classified into two main implementation dimensions: (1) geotechnical risk management methodologies and (2) organizations routinely using geotechnical risk management. This paper presents the key conditions for implementing geotechnical risk management in organizations in a conceptual model, together with two main implementation suggestions.

In conclusion, the research results demonstrate that the organizational dimension, which is usually entirely neglected, is of key importance for realizing the routine application of geotechnical risk management methodologies throughout all of the phases of construction projects. The synthesis of innovation management and risk management concepts and variables increases the chance for more effective, efficient, and persistent organizational implementation of geotechnical risk management in construction projects. This may dramatically strengthen the geotechnical role in, and contribution to, the successful completion of engineering and construction projects within our societies.

1 INTRODUCTION

The growing interest for risk management in construction projects is paramount. For example, on November 1, 2007, leading Dutch organizations signed a joint agreement for rigorously implementing risk management within the construction industry. By the year 2012, three ministries, the four largest cities, and the national organizations of contractors and consulting engineers aims fully applying risk management in eighty percent of the projects in the Netherlands. Expected benefits are less failure costs, less time delays, and a reduction of the number of disputes, by building trust, increasing transparency, and improving communication between all construction project parties. Therefore, it is promising that over the years, at least in the large and complex projects, the application of geotechnical risk analysis seems becoming common practice.

However, contrary to other papers, this paper does *not* introduce any new or updated methodologies for applying geotechnical risk analysis or geotechnical risk management. While still rather limited, the amount of literature about geotechnical risk management is growing. For example, for *generic* geotechnical risk management methodologies reference is made to Clayton (2001) and Van Staveren (2006).

Moreover, there is an increasing amount of literature covering *specific* geotechnical risk analysis and management topics. Examples of these are the difference between unsafe geotechnical certainty and safe geotechnical uncertainty (Barends, 2005), the role of the human factor in achieving geotechnical reliability (Bea, 2006), objective and subjective ways of geotechnical risk classification (Altabba et al., 2004), and contractual allocation of geotechnical risk (Essex, 2007).

Unlike most other papers, this paper focuses on *implementing* existing geotechnical risk management methodologies in organizations. Implementation is here simply defined as the *routinized application* of risk management during the entire design and construction process. Implementation thus differs highly from often incidentally application of risk analyses within construction projects.

For instance, Halman (2008) addresses the importance of *implementing* risk management in the Dutch construction industry. The need for particularly implementing geotechnical risk management in organizations in the construction industry has been raised by Smith (2008). A workshop of the US GeoCouncil, in December 2006 with a group of fifty geoprofessionals, revealed that currently the main areas of attention in the construction industry are innovative contracting, safety, cost analyses, and research, development, and training. Attention to these trends should contribute to providing better, faster, and cheaper solutions to geotechnical problems in construction projects. Geotechnical risk management was considered as the best chance for meeting these demands in *each* of the trend areas (Smith, 2008).

Obviously, geotechnical risk management should be *routinely* applied, and thus be well implemented within organizations, for materializing benefits. However, the author's experience teaches that even when geotechnical professionals and their managers *say* that they are applying geotechnical risk management in engineering and construction projects, often they are not actually *doing* it in an explicit and well-structured way. Moreover, even if they do it in that explicit and well structured way, they often execute more of a risk *analysis*, rather than executing the full risk *management* cycle within each and every project phase.

By conventional "hit and run" risk management of doing one or two analyses, the potentially large benefits of routinely applying geotechnical risk management remain hidden. This results in missed opportunities, for instance saving lives of construction workers by reducing unsafety, increasing profits by reducing failure costs, and speeding up the construction process by reducing delays. Similar to quality management (Imai, 1989), a *cyclic* approach with continuous attention to improving "little things" is required for effective geotechnical risk management (Van Staveren, 2006). This requires full implementation within (project) organizations.

Therefore, after many debates over the last years, about *why* to *apply* geotechnical risk management in construction projects, now a new type of question emerges within the geotechnical community: *how* to *implement* geotechnical risk management effectively in construction projects? This how-question seems even more difficult to answer than the previous why-question. For instance, how to relate discipline-based geotechnical risk management to project risk management in construction projects?

Therefore, this paper addresses a yet highly underestimated topic: How to realize a *routine use* of geotechnical risk management during planning, engineering, and construction of all sorts of buildings and infrastructure projects?

To date, there appeared to be no literature covering this topic, despite its utmost relevance. Any scientific research and resulting practical guidance about *how* to implement risk management in general is very scarce. Concerning *geotechnical* risk management in particular, research and guidance is entirely lacking. Therefore, there seems to emerge a free market paradox of high knowledge demand with no knowledge supply. The implementation of geotechnical risk management is still an unexplored area of research.

The practical research project *Implementing Risk Management* of the Dutch Delft Cluster Research Programme aims to answer the question of *how* to implement risk management in organizations in the construction industry. This research project is performed by involving researchers of the unit GeoEngineering of Deltares (formerly known as the Dutch National Institute for GeoEngineering, GeoDelft), the unit Innovation and Environment of TNO, the Technology, Policy, and Management faculty of the Delft University of Technology, and the Construction Management and Engineering research group of the University of Twente, Netherlands. The research will be completed by the end of the year 2009. However, recent research results for successfully implementing geotechnical risk management in organizations are readily available to be shared with the international geotechnical community.

One of the innovative research approaches of the *Implementing Risk Management* project is considering the implementation of risk management in organizations a sort of *innovation*. If new to (part of) an organization, fostering the routine application of geotechnical risk management in (part of) the organization proved to have a lot in common with implementing innovations in organizations, such as geotechnical quality systems or software for geotechnical design. These organizations are either a temporary project organizations for realizing a construction project, or well-established firms.

After this necessarily comprehensive introduction, this paper continues with presenting the research approach. Then, the research results about risk management, innovation management and their synthesis for implementing geotechnical risk management are presented. This generates the suggestions for implementing geotechnical risk management, the very core of this paper. It ends with the main research conclusions.

2 RESEARCH APPROACH

2.1 *Introduction.*

This chapter briefly presents the research *approach* for investigating the implementation of geotechnical risk management in (project) organizations. These organizations involve people, who work together for realizing common goals. In the construction industry, the common goal is usually realizing projects according to pre-set quality specifications, and within budget and planning.

In organizations in general, and particularly when dealing with risk, the so-called *human factor* or *people factor* plays a dominant role (Bea, 2006, Van Staveren, 2006). Therefore, regarding the nature of reality (*ontology*), a hermeneutic worldview has been chosen for this research. This considers the world as a social construct, with its inherent subjectivities.

The *epistemological* point of view concerns assumptions about the nature of knowledge about reality. The design science paradigm with a practical research approach (Van Aken, 2004) has been purposefully selected, for generating solution–oriented knowledge about implementing risk management in organizations. Together, the ontological and epistemological positions provided the scientific research framework, which synthesized *geotechnical* and *organizational* aspects. This framework consisted of subsequently exploratory and synthesizing research of risk management and of innovation management. In the following sections, the four resulting research steps are described.

2.2 *Exploratory risk management research.*

The exploratory risk management research consisted of literature surveys and field research. Both aimed identifying the relevant risk management concepts and variables. Extensive literature research has been performed by using Van Staveren (2006) and performing an additional survey, which is reported in Van Staveren (2007).

Field research involved in-depth interviewing of four academic geotechnical and mining experts of leading universities in the US (Massachusetts Institute of Technology, University of California, Berkeley), the UK (University of Southampton), and South Africa (University of the Witwatersrand). In addition, three geotechnical and mining consultants from the UK and South Africa were interviewed. Moreover, Dutch experiences with applying geotechnical risk management were retrieved from a previous and the actual Delft Cluster research project, as well as from RISNET. The latter is the Dutch joint knowledge platform for applying risk management in the construction industry.

2.3 *Synthesizing risk management research*

The synthesizing research part included analysis and classification of the identified risk management concepts and variables. Proven research tactics, including data and investigator triangulation were applied. All variables were classified into either *hurdles*, which obstruct the application of geotechnical risk management, or *conditions* that are required for *applying* geotechnical risk management.

An in-depth analysis generated 7 key hurdles and 10 key conditions for applying geotechnical risk management, which were considered the most relevant variables. This research result triggered another research question: Are these key hurdles and key conditions appropriate for actually *implementing* (*routinely* applying) geotechnical risk management within organizations?

2.4 *Exploratory innovation management research*

The exploratory innovation management research also consisted of literature surveys and field research for identifying relevant concepts and variables. An extensive literature survey has been performed, which included Ph.D. theses, scientific top journals and additional literature about innovation management. The focus was on *implementing* innovations in organizations. Field research included in-depth interviewing of seven Dutch experts in implementing innovations by realizing planned organizational change. All but one are well-known Dutch professors from universities of Amsterdam, Rotterdam, Eindhoven, Groningen, and Twente, who also perform top management consultancy. The one remaining expert is a professional risk manager involved in implementing risk management in public organizations.

2.5 *Synthesizing innovation management research*

The synthesizing research part included analysis and classification of the identified innovation management concepts and variables. Proven research tactics, such as data, and investigator triangulation were applied.

In total 55 hurdles and 93 conditions for implementing innovations in organizations were identified. These variables were compared with those from the risk management research part However, because of the maximum length of this paper and the focus on geotechnical risk management, this comparison and its conclusions could not be presented here.

Nevertheless, from the synthesizing research part of innovation management particularly the resulting concepts for implementing innovations in organizations are used in the remaining part of this paper.

3 GEOTECHNICAL RISK MANAGEMENT

This chapter presents the results of the exploratory and synthesizing research of geotechnical risk management *concepts* and *variables*.

3.1 *Risk management concepts*

Analyzing the identified risk management concepts revealed three interrelated levels for implementing risk management: (1) the *discipline* level, (2) the *project* level, and (3) the *organizational* level. Figure 1 symbolizes these three levels as a mountainous area, of which the risk mountains have steep and slippery slopes.

Geotechnical risk management represents the discipline level. When reaching the top of *geotechnical* risk management, indicating routinely applied risk management, there raises another and higher top that represents the *project* risk management mountain. If that top has been reached as well, indicating well-embedded geotechnical risk management in project risk management, another top is still there. This latter top is representing the *organizational* level of risk management. This level involves managing risks of entire project portfolios of a firm. For example, a contractor having ten projects under construction should compensate one very risky project with the remaining nine and less risky projects. This would avoid going bankrupt, when all risks within the risky project occur.

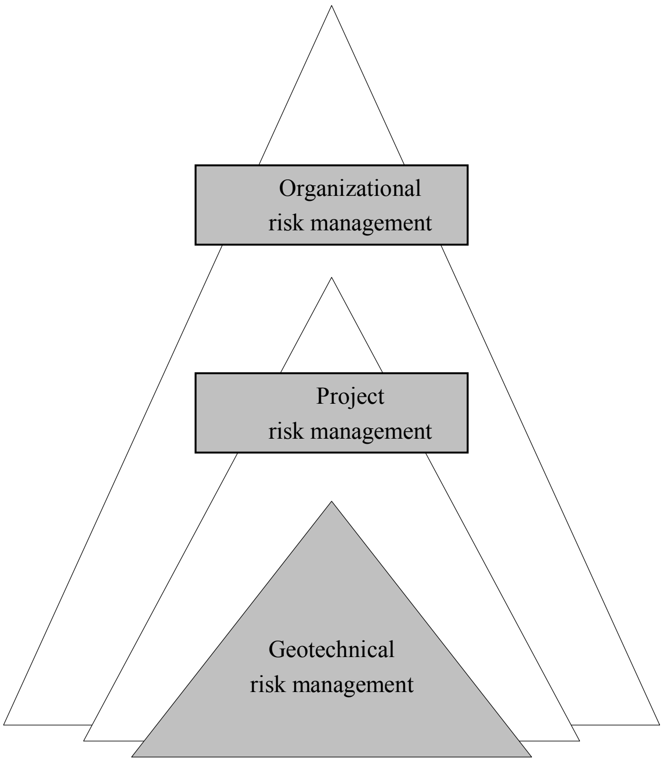

Figure 1. Three risk management mountains.

In summary, for reasons of acceptability, as well as for effectiveness, efficiency, and persistence over time, geotechnical risk management should be well-embedded in project risk management. Preferably, it should furthermore be related to portfolio risk management. Obviously, realizing this challenge is more of a *management* responsibility than that of a *geotechnical* engineer. However, the latter engineer may substantially contribute to both project and portfolio risk management, by adequately performing geotechnical risk management during all engineering and construction project phases.

3.2 *Risk management variables*

As mentioned before, all identified variables for applying geotechnical risk management in organizations were classified into either *hurdles*, obstructing the application of geotechnical risk management, or *conditions* that are required for applying geotechnical risk management.

From the literature survey and field research, in total 109 hurdles and 147 conditions for successfully applying geotechnical risk management were identified. Table 1 shows the distribution of these hurdles and conditions over the different data sources.

Table 1. Numbers of hurdles and conditions for applying geotechnical risk management, from several data sources.

Data source	Hurdles	Conditions
	no.	no.
Van Staveren (2006)	5	10
Van Staveren (2007)	17	26
Interviews with 7 experts	63	73
Delft Cluster and RISNET	24	38
Total numbers	109	147

Despite some overlap of a number of factors, the high numbers in Table 1 demonstrate the enormous complexity of applying geotechnical risk management. This raised the following research question: Which of the unworkable large series of hurdles and conditions are the most significant hurdles and conditions?

For answering this question, these hurdles and conditions have been clustered and synthesized into seven key hurdles and ten key conditions for effectively *applying* geotechnical risk management. Three purposeful selected main categories were *motivation* of engineers for applying geotechnical risk management, *training* required for learning how to operate geotechnical risk management methodologies, and *tools* for facilitating the execution of geotechnical risk management.

3.3 *Hurdles for geotechnical risk management*

Table 2 presents the seven *key hurdles* or obstructions that resulted from the data analysis, including the category.

Table 2. Key hurdles for applying geotechnical risk management.

No.	Category	Description
1.	Motivation	Lack of geotechnical risk management awareness.
2.	Motivation	Lack of geotechnical risk management benefits.
3.	Motivation	Fear for geotechnical risk transparency.
4.	Motivation	Difficulty of applying geotechnical risk management.
5.	Training	Lack of geotechnical risk management understanding.
6.	Tools	Lack of geotechnical risk management methods, protocols, software, guidelines.
7.	Tools	Lack of geotechnical risk management benchmarks.

Remarkably, four out of the seven key hurdles are motivational. Lack of geotechnical risk management awareness, the benefits of it, as well as fear for geotechnical risk transparency and difficulty of applying geotechnical risk management are hurdles at the level of the individual geotechnical engineer. Presence of these hurdles will highly restrict his or her motivation for routinely applying geotechnical risk management in his or her day-to-day activities. Van Staveren (2006) present six suggestions for overcoming these individual hurdles, including developing risk awareness and taking sufficient time for actually applying risk management.

Of the remaining three key hurdles, one is training-related and two concern the role of tools for applying geotechnical risk management. Some sort of education and training is required for operating risk management tools, such as risk data bases. Remarkably, the seventh key hurdle explicitly addresses the lack of geotechnical risk *benchmarks*. This means that a lack of clear levels of acceptable geotechnical risk, such as maximum allowed differential settlements, is also a key hurdle for applying risk management. This key hurdle has been allocated to the tools category, which includes for example geotechnical design software. Such software may be required for setting geotechnical risk management benchmarks.

3.4 *Conditions for geotechnical risk management*

Similarly, Table 3 presents the ten *key conditions*, which resulted from the data analysis. Table 3 present also the category of each key condition. In total, six out of the ten key conditions are of a motivational type. Similar to the hurdles, motivational key conditions dominate.

Obviously, it should be clear to any individual geotechnical engineer *why* routinely applying risk management. Therefore, clear objectives and goals should be defined, before starting any activities. Preferably, these goals are measurable. Closely related to the first key condition, there should be an individual awareness of the consequences of geotechnical risk. What are the effects to which parties when a geotechnical risk occurs? This awareness may raise the desire to avoid the risk to occur, and thus grows risk management motivation.

It may help when geotechnical risk management responsibilities are clearly defined. A geotechnical baseline report (GBR) may be useful for allocating the risk of differing site conditions (Essex, 200, Van Staveren, 2006). By relating, and preferably incorporating, geotechnical risk management within project risk management, economies of efficiency may be realized that contributes to the motivation of engineers to apply geotechnical risk management.

Involving other project stakeholders is also a motivational factor. Particularly, clients requesting geotechnical risk management may be helpful for increasing the motivation of geotechnical engineers. The last motivational key condition concerning resources seems obvious. In most largely money-driven firms in the construction industry, which put also large time pressure on their projects, resources such as budget and time should be made available to the geotechnical engineers who should apply geotechnical risk management. If risk management is effectively applied, the return of investment may be as high as a factor ten, or more (Smith, 1996, Sperry, 1998).

Table 3. Key conditions for applying geotechnical risk management.

No.	Category	Description
1.	Motivation	Clear objectives and goals for applying geotechnical risk management.
2.	Motivation	Awareness of geotechnical risk consequences.
3.	Motivation	Contractually arranged responsibilities for geotechnical risk and its allocation.
4.	Motivation	Clear relationship of geotechnical risk management and project risk management.
5.	Motivation	Involvement of all project stakeholders in applying geotechnical risk management.
6.	Motivation	Availability of resources (budget, time) for applying geotechnical risk management.
7.	Training	Understanding of geotechnical risk management by geotechnical engineers.
8.	Training	Understanding of risk management in teams by geotechnical professionals.
9.	Training	Understanding of risk management and culture by geotechnical managers.
10.	Tools	Fit of geotechnical risk management methodologies with the project objectives.

The training-related key conditions address the need for understanding geotechnical risk management, supplemented by understanding the application of geotechnical risk management in teams. The latter is of importance for dealing with the inherent differences in subjective risk perception, even when based on the same factual information, such as cone penetration test results or results of laboratory index tests (Van Staveren, 2006). Moreover, particularly geotechnical managers, who are responsible for the use of geotechnical risk management methodologies by their appointed geotechnical engineers, should understand the dominant role of organizational culture in routinely applying geotechnical risk management (or not).

Finally, the selected risk management tools for applying geotechnical risk management should fit with the targeted users of those tools (geotechnical engineers), as well as with the complexity and risk profile of the project. Rather sophisticated tools, such as Monte Carlo type of software, may be required in complex projects, while just performing some sensitivity analyses with already available geotechnical software may be sufficient within the less complex and smaller projects. Obviously, there is no one recipe for which tools to select. This entirely depends on the type of project, expected ground conditions, the risk propensity of the clients and the involved engineers, and so on.

4 INNOVATION MANAGEMENT

This chapter presents the results of the exploratory and synthesizing research of innovation management *concepts* and *variables*. The main objective of this research part was providing additional scientific evidence for the relevance of the key hurdles and key conditions for implementing geotechnical risk management in organizations. An innovation management perspective was considered useful, because of the assumed similarities between implementing innovations and implementing new risk management methodologies in organizations.

4.1 *Innovation management concepts*

By analyzing the identified innovation management concepts, the innovation diffusion model by Rogers (2003) was considered the most complete and relevant model. This has been confirmed by comparing this model with the few other available models, including those by Klein & Sorra (1996) and Lewis & Seibold (1993). A number of factors of the direct and indirect network externalities adoption model (Song, 2006) were added to the model by Rogers (2003). Combining these models generated two main dimensions for hurdles and conditions for implementing innovations: (1) those related to the *innovation*, and (2) those related to the *organization*, in which the innovation has to be routinely used by its implementation.

4.2 *Innovation management variables*

Similar to the identified risk management variables, the variables for implementing innovations in organizations were classified into either *hurdles*, obstructing the routine application of innovations, or *conditions* that are required for implementing innovations.

From the literature survey and field research, in total 55 hurdles and 93 conditions for successfully implementing innovations were identified. Table 4 shows the distribution of these hurdles and conditions over the different data sources.

Table 4. Numbers of hurdles and conditions for applying geotechnical risk management, from several data sources.

Data source	Hurdles no.	Conditions no.
Ph.D. theses	4	14
Scientific top journals	6	8
Additional literature	10	22
Interviews with seven experts	35	49
Total numbers	55	93

Despite some overlap of a number of factors, similar to Table 1 concerning risk management, the high numbers in Table 4 demonstrate the enormous complexity of implementing innovations in organizations. This raised the following research question: Which are the main characteristics of the two previously mentioned main dimensions for implementing innovations: (1) the *innovation* itself, and (2) the *organization*, in which the innovation will be implemented?

For answering this question, the risk management key hurdles and key conditions (see Table 2 and Table 3), as well as all identified hurdles and conditions for implementing innovations (see Table 4 for their numbers) have been classified according to the main characteristics of innovations and organizations, as derived from combining the models of Rogers (2003) and Song (2006). Next, the results of this exercise are presented.

4.3 *Innovation management characteristics*

By attributing the 55 innovation hurdles and 93 innovation conditions to the main characteristics of innovations, it became clear that there are seven main characteristics of innovations. However, attributing the 7 key hurdles and the 10 key conditions to these innovation characteristics revealed only three out of the seven main characteristics of innovations. In other words, by considering a risk management perspective only, the majority of relevant characteristics of *risk management methodologies*, 4 out of 7 characteristics or 57 percent, would remain hidden.

As Table 5 indicates by the word *no* in the right column from an innovation perspective, these hidden risk management characteristics are compatibility, observability, indirect network effect, and relative usefulness. Therefore, for successfully implementing risk management methodologies, also these four characteristics need to be addressed, in addition to the three characteristics that are indicated by yes in the right column of Table 5. The latter originate form solely a risk management perspective.

Table 5. Main innovation characteristics.

No.	Innovation characteristics	Acknowledged in risk management
1.	Relative advantage	yes
2.	Compatibility	*no*
3.	Complexity	yes
4.	Triability	yes
5.	Observability	*no*
6.	Indirect network effect	*no*
7.	Relative usefulness	*no*

A similar exercise has been performed for the main dimension of the *organization* in which risk management has to be implemented. Table 6 shows the results.

Table 6. Main organization characteristics.

No.	Organization characteristics	Acknowledged in risk management
1.	Structure of the organization	yes
2.	Norms within the organization	*no*
3.	Organizational implementation decision	*no*
4.	Organizational innovation consequences	yes

When attributing the 7 key hurdles and the 10 key conditions to the main innovation characteristics, only two of the four main characteristics of were acknowledged. In other words, by considering a risk management perspective only, fifty percent of the relevant characteristics of organizations in which risk management methodologies have to be implemented would be entirely neglected.

As Table 6 indicates by the word *no* in the right column from an innovation perspective, these hidden organizational characteristics are the norms within the organization and the type of decision making within the organization, such as cooperative decision making by involving risk management users or top-down decision making. For successfully implementing risk management methodologies in organizations, these latter two characteristics need also being addressed.

5 RISK AND INNOVATION MANAGEMENT

By using the selected innovation management concepts, as introduced in the previous chapter, the key variables for implementing geotechnical risk management were further synthesized and classified into the two main *implementation* dimensions. Figure 2 presents the resulting key conditions, which are presented in a conceptual model for implementing geotechnical risk management within organizations.

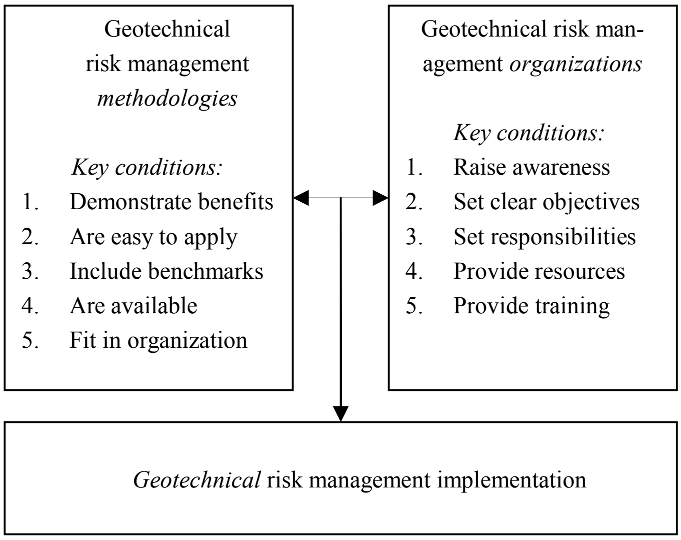

Figure 2. Conceptual model for implementing geotechnical risk management in (project) organizations.

Figure 2 aims to demonstrate that for successfully implementing geotechnical risk management in organizations, five key conditions for the risk management methodologies and another five key conditions for the organization should be fulfilled. Moreover, geotechnical risk management needs to be related to project risk management. The latter needs to be related to portfolio risk management, when present in the organization. The synergies of these three levels of risk management would provide the maximum geotechnical risk management benefits.

6 MAIN IMPLEMENTATION SUGGESTIONS

Summarizing this research provides two main suggestions for implementing geotechnical risk management in (project) organizations in the construction industry:

1. Incorporate geotechnical risk management as much as possible in project risk management at project level, and in portfolio risk management at organizational level;

2. Maximize the presence of the five key conditions for implementing geotechnical risk management methodologies, as well as that of the five organizational key conditions.

Based upon the comprehensive research undertaken, it is expected that using the two main suggestions considerably increase the chance to realize effective, efficient, and persistent implementation of geotechnical risk management in (project) organizations in the construction industry.

At the moment of writing this paper, these suggestions are being empirically tested in four case studies. Moreover, a major Dutch public client is using the suggestions for reducing the geotechnical failure costs with fifty percent by the year 2015 (Van Staveren et al., 2009). Realizing this objective will save this organization tens of millions Euro per year. Moreover, a number of other Dutch organizations are following the suggestions as well.

7 CONCLUSIONS

This paper intends to create awareness about the importance of the routine application, defined *implementation*, of geotechnical risk management. This topic stretches conventional geotechnical engineering, but from now on, it can not be neglected anymore. For targeting geotechnical engineers and their managers, the main results of an still ongoing Dutch research project about how to implement risk management in organizations in the construction industry are summarized. This research revealed the enormous complexity of implementing risk management methodologies. Synthesizing risk management and innovation management concepts considerably *structured* and *reduced* the many implementation variables, while fostering their *completeness*.

In general, conclusion, for realizing effective, efficient, and persistent geotechnical risk management during the entire engineering and construction process, (much) more attention should be paid to the *implementation* of geotechnical risk management methodologies in (project) organizations. This should be related to project risk management and to portfolio risk management, for realizing maximum results. Moreover, the presence of ten risk management key conditions should be maximized. Only then, the pursued benefits of geotechnical risk management are expected to occur. This will give geotechnical engineering, and particularly its engineers, the credits and rewards they deserve, given the enormous impact of ground conditions on construction projects. It is up to us, the frontrunners of geotechnical risk management, to realize this organizational-geotechnical challenge.

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