ISSMGE TC304-TF3

INTERNATIONAL STATE OF THE ART REPORT

on

Integration of

Geotechnical Risk Management

and

Project Risk Management

PART 2 – COUNTRY REPORTS

FINAL

Version 2

October 2013

Reporter - Affiliation

TC304-TF3 Country Representatives – Various (see Country Reports)

Disclaimers

This report with its appendices reflect the individual views of the reporters on the integration of geotechnical risk management in project risk management in their countries. This information is likely to be not complete and aims to present a general state of the art overview.

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PART 2 (Country reports in alphabetical order) page

TC304-TF3 COUNTRY REPORT

on
Integration of
Geotechnical Risk Management in
Project Risk Management

Country
The People's Republic of China

Period
2002 - 2013

Reporters - Affiliation
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1. State of art of ProjectRM

1.1 How is ProjectRM defined in China?

- The increasing attention of engineering risk management is paid more and more in China now. More than several ten years ago, risk assessment was only used for very large infrastructure projects and also focused on the project's economic risk, such as Three Gorges Hydropower Station and Shanghai 1st Line Metro.
- In 2002 quantitative risk assessment is used for the comparison among tunnel and bridge schemes when crossing Yangtze River from Pudong District to Chongming Island in Shanghai. After 2002 engineering risk management is warmly recommend in China large scale infrastructure construction.
- ProjectRM is defined as all activities and measures for dealing with technical risks for managing a project.
- ProjectRM is widely used in all the project phases which include the preliminary, feasibility study, design and construction for all big projects from National level.

1.2 Which ProjectRM guidelines, standards, and processes are used?

- Guideline for risk management for construction of subway and underground works edited by Prof. Hongwei Huang and Dr. Qunfang Hu etc. (issued 2007 / Ministry of Housing and Urban-Rural Development of the People's Republic of China, MOHURD)
- National Code for risk management of underground works in urban rail transit edited by Prof. Hongwei Huang and Dr. Qunfang Hu etc. (issued 2012 / Ministry of Housing and Urban-Rural Development of the People's Republic of China, MOHURD)
- Provisional regulation of Risk Assessment and risk Management of Railway tunnels revised. (issued 2007 / Ministry of Railways of the People's Republic of China, MOCR)
- Guideline of Safety Risk Management of Highway Bridge and Tunnel Design (issued 2010 / Ministry of Transport of the People's republic of China, MOT)
- Guideline of Safety Risk Management of Highway Bridge and Tunnel Construction (issued 2011 / Ministry of Transport of the People's republic of China, MOT)
- The ProjectRM guidelines or standards are used to manage the technical risks during the Projects's feasibility study, design and construction phases

1.3 In which kind of projects is ProjectRM applied?

- Mainly in large infrastructure projects (tunnels, roads, railways, bridges, harbour works)
- Some large public clients require the application of ProjectRM contractually
- Some large public clients use the ProjectRM plans of bidders in their selection process, as part of Best Value Procurement
- Some large projects built in complicated environment which may lead to serious lost

1.4 In which project phases is ProjectRM applied?

- In the preliminary phase by the government
- In the feasibility and contracting phase by public clients
- In the contracting, design and construction phase by contractors and engineers

1.5 What are the results of applying ProjectRM? Bring in examples

- Clients are better in controlling risk during their Design, Build, Finance and Maintenance type of projects
- Clients have accountability to politicians, by demonstrating that they apply ProjectRM in order to minimize additional and unforeseen project costs
- Contractors may reduce their failure costs by applying ProjectRM
- ProjectRM are used in the whole phases of Shanghai Yangtze River Tunnels in 2005-2009, which help the clients and builders to control the risks. And there are no serious risks or lost happened during the project construction

1.6 What are hurdles for applying ProjectRM?

- The results are not accepted by the clients
- Applying Project RM takes time and costs
- ProjectRM is often seen as a lot of additional paperwork
- ProjectRM successes are difficult to find if there is no risk happened in the projects (see section 1.5 before)

1.7 What are solutions for overcoming ProjectRM hurdles?

- Identifying and communicating ProjectRM successes, by evaluating the ProjectRM processes and measuring Total Costs of Risk of projects
- Demonstrating that time and costs investments in ProjectRM pays off
- Apply ProjectRM as lean and simple as allowable, for instance by aligning major project risks to project objectives, according to ISO/IEC 31000 on risk management
- Arrange a new team to help the clients and builders understand the ProjectRM conclusions if it is possible, and guide them to use the method for controlling the projects' risks

2. State of art of GeoRM

2.1 How is GeoRM defined?

- GeoRM is defined as risk management of geotechnical engineering, which is identify the main risks in projects' geology
- GeoRM is currently defined as explicitly, structured, communicated, and continuous dealing with geotechnical risks for achieving project objectives in the most effective and efficient way
- In China, GeoRM is also considered as the geotechnical part of the RISMAN project risk management approach

2.2 Which GeoRM guidelines, standards, and processes are used?

- A lot of joint industry CUR standards on applying geotechnical activities (e.g. on risk-driven site investigations and on risk-driven geotechnical monitoring)
- A chapter is included in China Guide or standards for projects' risk management which is listed in section 1.2. And the GeoRM is necessary to analyse for the large projects

2.3 In which kind of projects is GeoRM applied?

- Mainly in large infrastructure projects (tunnels, roads, railways, harbour works)
- Examples: large tunnel projects in Shanghai Yangtze River Tunnel etc.
- Applying GeoRM in projects from 1990s in China. And the clients think the GeoRM as a useful method for minimizing geotechnical failures

2.4 In which project phases is GeoRM applied?

- In the preliminary phase by the government
- In the feasibility and contracting phase by public clients
- In the contracting, design and construction phase by contractors and engineers

2.5 What are the results of applying GeoRM?

- Clients are better in managing their Design, Build, Finance and Maintenance type of projects
- Contractors may reduce their failure costs by applying GeoRM if they take some meausres to control the Geotechnical Risks.
- GeoRM are used in the whole phases of Shanghai subway tunnels which are buried in the city populated area

2.6 What are hurdles for applying GeoRM?

- Geotechnical professionals need to become used to make their rather implicit way of dealing with geotechnical risk much more explicit, which requires education and training
- By a number of professionals GeoRM is seen as an additional activity, which requires additional time and costs, while they are already very busy
- It may face the big problems that there is not enough geology information and its spatial variability.

2.7 2.7 What are solutions for overcoming GeoRM hurdles?

- Developing GeoRM tools, such as geotechnical risk checklists, procedures for geotechnical risk communication with the public around construction sites in cities, and providing procedures for allocating geotechnical risk between contract partners
- Applying the new method in investigating geology such as GPS and GIS which may collect more and more information and minimalize the spatial variability
- Continuing with technical data analysis for minimizing geotechnical failures and revising the geotechnical standards according to the draft specification verified by users
- Identification and communication of GeoRM successes and lessons learned.

3. Integration of GeoRM and ProjectRM

3.1 What is the status of GeoRM – Project RM integration?

- In China all GeoRM steps fit entirely in the ProjectRM steps which may identify the potential risks
- Nevertheless, a lot of times there is no continuous cooperation between the project risk manager and the professionals dealing with geotechnical risk. This implies that geotechnical risk is often (too) generally mentioned in project risk registers
- An example is the indication of “settlement risk” in a project risk register. What the settlement risk exactly is, and how to control it by a risk-driven monitoring programme for instance, is often not worked out. More integration of GeoRM in ProjectRM, by more cooperation between the respective managers and professionals, may overcome this hurdle

3.2 How contributes GeoRM to Project RM?

- In China failure costs of construction projects are generally assessed as about 3.5 % of the total project turnover, which is in total several billion RMB Yuan per year. Geotechnical problems have a considerable stake in these project cost overruns. GeoRM may therefore contribute to ProjectRM, by more effective and efficient management of the geotechnical causes of project risk
- Involving QA/QC managers and professionals for remediating geotechnical risk within projects is useful for aligning processes and achieving economies of scale and learning
- GeoRM will provide some measures for ProjectRM to control risks

3.3 How is GeoRM communicated to non-geotechnical persons? (such as project managers, contract managers, public living around construction sites)

- It is a problem that non-geotechnical persons may pay no attention on GeoRM. And the guidelines, standards requires to finish GeoRM before ProjectRM by developing a procedure to be used by communication managers and geotechnical engineers together in a project
- For many clients and contractors it is quite a dilemma to either communicate about geotechnical risk before starting the project (which may make the public feeling uncomfortable about the project), or only after a geotechnical problems occurs (for instance damage due to settlements that make the public not only feeling uncomfortable but quite angry as well)

3.4 What are ProjectRM lessons from other industries for GeoRM?

- ProjectRM in the aerospace industry learns for instance an integration of risk management in systems engineering and to focus on effective team communication regarding project risk assessments and remediation. Also, in the aerospace industry improving project risk management is part of the QA/QC department and managed by a continuous improvement manager, by setting and following clear key performance indicators.
- The large infrastructures like subway or road tunnels are so complicated that they could not be built by one person or one speciality. ProjectRM is well carried out on the basis of GeoRM

4. Conclusions on integrating GeoRM and ProjectRM

- GeoRM is necessary for risk management, and is elementary part for ProjectRM
- The processes of GeoRM and ProjectRM are equal and fit well
- The definitions used in practice of GeoRM and ProjectRM are more or less similar
- However, in practice it seems that the integration of GeoRM in ProjectRM can be improved, in order to be able to control project risks by better controlling geotechnical risk

5. Recommendations on integrating GeoRM and ProjectRM

- Identify and communicate success stories of integrating GeoRM and ProjectRM for achieving project objectives within time and budget
- Learn geotechnical professionals to communicate the effects of geotechnical risks in the language of non-geotechnical managers, such as project managers and contract managers
- Provide short courses for non-geotechnical risk managers about the need and benefits of integrating GeoRM in ProjectRM
- Some new investigation methods or technologies, such as GPS and GIS etc., will be .adopted in GeoRM to provide the enough geotechnical information to minimalize the uncertainty in ProjectRM

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TC304-TF3 COUNTRY REPORT

on
Integration of
Geotechnical Risk Management
in
Project Risk Management

Country
Czech Republic

Period
2012 - 2013

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1State of art of ProjectRM

1.1 How is ProjectRM defined?

- There is no definition of ProjectRM that is generally used in the Czech construction industry

1.2 Which ProjectRM guidelines, standards, and processes are used?

- There are no guidelines/standards that would be generally accepted in the Czech construction industry.
- ISO/IEC 31000 (ISO 2009) on risk management is not well known in the construction community
- Project RM is mentioned in the standards of Czech Chamber of Chartered Engineers: (Kupilík, 2000), (Matějka, 2001), (Staněk, 2001).
- Other publications and works focusing on construction ProjectRM typically take over methodologies and practices from other countries. Examples of such publications are: (Tichý, 2006), (Rozsypal, 2008) , (Špačková, 2007).

1.3 In which kind of projects is ProjectRM applied?

- No standardized systematic ProjectRM is applied in the construction projects.
- It has been common that the public clients transfer all the risks to their contractors (both designers and construction companies). They do not implicitly require any systematic ProjectRM.
- The interest in application of ProjectRM is quite recent and it mostly arises from projects such as tunnels or major highways. The main motivation is in managing the geotechnical risk. The GeoRM is thus more advanced than ProjectRM.
- The insurance companies providing the insurance of construction projects have not required application of Code of practice (ITIG, 2006) or any similar standards. After major accidents that occurred in the last years, the insurance companies are getting interested in the topic of ProjectRM.

1.4 In which project phases is ProjectRM applied?

- The risks are better managed in the construction phase of the project on the side of the contractors.
- In the pre-construction phases, the ProjectRM is practically not carried out.
- As one exception we might name the project for construction of railway tunnel Prague-Beroun, which is still in the planning phase. For this project the client ordered preparation of two different risk analyses (cca in 2006). However, the planning and design works have been stopped due to complicated conditions and high financial demands.

1.5 What are the results of applying ProjectRM? Bring in examples

- Contractors may reduce their failure costs by applying ProjectRM
- Application of ProjectRM improves the communication amongst participants during the construction and it allows preventing potential conflicts.

1.6 What are hurdles for applying ProjectRM?

- The position of the public client in management of the construction projects is generally weak. Due to historical, legal and political reasons (Czech Rep. is the only country in the EU with missing “Public Service Employment Act” in force), the

public administrative bodies have severe structural problems. The specialized departments of the administrative agencies that had the technical and other necessary capacities in managing/controlling construction projects were dissolved due to their restructuring. Today it is necessary to build these teams again, but it takes time.

- The lack of transparency in the planning and management of the construction projects. A tendency to hide potential risks and problems instead of communicating them with other parties.
- Missing long-term planning, prioritization and insufficient preparation of the projects in the planning phase. The decisions are not supported by objective and transparent analyses of different project options that would clearly state their pros, contras and risks (Špačková, 2009).
- Aversion of participants to additional work.
- Focus on solving actual problems ad hoc (solve problems as they come) instead of thinking ahead and trying to avoid the potential problems.
- High level of political influence on decisions in major project's planning, leading to low demand for objective analyses and application of ProjectRM.
- Project RM is new field/activity and needs establishment of competent and qualified capacities (personnel/experts) in relevant positions to introduce RM into public client´s standard procedures. However there is little motivation for adequately competent personnel to work there due to above-mentioned reasons.

1.7 What are solutions for overcoming ProjectRM hurdles?

- The public clients should be required to apply ProjectRM in the (large) construction projects.
- There should be more emphasis on good planning and preparation of the projects, the public clients should be willing to invest more into this phase. E.g. selection of the designer/consultant solely based on the lowest bid price is highly criticized but it is still a common practice.
- The community participating in the construction projects should be better educated in ProjectRM and its benefits.
- The transparency and communication amongst involved parties should be improved. The general environment should be more open and it should be based on trust amongst the participants.
- If a mistake occurs, one should not always blame concrete people but rather search for mistakes in the system and try to improve them. This would increase the confidence of the participants and their motivation to implement innovations.
- One should systematically analyse the finished projects in order to learn lessons from them. This is a large unused source of know-how.
- Risks should be recognized, identified, described, discussed and managed, not overseen and ignored.
- RM in general should be taught at universities and absolvents should therefore be aware of the RM existence and may accelerate its introduction as a standard part of project planning and cnstruction.

2 State of art of GeoRM

2.1 How is GeoRM defined?

- There is no definition of GeoRM that would be broadly used in the Czech construction industry

2.2 Which GeoRM guidelines, standards, and processes are used?

- There are no guidelines/standards that would be generally accepted in the Czech construction industry. The different types of projects are in competence of different public agencies; their requirements differ.
- Recently, the Czech authorities have started to accept the GeoRM concept. Analysis of geotechnical risks is now required by several documents, e.g.: (Český Báňský Úřad, 1996) after its amendment in 2012 or (Rozsypal, 2007).
- Publications that focus on the GeoRM are: (Rozsypal, 2001)

2.3 In which kind of projects is GeoRM applied?

- Some principles of GeoRM has been applied in major tunnel projects.
- Examples: Dobrovsky (Kralovopolsky) tunnel in Brno, extension of Metro lane A in Prague Dejvicka-Motol.
- GeoRM is in general a new thing. For example, the Czech State Mining Authority, a legal body approving all underground construction activities and controlling the safety during construction of mined underground works, has accepted the concept of risk just recently. Before that, admitting any risk/hazard would mean stopping of the works (which motivated all involved parties including construction companies to hiding potential problems).
- The initiative for applying GeoRM arises mostly from tunnelling projects. The GeoRM in the tunnel construction projects is probably the most advanced. The interest in GeoRM increased after severe problems in Blanka tunnel in Prague (3 cave-in collapses during construction) and on the D47 highway (problems with subsoil during operation – differential settlement).

2.4 In which project phases is GeoRM applied?

- In the planning phase, the geotechnical risks are typically not well analysed and managed. The public clients tend to transfer the geotechnical risks to contractors. The geotechnical surveys are typically carried out as part of the design. During construction, the geotechnical risk is transferred fully to the construction company.
- In the construction phase the GeoRM is tightly connected with the geotechnical monitoring (Rozsypal, 2011). The regular meetings of the experts in geotechnics are part of the project management meetings. The communication of the geotechnical risk is thus well integrated in the construction RM (refers to the tunnel projects).

2.5 What are the results of applying GeoRM?

- Efficient communication of geotechnical risk to the non-geotechnical experts during the construction.
- A broadly used information system for sharing the geotechnical information amongst all participants of the construction project proved to be very efficient.
- Examples of success:
    - Dobrovsky (Kralovopolsky) tunnel in Brno – build in very difficult geotechnical conditions under built-up area. To avoid damage on the buildings above the tunnel, extensive compensation grouting was applied.

- Extension of Metro lane A in Prague Dejvicka-Motol - utilization of the TBM technology for the first time in the Czech Republic has been so far successful.

2.6 What are hurdles for applying GeoRM?

- Unwillingness and limited competence and capacity of the public clients to accept and bear the geotechnical risks
- Underfinancing of preparation, planning and design works for the main infrastructure construction projects (incl. geotechnical investigations and above all analysis of their results). Most of the problems are solved as they come during the construction. Better planning and analysis of information in the planning phase might help to choose better concepts, design, technology etc.
- Projects are influenced by different legislation and different controlling authorities, their requirements may be contradicting.

2.7 What are solutions for overcoming GeoRM hurdles?

- Education of the participants in the GeoRM practices
- Standardization of the procedures of GeoRM
- Putting more emphasis on the planning and preparation of the projects. The decisions made in this phase should be based on objective analysis of the potential risks.
- The public clients should be willing to recognize and bear some of the risk.
- It is necessary to improve the practices in allocation of geotechnical risks. Experts on contractual allocation of risks, who have both the technical and legal competences, should be educated and employed by the different parties.

3 Integration of GeoRM and ProjectRM

3.1 What is the status of GeoRM – Project RM integration?

- During the construction phase, the GeoRM is well integrated into the Project RM (at least in the tunnel construction projects). In the planning phase, the RM is almost completely missing.
- There are no standardized procedures for both GeoRM and Project RM, however, observational method in geotechnics, widely used in Czech Republic, implies RM procedures and principles.
- It is possible to say that the GeoRM is more advanced than Project RM. Application of the RM is mostly driven by the experts in geotechnics. It was motivated by geotechnical failures, the geotechnical risks are thus perceived as the major ones.

3.1 How contributes GeoRM to Project RM?

- The geotechnical failures are sever problems in the Czech republic. Serious accidents occurred in recent years in the tunnel construction projects (CzTA Seminar 2010, Srb, 2013, Špačková, 2012) resulting in long delays and high financial losses. There is therefore an increasing interest to mitigate these risks.
- Systematic gathering of geotechnical information along with other information (e.g. construction performance and construction cost) would help to improve the know-how and to learn from the past projects.

3.3 How is GeoRM communicated to non-geotechnical persons? (such as project managers, contract managers, public living around construction sites)

- During the construction phase, the geotechnical information are discussed on the regularly meetings of the project management team. However, sometimes the pressure on construction time and costs can cause that the geotechnical risks are not taken seriously enough.
- Communication with the public is quite good in the large projects; the people who are interested have the opportunity to get information in information centres and during Doors Open Days. However, the many serious accidents and cost overruns that occurred in the last years caused that the public is generally suspicious about the large construction projects. Open communication of geotechnical risks in future projects can thus cause exaggerated reactions of the affected inhabitants.

3.4 What are ProjectRM lessons from other industries for GeoRM?

- Generally the civil engineering industry has a lot to do for optimization of the production. Compare to, for example, large producers in mechanical industry, the innovations in the civil engineering construction are very slow (the productivity has been practically not increasing). One, often repeated, argument is that the civil engineering projects are unique and that they are not comparable to production of cars etc. However, in spite of this uniqueness, better planning of the civil engineering projects and systematic gathering of know-how from past projects (and learning from mistakes) might improve the productivity.
- For improvement of the RM, it is crucial to gather and share information. Organization of the construction companies and other participants in construction projects is typically decentralized; the sharing of know-how amongst the different project teams is very limited. This is one of the areas, where construction industry might learn from other industries.

- There is a big emphasis on expert knowledge in the construction industry. The expert knowledge is crucial and irreplaceable. However, one should always be aware that experts are likely to make mistakes in their assessments and that they are often biased. The experts´ estimates would be better, if they were based on well-structured data from the past projects. The experts are irreplaceable in assessing the specifics of the concrete project, but they should have real data at hand to make the right decision or to give a consistent recommendation.
- The clients in construction industry are typically not willing to spend money on planning, design, gathering data, analysis of data and computational modelling. This is likely to lead to selection of suboptimal organization and technologies and it motivates the participants to making conservative decisions. Because of the lack of information and insufficient analysis of alternatives, the participants want to stay at the safe side. This situation originates already in the way, how civil engineers are educated (applying codes instead of finding innovative solutions).

4 Conclusions on integrating GeoRM and ProjectRM

- The topic of ProjectRM and GeoRM is relatively new in the Czech construction industry. The interest seems to increase amongst the public clients and insurers of the construction projects in the recent years as a reaction on major accidents.
- The GeoRM seems to be more advanced than ProjectRM. The application of RM in construction projects has been motivated by major accidents that have geotechnical origins. The application of GeoRM is probably most advanced in the tunnel projects.
- **The main issue of the Czech construction industry is thus not the INTEGRATION of GeoRM and ProjectRM but an INTRODUCTION of systematic RM into the practice.**
- Several processes and techniques from international standards of GeoRM and ProjectRM are applied in the Czech construction practice. However, the processes are not standardized and formalized.
- Position of risk manager does not exist, the risk management is carried out by different people (Project managers, people responsible for safety of works, geotechnical experts…)
- There are no broadly used standards and processes for ProjectRM and GeoRM in the Czech construction industry. The education at the universities in the field of RM is not of high quality.

5 Recommendations on integrating GeoRM and ProjectRM

- **These are mostly recommendation on INTRODUCTION of systematic RM into the practice:**
- Increase the interest of public clients in RM, risk allocation and risk communication. Increase their willingness to invest time and money into the planning and RM.
- Increase the pressure of insurance companies on application of Code of practice.
- Improve the education of the students and practitioners in Project RM and GeoRM
- Improve the quality of contractual risk-sharing.
- Provide standards for RM processed in public investments projects that would be broadly accepted by the community. The standards should be developed as a living document in close communication with different parties (public clients, consulting companies, construction companies); only in this way they can be accepted as a helpful tool, not as a formality.
- Provide tools for communicating the concept of probability, uncertainty and risk with people who are not expert in this field.
- Harmonize the requirements of the different public bodies that are supervising and controlling the safety of the construction works.
- Improve the know-how management; systematically learn from finished projects.

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TC304-TF3 COUNTRY REPORT

EXAMPLE
(for information only and not complete)

on
Integration of
Geotechnical Risk Management
in
Project Risk Management

FINLAND

Period
2012 - 2013

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1 State of art of ProjectRM

1.1 How is ProjectRM defined?

- In Länsimetro projct (the Western Metroline in Helsinki region) the risks have been mapped in the beginning of the construction design phase. There is one whole-time person in Länsimetro project who looks after risks. The management of risks is involved into design and guidance and supervision of construction.
- The Finnish Traffic Agency has published guidelines about the safety at railway construction work sites.
- Lemminkäinen construction company makes a risk analysis, risk management plan for the tendering and construction phases, which includes also a separate safety risk analysis for the operational phases. A more detailed operational plan is done during construction phase, which is gone through with the operational group.
- In Kehärata project (Ring Rail) the Project RM has very important role as a whole. The Project RM is divided into different groups, which are:
    - management,
    - construction works,
    - operational and
    - environmental.
    - Also other Risk Management fields are presented during the Kehärata project – such as occupational safety in general and near miss event reporting.
- Besides the above there are several other separate RM for smaller projects connected to the Ring Rail concentrating more specific and limited risks. The parties are designers, contractors, Transportation Agency, involved cities and other authorities, developer consultant and many subcontractors. The company Marsh has been chosen to be a facilitator in Project RM process.

1.2 Which ProjectRM guidelines, standards, and processes are used?

- Finnish laws and regulations compiled with the project case instructions.
- Finnish Transporation Agency has created the guidelines for the works in railway construction site. For the road works the guidelines cover only the traffic safety at site.
- In Ring Rail ISO/IEC 31000 and guidelines of Transportation Agency http://alk.tiehallinto.fi/julkaisut/pdf2/4000634-v-riskienarviointi_kirjallisuustutkimus.pdf (only in Finnish)
- The guidelines of ERA (European Railway Agency) and European directives
- Lemminkäinen construction company acts according to their certificated operation system.

1.3 In which kind of projects is ProjectRM applied?

- In all subprojects of Länsimetro and Ring Rail.
- In all of the construction projects of Lemminkäinen from contracting to construction
- In all railway construction projects throughout the project from design to construction according to Transportation Agency
- And at least in all bigger road construction project.

1.4 In which project phases is ProjectRM applied?

- In all phases of Länsimetro construction site and Ring Rail.
- Otherwise see 1.3.

1.5 What are the results of applying ProjectRM? Bring in examples

- In Länsimetro the aim is to anticipate the possible risks and to find remedies for them. As an example the safety at work is much better than the average value is.
- By systematic mapping and managing of the safety risks Lemminkäinen has succeeded to improve the safety at work level remarkably. Only the indentified risks can be controlled and they have succeeded in this.
- Ring Rail has got three successive times the 'Safety at work' prize.
- The reaction time is shorter for the realization of the risks, like in Ring Rail project where glycol was found as a possible contamination of soil from outside activities was suspected in the risk evaluation.
- The project and the parties get a better image.
- The realized risk can be indentified quicker and the consequences can be limited with anticipated actions.

1.6 What are hurdles for applying ProjectRM?

- The Länsimetro see this as a matter of will.
- For the works of Transportation Agency there is not guidelines about this.
- According to Lemminkäinen there is a danger that ProjectRM is only done as part of the additional paperwork and it is not put into work.
- The Project RM is a normal part of the project with its up-hills and down-hills. In long projects it is challenge to keep the people involved in RM motivated and informed all the time.

1.7 What are solutions for overcoming ProjectRM hurdles?

- The Länsimetro see this as a matter of will.
- In Lemminkäinen the ProjectPM is done together with those people who are doing them. In this way they commit better into the Project PM.
- Transportation Agency is creating a risk register for the design, construction and use phase including maintenance for all of their undertakings.
- The motivation to participate into RM is important during the long-term projects. In big and long-term projects, like Ring Rail the Project it was noticed that the motivation of the participants is better maintained when the RM meetings are occasionally oriented so that only a specific risk issue is treated in the meeting and those people directly involved can take part into meetings.

2 State of art of GeoRM

2.1 How is GeoRM defined?

- GeoRM is part of the Project RM in Länsimetro and Ring Rail project. In general there seems to be no special need to separate them. That is the opinion shared with Transportation Agency and Lemminkäinen.

2.2 Which GeoRM guidelines, standards, and processes are used?

- See 1.2.

2.3 In which kind of projects is GeoRM applied?

- In the same project as ProjectPM is applied.

2.4 In which project phases is GeoRM applied?

- In all phases, like Project PM.

2.5 What are the results of applying GeoRM?

- See 1.5. No separate results.

2.6 What are hurdles for applying GeoRM?

- See 1.6 No separate hurdles.

2.7 What are solutions for overcoming GeoRM hurdles?

- See 1.7. No special solutions.

3 Integration of GeoRM and ProjectRM

3.1 What is the status of GeoRM – Project RM integration?

- GeoRM is essential part of ProjectPM.

3.2 How contributes GeoRM to Project RM?

- GeoPM is part of the ProjectPM. No separate information of the part of the geotechnical risks from the other risks. The definitions used in practice of GeoRM and ProjectRM are more or less similar.

3.3 How is GeoRM communicated to non-geotechnical persons? (such as project managers, contract managers, public living around construction sites)

- This dealt with coordination and common practices inside project.

3.4 What are ProjectRM lessons from other industries for GeoRM?

- No special identified lessons.

4 Conclusions on integrating GeoRM and ProjectRM

- The following of the ProjectPM is essential part of the following up of the total project progress.
- In all railway construction projects the guidelines of Transportation Agency is used, which includes also a list of the risks of geotechnical works. This list consists of the following: ground water data, local conditions, sulphide clays, vibration in the embankment, artesian ground water,…. The environmental risk list includes: heavy rains, accumation of mud, overflowing, the condition of the dykes,…
- For road construction projects there is no special guidance, the only thing that has been said is that the risks should be evaluated.
- In general a big challenge in long-term and big projects where the responsible people are changing is the motivation and ensuring the continuity of the RM process during several years and project phases. So the commitment of the management and people involved is essential.

5 Recommendations on integrating GeoRM and ProjectRM

- The risk management should be part of the all construction projects and all of its phases.
- A big challenge seems to be the feed-back and re-evaluation of the actions. The ProjectRM would like know, how the RM has been executed in real subprojects and work.

TC304-TF3 COUNTRY REPORT

on
Integration of
Geotechnical Risk Management
in
Project Risk Management

Country
Germany (with overlap to other German speaking countries, i.e. to Switzerland and Austria)

Period
2012 - 2013

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This report reflects the individual views of the reporters on the integration of geotechnical risk management in project risk management in their country. This information is likely to be not complete and aims the present a general state of the art overview.

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1 State of art of ProjectRM

1.1 How is ProjectRM defined?

- In the German speaking countries, i.e. not only in Germany but also in Switzerland and Austria, it is more common to speak about “safety” (“Sicherheit”) rather than about “risk” (“Risiko”). The term “risk” is accepted with regard to natural hazards or with regard to financial/economical risks or business risk. It is, however, only seldom used in the context of infrastructure or construction management, where safety of people (workers, third parties or users of the infrastructure) is involved.
- There is not any broadly accepted definition, some alternatives are:
    - RM is a process of decision making based on risks
    - RM is a systematic collection, assessment and control of different risks, i.e. a tactic handling of risks (Linnemann and Jörger, 2008)
    - Project RM serves to increase the chances of achievement of project aims and to minimize the risks, which can lead to failure of the project.
- The Safety management is defined as a continual process, which refers to the whole life cycle of the structures and facilities. It determines the responsibilities; it treats the interdependencies amongst persons, objects and environment; it assesses the hazard patterns; it defines, if necessary, the measures to be taken and it regulates their implementation. (SIA 1998)

1.2 Which ProjectRM guidelines, standards, and processes are used?

- There are no standardized procedures or guidelines for the application of ProjectRM in construction projects.
- Some publications give guidance on the ProjectRM from an economic and entrepreneurial perspective, e.g.: (Werner, 2003; Girmscheid and Busch, 2008)
- In the field of safety during development and operation of constructions and infrastructure, the following publications and standards are available in Switzerland: (Matousek, 1982; Richtlinie SIA 465, Norm SIA 260, Norm SIA 197). These documents focus on the risks that can endanger the safety of the structure; according to SIA 260 the designer is obliged to analyse the hazards and give an overview of accepted risks that can potentially endanger the structure such as explosion, natural hazards etc.
- Code of Practice for Risk Management in Tunnel works (ITIG, 2006) has been translated into German by Munich RE
- ISO/IEC 31000 (ISO 2009) on risk management is not well known in the construction community
- Based on the aforementioned standard the Austrian Standards Institute drew up the ON Rule 49000 “Risk Management for Organizations and Systems - Terms and basics - Implementation of ISO 31000”.

1.3 In which kind of projects is ProjectRM applied?

- No standardized systematic ProjectRM is applied in construction projects.
- The contracting authorities tend to transfer the risks to their contractors. They do not implicitly require any systematic ProjectRM.
- The process of business/economic risk management has been standardly applied in large construction companies in Germany. The motivation for introduction of the RM system in the companies was an act on control and transparency in the business sector that came to force in 1998 (Deutschen Bundestag, 1998). The law was motivated by several failures of large companies and it requires the

corporations to implement an effective RM system. In case of construction companies, this also requires an efficient management of project risks (Busch, 2005).
- Application of ProjectRM it thus mostly driven by the construction companies due to their legal obligations.
- In tunnel projects, the insurance companies require application of the Code of Practice for Risk Management in Tunnel works (ITIG, 2006).

1.4 In which project phases is ProjectRM applied?

- Different types of risk are addressed in each stage of a construction project within the general management systems. However, a stand-alone risk management system or standardized procedures for ProjectRM are missing.
- In the **pre-construction phase** the clients assess the financial and contractual risks within a feasibility study and/or as a part of the selection of an appropriate construction method.
- The risks are supposed to be analysed by the construction companies in the **tender phase**. (It is common to divide the projects into smaller parts, then the risk analysis should be carried out within the tender for each of the part.) For example, the Austrian standard (ASI, 1999) requires estimation of a risk premium to the bid price. However, in practice, an proper analysis of risks in the bidding process is mostly impossible due to time limitations and insufficient information that the bidding company has (Herdina, 2008).
- In the **construction phase**, the risks are managed by the construction companies. Some of the leading companies have standardized ProjectRM procedures. To guarantee the safety of workers, extensive accident prevention regulations must be fulfilled on the construction site. Therefore a safety and health coordinator has to be employed, who draws up schedules for safety and health provisions.

1.5 What are the results of applying ProjectRM? Bring in examples

- Contractors may reduce their failure costs
- Application of ProjectRM improves the communication amongst participants during the construction and it allows preventing potential conflicts.
- Application of ProjectRM can increase the acceptability of the project amongst public
- Examples of success:
    - Gotthard Basis Tunnel in Switzerland (Ehrbar, 2013) - systematic RM in this megaproject helped to prevent conflicts, find innovative solutions for unexpected situations and preserve the public acceptance in spite of cost and time overruns and nine fatal accidents
    - A similar risk RM system was also used in the Lötschberg basis tunnel and Brenner tunnel (both in Switzerland).
    - A9 highway baypass Visp, Switzerland – extensive safety plan for the whole system (including tunnel, bridges, total cost ca. 1.2 Mrd. Euro) during the construction phase according to SIA 465.
    - PPP Ostregion – Build Operate Transfer (BOT) project for 51 km of motorways/expressways in Austria - sensible allocation of risks depending on the spheres of influence; different types of risk considered, e.g. geological risk, construction volume exceeding risk, traffic volume risk, licensing requirements risk, risk of changes in operation requirements, construction costs risk, availability risk, tender planning risk.

1.6 What are hurdles for applying ProjectRM?

- The generally risk-averse culture, which puts high value on safety and certainty and which thus does not allow admitting and communicating potential risks.
- Risks are always addressed in a contractual manner. The RM is perceived as a question of distribution of risks and responsibilities not as a systematic communication and control of risks.
- High confidence in normalization and standardization and resulting belief, that if everything is carried out according to the valid norms and standards, nothing can go wrong.
- The unwillingness of the public clients to admit and communicate potential risks.
- Lack of communication in the planning and management of the construction projects. A tendency to hide potential risks and problems instead of communicating them with other parties.
- Construction projects in Germany are always performed by applying the concept of separation of duties. The design is strictly divided from the execution of construction work (design–bid–build instead of design-build contracts). The responsibilities are thus distributed amongst different parties. The communication and cooperation is limited as there is no clear leader or coordinator.

1.7 What are solutions for overcoming ProjectRM hurdles?

- The public clients should accept the ideas of ProjectRM, they should gain confidence that applying ProjectRM can decrease the construction time and cost and ensure the project quality. As a result, they should require application of ProjectRM in the (large) construction projects.
- The participants should accept the fact that risks do exist and that identification and communication of the risks is necessary for their effective control.
- The perception of RM should be changed/extended from a mere contractual allocation of risk to active cooperative control of risk.
- The communication amongst involved parties should be improved. The general environment should be more open and it should be based on trust amongst the participants.
- If a failure occurs one should try to identify mistakes in the system instead of blaming individual participants. This would increase the confidence of the people and their motivation to implement innovative solutions.
- One should systematically analyse the finished projects in order to learn lessons from them. This is a large unused source of know-how.
- The community participating in the construction projects should be better educated in ProjectRM and its benefits.

2 State of art of GeoRM

2.1 How is GeoRM defined?

- There is no unified definition of GeoRM
- The term of "subsoil or foundation soil risk" (Baugrundrisiko) is defined in the norm DIN 4020 (DIN, 2010). The client provides the soil as a building material and thus bears the risk of unexpected soil and groundwater conditions. The contractor bears the risk that he chooses the details of the construction method for the production according to the client's specifications (i.e. results of a soil exploration) correctly.

2.2 Which GeoRM guidelines, standards, and processes are used?

- There are no guidelines on GeoRM that would be broadly used.
- Several standards on applying geotechnical design and investigations are available, e.g.: Standard on Verification of safety of earthworks and foundations (DIN, 2005) and Standard on Geotechnical investigations for civil engineering purposes (DIN, 2010) in Germany, Norm on General conditions on underground constructions (SIA 2007) in Switzerland or Eurocode (DIN 2011).

2.3 In which kind of projects is GeoRM applied?

- Theoretically, GeoRM should be applied in every construction project. Norm DIN 4020 (DIN, 2010) describes the requirements on sharing the geotechnical risk in construction projects. The norm states that the owner (client) is obliged to carry out appropriate geological investigations and provide adequate information to the contractor. The risk of unexpected geotechnical is born by the owner (Sondermann and Trunk, 2008).
- However, in practice, the GeoRM has not been applied to all projects but the share of projects where it is used is increasing.
- The application of GeoRM is mostly promoted by the construction companies.

2.4 In which project phases is GeoRM applied?

- In the planning phase, the geotechnical risks are typically not well analysed, communicated and managed.
- In the construction phase the application of GeoRM is more common

2.5 What are the results of applying GeoRM?

- Sharing of geotechnical risks helps to avoid potential conflicts and decrease the construction time and costs for all participants.
- GeoRM can improve the safety of the construction works through identification and control of possible unexpected conditions.
- Examples of success:
    - Offenbau tunnel in Germany (Linnemann and Jörger, 2008) – GeoRM carried out cooperatively by all participants allowed to efficiently react on unexpected geotechnical conditions

2.6 What are hurdles for applying GeoRM?

- Analogously with the ProjectRM, also the GeoRM focuses primarily on the contractual allocation of risks. There is insufficient motivation and will to communicate and cooperatively control the risk (especially amongst the public clients, the construction companies are generally more interested in GeoRM).

- The participants are used to apply standards and norms, they are not wont to search for project specific solutions.
- The importance of planning and design works (incl. analysis of the results of the geological investigation) is often underestimated.
- GeoRM can be seen as an additional activity, which requires additional time and costs and the benefits are not always obvious.

2.7 What are solutions for overcoming GeoRM hurdles?

- The public clients should be willing to openly communicate the geotechnical risk with the contractors.
- The perception of GeoRM should be changed/extended from a mere contractual allocation of geotechnical risk to active cooperative control of risk.
- The participants should be educated in the GeoRM practices
- More emphasis should be put on the planning and preparation of the projects

3 Integration of GeoRM and ProjectRM

3.1 What is the status of GeoRM – Project RM integration?

- In Germany, the large construction companies are obliged to have general RM standards on the company level; because the main activity of the construction company consist in executing individual construction projects, the ProjectRM is an inevitable part of the overall RM system. The GeoRM is also required normatively in the sense of sharing the geotechnical risk between the client and contractor. However, the integration of these two fields is not perfect.
- ProjectRM and GeoRM is a must for large construction companies. However, the motivation of the public clients to applying ProjectRM and GeoRM is much lower. The RM is thus typically applied too late (in the bidding phase or even later) and the communication of the risks between the contractor and client is in most cases not satisfactory.
- Both ProjectRM and GeoRM are mostly understood as contractual allocation of risks and responsibilities. The aspect of communication and cooperative management of risk is omitted.

3.1 How contributes GeoRM to Project RM?

- The geotechnical uncertainties have major influence on the construction projects. Compare to other construction materials, ground is extremely heterogeneous and our prior knowledge about the geotechnical conditions can never be complete. GeoRM therefore plays a crucial role in ProjectRM.
- Managing geotechnical risks helps to increase the safety of the works and of the final constructions as it allows identifying potential hazards.
- Joint collecting of geotechnical information along with other information (e.g. construction performance and construction cost) would help to improve the know-how and to learn from the past projects.

3.3 How is GeoRM communicated to non-geotechnical persons? (such as project managers, contract managers, public living around construction sites)

- Communication of risks in general is quite limited. This is mainly due to the cultural specifics that do not motivate open admission of potential problems. Especially in the technical field, the engineers highly rely on standards and norms and they are not used to analyse possible deviations from and ideal standardized state/progress.
- The risks are typically not communicated to the public in advance; it has been common to present the project as a safe and certain action. However, this paradigm seems to be changing. There has been a rising debate about the number of sever cost overruns in large construction projects and about the fact, that uncertainty of the cost estimates should not be neglected in the planning phase.
- The situation might be slightly different in Switzerland, where the direct democracy is well established and the public is in general more involved in decisions about the large projects. On the example of the Gotthard base tunnel it can be shown that involvement of the public into the process (three referenda on realization of the project, on its financing etc.) ensured a general acceptance of the project amongst people in spite of large time and cost overruns and even fatalities during its construction.

3.4 What are ProjectRM lessons from other industries for GeoRM?

- See report on the Czech Republic.

- There is an increasing interest in simulation tools for construction processes in recent years in Germany. These tools allow optimizing the organization of construction process. Application of these tools is already sometimes applied in practice, for example for construction of industrial premises for clients from the field of mechanical engineering such as car producers that are used to optimize the production processes in their core activities and they thus demand similar approach also in the production (construction) of their factories. The simulation tools might also help in the process of analysing the risks.

4 Conclusions on integrating GeoRM and ProjectRM

- In Germany, GeoRM is required by law in the sense of the contractual sharing of the risks rising from uncertain geotechnical conditions between the owner and the contractor. The ProjectRM is required by law from the large construction companies as a part of the management of companies' entrepreneurial risks. However, in the practice these two fields are not very well integrated and some aspects of the ProjectRM and GeoRM are overlooked.
- The GeoRM and ProjectRM are promoted mostly by the construction companies. The interest of the public clients on their application is rather low; they tend to transfer the risks to the contractor.
- RM is primarily understood as contractual allocation of risks. The communication of the risks and cooperation between the parties is rather low.
- Some processes and techniques from international standards of GeoRM and ProjectRM are applied in the practice (e.g. in the tunnelling projects, the Code of practice is typically required). However, the processes for different types of public investments are not unified and they are split into smaller parts related to different project phases. An integral RM process that would cover the whole project life is missing.
- In Switzerland, the management of technical risks is on very high level (processes for guaranteeing safety of the structure, safety of the operation, safety of works during the construction) but the processes are in many cases not sufficiently integrated with management of other types of risks such as economical risk, risks of delays etc.

5 Recommendations on integrating GeoRM and ProjectRM

- Increase the interest of public clients in RM, especially in effective risk communication and cooperation with the contractors. Increase their willingness to invest time and money into the ProjectRM and GeoRM.
- Increase the awareness about existence of risks. Open communication of risks and uncertainties would increase their acceptance both in the society and amongst the practitioners.
- Increase the willingness of the participants to openly communicate the risks (by education, change of attitude).
- Identify and communicate success stories of integrating GeoRM and ProjectRM.
- Improve the education of the students and practitioners in Project RM and GeoRM
- Provide standards for RM processes in public investments projects that would be broadly accepted by the community.
- Provide tools for communicating the concept of probability, uncertainty and risk with people who are not expert in this field.
- Improve the know-how management; systematically learn from finished projects.

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TC304-TF3 COUNTRY REPORT

on
Integration of
Geotechnical Risk Management
in
Project Risk Management

Country
Japan

Period
2012 - 2013

CONTENTS

1. STATE OF THE ART OF PROJECT RISK MANAGEMENT (PROJECT RM)

Definitions and standards / guidelines used in Japan for Project RM

- **Ministry of Land, Infrastructure, Transport and Tourism, Japan Construction Management Practical Use Guidelines - An introduction to Japanese Style Construction Management -2002/02**

→ **Concerning the Guidelines for Usage of the CM Model**

In recent years, interest in the CM Model has also become stronger in Japan with regard to the transparency of cost composition and substantive and qualitative supplementation of technical experts in ordering organizations and usage has begun for some private construction work.

However, looking at the construction industry as a whole, efforts for the CM Model are just starting,

The CM Model is one of the "construction industry management systems" where CMRs (construction managers), who are the assistants and agents of ordering organizations, stand on the side of the ordering organization while maintaining technical neutrality and conduct, in part or in total, management work

The total ordering model is widely used in Japan, and work execution management is mainly the responsibility of the master contractor (general construction business).

Compared with the total ordering model, the CM Model is considered to promote transparency of the cost composition, although the risk of the ordering organization is greater.

The need for the CM Model is high in public works, and public ordering organizations who do not have sufficient numbers of technical experts are expected to become the main area of its use.

The CM duties can be included in project management (PM), and the duties are therefore sometimes called “PM/CM system”.
Project management (PM) is defined as the process implemented for the most effective and feasible project realization for a client. Specifically, it is defined as the comprehensive management for a project in its entirety. The person who undertakes the job is called the Project Manager (PMR).

The difference between PM services and CM services is that the PM services commence earlier in the project planning and conception stage.

The whole guideline is presented next.

Construction Management Practical Use Guidelines
- An introduction to Japanese Style Construction Management -

February 6, 2002
Ministry of Land, Infrastructure and Transport and Tourism

I. Introduction

The Construction Management system (hereby referred to as CM) began as a construction/manufacturing management system in the 1960's in the USA. However, in recent years Japan's interest in the CM system has increased, with private sector construction works led by foreign companies and major developers already using the system.
Nevertheless, concerted effort in regards to using the CM system in Japan is rare. In order to solidify the CM system for general use, and in order to establish the construction/manufacturing management system hereafter, all of the construction work that is carried out must be done by contractors, designers, and clients etc., who have a common appreciation, and understanding of the CM system and its issues. An efficient, suitable and smooth application of the CM system is a pressing need for Japan's future.
In order to cultivate a better understanding for those concerned/authorized with the CM system, as well as to contribute to the future spread of the CM system, we have reviewed the CM, aiming to create a basic guideline for the CM system as well as arrange the CM system contents and themes within a written report.
A the written report using only the US CM system that already has its fixed institution, culture and customs etc., would be incomplete, because it would not take into account the differences between our two country's cultures. We therefore styled the Japanese CM system on the American CM system, although we edited it as appropriate for our cultural/infrastructure differences.

II. CM System Summary

1. CM System (Pure CM)

The CM (Construction Management) system is one of the most widely used construction/manufacturing management systems in the USA. While standing neutral in the technological arena, the construction manager (CMR) acts in the client's interest at each step of the designing, ordering and construction process, performing all or a part of the management work. This includes the reviewing of design work, examining the ordering method, process control, quality control, and cost administration

In recent years, Japan, too, has seen improvement in the practical usage of the CM system, led by private construction works.

(Note 1): Although it is dependent upon the size and nature of the project, the CMR is often made up of two or more specialists. In this guideline, the team that works for the client as proxies and assistants are called the "CMR", while an individual member of the "CMR" (or leader) is called a "CMr".

Under the CM system, the management work, such as designing, ordering and construction, that are undertaken individually by the designer, client and construction contractor respectively under the traditional package contract (all-in one contract), is carried out by the client. The CMR acts as the client assistant or proxy to provide all, or a

part of the managerial service under a “Management Business Agreement” concluded between the CMR and the client. The client pays the CMR compensation for the services.

In the case regarding the construction execution, the client, under advice from the CMR, separately classifies each order in accordance with the nature of the construction work (3). The client and the contractor (4)conclude a separate “construction work undertaking contract”

Note (2): The compensation for the CMR consists of the CM remuneration, (CM Fee), and actual expenses for the management/administration (the cost that the CMR spent in executing the management services).

Note (3): Depending on the client’s needs, there are two cases:
a) ①While separate orders are placed to multiple varieties of specialist construction companies, the rest that are not suitable for splitting up are ordered collectively as a package contract.
b) Orders are split up and placed with individual specialized construction companies. However, under exceptional circumstances when the CMR is uncomfortable with the separate orders, the orders are put together for one construction work as a collective order.

Note (4): The “contractor”, in regards to construction work, is classified into two groups: one is the whole package contractor who integrates various types of specific jobs. The other is an individual specialist who undertakes a specific job (e.g. scaffolding erector, earthwork laborer, concrete iron bar reinforcer, plasterer/coater, interior design finisher, electrics installer, air-condition installer etc.). In the case of a collective order, the package contractor acts as the “Prime Contractor” to undertake the overall management function, where the specialized construction companies perform their specific work as “subcontractors” of the prime contractor. In the case of the SM system, because each type of work is ordered separately, it is often the case that the specialized construction companies are not “subcontractors”, but rather accept orders directly from the client and are “prime contractors”.

- In the USA, this kind of unmixed CM method is called “Pure CM” (also sometimes known as “Agency Style CM” or “For Fee Style CM”), and is distinct from what is described in 2 as “At risk CM”.
- In Japan, designers (5) have been studying “Pure CM” intensely.

Note (5): In this guideline, “Designers” is defined as both the “architecture designer” and the “construction consultant” who are engaged in civil engineering designs etc.

2. At Risk CM

In the CM system (Pure CM) the client bears the final risk regarding the construction work (the risk inherent in completing all of the separate projects and the completion of the construction work in its entirety). It is therefore possible that the client’s expenditure for construction costs may increase. In the USA, in order to decrease the client’s construction costs, the CMR is often made responsible not only for the management, but also for the total risk in the construction work. This kind of CM system is called an “At Risk CM”.
In the case of the “At Risk CM” in the USA, there are times when the CMR exceeds the position of assistant to the client and takes on the role of a manager. This is especially the case when, in the final stage of planning, the CMR bears the risk regarding the construction work by establishing the Guaranteed Maximum Price (1), and tries to lower the risk by concluding a construction contract with the related specialized construction

companies. In this way, the CMR becomes more than the basic management administrator, and can be seen instead as a general contractor. Regarding this kind of case, there is a tendency for the CMR to have its pay augmented proportionally to the amount of extra work it must do for the risk related management.
That point aside, the fundamental administrative/managerial duties of the “At Risk CM” are the same as that of “Pure CM” (2).

(Note 1) In the USA, the client may ask the CMR, at the final stage of designing, to present the estimate of the total construction cost and offer the Guaranteed Maximum Price (GMP).
Regarding the GMP, if an agreement is reached between the client and CMR after clearly specifying the scope of the CMR’s duty and responsibility, the CMR undertakes management on the bidding as in the case of a “Pure CM”. It is often the case that the CMR concludes its own contract with the chosen contractor to perform the management of the completion date, the cost, quality control etc. In the case that the GMP has been established, the CMR guarantees the upper limit of the sum total of construction costs, and if the actual cost exceeds the GMP, the CMR must bear the excess amount. However, if circumstances change after the agreement, it is often the case that the agreements are in turn revised. Also, an upper limit is set for the CMR’s responsibility in accordance to the circumstances of the construction etc. If it is the case that the project is going better than expected, then there is often an incentive such as a bonus specified in the contract for the CMR. These “At Risk CMs” are often referred to as “Ceiling price CM style”, or “At Risk CM with GMP”.

(Note2) In the USA, in the project’s initial stages, the client concludes the “Management Duties Contract”, as is the case with a “Pure CM”. However, a special clause in the initial contract states whether the CMR will be responsible for the risk (the stipulation of the MGP). At the stage when the sum total of the construction cost is worked out in the plan, the client demands the CMR establish a GMP. When an agreement is reached between the client and the CMR, then the MGP clause comes into effect.
In Japan, with the package contract system that is in place, the general contractor does much the same job as the CMR in an “At risk CM” system.
Certainly, if you look only at the fact that the general contractor’s construction management ability is high, one could say that s/he fulfills the role of the CMR. However, the package contract system is very different from the “At Risk CM” system in its transparency.

In the package ordering system, the general contractor is free to create contracts with the subcontracted specialized construction companies at her/his own discretion, usually without showing the contracts to the client, nor taking any directions from the client.
In the case of the “At Risk CM” in the USA, the CMR must obtain the client’s prior consent before creating contracts with the subcontractors and material suppliers. This is in order to ensure the client’s discretionary authority regarding the choice of subcontractors, through which the contracted prices become evident. In cases when the open book system is applied (3), the invoices from the CMR to the subcontractors or suppliers reveal the actual amount of payment (or planned payment) to them, as well as all other expenses.
(Note3) The open book system discloses the process of all of the construction costs incurred by the contractor. Because it impartially shows all payments and the equivalent value, the contractor discloses all of the cost related information to the client, which is audited by either the client or an unaffiliated party. The open book system assures the transparency in the cost structure because:
a) The contract price between the CMR and contractor is made clear.
b) All of the receipts for piecework payments to the contractor are attached and presented to the client every month or quarter year, making the actual payments clear.

c) The costs for the common temporary construction, administration at the site, and general management etc., are settled so that all of the actual expenses such as labor fee, materials fee, subcontracting fee are made abundantly clear to the client.
d) If necessary, the client can commission a third party to audit the open book.

Furthermore, in the USA the open book system is used even with the bulk order system. In this case, the construction cost is broken down into various components to be shown to the client, as well as a list of subcontractors.
This means that in Japan, if the general contractor gets the CM fee as a manager for the client to disclose the subcontracting expenses to the client, an “At risk CM” System that is supported by the excellent administration capability can be realized. This fact needs to be properly taken in consideration when preparing a “Japanese version of CM system”.
It is necessary to clarify questions for the “At risk CM system” such as:
a) Is the agreement between the client and the CMR made under an entrustment or contract?
b) Does the CMR need a license required by the construction industry law? (4) etc.

(Note 4) Few examples exist in Japan of actual implementation of the “At Risk CM” system, and careful studies are therefore required for detailed plans. If the CMR is engaged in business such as contracting the completion of a series of construction works, it is required for the CMR to obtain the construction license (Article 3, Construction Industry Law). Also in the case that the CMR is directly contracted by a client for the construction work of a public facility or utility, a prior examination of the CMR’s business status is required (Clause 23, Article 27, Construction Industry Law).

3. The Role of the CMR in Designing, Ordering and Executing Construction Work:

(1) Package Contract System Flow

In Japan, under the construction/manufacturing management system, with the exception of public construction projects where separate orders are placed, it is general practice for the client to give a package contract to a general contractor for a lump sum price.

〔Japanese Package Contract System Flow〕

a)Designing：The designer draws up a blueprint to fit the client’s needs and demands
b) Ordering：The client calculates the estimated construction cost based on the blueprints and hires a general contractor who successfully bids as the prime contractor.
c) Execution：The general contractor draws up the work and construction schedule based on the design documents, hires specialized subcontractors to carry out the construction work, and administers the management and quality control to complete and deliver the construction work . Construction management is performed according to the Building Standards Act, and the Architect and Builder Act.
Due to this being the “Package Contract System for a Lump Sum Price”, the client is not involved in any cost details, and the cost management is all performed by the general contractor, who pays the subcontractors, but normally does not divulge this information to the client.

(2) CM System Flow

In the case of the package contract system, in terms of actual designing and construction, it is often the case that the client feels uneasy and questions if the cost, progress and quality are consistently optimized. The client may also worry as to what extent, and how, management utilizes funds and undertakes risks.
With the CM system, in order to erase these kinds of client fears, the management responsibility for all of the work by the designer, client, and contractor for designing, ordering and constructing are borne by the client, and all or a part of the of the duties are performed by the CMR directly under the client.
In the case of the CM system, although it varies due to the scope of the CMR's duties, a typical set of duties would be similar to the flow below:

(Flow when the CM system is applied)
a) Design: The CMR gives the designer necessary advice for processing the schedule and cost, and proposes ways to lower the costs by reviewing the design documents. According to the client's requests, the CMR sometimes makes the "VE on Design" (1).
b) Ordering: The CMR makes a proposal about the separate orders and the ordering method, and gives advice about the recruiting and selection of contractors. (In the USA, it is common to make separate orders for specialist construction companies.)
The CMR also performs other functions, such as estimating the construction costs and drawing up the contract documents.
c) Execution: The CMR carries out the duties such as coordination among the contractors, management of the construction work schedule (preparation of the work schedule), and reviewing the construction drawings from the CMR standpoint (2).
Regarding the payment from the client to the contractors, the CMR performs cost administration and management, such as checking the partial payments on piecework after reviewing the contractors' invoices, as well comparison to the actual expenditures for common temporal construction etc.

(Note 1) "VE on design" or "Value Engineering on Design" proposes alternative plans in order to improve the original design at the basic designing and/or detailed designing stages.

(Note 2) Even in the case of the CM system, it is necessary for the construction work supervision to be based upon the Building Standards Act and the Architect and Builder Act. It is necessary to investigate if the CMR should have similar qualification requirements, or if it is necessary for a special supervisor to be appointed to share some of the workload responsibilities.
As mentioned above, under the CM system, CMR management duties are normally regularized at the planning stage. However, because the CMR aims to bring the client's needs and demands regarding the construction project to realization to the greatest extent possible, the CMR sometimes takes part in the earlier stages of the project (e.g. advice for the client to determine project details, or involved in later stages, after the completion of the project, by giving advice on maintenance). Because of this, the CM duties can be included in project management (PM), and the duties are therefore sometimes called "PM/CM system".

(Note 3) Project management (PM) is defined as the process implemented for the most effective and feasible project realization for a client.
Specifically, it is defined as the comprehensive management for a project in its entirety. The person who undertakes the job is called the Project Manager (PMR).

Normally, both the client and contractor manage the proceeding of the project. The service of working for project management is a known as project management services (PM Services). In general, the difference between PM services and CM services is that the PM services commence earlier in the project planning and conception stage.
In the case of a package contract, it is generally difficult for the General Contractor to offer the VE proposals before the bidding. However, if the CM system is utilized practically, the CMR can give assistance as a part of its duties to help design a new construction method, and to adopt a new, more effective plan for lessening the work schedule and cost.

4. Contents of CMR Responsibility

The content of the main management responsibilities of the CMR are listed below:
The actual management responsibilities of a CMR do not include all of the management contents listed below, but rather are a selection from the list below to fit the client needs (sometimes things other than this list as well), and can be made into a concrete contract. Here, to make the responsibilities of the CMR's management easy to understand, the contents have been split into three parts: Design, Order, and Construction.

[Contents of CMR's Main Responsibilities]
(1) Design Steps
1. Design applicant assessment
2. Advice for client regarding designer selection
3. Advice for client regarding designer contract
4. Examination of plan (in terms of execution, cost, schedule)
5. Suggestions for VE on design
6. Suggestions for execution schedule
7. Examination/suggestions for construction budget
(2) Ordering Steps
1 Proposal for order division (construction work assortment)
2. Ordering method suggestions
3. Contractor recruiting, selection advice to client
4. Advice to client regarding contractor assessment, qualifications
5. Construction work cost calculation support
6. Draw up construction work undertaking contract
7. Advice to client regarding contract
(3) Execution Step
1. Coordination among contractors 2. Draw up process plan
3. Work process management
4. Check the detailed construction drawings from the CMR's perspective
5. Check the quality control to be performed by the client (from the CMR's perspective)
6. Check the ordering of labor, equipment
7. Contractor evaluation
8. Invoice management/payment management
9. Cost management
10. Report to the client regarding construction progress (work schedule, construction costs etc.)
11. Manage documentation regarding construction
12. Technical support and backing/settlement of disputes regarding contractor complaints
13. Forming an information transmission system to prevent information misunderstanding
14. Present at intermediate and final inspections
15. Confirmation of document handover
16. Draw up work report

(Reference) A standard CM contract format is set by the Construction Management Association of America (CMAA), The Associate General Contractors of America (AGC), and the American Institute of Architects (AIA). Regarding the contents of the CMR duties, in the case of the CMAA, construction is a 5-step process segregated into: Pre-designing, designing, bid and acceptance, construction, and post-construction. According to the AGC, construction is described as a 2-step process: pre-construction and construction.

5. Required nature/ability of CMR

(1) Client and CMR relationship of mutual trust
In the CM system, the CMR functions as the assistant and proxy for the client, and it is his greatest responsibility to protect the client's interests. Because of this, the major duty of the job is a relationship of mutual trust with the client, and therefore the CMR must be someone of high ethical standards.
For the client, the CM system is not a "miracle cure". It is necessary for the client to be fully aware that if the CMR does not have the nature or ability required for this post, the client's risk and costs may rise.

(2) Independence from designer, contractor
There are cases when the CMR fully understands the client's desire for quality, work schedule, and cost, and therefore steps into the client's shoes, and takes control of the designer and contractor. In that case, the CMR is required to have a separate position from the designer and contractor as a general rule.
(Note) In Japan, in the current state where the CM system is not spreading, there may be a case where designers and contactors, having skills and abilities as a CMR, may take on a CMR role. However, it is preferable as a general rule that such a contractor or designer does not handle construction or design for a CM project.
However, the above will not apply if the CMR is, in case of the "At Risk CM", is identical to the independent contractor (which is specified by the Construction Act). The CMR may then surpass its original role, and can perform management duties for the client via contract.

(3) Required abilities of a CMR
A CMR, as explained below, requires specialized experience backed by a high level of ability. It is not necessary for all of the following abilities to be possessed by one person, but rather a team of people endowed with them.

- Planning, purchasing, and executing management ability
- The ability to understand the designer's philosophy, and to review and revise design documents
- Understanding of the varieties of construction work and the ability to propose order divisions
- The ability to manage contractor complaints
- The ability to regulate work schedule, quality and cost to the client's satisfaction
- The ability to manage contractor payments (precise checking of invoice accuracy)
- The ability to check the construction drawings drawn up by the contractor
- Understanding of the work contents of each division regarding specialized contractors, their business conditions/features, as well as industrial relations etc.
- The ability to make reports and documentation for the client
- Practical business ability related to construction work contracts and construction industry business management

• Risk management ability: disasters, project alterations, work schedule alterations, cost fluctuations etc.

III. An Introduction to The present state of needs in the Japanese Market for the CM System

1. The Situation for Needs and Use of the CM System

(1) The Market Needs of the CM System
According to the “Survey of the Current State of the CM System in Civil Construction” (March 2001, effective response: 66 companies) conducted by the Research Institute of Construction & Economy (Kensetsu Keizai Kenkyujo), 90% of major civil clients with large of annual orders recognized the CM system, and 70% have undertaken at least some kind of approach to the CM system.
According to the “Survey of Order Processing for the Public Construction Works by Local Public Bodies: The status of Using External Assistance and Implementing the CM System” (February 2001, Effective response: 673 companies) conducted by the Research Institute of Construction & Economy (Kensetsu Keizai Kenkyujo),71.6% of the local public bodies consider that it is necessary to receive assistance from an external party or parties for construction order processing. Among responses, the main reasons for receiving external assistance (multiple answers allowed) were “Need Professional Knowledge and Skills” (57.2%), “Can Expect to Improve the Efficiency of the Business” (23.6%), and “Insufficient Technical Staff” (15.4%).
Also, 21.5% answered that they would like to use a form of CM service if such a service is available.

2. Background to Implementation of the CM System in Japan

(1) Changing Client Concience
The present construction/manufacturing management system in Japan has, except for public construction works where the separate purchase system is used, mainly used the package contract system in practice. Under the package contract system, the General Contractor has been carrying out the construction management, as well as taking the responsibility for securing the quality, as well as lightening the risk and labor for the client. This has been of great merit for the client.
However, in the rapid upheaval of the economic environment surrounding clients, consciousness of costs has been rising. On the other hand, technological strength of specialized contractors has been enhanced, and the individual clients themselves have started seeking more diversity in construction/management systems. For these reasons, people have started focusing on the CM system from the following perspectives:
a) Transparent cost structure
b) Transparent subcontractor selection and purchase process
c) Understanding of what is a fair and reasonable price
d) Securing quality
e) Reinforcement of purchase departments
Especially in Japan, because of cost structure transparency, there are large expectations that the CM system can be a viable choice over the package order system.
It is conceivable that the CM system will come to be expected for local public bodies.
It is conceivable that the CM system will be a certain expectation mainly for local public bodies, with a shortage of engineers, in perspective of complementary supplementation for engineers as well as functional enhancement of clients in the stages of design, order and construction.

Also, due to implementation of the " Act for proper processing of public construction tender and contract " etc. the amount of work required of public clients is expanding, such as request for disclosure of information about tender/contract. To meet the swelling requirement, there may be a need for local bodies for enhancing their ordering function in a shortage of their own engineers.
In this case, there will be additional duties for the public engineers, such as selection of CMR, finalization of contract contents, supervision, assessment of achievement etc.

(2) Designer's conscious change
Some designers have an experience in management work through management services carried out from the planning stage as an engineer for the client, in occasions such as an overseas governmental development assistance project. In Japan, the CM system has been considered as a new business corresponding to the client's conscious change. Some companies are enhancing their organization to undertake the CM business through actual CMR services rendered to civil construction work.

(3) Contractor's conscious change
Corresponding to the client's conscious change, the contractor's conscious regarding the CM system is also changing. General contractors have been demonstrating their high management ability in the package contract method, and have had relatively less concern about the CM system. However, recently, they are increasingly concerned about the CM system as a fee-based business, corresponding to the needs from clients who seek transparency. Also, some general contractors are restructuring their organization to be able to undertake the CM business.
Specialized contractors have also had less concern about the CM system except for some facility construction companies, as it has been a trend that they work for a general contractor as its subcontractor.
However, there have been increasing expectations towards the CM system among specialized contractors in the circumstance that their technical skills have improved, and they are now trying to avoid receiving an order from a prime contractor at a low price. The CR system increases opportunities for specialized contractors to directly enter into contract with the client through separate order placement or a public recruitment of specialized contractors.
"Innovation strategy for specialized contractors" prepared by the Ministry of Land, Infrastructure, Transport and Tourism in July 2000 pointed out that the CM system would be a big business chance for specialized contractors having excellent quality and skills.

(4) The Activities of the Japanese CM Association
To meet the citizen needs, "We would like to construct economically and efficiently high quality buildings", and boost consumer satisfaction (CS), the "Construction management Association of Japan" (CMAJ) were established in April 2001 with the following activity goals :
a) The CM system's wide reach to engineers and consumers
b) CM system research/investigation
c) CMr training
d) Exchange and coordinate with domestic and overseas organizations
The association is presently promoting activities to prepare ethical rules and CMR qualification requirements, aiming to reconstruct a sound construction/manufacturing system and train engineers to be a professional with a sense of ethics.

3. Expectations on the CM system

The practical aims for the CM system in Japan can be seen below:
• Due to the diverse manufacturing/construction management systems available, the client has a wide range of choices available
• The cost structure is completely transparent to the client, who can therefore grasp a reasonable price
 While there are cases where the cost is reduced by making cost structure transparent, there is also a perspective that total cost, including construction costs, would be cheaper with the package contract system.
• Securing the ordering process's transparency and accountability to the stake holders (shareholders, tax payers etc.)
・ Practical use of private sector technical management skills for each step in the designing, ordering and execution construction process
・ There are opinions that the cost and construction time can be reduced by obtaining assistance in design VE or design alteration from a CMR, or by asking the CMR to take care of process coordination. Also, for the sake of VE implementation, employment of a CMR who has an excellent ability to withdraw the know-how from the contractor and specialized contractors can be considered.
・ Thorough quality control
・ Reinforcing the ordering system (complementing technical experts in the ordering party supplementary)
・ Backing of highly skilled/good quality contractors (in particular specialized contractors)
In the USA, the CM system stresses the importance of assuring quality and on-time results.
Also, the reasons why the government agency in the USA adopts the CM system include office functions for handling technical complaints, complementing staff supplementary (considering seasonal fluctuation, too), and improving design contents. Controlling cost increment by preventing a delay of construction schedule, cost reduction by reducing and controlling labor cost are targeted, but general cost reduction is not a focus.

IV. Heeding the Matter of Practical Use of the CM System

In Japan, in the present climate where the CM system is not spreading enough, heeding the following matter is necessary for the possibility of practical use. Furthermore, there are a few topics below that are common even in advanced CM system countries such as the USA.

1. Public Position for the CMR

Presently there is no public position for the CMR according to laws and ordinances etc.
Concerning laws and ordinances for a public position for the CMR:
a) Because the practical use of the CM system has just been started in Japan, it is possible that public regulation could prevent the CM system from developing soundly.
b) In the USA, with the exception of public construction works in Idaho, it is not necessary for a CMR to hold an official license.
c) Due to the requirement that official qualifications for a license be at an agreed upon minimum level, the official licensing is not considered necessary as of this moment.
(Note) In Idaho, according to state law, under the CM system, a CMR is required to hold a license to perform public construction. In order to receive a license, a CMR must have experience and merit in the CM field, and must successfully pass an exam conducted by the state.

However, for the establishment of a trusting, ethical relationship between the CMR and client, it is necessary to exclude and punish unethical workers. It is desirable that the CMR related organizations promote activities to establish a CMR rating/evaluation system.

2. CMR Independence

Because it is the CMR's duty to guarantee the client's interest, and in order to secure the trust for the CMR, it is necessary for the CMR to be not only ethical but also independent from the designer and contractor in the project.
When establishing "Official Ethical Rules" on the relationship between the CMR, the designer and the contractor in the CMR industry group, it is necessary to also consider the independence.
(Note) In the USA, when a CMR is performing public utilities construction, it is not allowed for the CMR to be the designer or contractor. In Idaho, there is clear mention on the official CM permit that this is prohibited. However, as with army engineers, there are some cases where the designer and the CMR can be the one and the same, and in some small-scale construction projects in California, it is treated as an exception.

3. CMr Qualification System

The individual CMr who becomes the CMR team leader must have high ethics, as well as a high level of ability for CM duties such as management experience and knowledge.
In Japan, the present situation is unlike in Europe and the USA. There are no private training programs and qualifications for CMr's, and the database that holds all of the CMR's achievements is still not completed. Therefore, for immediate measure, when a client chooses a CMR, it is suggested that the client request that the CMr hold qualifications such as architectural, engineering or managerial qualification.
When the CM system becomes established and CMr's achievement information is stored, it could be thought that the management ability is a more important factor than qualification in a given specialty, and could therefore lead to the need for a new private qualification exam system.
It is expected that in order to contribute to the client selecting a CMR, the CMR related organizations will study on the CMR training program and the private CMR qualification examination system.
(Note) The CMAA (Construction Management Association of America) implements standardized levels for the Certified Construction Manager (CCM) certification program.

4. Responsibility and Guarantee/Insurance Regime

In the CM system, the risks relating to construction completion in a bulk ordering system, which general contractors as prime constructors bear, are given to the client and the contractor. It is generally said that each constructor bears the risk with construction dispersed by construction type, and the client bears the risk relating to the completion of overall construction.
Because in the "At risk CM", the client and CMR will share the risk of the client, it is necessary to clarify in the contract the scope of the responsibility and risks for the client and the CMR respectively (e.g. Guaranteed maximum price (GMP) etc.)
(Note 1) In the package ordering system, the risks relating to the construction completion which general contractors bear include;
1) Risk relating to construction (keeping construction schedule, securing quality, complying with construction budget, work safety etc.)
2) responsibility obliged to bear by law (prime constructor's responsibility based on the Construction Industry Act, providing a chief health and safety officer based on the Industrial Safety and Health Law, disposal responsibility based on the Waste Processing

Act, civil law, defect bond responsibility based on the housing quality control promotion law etc.)
A CMR can basically be thought of as not being responsible as a prime contractor. However, in case of the “At risk CM” system, the CMR makes direct contracts with specialized contractors, and the CMR acts like a contractor, it is necessary for the CMR to consider the necessity of granting the Construction Industry Act and the possibility of an application for the prime contractor responsibility based on the Construction Industry Act.

- Prime contractor responsibility based on the Construction Industry Act
- Establishment of responsible party in accordance to the Worker Health and Safety Act etc.
- Establishment of responsible party in accordance to the Waste Processing Act etc.

In the CM system, because it is the client’s sole responsibility to bear the risk relating to construction completion, it is required to prepare various schemes (bond, insurance etc.) listed below to avoid risk. Furthermore, as a precondition for the bond and insurance, the scope of role and responsibility of the client, CMR, designer, and contractor etc. upon introducing the CM system must be clearly stated in the contract etc.

- Performance guarantee system and payment guarantee system
- CMR specialist compensation responsibility insurance regime
- Contractor error compensation insurance regime

It is necessary to consider an “Open System” for the CMR system projects, where the facts are disclosed for the market to eliminate CMR’s who demanded the designer or contractor to provide unfair interests, caused damage to the client due to the error of the CMR, or produced a significant defect.

5. Way of Thinking about Cost

(1) Making the Cost Structure Clear
One of the key distinctions of the CM system is that because the construction is classified into categories, the actual payment for the contractor (and specialized contractors etc.) can be immediately grasped by the purchaser.
In the bulk purchase system, the construction costs are:
a) The direct construction cost of each construction classification
b) Hypothesized expense
c) Actual management expense
d) General management expense etc.
In many of the cases, it is organized like this, however, because the relationship between the purchaser and the general contractor is an “entire fee contract”, the contractor is at the freedom of his own discretion to make subcontracts as he wishes, and in general the amount of cases where the purchaser knows the payment of the subcontractors are few and far between.
In the CM system, because the CMR makes clear the calculations for the prices of all the specialist construction workers, the purchaser can grasp all of the payments and prices. Furthermore, because the CMR audits all of the contractor’s yields, and does all of the actual price management, it is much easier to grasp the cost structure in the CM system than in the Bulk purchase system for the purchaser.
Furthermore, in the CM system, because the cost management that is done by the general contractor in the package purchase system is handled by the client and the CMR, we should note that the workload on the client side is augmented, and the risk (e.g. increment of construction fee) will be involved.

[Note] About the “Cost + Fee system”
In the USA, the “Cost + Fee system” (Note) is becoming established. The CM System is adopting the “Cost + Fee system” because the cost breakdown is easy for the purchaser to grasp.
(Note) The “Cost + Fee System” is a legally disclosed payment system that consists of the contractor’s construction costs (Order fee, raw materials fee, workforce fee etc.), and the contractor fee (remuneration.)
The “Cost + Fee System” are classified into fee and cost, and cost is again classified into the following:
a) Assorted construction work and contractor for the purchased money
b) General condition cost (classified into hypothesized cost based and regulated in the contract)
In this case, the CMR is:
a) Construction Costs piecework payments
b) General Condition costs calculated actual expenses etc. inspecting of the invoices by the contractor, and informing the purchaser of the cost breakdown.
The “Cost + Fee System” is construction fee piecework payments and general condition cost and with the actual expense calculation, because the purchaser is able to grasp a fair and reasonable price, it can be said that it is easy for the cost to be lowered for the purchaser.
In Japan, the “Cost + Fee System” is rarely adopted in the private sector, (Note), Although in the case of conjugation with the CM system, it can be thought of as necessary of consideration.
(Note) The “Cost On System” where the client, contractor, and subcontractor enter into a contract after deciding the subcontractor’s fee and the prime contractor’s management fee can be considered as a kind of "Cost + Fee Systems".
(Note) In the USA, in the case of the “At Risk CM”, it is often the case that at the stage of planning when the total amount of construction costs is decided, similarly to the “Cost + Fee” system, the Greatest Maximum Price (GMP) is established, called the “Cost + Fee with GMP.”
(Reference) Not only the construction cost payments, the“ Cost + Fee system” is sometimes adopted, which divides the direct payments and compensation to the CMR

(2) A Consideration of CM Duties
In the CM system, the CMR is compensated for his CM duties. This compensation is called the “CM Fee”. This fee consists of management fees (the CMR’s managerial duties are the main expense.)
In the US CM System, the CMR’s compensation is written in the contract either as a “CM Fee”, or as “Lump sum fee” compensation.
The basis of the CM fee is mainly dependent on the scope of the CMR’s management duties, the scope of the project, and the amount of work etc.
(Note) Regarding the CM fee amount, it varies depending on the scope of the CMR management duties, and it is generally 2 to 5% of the total construction costs. However, in Japan where the situation differs from the USA in terms of the completeness of the design documentation, the size of the specialized construction workers etc., a thorough consideration about the fee calculation is necessary.
Again, in the case of the “At Risk CM”, there is a tendency that the bigger the risk, the bigger the amount of duties and affairs (and fee.)
In the USA, according to the Construction Management Association of America (CMAA), the CM fee is the profit that the individual CMR takes. However, the Associated General Contractors of America (AGC) say that the CM fee is the allowance from the CMR’s

branch office, the general management fee, capital expenses, and profits. These 4 items define the total CM fee.
There is one more element to be considered in the cost structure for the general management expenses (costs). In the “At Risk CM”, the subcontractor’s fee is also included, which makes this section increase.
As the CM fee is unfamiliar in Japanese construction industry and is not included in the process of integration of fees, substantial investigation and clarification about the difference, as well as measurement of the lump fee contract of a packaged contract is required.

(3) Contingency
Up until now with the package purchase method, the contractor and general contractor have been responsible for the risk. However, in the CM system, the purchaser is responsible for the risk. In the ISA, projects that have adopted the CM system that have an unpredicted event befall them, and have the cost rise due to unpredicted additional construction and design changes often fall back on “Contingency” (emergency budget in case of unplanned events/necessary changes.)
The contingency plan by the purchaser takes into account other similar projects and payment for construction workers and construction that is not normally in the budget. If the purchaser asks the CMR about the contingency, the CMR will offer the necessary advice, although normally the purchaser’s originally announced budget will not change.
If the project proceeds as originally planned, then the contingency fund is saved. However, if the construction project takes more man-hours than expected etc. then there are cases when the contingency fund may have to be used.

6. CMR Selection

In the case that the CM System is adopted, the success or failure of a project is dependent upon the purchaser choosing a CMR with ability.
If a CMR with a poor disposition and ability is chosen, then the purchaser’s risk and costs are in danger of rising.
At the time of CMR selection, the purchaser must not look only at the CMR fee, but also at the ability, experience and comprehensive evaluation in order to choose the correct CMR.
The purchaser must have ability in understanding the assessments of the CMRs.
The ideal method of CMR selection is not solely made on the price alone, but also must evaluate the CMR on management ability, appropriateness for the project and the ability to advise and propose ideas well. In Japan, the public works construction proposal system (note 1) etc. can be seen as reference for the CMR selection method (note 2.)

Note (1) The open proposal system based on the “Action Plan for Improvement of tendering and Contracting Procedures”, in January 2006 is considered to be required for procurement of CM works of certain scale in the public works sector that are subject to the WTO Government Procurement Agreement.

Note (2) There is a strong opinion that the method of CMR selection in public construction work should be the “Quality Based Selection Method” (QBS.) The QBS Method is recommended by the “Union of International Architects” (UIA.) The QBS method stresses the choice of “person” and ability over “price.” However, in Japan, it is normally the case that the local governments choose price as the main factor of importance.
At the time of choosing a CMR, much consideration must be given to the scope of the CMR’s affairs (duties/responsibilities), and to judge whether the CMR’s qualifications and achievements are suitable for the scope of affairs.
In Japan, the CMR system is in an early stage of practical use, and the development of the CMR is an issue in the future. For some time to come, design offices (including both

civil engineering and construction) and general construction vendors who have CMR experienced in oversees construction works are considered to be the major players who perform the management work as CMR as well as specialized CMR vendors. When CMR system becomes established in Japan in the future, CMR selection is considered to occur with performance and capability evaluation.

7. CMR Contract

The contents of the contracts in the USA for the “Management Duties Contract” between the purchaser and CMR can be thought of as very similar to the Japanese “Business Consignment Contact” (a contract of responsibility) (Note 1).
Note (1) Quasi-entrustment is a type of entrustment that only includes works that are not acts of law, and to which the entrustment rules of Civil Law are applied.
(Reference) Although some say that the “Management work contract” between the purchaser and CMR is a “contract” from the legal standpoint, the rules in the standard agreement of both CMAA and AGC indicate that it is considered to be very similar to the quasi-entrustment contract in Japan.
In Japan from now, it is necessary for the smooth practical use of the CM system, for the scope of management duties, and power and responsibilities, standard management duty contract (CM contract), to be adjusted. Also, in the case of the CMR taking part in the planning prerequisites, the planning contract, construction work superintendence contract, and the construction work undertaking contracts all need to be thoroughly examined.

8. Practical Use of Information Technology (IT) and the CM System

Presently, there is much progress in the Business to Consumer e-commerce marketplace. Many types of manufacturers and consumers (purchasers) directly connect via e-commerce over the internet. In the construction business too, there is progress being made by the many purchasers who are using electronic bidding and electronic ordering, having blueprint conferences over the Internet, and budget meetings over the Internet as well. (Note 1) This flow of IT reform has changed things that have hitherto been difficult for purchasers to grasp (especially for a purchaser who has had few previous construction transactions,) such as construction equipment and raw material prices, as well as contractor information. This has now become open, and it should be made clear that the bulk ordering method in terms of cost, and risk, if compared the CM system, the purchaser has much more choice in the CM system.
(Note 1) The Ministry of Land, Infrastructure and Transport has made information on the subject of electronic bidding and electronic ordering etc. in the “Ministry of Land, Infrastructure and Transport CALS/EC” (Public Utilities Integration Information system) and is making positive progress.
Again, in the CM system, there is the possibility of increased smooth intermediation and agency between the CMR, the purchaser, and the contractor. If the B to C marketplace develops well, the CMR may be able to use IT to make coordination smoother.
In the private sector construction marketplace, CMR’s and specialized construction workers etc. are already registered on the B to C electronic market. The consumer can therefore make a CMR selection, and with that support, bid contractors etc. The CM system is developing in accordance with IT use, and construction work can be reformed.
In order for IT to be introduced successfully to the CM system, the following steps are necessary:
1. Construction of the database which include evaluation about construction and management abilities of specialized construction workers.
2. Further investigation is required into the registration of CMRs on the electronic market that create security measure for purchasers.

9. Restructuring of the Construction industry

Because the construction and manufacturing system historical background and culture is unique, it can be thought that it would be difficult to import the Western CM system as is into Japan.
In the case of “The form of the Japanese CM system,” the designer, general contractor, and specialist construction workers etc. have been, up until now, serving their functions in the Japanese Construction Manufacturing system as expected. Much thought is therefore necessary to be put into what the roles would become and change with the introduced CM system.

(1) The Designer and CM system
Up until now in Japan, there has been consideration about the “Pure CM” as a “Japanese version of the CM system” mainly in the design world. In the “Pure CM” in Japan, the designer acts as the client’s manager, and depending on the type of project, makes a package purchase to the general contractor, or makes a separate order to a specialized construction worker.
In Japan it is often the case that the designer gives the purchaser advice since the project planning stage, with it possible to be seen as fulfilling the role of the CMR. Again, even in the advanced examples in Japan of “Pure CM” system projects, the planner can be seen as fulfilling the role of the CMR.
However, because the CMR can guarantee independency from the designer, in projects where the designer becomes the CMR, it is as a general rule not hoped that all of the planning duties are performed collectively under the same responsibility.
In the case when the designer firm etc. becomes the CMR, it can easily be pointed out that the construction knowledge management ability is much lower in terms of the package purchase system than that of a general contractor. However, there are planners in overseas management offices who, more than just taking part in planning, have more than enough construction management ability.
Again, in cases where the planning office etc. has already become the CMR in the project, it can be seen that these companies are proactively hiring technicians with construction management experience and planning to get more.
It is of note that in Japan, working diagrams supplement design documentation in the purchase/ordering phase, which are not to the quality it should be. Improvement of quality of the design documentation in the purchase/ordering phase is a challenge however, when implemented in the CM system in Japan.
Thus, during the design phase, the CMR should perform design management, including review of the design documentation from the perspective of implementation, and if necessary the CMR may redesign or perform design VE. It is necessary that the designer be fully aware of the role that CMR plays during design phase.
Boundary of each work type of construction work should be clearly defined, and as necessary CMR may review order partitioning, in terms of organization, method and schedule, with designers.
In the case of construction work, supervision of construction work and management work done by the CMR may sometimes overlap, and the scope of work for both should therefore be reviewed.
(Reference) In the USA, completeness of design documents is required to be high, though on the other hand there is no task such as “Construction management” defined in Building Acts and Architect Acts.

2) Client and the CM system
 Some clients regard the CM system as a type of all-purpose cure for cost reduction by making the cost structure and ordering process transparent. However it is absolutely not. Clients may rather take the greater risk of completion of the work under the CM system

than the existing packaged contract system. Clients need to pick the best system for construction, production and management which only having the proper understanding of the CM system can provide.
 While clients depend on a prime contractor in the existing packaged contract system, they should change their awareness in this regard and grow out of such a dependent mindset. Also, clients are required to build good partnerships with designers and contractors based on clearly defined contractual relationships through receiving adequate advice and support from the CMR.
 We see such movement when comparing the CM system with the existing packaged contract system and reviewing the pros and cons of each from the standpoint of a client (developer etc.) in the private construction sector.

(3) General contractors and CM system
 Domestic (Japanese) general contractors are expected to play the role of CMR in the "At Risk CM" by using their full capabilities to enforce management.
We should consider issues, in this regard, such as the relationship between clients and CMRs, which may be through entrustment or contract, and whether the CMR must have a proper construction license under Construction Industry Law (see Note 4 on page 5.)
 It is considered to be effective to overlap the design phase and the construction phase slightly in order that the CMR and "At Risk CM" can drive the construction work (Note 1.) However the CMR may be required to have a certain level of management capability and experience that general contractors possess.
Note (1) For a method where design and construction can be undertaken simultaneously, there is a "Design build (DB) system" in the USA, as opposed to the "At Risk CM." Also in the USA, for the purpose of early completion of the construction, once the design for the basement is completed, even before completing the design for the ground floor, it is considered that the "At Risk CM" has been created, because the Fast Track is implemented in commencing the basement section.
In the "Pure CM", in the case that the CM determines that it would be benefit the client, the CM may be able to prevent problems (e.g. failures etc.,) and improve the efficiency of the management by collectively ordering various types of construction from the general contractor, or ordering only one type of construction in a project with multiple construction processes to a general contractor.
As of now, while some general contractors are establishing an organization handling the CM system inside the company, considering it as a fee business, other general contractors are not proactive in regards to the CM system. It is anticipated that the CM system is considered a business change where general contractors can exercise their management abilities and therefore proactively consider introducing the system in the industry.

(4) Specialized Construction Workers and the CM System
If the CM system spreads in the industry, through separate ordering, specialized construction workers and the like, will enter directly into a construction contract, and the specialized construction workers can therefore exercise their technical proposal abilities. Because the specialized construction workers have high quality technique, it would lead them to a big business change.
Also, if an e-commerce and specialized construction business becomes an IT base (e.g. database), this trend may be accelerated.
The actual trading conditions of a prime contractor and a subcontractor in the package ordering system, according to the "Research for the Actual Business Conditions in the Specialized construction industry" conducted by the Ministry of Land, Infrastructure, Transport and Tourism (November 2000), the "Limit price" ordering" where the prime contractor demands a large discount without any reason, and the fact that the subcontractor unilaterally has to bear the construction waste disposal etc. are big issues.

In the CM system, because a written contract and thorough discussion of the estimation are required, some effects can be anticipated. For example, the traditional “wet” business relationship (e.g. work commencement before contract is made with an oral agreement) is rectified, and an explicitly stated (e.g. through a contract etc.) relationship will be more common.
On the other hand, upon introducing the CM system, it will be necessary to cultivate specialized construction workers who can handle multiple types of construction by workers of differing types of specialization working together, and who can integrate multiple types of construction on behalf of the general contractors.
Also, regarding the CM system, there is an indication that the coordination function of the specialized construction workers may be deteriorated at the site of each construction type for the separate ordering. Therefore, the CMR would be required to make the construction responsibility system at the site under a smooth liaison with the specialized construction workers.
Furthermore, in the CM system, because the specialized construction workers will bear the responsibility and the risks relating to the construction, specialized construction workers need to build a construction standard, defect guarantee system etc. between specialized construction bodies etc.

V. Issue and Application of the CM System for Public Construction Work

1. Study of CM System in Japan

Since the early 1990s, it has been indicated that the CM system is needed not only for public construction works, but for purchasing for construction work in general.
The reasons why the CM system is necessary for public works clients are;
1) The CM system will increase options for the client with various types of construction management systems.
2) The CMR that conducts design, order, and execution duties can support the public clients.
3) The CM system will make construction costs transparent
The Ministry of Land, Infrastructure and Transport (MLIT) has been addressed with the challenge of introducing the Japanese CM system. In particular, MLIT feels that the CM system will bring about significant benefits for construction works conducted by local governments. From this perspective, MLIT has set up “The CM System Study Working Group” which consists of academic experts, as well as representatives from private sectors and from public sectors.
In addition, since January 2001, MLIT launched a trial application of the CM system with Kiyosu JCT North, using construction work management of the private sector. In the construction management, a new bidding and contract process was implemented. At the same time, assessment and follow up of the construction work was conducted as well., MLIT installed “Assessment Working Group for Trial Projects of CM technology” in order to evaluate the CM system by studying various frameworks for bidding and contract creation based upon other types of management technologies and conducting next trial projects.

2. Demands for the CM system in Local Governments

When trying to apply the CM system to public construction work, it is expected that the local governments require the CM system because these local governments sometimes do not have engineers to manage their construction works. These local public governments will therefore be major CM system users. For some local governments that have sufficient engineering resources, the CM system is necessary only if applied to difficult or large scale public construction works

According to local governments taking a progressive approach to the CM system and the "Study on Using External Assistance in Local Public Sectors", needs for the CM system can be summarized as follows;

(a) Demands for Design and Procurement

○ The CM system would enable a more detailed document design check from the construction perspective.
○ Using the CM system, design change costs would be lowered.
○ Via Design Value Engineering and design review, the total construction cost would be reduced.
○ The CM system would be necessary for technologically advanced or non- repeatable construction work.
○ The need for consultation from experts regarding purchasing scope and purchasing method would be aided with the CM system.
○ There would be increased purchasing process transparency with the CM system.

⇒MLIT found that there are particular requirements for the CM system that provide consultation and support to clients at the design and purchase stage.

b) Demands for Cost Management and Payment

○ Increased transparency in cost structure and accountability to taxpayers
○ The contract value, its breakdown, and subcontracting value should be made clear.
○ Payment and billing procedure, (payment vs. progress/completion) should be assessed from a technical perspective.

⇒MLIT found that there are requirements for a transparent cost structure and cost management system.

c) Demands for Supervising and Inspection

○ To receive support for supervising and inspection, (currently difficult to receive.)
○ To receive advice from experts for construction schedule and quality assurance.
○ To improve efficiency in construction using the CM system.

⇒MLIT found that there are requirements for effective construction management for the CM system.

3. Purpose and Expected Benefits of the CM system

(1) Purpose and Benefits of CM system
○The purposes and expected benefits of CM system for public construction work are as follows;

・ Support for client procurements in terms of quality and quantity ("quantity" is defined as support for engineering resources)
・ Increased transparency in cost structure
・ Want to find an appropriate price level (results of design on value engineering and various management)
・ Maintain thorough quality management
・ Enhance clients' capabilities at the design and procurement stage.
・ Increase transparency in procurement process
・ Prevent corruptive behaviors and increase accountability to taxpayers
・ Reinforcement of supervising and inspection
・ Training clients' engineers (enhancing management capability)

* By introducing the CM system, engineers in purchasing organizations are requested to perform higher level management, such as selecting a CMR, defining contracting scope,

supervising, and assessing results. Types of CM system may differ depending upon purpose of the CM system.

(2) Support of Client's Work
The CM system functions effectively for local governments in which engineers are insufficient for managing their public construction work in the following 4 cases.
Case 1: The local governments do not employ engineers to manage their public works. The local governments always have a dearth of engineering staff compared to the volume of public construction works that need to be managed.
Case 2: The public construction work in which high-level technologies are necessary, and the client's engineers do not have appropriate technological capabilities, or in the case that the client's engineers are requested to have high-level management capabilities.
Case 3 The case when the client's engineers are not available temporarily when multiple construction works are going on in parallel. The case in which multiple contractors (designers or builders) are involved in a single construction work and the client's engineers are occupied by coordination work among these contractors.
Case 4 During the long-term construction work, it is sometimes necessary to move the client's engineers to other posts.

4. CMR Application Model for Public Work Clients

(Case A) Advisory Service Model
In this model, the CMR renders advisory services for clients by inspecting design drawings, design value engineering, as well as defining scope, and purchasing method.

(Case B) Cost Management Model
In this model, the CMR performs a part or all of cost management work including the construction cost estimate, cost analysis and payment approval.

(Case C) Construction Management Model
In this model, the CMR performs approval of drawings, coordination of contractors, quality management, and schedule management.

(Case D) General Management Model
In this model, the CMR performs a part, or all of the construction management work as an assistant to the client throughout the design, order, and construction phase of project.

MLIT is aware that some public work clients tend to feel that the CM system would be difficult to utilize effectively because its procedure is complicated and restricted. However, the CM system is not always as difficult as said public work clients may feel.
As mentioned in Case A, advisory services for design, procurement or consulting services are considered on occasion to be the CM system. There will likely be large demand for these services from local governments that have an insufficient number of engineers to manage public works.
The CM services can be classified from Case A to Case C. Such individual service items may be carried out individually or as a whole.
In particular, the case when many contractors involved in a project in which a single and consistent communication relay is necessary to coordinate the contractors, the CMR is likely to act as an assistant to the client for all construction management work (as mentioned in the Case D above.) It should be noted that there are some opinions that the advisory service, or technical assistance to public works clients by external organizations is not considered as the CM system.

However, the CM system aims that the “CMR performs a part of, or all of construction management work on behalf of public work clients in a neutral position in terms of technology throughout a design, procurement, and construction phase of project.” The CM service as mentioned in Case A is naturally included in the services provided by the CM system. For Case C and Case D, the CRM supports superintendent supervising services. Because building works need construction supervision as stipulated by building codes and authorized architect law, the CMR must have an equivalent qualification in order to share management roles with authorized construction supervisors.

(Reference) Public Construction Work Superintendent
1. In public construction works, the client’s engineers are appointed as authorized superintendents for both civil and building works. These superintendents are authorized to perform the following duties based on the Construction Contract Agreement;
・ To give instructions to, give approval of, and discuss with the contractor regarding performing contract obligations
・ To create and provide detailed drawings for construction work based on design drawings, or to approve detailed drawings
・ To control, inspect, and monitor the construction process upon based design drawings
2. Because some public works clients do not have sufficient engineering resources, superintendents for such organizations have multiple tasks to perform at the same time, resulting in a very heavy workload. These organizations therefore require assistance from outside experts in order to complementarily supplement their management capabilities. According to Building Codes and Authorized Architect Law, authorized supervisors are required for building works even if they are public building works.
3. As for civil works, there are certain cases in which superintendents take on the role of authorized supervisors, with construction consultants assisting them.
Management services as mentioned in Case C and Case D intend to support superintendents from the client’s side and these services differ from those of authorized supervisors required for building works. However, it should be noted that there is a distinction between CMR management services and the control of authorized supervisors because both activities may actually be similar at construction sites.
4. In building works ordered by public work clients, authorized supervising tasks tend to be outsourced.
Important parts of construction work, which are critical for quality are outsourced to parties other than design contractors. (In local public governments, occasionally design contractors perform supervising work for construction of the building they designed, much in the same way as can be seen in the private sector.)

5. Basic Approach to Using the CM System

(1) Basic Understanding
The CM services and duration of services that are required by public clients vary depending on the client’s organization and projects.
Consequently it is useful to define the “Implementation Procedure,” which stipulates the scope of CM services and role and responsibility of the client and CMR for each project.
* Even for clients who have an annual CM service contract with the CMR, it is useful to define the “Implementation Procedure” for the individual project base.
It is perceived that this “Implementation Procedure” will be changed in order to be applicable to all the projects throughout the year when the scope of the CM services can be defined for the yearly contract.

The “Implementation Procedure” should include the definition of the construction work under the CM services, scope of CM services, selection method of CMR, criteria of selection, and how to apply for the CMR.

(2) The Scope of CMR Services (example)
a) Planning, Purchasing Advisory Service Model (Case A)
- Technical advisory service for the design and procurement phase
- Advisory service for selecting and evaluating the designer
- Advisory service for inspecting design documents
- Advisory service for VE on design and defining project scope
- Advisory service for procurement approach
- Advisory service for evaluating qualifications of construction contractor
- Advisory service for bidding and selection of construction contractor
- Advisory service for terms and conditions of construction contract
b) Cost Management Model (Case B)
- Advisory service for construction cost estimate
- Analysis of construction costs (construction classification)
- Evaluating invoices submitted by contractor for progress payments or completion payment
- Advisory service for assessing and adjusting costs incurred by design changes
- Payment administration etc.
c) Execution Management Model (Case C)
- Coordinating contractors
- Preparing construction plan
- Schedule control
- Review of detailed drawings prepared by construction contractors
- Review of quality management performed by construction contractor
- Reporting on work progress
- Contract execution related documentation/recording administration
d) Construction Management Model (Case D)
The scope of this model is any item listed in(1) ~(4)
* The above information is an example. Depending on the public client’s needs, the scope of the CMR’s responsibilities may be only some parts of the above information, or in some cases duties that are not mentioned in the above information.

(3) Organization and Qualifications of CMR
Organizations which play a CMR role are not only companies specialized in the CMR business, but architect design offices and construction technology centers which have experience in construction management for public construction works.
When architect design firms and construction technology centers are employed as a CMR, they must fully understand the client’s goals for the project. The main goal to be adhered to in the project may be the quality, schedule, or cost of the project. The CMR should be in a position on to represent the client and be independent from designers or contractors.
* In the future, CMR qualifications and prerequisites for should be studied by official organizations. In addition to such study, the official registration system in which potential CMR companies can subscribe will also be one of issues to be addressed. Through the registration system, MLIT will be able to collect information for the basis of selecting a CMR.

(4) CMR Selection
Ideally, the public sector construction work method for choosing a CMR would evaluate the CMR’s management ability, and technical proposal skills that relate to the project.

There is therefore a proposal system that can be thought of as adequate (elaborated in page 18, (Note 1).
CMR recruiting and application acceptance should be guaranteed unbiased and made abundantly clear, for example a public appeal system such as demanding a “CM Duties Written Proposal”.
In order to exclude selecting CMR’s for selfish reasons, a basic necessity is to prepare a “CMR Selection Criteria” that the selection will be made upon that is ensured to be clear.
Again, because there have been exceedingly few actual results for orders by public utilities, it is necessary to create a provisional selection criterion.
Examples of CMR selection criteria:
a) Enterprise undertaking technological strength and experience (entrusted expected responsibilities for the project and similar successful prior results, as well as possession of technical personnel etc.)
b) CMR ability/experience (entrusted expected responsibilities for the project and similar successful prior results, the CMR team leader (CMr), and each team member’s qualifications, experience etc.)
c) CM Business plan proposal and validity for the CMR in regards to entrusted expected responsibilities for the project, appropriateness for understanding the nature of the project, operation plan, work schedule plan, operation technique etc.
d) Client system support (client system support, through the CMR team’s directions and operation enforcement, the client’s personnel management ability is effectively increased etc,) can be considered.
Especially if:
a) It is thought that technological strength should be considered an important factor.
b) Client system support (client system support, through the CMR team’s directions and operation enforcement, the client’s personnel management ability is effectively increased etc,) can be considered.
Especially if:
It is thought that technological strength should be considered an important factor.
For a CMR selection system, the establishment of a selection committee board can be considered, although the selection method and committee board construction, as well as choosing beforehand whether or not to disclose the reasons for the choices that are made, as well as the choice criteria must all be previously established. In order to ensure a clear choice, it may be relevant to bring in a specialist from outside to the selection committee board in order to independently monitor that the selection criteria are kept to.

(5) CMR Contract
In (Case A) ~ (Case D), the character of the management business contract between the CMR and the client can basically be thought of as “the level of trust” between the two.
Furthermore, although more consideration is necessary, in cases such as (Case A), when the CMR is an individual, he can also be thought of for part time work as a special government agent legal advisor etc. The business contract between the CMR and the client can be thought of as decided by the contents of the business venture, the scope of the business venture, the duration of the works, the CMR’s position (client, planner, builder etc. relations,) entrusted materials and method of payment, the rights and obligations of the work, non-disclosure agreement, re-peat consignment prohibition, business performance report, injury responsibility, contract release etc.
From hereafter, it will be necessary for even public construction to prepare a standard business management contract (CM contract) covering the scope of management affairs power, and responsibility etc.
Again, consideration is necessary for how, in the case that the CMR participates in the pre-planning, the planning contract, construction superintendence contract (in the case of architectural construction work), and construction work undertaking ought to be.

Sometimes contracts are contracted for each project, and sometimes only for a certain period of time, regardless of certain projects.

6. Points to be considered in CM System Utilization

(1) Bidding and Contract
In (Case a) ~ (Case d), there is no major constraint under current tendering and contracting systems because the CMR is the trustee of the work.
However, for some management operations the CMR is entrusted with, the public construction works client may need to review the consistency with current system. In particular, the interrelationship between the CMR supervising and inspecting operations for the client need to be fully organized in accordance to the public accounting law and Local Government Act.
Also in the process of CMR appointment, the client is required to evaluate comprehensively not only the price but also skill and experience of the CMR. Therefore, when proposal assessment is applied, a rational selecting criterion and selection system should be prepared. On the other hand, when assessments other than the proposal are applied, the interrelationship with the so called “automated award system” (as a general rule lowest bidder in target price range wins,) defined in public account law and Local Government Act needs to be organized.

(2) Estimation Method for Work management etc.
The total amount of compensation for the CMR’s management work can be measured by adding the primary cost (primary labor cost and direct cost) with the general management fee (which is calculated by multiplying the direct labor cost by a certain ratio. In the future, a better framework for calculating the value of the management work (for instance a specific calculation for the general management fee,) should be organized.
For the value of the management work that a CMR performs, a “Calculation Standard for CMR Compensation”, which includes the calculation method of the CM fee (CM compensation) and management cost, should be defined.
In case each of (case a) ~ (case d) are ordered separately under the current calculation system, too precise order partitioning requires common temporary work cost, site management cost and the general management fee for each type of work, and may therefore increase the cost. Thus great care must be taken in the partitioning of the order type.

(3) Performance Evaluation for the Management Work
When a CM system is introduced, the performance of CMR management work and the effect of introducing the CMR system should be fully evaluated in terms of public construction work. Likewise the evaluation result is expected to be utilized in the selection of the CMR for future reference.

(4) Responsibility of the CMR
When the CMR’s management work is primarily providing advises to the client, external responsibility for executing the business is attributed to the client.
However the contract should include a clause that states that if any errors that are attributable to the CMR are identified, the CMR must bear the responsibility.
When the CMR management work is entrusted under a quasi-entrustment contract, it is considered that the CMR owes General Legal Obligation but no-fault liability (such as the defect liability of a contract.)
However care must be taken in the contract of management operations with a CMR because the client could cancel the contract or claim damages if the CMR is considered to be liable. The contract should define liability, and liability insurance in particular, which is necessary in the event that damage is incurred by the CMR’s execution of management

work (such as the review of a detailed drawing plan , or supervision of process management and quality management)
When the CM system is implemented, it is expected that each order can be segmented into smaller units and one order is divided and then goes to multiple parties. Therefore attention must be paid to the construction of a structure that consists of responsible vendors and eliminate the gap between works, which could be a defect, and therefore prevent any conflicts.

(5) Other Considerations
The Following should be considered :
 Involvement of the CMR with things that are not related to client's direct construction such as coordination with the neighborhood.
 Handling of the cost for management work in a governmental subsidy program.
 Relationship between construction supervisor and CMR's work
 Appointment of health and safety regulator under the Industrial Health and Safety Law when the orders were separated.

7. Issues That May Occur When a CMR Bears Risks

When the CM system is utilized, it is expected that a client asks the CMR to bear risks as well as to perform management work, since the client takes the risk concerning completion of total construction. To cope with such needs from clients, the "At Risk Form CMR" is considered in (Case e).
If a CMR meets said client's need, the CMR can assume the role of a construction contractor.

(Case e) "At Risk" form CMR Takes the management work in (Case a) – (Case d) as well as taking risks. Further research is required, such as the positioning in construction industry law)

(Case e) needs to be considered based on "At Risk CM" in the USA. See II. 2 (page 3). Normally it is undesirable that a CMR assumes actual construction work for the project, although occasionally, as in the case of "At Risk CM" in the USA, a CMR can take a risk at a maximum based on the client's needs and can then contract with specialized constructors directly as a guarantee (Note 1).
(Note 1) We need to perform further research on the "At Risk CM", because there are few actual cases implemented in Japan. However, the one thing that is clear is that the CMR should perform construction with a construction license when it has a contract work basis (Article 3 of Construction Industry Law). review of the CMR's business status is also required when the CMR gets a contract for public facilities or construction directly from a client (Article 27-23 of Construction Industry Law).
When CM system is implemented, and the CMR takes risks as in the "At Risk CM" in a public construction work, there may be issues need to be considered in terms of construction industry law and tendering contracting system. Following is a list of the major issues:

(1) Legal issues under construction industry law
 Does a CMR's job fall under a construction contract?
 Does a CMR need to have a construction license?
 Will CMRs be reviewed by the criteria of the CMR's business status? If so, what will the screening criterion be?
 Will the safeguards under construction industry law be applied to CMR?

 Must a CMR have an administrative engineer and a chief engineer?
 Is a CMR eligible for Act for Promoting Proper Tendering and Contracting for Public Works (which imposes the execution of the account book system, with an obligation to present it to the client.)

(2) Issues of the Bid and Contract system
 Is a CMR required to be cleared for screening of the bidding qualifications?
 How will CMR grading be handled?
 What does a CMR's technical assessment consist of?
 The relationship with WTO Government Procurement Agreements (is it applicable to the construction service as well as design and consulting services?)
 What is the nature of a contract between a client and a CMR entrustment or contract in the case like "At Risk CM"?
 How do we convert a management contract to another contract which bears the risk? (Would it be treated as a supplementary contract or a discrete contract? In the latter case, would it fulfill a private contract?)

(3) Cost Management Issues
 What is the method of estimating remuneration for a CMR that takes on the role of a construction contractor? (In the USA in the "At Risk" CM, subcontracting work must be included and integrated into the cost because the remuneration is the sum total of the fee and expenditure.)
 In the process of a target price estimation, is it possible to specify items such as individual orders, general condition costs (e.g provisional) and contingency?
 Is it possible to specify a Guaranteed Maximum Price (GMP?)

(4) Responsibilities
 How is the interrelationship with the current fulfillment warranty system to be recognized?
 To what extent is a CMR responsible for risks and work completion?

(5) Others
 Is it possible to include contingencies or reserves?
 How should the relationship between the CMR and supervising and inspection duties of engineers be managed by the client?
 What should the relationship be between the CMR and the construction supervising duties be controlled?
 What should the relationship between the CMR and the responsible party for health and safety regulations be controlled?
 Is the CMR responsible as a prime contractor under Waste Management Law?

VI. Conclusion

In order to expand the CM system in the future, as already stated, various issues remained.
While there are issues with which each field ought to struggle, such as the assurance of the ethics of CMR, the training of CMr's , the preparation of standard contracts, and progress in the completion of blueprints; there are also issues such as the division of duties with construction managers, the regulation of relationships with already-existing institutions, and the relationships with the laws concerning the construction industry. In order for the CM system to be put to practical use in cities and towns, and for the parties

ordering materials to participate, standard guidelines for putting the ＣＭ system into practice、the standards for selecting a ＣＭＲ, and other topics must be studied.
Among these issues, there are numerous areas where these interactions exert a large influence on this country's systems of control and construction, as well as areas where medium- and long-term investigations are necessary. Furthermore, the accumulation of examples of putting the CM system into practice are anticipated in the future, however, in order to effectively investigate the issues, it is thought that the empirical investigation of examples put into practice will be effective.
Furthermore, most of the issues until now have been areas that concern those that contractors, designers, clients, and others who participate in construction. In the future however, it will be necessary for all people concerned to cooperate and proceed with the studies.

- **Ministry of Land, Infrastructure, Transport and TourismJapan CM system practical use manual tentative plan of a municipal corporation」2002・12**

→ This manual tentative plan is published as a business guide, and spreading and promotion of CM system are aimed at.

- **Japan Society of Civil Engineers Construction Management Committee Risk management Manual for Road Projects（Ver.1.0）」2010/03**

→ Risk is defined as [the phenomenon which obstructs achievement of the target which was being planned till then".
Risk Management inhibits the influence of risk as much as possible, and is supposed to aim at achieving the aim of Project efficiently by utilizing limited resources effectively.

- **Japanese Industrial Standards JIS 31000:2010（ISO31000：2009）「Risk management-Principles and guidelines」**

→ The organization of all business condition and scale is faced with the element and influence of the outside and inside which make inaccurate their success or failure and time of purpose achievement. A risk means the influence of this uncertainty on the purpose of an organization.
Risk management is defined as Coordinated activities to direct and control an organization with regard to risk.

2. State of art of Geotechnical Risk Management (Geo RM)

Definitions and standards / guideines used in Japan for Geo RM

- **The Japanease Geotechnical Society, Kanto Branch Case study committee on Geotechnical Risk Management「Geotechnical Risk Management」2009**

→ In the construction industry,We have no standards / guidelines as a comprehensive management system for Geo risk in Japan yet, because of uncertainty of geological issue. We just are in progress of study now.

- **Geology risk management society / The Japan Geotechnical Consultants Association 「The business risk examination report on geology 」2006/07**

→ Geo risk is defined as a business risk concerning geology including two concepts, a loss of a business cost and the uncertainty of a factor .
Currently ,we are treating with Geo risk as [unforeseeable] in Japan,and we've just started to research into recognition and understanding regarding Geo risk.

- **Material and Geotechnical Engineering Research Group of the Public Works Research Institute (PWRI)「The risk in geological engineering, and its management」**

→ Geo risk is defined as [Combination of undesired Geological phenomenon , occurrence probability and quantity]. Risk Management is defined as [Composition of risk identification, estimation, assessment, judgment and countermeasures]

3. State of the art of integration of Geo RM and Project RM

Degree of integration of Project RM and Geo RM and brief conclusion on it

→ As mentioned above, we are on the way to establish the Risk Management System for Construction Project.

In Japan, Geo Risk has been treated as “unforeseeable or unpredictable” geological condition, which is better to make action for countermeasure after the risk is revealed. However, such current situation is generating serious problems in Public works.
Our study is approaching the new geological risk management system which consists of Risk quantification, Process management system and Geological advisor for the public client. We intend to integrate Geological advisor in Geo RM and CMr in Construction Management System in future.
Geotechnical professionals should be entitled to be a Geo Manager as a function of CMr (Construction Manager) in Project client.
And, Formation of an engineering advisor system based on the actual proof of the cost reduction effect by geology risk management and on systematization of the accountability of the geology risk for business execution consensus building should be realized.

TC304-TF3 COUNTRY REPORT

The Netherlands
Status per 15-06-2013

on
Integration of
Geotechnical Risk Management
in
Project Risk Management

Country
The Netherlands

Period
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Disclaimers

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1 State of art of ProjectRM

1.1 How is ProjectRM defined?

- *ProjectRM is defined as all activities and measures for dealing with risk for managing a project. This is the RISMAN definition by Van Well-Stam et al (2004).*

1.2 Which ProjectRM guidelines, standards, and processes are used?

- *RISMAN method by Van Well-Stam et al (2004)*
- *ISO/IEC 15288 (2008) on systems engineering*
- *ISO/IEC 31000 (ISO, 2009) on risk management*

The above standards are known and are used. Many companies however, developed their own tools and/or processes based on, or elaborating on, the principles given. These tools are sold in the market as 'a consultancy product', or they are used directly as an 'in company tool', integrated in the company's own quality assurance system. Examples hereof can be found in the Engineering Consultancy, with Contractors, but also with Public (Client) organizations.

A clear trend can be recognized to integrate and process different types of information with the objective to minimize probability of 'failure', meant in the broadest sense possible, but also to correctly set the project priorities (e.g. to put the project efforts on those items that really matter). The process is usually supported by a strong and 'suite-for-purpose' ICT environment. Risks might be technical and/or product orientated and/or process orientated and/or organization orientated, concern the whole project life cycle and are managed in a risk driven way.

Some examples of tools/processes that found a place within ProjectRM processes and or procedures are:

- *RISMan*
- *Virtual Designing & Constructing (VDC)*
- *Building Information Management (BIM), Revit, Civil3D, etc.*
- *Systems Engineering & Relatics*
- *BIM coupled with GIS.*
- *Etc.*

These tools might not directly be recognized as a tool for risk management, but are used to reduce the project's risk profile by making risks explicit or visible (stand-alone or in combination with other tools/processes). Although some of them treat risk in a more explicit way, others manage risk more implicitly aiming to prevent design and/or process 'failures' and/or to assign risk over different stakeholders and to make important project decisions in a rational and risk driven way (which also may include accepting of risk).
As many tools/processes and opinions exist, it is considered that the list above may not be complete. It is also considered difficult to honor 'all' efforts and ideas on ProjectRM to their correct value.

1.3 In which kind of projects is ProjectRM applied?

Project RM might be called a 'standard routine' in the bigger infrastructure projects. In multidisciplinary projects which are characterized by the complex interactions that exist between different actors and stakeholders, which sometimes work based on different requirements/conditions and/or with different interests. The complex project structure, but also the project size, makes it difficult to keep in full control, which makes the project implicitly vulnerable to error/failures. ProjectRM is clearly recognized as a tool to manage and control the project risks in a systematic way.

Projects where ProjectRM is more or less 'common practice' in The Netherlands may be found in:

- *Line Infrastructure: roads, railways, dikes*
- *Important structures and/or facilities: harbours, large dams*
- *Underground building: tunnels, subway (metro) stations, parking facilities.*

ProjectRM is also used in projects and/or industries where it is a-priori recognized that a failure can have huge financial consequences or in cases where the impact of the failure is considered high (think of: 'loss of momentum and/or public support' or even in 'loss of life').

Some large public clients require the application of ProjectRM contractually and/or use ProjectRM in the procurement as part of the Best Value Procurement. In these cases Project RM is explicitly included, as it simply is a project demand. Often the RM procedure is defined as subject for the audit process between Client and Contractor.

1.4 In which project phases is ProjectRM applied?

Usually in all project phases, but not always in a systematic and transparent way.
The way the project risks are managed, considered over the whole project's life-cycle, is also dependent on the contract form. Compare for example 'performance based contract forms' versus more 'traditional execution contracts'.

At 'traditional execution contract' (construct only) a clear cut can be recognized between the design and the execution, where design and execution are dealt with by different parties (which also means that the responsibilities differ).
For construct only contracts legal rules are defined to deal with geotechnical risks (UAV-gc). For this reason, ProjectRM might have been applied in the feasibility and contracting phase in contracts prepared by public clients, while Contractors and Engineers might use ProjectRM in the contracting, design and construction phases. The connections and interactions between the risks identified in different project phases are not always well considered and/or well transferred/communicated from one phase to the next phase (with complicating factor that the risks are not always managed and controlled by the same entity or person).

At D&C or DFBM contracts RM is generally applied in all the stages of the projects, either as a result of the contractual requirements, or based on the quality system of the contract parties. Occasionally (for example at the land reclamation/extension of harbour Rotterdam Maasvlakte), the risks are identified in the tender phase, as a joint effort between the public client and the contractors. In

the latter case, the consequences, possible measures and the ownership of the risk was explicitly defined.

1.5 What are the results of applying ProjectRM? Bring in examples

- *Better in control in managing their Design, Build, Finance and Maintenance type of projects.*
- *Accountability to relevant stakeholders, by demonstrating that they apply ProjectRM in order to minimize additional and unforeseen project costs (overspendings). It is a requirement that risk is also assigned to a party (has a owner) in order to avoid problems at later stage should something go wrong.*
- *Reduction of 'probability of failure'; in the end minimizing 'failure costs' against an acceptable risk profile, where costs may originate from different origin: 'delays in the project realization', 'structural failure (including geotechnical)', 'loss of public support', etc.*
- *Structure and transparency resulting in a timely awareness of the project risks (which enables the possibility to manage these risks in a rational and transparent way).*
- *Making risks explicit, including consequences, improves awarenss throughout an organization instead of only amongst the different specialists.*

1.6 What are hurdles for applying ProjectRM?

- *Applying Project RM takes time, costs and additional paperwork, while it is not always easy to proof the 'return on these investments'.*
- *Underestimation of the need, based on experiences gained in the past (a failure was never experienced before, on a specific job, until it finally happened).*
- *Knowledge. Some (smaller) companies sometimes seem to lack the knowledge to properly apply ProjectRM. In other cases companies do not know where to find the knowledge and/or the tools developed for proper ProjectRM.*
- *Differences in culture between different project entities (risk managers (management), engineers (design), contractors (execution), etc.).*
- *Openness about risks can be considered a weakness (or not be valued to its value).*

1.7 What are solutions for overcoming ProjectRM hurdles?

- *Demonstrate that time and costs invested in ProjectRM pays off (identify and communicate ProjectRM successes).*
- *Apply ProjectRM as lean and simple as allowable, for instance by aligning major project risks to project objectives, according to ISO/IEC 31000 on risk management.*
- *Work on the 'mind-setting' of all the people involved ('it is between the ears', 'it should become a habit', 'it is for your own sake', etc.).*
- *Turn the application of ProjectRM to project condition (directly or indirectly, the later, for example, by explicitly asking for it as part of the Best Value Procurement) .*
- *Anchor and embed ProjectRM in the company's QHSE systems.*
- *Share knowledge and experiences via publication, courses, workshops, etc.*

2 State of art of GeoRM

2.1 How is GeoRM defined?

- *In the Netherlands, GeoRM is considered that part of the RISMAN project risk management approach that specifically considers the ground-bounded risks (geotechnical engineering is implicitly included)*
- *Geotechnical risk management has a long history in The Netherlands, explicitly by the use of spreadsheets specifically addressing geotechnical risks, recommendations for monitoring, definition of warning values, remedial measures should these be required, etc. But also implicitly as part of the soil (site) characterization and weighing of design alternatives (for example during selection of foundation options, retaining wall selection, etc.) It is considered very important that geotechnical risk management is done in a transparant way in favor of all parties involved.*
- *Geotechnical risk management is also used (in The Netherlands) to assign the risks identified in the optimal way over the project stakeholders. Stakeholders that can have influence on the risk identified are in the best position to reduce the risk, manage and control the risk, to take the risk, to assure the risk. A rational and sensible distribution of the project risks over the different stakeholders involved results likely in the most economic design with the lowest failure costs.*
- *GeoRM was put in the market in a more explicit way in 2006 as 'GeoQ geotechnical risk management', with Q standing for quality (Van Staveren, 2006). Here, GeoRM is defined as explicitly, structured, communicated, and continuous dealing with geotechnical risk for achieving project objectives in the most effective and efficient way (Van Staveren, 2010)*

It is noted that the question is not, in the context of this chapter, if geotechnical risks have been (or are) properly dealt with, but rather if GeoRM is done 'provable in an explicit way' or not.

2.2 Which GeoRM guidelines, standards, and processes are used?

- *Some 'joint industry CUR guidelines have been prepared on applying geotechnical activities specifically in a risk driven way:*
  - *risk-driven site investigations (CUR)*
  - *risk-driven geotechnical monitoring (CUR)*

  Geotechnical risks have also been identified in other standards and guidelines, but not anchored in a typical risk management and control procedure. Those standards and guidelines cover typical geo-engineering/geotechnical subjects /structures (and are limited to a single geo-engineering subject or structure):
  - *Soil retaining walls (CUR 166)*
  - *Flow liquefaction*
  - *Dike engineering (TAW, ENW, etc.)*
  - *Piping*
  - *Etc.*
- *The "Yellow guide", a Dutch practice guide on GeoRM (Van Staveren, 2010), which describes the same risk management steps as the project risk management guidelines of RISMAN (Van Well-Stam, 2004) and ISO/IEC 31000 (ISO, 2009). GeoRM explicitly deals with GeoRM as a procedure and tool to deal with geotechnical risk regardless the geo-engineering subject or procedure.*
- *Communication about risk in a well-organized (and risk driven) way, using advanced technology and procedures in a setting wherein the most relevant stakeholders can attend on an equal basis.*

2.3 In which kind of projects is GeoRM applied?

- *Mainly in large infrastructure projects (tunnels, roads, railways, harbour works)*
- *Examples: large tunnel projects in the cities of Delft and Maastricht.*
- *Applying specifically GeoRM in projects is relatively new in The Netherlands'. The Dutch joint industry programme Geo-Impuls, for minimizing costs associated to ground bounded risk, aims to have applied GeoRM in 100 projects by 2015. It is noted that most experts in the field (representing different stakeholders) share the opinion that even if geotechnical risk are dealt with in a more explicitly way, GeoRM should be a fully integrated part of ProjectRM (GeoTOP 2012).*

2.4 In which project phases is GeoRM applied?

- *In all project phases.*

2.5 What are the results of applying GeoRM?

- *Explicit results are yet scarce, as GeoRM has not been applied in many projects. The expectation is however, that the application of GeoRM (treating geotechnical risk in an explicit way) by well-educated and qualified staff will result in a significantly lower probability that major geotechnical risks are missed. Achievements so far are e.g.:*
    - *Improving geotechnical quality in about 10 public projects by performing so-called GeoRM scans, in which the process and content of GeoRM in a project is checked by external geotechnical risk management experts.*
    - *Preventing leakage and deformation problems in a diaphragm wall close to a main station in a city, by applying an innovative way of risk-driven control of concrete quality in diaphragm walls*
    - *Implementation of better communication protocols and tools in order to communicate about risks in a transparent and open dialogue (Project A2).*

2.6 What are hurdles for applying GeoRM?

- *Project structure, project hierarchy, communication protocols. Geotechnical risks are sometimes under-estimated (lack of awareness, knowledge), in spite of their potentially large impact.*
- *Economic situation: budgets for public clients are strict, need for winning projects is high for contractors: organisations tend to underestimate risks*
- *Geotechnical professionals need to become used to make their rather 'implicit way' of dealing with geotechnical risk much more explicit (irrespective of their place in the project hierarchy).*
- *Overestimation of own geotechnical knowledge and experience with professionals not trained in geotechnical engineering (underestimation of the complexity of dealing with geotechnical risk).*
- *Lack of education and training with geotechnical professionals to operate in a project risk management environment and to adequately communicate the geotechnical risks in a broader perspective.*

2.7 What are solutions for overcoming GeoRM hurdles?

- *Continuing with the Dutch joint industry programme Geo-Impuls, for minimizing geotechnical failures. In the Geo-Impuls over 40 clients, contractors, engineering firms, and knowledge institutes work together in implementing GeoRM in the Dutch construction industry*
- *Developing GeoRM tools, such as geotechnical risk checklists, procedures for geotechnical risk communication with the public around construction sites in cities,*

and providing procedures for allocating geotechnical risk between contract partners

- *Identification and communication of GeoRM successes and most important lessons learned ('spread the message').*
- *Anchoring GeoRM explicitly in the ProjectRM procedures and company's QHSE systems/protocols.*

3 Integration of GeoRM and ProjectRM

3.1 What is the status of GeoRM – Project RM integration?

- *In The Netherlands all GeoRM steps fit entirely in the ProjectRM steps*
- *A lot of times there is no structured (continuous) and direct interaction between the project risk manager (dealing with Project RM) and the professionals dealing with geotechnical risk (GeoRM). This implies that geotechnical risk is often (too) generally mentioned in project risk registers. The risk might have been identified, but follow-up by for example risk-driven monitoring and mitigation alternatives is not always worked out to the optimum level of detail. More integration of GeoRM in ProjectRM, resulting in a more efficient and closely cooperation between the respective managers and professionals, may overcome this hurdle.*

3.2 How contributes GeoRM to Project RM?

- *In The Netherlands failure costs of construction projects are generally assessed as 10 % of the total project turnover, which is in total several billion euros per year. Geotechnical problems have a considerable stake in these project cost overruns. GeoRM may therefore contribute to ProjectRM, by more effective and efficient management and control of the geotechnical causes of project risk.*
- *Involving QA/QC managers and professionals for remediating geotechnical risk within projects is useful for aligning processes and achieving economies of scale and learning.*

3.3 How is GeoRM communicated to non-geotechnical persons? (such as project managers, contract managers, public living around construction sites)

- *This has serious attention in the earlier mentioned Geo-Impuls joint industry program on reducing geotechnical failure, which developed a procedure to be used by communication managers and geotechnical engineers together in a project*
- *For many clients and contractors it is quite a dilemma to either communicate about geotechnical risk before starting the project (which may make the public feeling uncomfortable about the project), or only once the geotechnical problems indeed occurs (for instance damage due to settlements) which would make the public not only feeling uncomfortable but quite angry as well.*

3.4 What are ProjectRM lessons from other industries for GeoRM?

- *Aerospace industry, for instance, shows that it is beneficial to integrate risk management in systems engineering and to focus on effective team communication regarding project risk assessments and remediation. Also, in the aerospace industry, the improving of project risk management is part of the QA/QC department and managed by a continuous improvement manager, by setting and following clear key performance indicators.*

4 Conclusions on integrating GeoRM and ProjectRM

- *The definitions used in practice of GeoRM and ProjectRM are more or less similar, the processes of GeoRM and ProjectRM are equal and fit well. No major objections exist that obstruct the integration of GeoRM and ProjectRM.*
  The application of GeoRM, according to the definition of Section 2.1, can still be improved, enabling a further reduction of the project risks by a better management and controlling of the geotechnical risks.

5 Recommendations on integrating GeoRM and ProjectRM

- *Create an environment allowing for the integration of GeoRM and ProjectRM (ask for it, make it a project requirement, provide training (see below), etc.).*
- *Risk is not only about 'risk registers'. Tools like 'review sessions', 'checks between colleagues', 'risk sessions', 'second-opinions', will also help to properly address geotechnical risks.*
- *Provide training on geotechnical risk management/make risk management part of the curricula:*
    - *Learn geotechnical professionals to communicate the effects of geotechnical risks in the language of non-geotechnical managers, such as project (risk) managers and contract managers*
    - *Provide short courses for non-geotechnical risk managers about the need and benefits of integrating GeoRM in ProjectRM*
- *Identify and communicate success stories of integrating GeoRM and ProjectRM for achieving project objectives within time and budget*

6 References

The following literature is considered as being useful for integrating GeoRM with Project RM:

- *ISO/IEC 15288 (2008). Systems and software engineering -- System life cycle processes. ISO, Geneva.*
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- *Van Staveren, M.Th. (2011). Geotechnics on the Move – A Practice Guide for Risk-Driven Geotechnics (currently in Dutch, English translation expected to follow). Geo-Impuls & VSRM, Delft.*
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on
Integration of
Geotechnical Risk Management
in
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Country
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Period
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Reporters:
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Committee on Risk Assessment
(group-work)

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1 State of art of ProjectRM

1.1 How is ProjectRM defined?

- ProjectRM is defined following ISO 73:2009: coordinated activities within a project to direct and control the project organization with regard to risk

1.2 Which ProjectRM guidelines, standards, and processes are used?

- ISO/IEC 31000 (SS-ISO 31000:2009) on risk management
- Fia Sweden: "Manual for Risk Management in the Construction Document-, Procurement- and Production Stages of Civil Engineering Projects." (in Swedish)
- Proprietary guidelines and processes within different companies and major clients working with infrastructure projects

1.3 In which kind of projects is ProjectRM applied?

- Risk management is applied in most projects, but not always exactly following e.g ISO 31000 or other standards or guidelines
- ProjectRM following standards like ISO 31000 is applied mainly in large projects
- Some large public clients require the application of ProjectRM contractually

1.4 In which project phases is ProjectRM applied?

- In the feasibility and contracting phase by public clients
- In the contracting, design and construction phase by contractors and engineers

1.5 What are the results of applying ProjectRM? Bring in examples

- ProjectRM should help both the client and the Contractor to reach their respective objectives without mishaps that cost money and cause time overdraft
- Brings focus on critical activities
- Brings all parties to follow the same direction towards a good project
- Examples of ProjectRM success are quite difficult to find and not readily available
- Citytunnel Malmoe, Citybanan Stockholm, Hvalfjördur Tunnel (Iceland)

1.6 What are hurdles for applying ProjectRM?

- It is not understood by Clients and Contractors that ProjectRM is no more than a structured way to perform the Risk Management (handling of uncertainties) that is already done today in all projects
- ProjectRM is therefore seen as a slavish following of standards, not noticing that the same standard (ISO 31000) prescribes that ProjectRM should be tailored to the project
- ProjectRM is often seen as a lot of additional paperwork
- ProjectRM successes are difficult to find (see section 1.5 before)
- Often too detailed at first sight
- Since it is often regarded as a hurdle, it is not used properly and creates bad feelings among parties.

1.7 What are solutions for overcoming ProjectRM hurdles?

- Making clear what ProjectRM is and what it is not, c.f. section 1.6: it is a way of helping you to be a skilled engineer. It is not a straight-jacket.
- Apply ProjectRM as lean and simple as allowable, for instance by aligning major project risks to project objectives, according to ISO/IEC 31000 on risk management
- Make it a routine at meeting to pinpoint what measures are needed to manage next critical activities. All parties must be in a good "partnership-mode" and realize that ProjectRM helps to avoid mistakes and conflicts.
- Education – both in practicing ProjectRM as well as in showing the good results in successful projects

2 State of art of GeoRM

2.1 How is GeoRM defined?

- In Sweden GeoRM is not defined as a separate Risk Management, it is part of the overall ProjectRM. In the following we use GeoRM in that sense. Of course it can be the main part of a project such as a tunnel. It should also be pointed out that hazards like landslide, mudflow and dam breakage can be present and must be handled
- Reports on soil and rock conditions, recommendations by the geotechnical engineer etc are part of the total ProjectRM and constitute the basis for estimating geotechnical risks,

2.2 Which GeoRM guidelines, standards, and processes are used?

- We are today following the Eurocode EN1997 and the recommendations for ground investigation and controlling and review (in some cases an independent reviewer).
- For the work environment the Work Environment Act applies with demands i.a. for a work environment coordinator for both planning and execution stages of the building project. They are responsible for developing work environment plans, which can have a large influence on the execution of foundation works, as those are often considered as being connected with special risks.
-

2.3 In which kind of projects is GeoRM applied?

- •Risk management is applied in most projects, but not always exactly following e.g ISO 31000 or other standards
- The Work Environment Act applies to all project (but it is possible to sort out early in the process projects with minor risks).

2.4 In which project phases is GeoRM applied?

- In the feasibility and contracting phase by clients
- In the contracting, design and construction phase by contractors and engineers

2.5 What are the results of applying GeoRM?

- Explicit results are yet scarce, as GeoRM has not been evaluated separately in many projects.
- GeoRM will lead to adequate supervision in the construction phase with mitigation and alternative design solutions. Risks will be dealt with why it is seldom clear that it was the successful Geo RM that eliminated project risks.

2.6 What are hurdles for applying GeoRM?

- The same as for ProjectRM, see section 1.6.
- Geotechnical professionals need to become used to make their rather implicit way of dealing with geotechnical uncertainty and risk much more explicit. .....

2.7 What are solutions for overcoming GeoRM hurdles?

- Developing GeoRM tools, such as a geotechnical Risk Breakdown Structure (RBS) and geotechnical risk checklists, procedures for geotechnical risk communication with the public around construction sites in cities, and providing procedures for allocating geotechnical risk between contract partners
- We should encourage education and also actively discuss the benefit and problems associated with application of GeoRM

3 Integration of GeoRM and ProjectRM

3.1 What is the status of GeoRM – Project RM integration?

- In Sweden the GeoRM and the ProjectRM are already integrated, or rather not separated.

3.2 How contributes GeoRM to Project RM?

- In Sweden it is part of it

3.3 How is GeoRM communicated to non-geotechnical persons? (such as project managers, contract managers, public living around construction sites)

- For many parts in Sweden the geotechnical hazard is not limited to construction sites, e.g in landslide prone areas. For parts of the country there are landslide hazard maps that give an overview of these areas, e.g. The investigation on slope stability along river Götaälv (in Swedish: Göta Älvutredningen)
- For construction projects, geotechnical risks are sometimes communicated via consultations with the public as required in making the assessment of the effects of certain public and private projects on the environment .

3.4 What are ProjectRM lessons from other industries for GeoRM?

- Construction projects are rather different from other industries with large uncertainties, few data and most often one-off projects. We should try to find out: how did they gain a foothold with management? What tools and techniques can we adopt?

4 Conclusions on integrating GeoRM and ProjectRM

- In Swedish practice GeoRM is part of ProjectRM although of course a project might be almost completely concerned with soil and rock works

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5 Recommendations on integrating GeoRM and ProjectRM

- In Sweden we do not differentiate between the two and thus our comments are more general:
- Make an effort to get the people who handle risks today to adopt those parts of RM that they can benefit from. Most of those people are not called Risk Managers, they are those people that are responsible for reaching a certain objective, for instance a safe excavation.

6 References

The following literature is considered as being useful for integrating GeoRM with Project RM:

- ISO/IEC 15288 (2008). Systems and software engineering -- System life cycle processes. ISO, Geneva.
- ISO/IEC 31000 (2009). Risk management – Principles and guidelines. ISO, Geneva.
- Van Staveren, M.Th. (2006). Uncertainty and Ground Conditions – A Risk Management Approach. Elsevier, Oxford.
- Van Staveren, M.Th. (2009). Risk, Innovation & Change – Design Propositions for Implementing Risk Management in Organizations. Lambert Academic Publishing, Köln.
- Van Staveren, M.Th. (2011). Geotechnics on the Move – A Practice Guide for Risk-Driven Geotechnics (currently in Dutch, English translation expected to follow). Geo-Impuls & VSRM, Delft.
- Van Well-Stam et al, D. (2004). Project Risk Management – An essential tool for managing and controlling projects. Kogan Page, London.
- Eurocode. eg En 1990,EN 1997:1 and EN1997:2
- Stille, H., Andersson, J. & Olsson, L., (2003). Information based design in rosck engineering. Swedish RocK Engineering Research (SveBeFo) Report 61.

TC304-TF3 COUNTRY REPORT on Integration of Geotechnical Risk Management in Project Risk Management

Country
United Kingdom (UK)

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Reporters – Affiliation

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CONTENTS

Disclaimers

This report reflects the individual views of the reporters on the integration of geotechnical risk management in project risk management in their country. This information is likely to be not complete and aims to present a general state of the art overview.

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Preamble

- This report has been completed by consideration of the management of project and geotechnical risk in the UK construction industry and is not intended to reflect practice in other sectors such as mining or oil and gas.
- Whilst there has been a call for evidence from the geotechnical community in the UK to support completion of this report, its nature is such that it has been drafted based on an incomplete data set. This is typical for geotechnical risk management!
- Call for evidence responses are acknowledged in section 6 of this report and their responses are incorporated fully and often verbatim in this report.
- By necessity this report is biased towards the views and experiences of the reporter who is not a risk management expert in all areas of the UK construction industry and as such the responses may not reflect all sectors. Indeed, the issues raised are wide ranging, unlikely to be exhaustive and are likely to possess different levels of validity depending on the construction sector under consideration.
- The report is predicated on the understanding from published literature and generally supported by the UK ground engineering community of practice that:
    - *'Many investigations bought cheaply fail to present an accurate account of the ground or groundwater conditions; it is therefore not surprising that the groundworks designed for the site are often not suited to the actual ground conditions. In such circumstances the costs of remedying wrongly designed works or mobilising alternative construction methods are usually far in excess of the cost of the original site investigation. The solution to the problem, however, is not just to throw more money into more site investigation. In many cases, greater benefits for the client can be obtained simply by better planning of the investigation using a geotechnical specialist, i.e. a chartered engineer or chartered geologist with appropriate expertise and experience in geotechnics'.* Thomas Telford (1993). Without site investigation ground is a hazard – Site Investigation Steering Group.
    - *'Building and construction case records show that ground conditions are often the cause of very large cost and time overruns. Geotechnical risk can affect all those involved in construction, including the client, the designer and the constructors.'* C.R.I Clayton (2001) Managing Geotechnical Risk: Improving productivity in UK Building and Construction.
    - *'Ground-related problems can adversely affect project cost, completion times, profitability, health and safety, quality and fitness for purpose, and can also lead to environmental damage (including whole life carbon impacts) - not forgetting the corporate damage that can ensue when things go wrong .'* Paul C Maliphant (Halcrow) after C.R.I Clayton (2001) Managing Geotechnical Risk: Improving productivity in UK Building and Construction.
    - *'For the last decade, the industry has been sheltered by a healthy economy. This has enabled construction to prosper without having to strive for innovation. The current economic crisis is a perfect opportunity for us to think again. We can not afford to waste it.'* Constructing Excellence (2009) Never Waste a good Crisis: A review of progress since Rethinking Construction and Thoughts for our Future.
    - *'The weight of evidence confirms that the UK is more expensive that its European peer group and demonstrates that there are significant opportunities to reduce costs in the delivery of infrastructure. ….. There is a clear opportunity to realise savings of at least 15 percent, which can deliver sustainable benefits of £2 to 3 billion per annum.'* H M Treasury and Infrastructure UK Infrastructure Cost Review December 2010. Key factors driving higher costs identified in the Dec 2010 Infrastructure Cost Review and

where more effective management of geotechnical risks could enhance cost and carbon outcomes include:
    - *'…lack of clarity and direction, particularly in the public sector, over key decisions at inception and during design. Projects are started before the design is sufficiently complete.'*
    - *'…over-specification and the tendency, more prevalent in some sectors than others, to apply unnecessary standards, and use bespoke solutions when off-the-shelf designs would suffice.'*
    - *'…lack of targeted investment by industry in key skills and capability limiting the drive to improve productivity performance.'*
  - *'perhaps the greatest challenge is how we can deliver a built environment that supports the creation of a low carbon economy for the UK. ……. We believe that the era of client-led change is over, at least for the moment, and that it is now time for the supply side to demonstrate how it can create additional economic social and environmental value through innovation, collaboration and integrated working – in short, the principles outlined in Rethinking Construction. Clients should focus instead on professionalising their procurement practices to reward suppliers who deliver value-based solutions. …. For Government as a policy maker, the challenge is to create an environment that incentivises innovation and speeds up the modernisation process. …….. We also need industry bodies and professional associations to cooperate better to represent our industry effectively to Government and the public.'* Constructing Excellence (2009) Never Waste a good Crisis: A review of progress since Rethinking Construction and Thoughts for our Future.
- Fundamental to understanding the nature of the current situation in the UK is consideration of prevailing terminology. However, this can prove problematic as different construction professions speak different risk 'dialects' and even the word 'risk' has a different dictionary definition from that set out by the International Organization for Standardization (ISO) and that envisaged by the Royal Society ie
  - Dictionary: 'degree of probability of loss', 'to incur the chance unfortunate consequences by (doing something)'.
  - ISO/IEC Guide 73 (2009): 'the effect of uncertainty on objectives' thus referring to positive possibilities as well as negative ones.
  - Risk has been defined as "A combination of the probability, or frequency, of occurrence of a defined hazard and the magnitude of the consequences of occurrence" (Royal Society 1992). Hazards are situations that in particular circumstances that could lead to harm (Royal Society 1992). Hazards can be viewed as any event presenting the possibility of danger (HSE 2001). The ISSMGE TC32 - Technical Committee on Risk Assessment and Management define hazard as the probability that a particular danger (threat) occurs within a given period of time (ISSMGE 2004). Adverse consequences might include accidents, loss of life, damage to property, services and infrastructure, environmental impacts and associated financial losses.
- Further to any definition of risk, project risk and geotechnical risk and also the development and publication of guidelines, standards and processes, the effectiveness of risk management will be influenced to a greater or lesser extent to one or more of the following:
  - The aims and aspirations of all the organisations involved in the project which will need to be aligned if the greatest value can be achieved for any particular project. For example the following may typify current business realities:
    - From a contractors perspective, risk management is often driven by the desire to limit commercial exposure
    - From a clients perspective, risk management can be driven by the desire to divest themselves of risk responsibility whilst not always recognising that they will pay for this luxury

- From a consultants perspective, risk management can be used to minimise liability without necessarily providing maximum value to clients
- From a legal perspective, the main causes of legal disputes arise from inadequate risk identification and allocation as well as an inconsistent approach to standard forms of contract
- From the Health and Safety Executive perspective, risks can be better understood through early involvement of a ground engineering practitioner noting also that 6-7 persons are killed and 400 persons seriously injured in the UK due to incidents related to the ground and foundations
- The NHBC offers a commercial warranty for residential properties with approximately 50% of claims being related to ground conditions.
- The insurance industry wish to be involved with projects constructed by the right people, doing the right thing, in the right place, in the right way noting also that insured UK 'subsidence' losses average c£400m per year (source British Geological Survey).

- The appointment of suitably knowledgeable and competent specialists including ground engineers and risk managers
- The attitudes of the personnel involved and the teams attitude towards risk allocation and transfer amongst the various parties
- The drivers behind the management of risk ie the delivery of auditable, process compliant risk management or the delivery of successful and value adding outcomes as agreed by all parties
- The availability of funds and the understanding of the Client and fellow professionals that it is a false economy to under resource the management of geotechnical risk at the early stages of project development
- The contract form that binds the team together
- Timing of commencement of the risk management process and the completeness of understanding of all the project risks and all the geotechnical risks accepting that the completeness of this understanding will vary through time ie understanding and hence completeness will increase as the project develops
- The management of uncertainty as a key construct of risk management ie
  - The uncertainty element of ground engineer's ability to assess both the probability and impact of an identified potential consequence to the scheme associated with a stated ground hazard (ie a lack of data with which to assess effectively an identified risk).
  - The uncertainty as to the full scope of potential mitigation options due to a potentially incomplete understanding of the wider project risks and opportunities ie is a ground engineering solution required for a particular ground engineering problem or can we manage the risk via alternative means (eg insurance), by re-allocation to a different Client budget holder (eg capital or revenue budget), or by exchange of the identified risk for others that may or may not be geotechnical but where there is an understanding of potential greater project value from the exchange (eg additional land purchase allowing revision of cut/fill slope angles to negate the need for reinforcement or retaining structures).

- Effective communication between all parties and associated knowledge management (ie *real* communication not just attempts at electronic knowledge transfer).

The Aberfan disaster (right) of 21 October 1966 resulted in the loss of 144 lives including 128 children in what, under the then applicable health and safety legislation, was not a reportable incident as nobody from the colliery was injured. Furthermore the professional responsible for construction of the colliery spoil heap was a mechanical & electrical engineer (because he was responsible for the conveyor belt system transporting the waste to the tip site). The failure mechanism was also predictable as it had occurred before just a few miles down the road at Cilfynydd in 1939 though nobody was injured on that occasion. This combination of poorly focussed legislation (for which read standards), use of inexperienced or incompetent staff and an overall inability to learn lessons and communicate that knowledge to all the relevant people remains a situation with resonance within parts of the UK construction sector.

A selective bibliography of publications and other references has been included in section 6. It is unlikely that this is comprehensive for any sector of the UK construction industry but it is considered as representative of the plethora of relevant risk based literature.

1 State of art of ProjectRM

1.1 How is ProjectRM defined?

The term Project Risk is not universally understood by all members of the UK construction industry and various definitions of project risk management have been identified including:

- The management of all risks in projects, including the risks which will arise when the project becomes operational
- Management of risks to a project to make project meet its objectives with respect to Time, Cost and Quality, Environment, Health and Safety, Reputational risk, contractual and regulatory risks
- Project risk can be defined as an unforeseen event or activity that can impact the project's progress, result or outcome in a positive or negative way (Source: Wikipedia)
- Corporate/strategic (e.g. Corporate Risk Management Policy and Guidance, Network Delivery and Development Directorate (NDDD) Risk Management Strategy and guidance). Ref. Highways Agency (2012) Risk Management Policy and Guidance. (Source – Highways Agency)
- Safety, journey time, reliability, environment, reputation and cost. (Source – Highways Agency)
- On the Canary Wharf Crossrail Station box construction project risk management is lead by the project management team (Canary Wharf Contractors Limited). The overall risk management is linked into management of cost, technical issues, programme, contractual risks etc.
- Project risk management aims to control project risk including cost overruns, delays, and non-performances on safety and quality.
- By generic project wide risk registers as part of the Construction (Design and Management) Regulations 2007 (CDM) procedures in the UK.
- Contractual, financial, programme, technical
- The full British Geological Survey Resource Management System risk assessment covers all aspects of risk – Health & Safety, Corporate, Project Delivery, Financial, Contractual and Resource analysis.
- Managing potential changes in scope.
- Risk management for: economic outcomes; social outcomes; environmental outcomes. Plus political (big and small P).

The above reflect the different views of a selection of construction professionals. There are a variety of foci for the definitions such as:

- quality assurance
- health and safety
- holistic non specific and specific
- risk as potential negative outcomes only
- risk as potential positive or negative impact on outcomes
- risk drivers

Only one recognises formally that project risk management must extend to the operation stage. None formally reflect any linkage to longer term post operational phase (eg decommissioning, redevelopment, demolition etc) which would be part of whole life costing. Only one reflects a focus on potential social outcomes. None have an overt focus on low carbon construction preferring the all encompassing ‘environment’ tag. There is no clear

articulation of the *value* that can be captured through Project Risk Management leading to beneficial outcomes for all parties. All above definitions are hence only partial.

1.2 Which ProjectRM guidelines, standards, and processes are used?

Project Risk Management guidelines, standards, and process have often been developed on a sectoral basis reflecting Client specific needs though others have been developed with a more holistic intent. They vary widely depending on sector, country and client. The development of risk registers which feed into software such as Active Risk Manager (ARM) is a common approach.

UK examples include:

- Actuarial Profession; Institution of Civil Engineers (November 2005). Risk Analysis and Management for Projects (RAMP) 2nd edition
- Association for Project Management (2010). Project Risk Analysis and Management (PRAM) Guide 2nd Edition
- ISO/IEC 31000 (2009). Risk management – Principles and guidelines. ISO, Geneva.
- ISO/IEC Guide 73 (2009). Risk management – vocabulary – guidelines for use in standards
- ISO 9001 (2008). Quality Management
- In-house guides for organisations such as Canary Wharf Contractors Limited Network Rail (Yellow Book), London Underground Limited (LUL) and best practice guides for industries such as wind farm development.
- The Highways Agency has a significant library of published procedures and associated documentation though these are only mandatory for trunk roads though local authorities adopt some at their convenience. These include:
    - Corporate/strategic (e.g. Corporate Risk Management Policy and Guidance, Network Delivery and Development Directorate (NDDD) Risk Management Strategy and guidance)
    - Highways Agency (various) Design Manual for Roads and Bridges (DMRB), associated Interim Advice Notes (IANs) and Area Management Memos (AMMs)
    - Highways Agency (1999) Value for Money Manual. April 1999
    - Highways Agency (2003) Maintenance of Highway Geotechnical Assets. HD41/03
    - Highways Agency (2004) Value Management of the Structures Renewal Programme October 2004
    - Highways Agency (2005) Value Management of Local Network Maintenance Schemes February 2005
    - Highways Agency (2008) Managing Geotechnical Risk. HD22/08
    - Highways Agency (2010) Risk Management Manual (Version 2)
    - Highways Agency (2012) Risk Management Policy and Guidance
- PAS 55-1: 2008 Asset Management. Part 1: specification for the optimised management of physical assets
- PAS 55-2: 2008 Asset Management. Part 2: Guidance for the application of PAS55-1
- NCHRP (2009) An asset-management framework for the interstate highway system, Transportation Research Board (TRB) of USA
- International Infrastructure Management Manual (2006)
- HMSO (2007). Construction (Design & Management) Regulations 2007
- HMSO (1999). Management of Health & Safety at Work Regulations 1999
- HMSO (2001). Reducing Risks, Protecting People. HSE's decision-making process
- Rail Safety and Standards Board (RSSB) decision-making framework (rail industry)

See also section 6, References.

1.3 In which kind of projects is ProjectRM applied?

Evidence in the UK indicates that the application of ProjectRM is only inconsistently applied to selected projects. Consultee responses include:

- Can be applied to all projects however, generally confined to:
  - assess risks during the bidding process
  - on large scale infrastructure projects such as Crossrail, Canary Wharf, Highways, HS2, wind farms, nuclear power, tidal power etc.
- Should be used in all significant projects, though often done incompletely
- More so in larger infrastructure type projects than in building projects.
- ProjectRM is applied to all engineering activities undertaken in the Highways Agency. The detailed procedures followed will depend on the category of work: a function of the nature of the works (e.g. building new infrastructure or renewing existing) and value e.g.
  - Managing Agent or Area Support Renewal Scheme, which lies within a specific HA network geographical area < £5 million
  - Asset Support Framework Contractors (ASF) < £15 million
  - Major Projects Directorate (MPD)

1.4 In which project phases is ProjectRM applied?

Evidence indicates that ProjectRM is applied inconsistently across project phases in the UK with consultee feedback including:

- For Highways Agency schemes ProjectRM is applied at all key development stages in the life cycle of a project i.e. Inception, Development, Detailed Design, Construction, Maintenance and Decommisioning/De-trunking. For example, this is set in the Project Control Framework applied by teams to all Major Projects (see Highways Agency Major Projects Risk Management Manual V. 2 for details). In addition, Office of Government Commerce (OGC) Gateway reviews are undertaken by experienced people (independent of the Project Team) at key stages and this includes a number of key risk related queries inc.
  - Gateway Stage 1: Have we identified major risks, and do we have outline risk management plans?
  - Gateway Stage 2: Do we have adequate risk and issue management plans and procedures?
  - Gateway Stage 3: Do we have sounds plans for managing implementation, risk and change, and are they agreed across the supply chain?
  - Gateway Stage 4: Do we have shared plans for managing risk, with contingency and business continuity plans in place?
  - http://webarchive.nationalarchives.gov.uk/20110822131357/http://www.cabinetoffice.gov.uk/content/government-efficiency-overview
- Different risk techniques are applied as project progresses. Qualitative risk assessment at conceptual stages, development of quantified risk assessment at preliminary design with identification of risk mitigation and owners, safety and reliability studies at detailed design. The general rule of thumb is that risk management has a greater impact early in the project cycle when cost of change is low.
- On Canary Wharf Crossrail Station the process of risk and cost review looked at options and progressively tied down the design (see Institution of Civil Engineers (May 2012)).

- In our experience this is completed just before construction phase and is not considered sufficiently or rigorously during the design phases, apart from an awareness of design factors of safety.
- Conception, planning, design, construction

1.5 What are the results of applying ProjectRM? Bring in examples

Example responses include:

- Clarification of ownership to risks in contract negotiations and claims
- Identification of action owners responsible for mitigating risks
- For inclusion in tender pricing
- Early identification of risks and mitigation options
- Better understanding of project, responsibilities, likely outturn costs, decisions on Go/No Go
- Useful communication tool to project and client teams
- Should result in projects meeting their goals in terms to cost, programme and quality
- Better understanding of project value and opportunities
- Applying ProjectRM enables the Highways Agency to meet its Strategic goals ie
    - provide a service that customers can trust
    - set the standard for delivery
    - maintain UK roads as the safest in the world
    - deliver sustainable solutions
    - Maintain the network as a dynamic and resilient asset
- Highways Agency example: Arnold, P. (2012) Going under the Devil's Punch Bowl: the story of the A3 Hindhead tunnel, UK. Proceedings of the ICE – Civil Engineering, Volume 165, Issue 4.
- Successful projects, sustainable safe designs, no surprises, on time, on budget.
- As consulting engineers, often relegated these days to the role of designer only, we are generally not privy to the outcomes of ProjectRM. This is a problem for the industry, as it illustrates the lack of integration between designer and constructor. A notable exception to this rule was the use of ProjectRM on a dock wall stabilisation project in London that facilitated the design process and the construction progress.
- Should increase the chances of project success. HM Government recognise Risk Analysis and Management for Projects (RAMP) in the Green Book (HM Treasury guidance for Central Government) as a useful tool for managing risk in projects and it has also been commended by executives of the Office of Government Commerce.
- Application of ProjectRM eased the construction of a new viaduct on A82 in Scotland.
- Application of ProjectRM facilitated development of a layout designed that eased the planning consent process.

1.6 What are hurdles for applying ProjectRM?

Hurdles include:

- Cost and expertise. Too often the users are not involved in design of the asset, which then turns out to be sub-optimal. The search for the “best” project may sometimes be closed down too early.
- Getting the client to see the value of it. Reluctance by Clients to include a provision for risk management.
- Knowledgeable and competent staff in all positions. Lack of trained risk managers within engineering teams

- Management of the interface between risk management logic and real day to day business drivers
- Unwillingness to dedicate resources to mitigation of risks especially those of high impact, low probability
- Getting the design lead to implement it and to maintain it
- A limited focus on risk *and* opportunity – most focus on mitigating the risk of negative outcomes without championing the positive.
- Apathy within project teams and considered to be an additional level of bureaucracy
- Good lines of communications
- Effective communication
- Problems with quantification of risks
- Feedback is generally non-existent leading to no lessons learnt
- Confusion between CDM/Designers' Risk Assessments/H&S RM and ProjectRM.
- Lack of team experience at planning/ development stage
- Different pre-occupations apply at early scheme development
- Schemes with adverse risk profile don't get started (risk averse decision or an aversion to managing risk?)
- Within the Highways Agency there are no hurdles as ProjectRM is implicit in all activities, at all levels of expenditure
- Good open discussion of geotechnical and other risks with the team
- Being clear who owns what risks. A risk register is very important
- The project manager MUST have a good dialogue with his design team.
- The project manager needs an open discussion on technical risks and what can be done and the risks of building the project in different ways
- The project manager needs a cost / programme team to price the different options
- Optioneering may take many loops to go round to drive out risks and costs. Time and designer costs go up. At tender – negotiations take place on different options. This takes time
- Multitude of systems
- Unclear protocols and governance
- Management of change
- Training and experience levels
- Compliance/audit
- Commencement early enough in the project cycle
- Cross disciplinary understanding
- Limited evidence of successful application
- Geotechnics in building projects is considered a specialisation like facades or people movement and therefore not a high risk item to the project
- A good example of non-application of ProjectRM is the lack of appreciation by the Project Manager and/ or Contractor to have site supervision of key risk elements by the designer (e.g. no resident engineer, part time supervision of ground investigations, piling etc). This is money driven and is penny wise, pound foolish.
- ProjectRM must be a facilitator for rapid and effective decision making and not a source of excessive bureaucracy.

1.7 What are solutions for overcoming ProjectRM hurdles?

Potential solutions include:

- Create an evidence base to demonstrate value beyond reasonable doubt
- Education of Clients of the benefits to them and the project supply chain of risk management
- Cross disciplinary training

- Develop and implement effective communication strategies for target audiences
- Training and development of risk management and technical professions including familiarity with RAMP and PRAM
- Better Risk management education
- Standardised systems for industry, clear protocols/governance, training, regular audits
- Standardised terminology across construction disciplines
- Ensure ProjectRM is fully defined and differentiated from other forms of risk management
- Start early and recognise that risk management is an evolutionary process with management of uncertainty at its core
- Regulation
- Enforcement of legislation that requires a phased approach to ProjectRM throughout the design as well as the construction phases of the project.
- The use of generic pro-forma sheets covering the usual risk items followed by a bespoke project specific risk register. These should be reviewed/checked on a phased basis by a competent, senior person.
- The use of Category I, II or III levels of review dependant on the level of risk to the project and to society.
- Full time resident engineer on identified medium and high risk elements of work (e.g. groundworks, piling, ground investigation, slopeworks, basements etc.)
- Allocation of sufficient resources (both people and money) for the risk management process.
- Consideration of H&S risk as a sub-set of ProjectRM.
- Development of more user friendly and cheaper ProjectRM software (e.g. @Risk)
- Good lines of communications.
- Good open discussion of geotechnical and other risks with the team.
- Being clear who owns what risks - A risk register is very important.
- Seek out opportunities for project enhancement whilst still proactively seeking to mitigate risks of negative outcomes.

2 State of art of GeoRM

2.1 How is GeoRM defined?

There is no universal definition of GeoRM in the UK. The following example responses reflect this.

- Geotechnical Risk is defined by the Highways Agency as *'the risk to the project or the Overseeing Organisation's asset created by the site ground conditions, public, environmental, construction and operational activities'*. Geotechnical Risk Management is the identification and management of these risks.
- Under a qualitative risk assessment, the *degree* of risk is the expected impact of damage, loss or harm for a given hazard, under particular circumstances which is expressed as: Degree of Risk = Probability (P) x Impact (I)
- Ad hoc depending on sector, country and client
- Generally GeoRM has 2 aspects,
    - Geotechnical risk as a project risk to be managed in a similar way and using the same methodologies as ProjectRM. This would include mitigation of geotechnical project risks affecting construction project.
    - Geotechnical risk as an engineering hazard to be considered in a similar way as engineering risk (Probabilistic risk assessments, application of ALARP (as low as reasonably practicable) Principle).
- A development of this is the use of risk as an asset management tool for example earth structures asset management for clients such as London Underground Limited (LUL) and Network Rail where interventions (e.g. inspections or planned maintenance) are programme using a risk based (rather than condition based (e.g. A (good) to E (poor) condition rating with shorter interval between inspections for E) – and previous interval based – e.g. 5 years whatever risk or condition) approach. This involves considering risk in terms of asset failure probability and consequences (and cost impact), assessing risk in terms of tolerability (using ALARP Principle) mitigation measures (and costs) and undertaking cost-benefit analysis to determine optimal solution.
- Ground poses a major risk for projects if the conditions are not properly identified and addressed. Part of the problem is procurement since despite assertions by many to the contrary, there is a focus on appointing on the basis lowest price rather than best value for Ground Investigation (GI). Since the work by Stuart Littlejohn (Thomas Telford (1993)) indicates that the average spend on GI is 0.21% of project cost, so the differential between prices must be an order less, this approach seems to be a false economy when the benefits of well structured competent investigation far outweigh the costs. It still surprises me that insurers don't realise that.
- Geological and soil parameter uncertainty is explained at desk study and concept design. This equated to a range of foundation options. The foundation cost options are assessed. The ground investigation is geared up to these uncertainties. The design evolves around cost and risk uncertainty.

2.2 Which GeoRM guidelines, standards, and processes are used?

GeoRM guidelines, standards and procedures prevalent in the UK include:

- Highways Agency (2008c) Managing Geotechnical Risk. HD22/08
- Highways Agency (2003) Maintenance of Highway Geotechnical Assets. HD41/03
- C.R.I Clayton (2001) Managing Geotechnical Risk: Improving productivity in UK Building and Construction.

- Thomas Telford (1993). Without site investigation ground is a hazard – Site Investigation Steering Group.
- Natural Scotland (2006). Peat landslide hazard and risk assessment. Best Practice Guide for Proposed Electricity Generation Developments
- Baseline Geotechnical Reports which define a contractual basis for claims/compensation events
- Observational techniques during construction (especially in tunneling), use of increased factors of safety to reduce risk, robust construction techniques (such as use of bored piles to get to required depths, rather than driven piles when ground conditions uncertain) and tolerable forms of construction (use of construction techniques that can be changed during construction to suit differing ground conditions)
- The Canary Wharf Contractors Limited risk management process is not set down. This is the way CWCL work. This has evolved over 20 years of working together at one site.

2.3 In which kind of projects is GeoRM applied?

GeoRM is not applied to all projects in the UK. It is a generalisation but the evidence suggests that the smaller the financial value of a project the less likely that GeoRM will be applied. It is an unfortunate but perhaps unsurprising correlation that the greater portion of Health and Safety Executive (HSE) accident and fatality statistics for ground and foundation related incidents are accounted for by these smaller projects.

The following opinions on the kinds of projects where GeoRM is applied have been expressed by consultees to this report.

- GeoRM as a project management tool can be applied to most projects with a geotechnical element but generally is applied to large infrastructure projects or ones aimed at mitigating a specific geotechnical risk such as landsliding.
- Typically following damage events requiring remediation e.g. landslides, structural failures. A few informed clients will apply GeoRM at feasibility/planning and Front-end engineering design (FEED) stages to mitigate potential problems during construction and post-construction. Sadly, the majority of clients are not that informed and are reluctant to invest in GeoRM early in projects, if at all. The informed clients tend to be those who have incurred significant losses in the past, or those dealing with natural hazards on a regular basis.
- Generally Civil engineering type projects particularly infrastructure and slope stability. It has been used on an infrequent basis for construction projects, generally if there are sensitive adjacent structures.
- All Highway Work (including non-trunk roads)
- All Wind Farm Developments in Scotland
- GeoRM is applied to all engineering activities undertaken in the Highways Agency with a recognised geotechnical component to the project. The detailed procedures followed will depend on the category of work: a function of the nature of the works (e.g. building new infrastructure or renewing existing) and value e.g.
    - Managing Agent or Area Support Renewal Scheme < £5 million
    - Asset Support Framework Contractors (ASF) < £15 million
    - Major Projects (MPD)
- All Canary Wharf Contractors Limited (CWCL) projects with foundations.
- Tunnels. Note that in the 1990-2000s there were major tunnel losses and insurance claims resulting in insurers reducing their exposure and hence restricting insurance cover availability. Industry response was to develop and agree a new Joint Code of Practice; use Risk Registers; record Reference Conditions; increase risk awareness

and allocation; improve risk selection with involvement of insurers post-binding; and ensure price adequacy.

2.4 In which project phases is GeoRM applied?

GeoRM is incompletely applied across all project phases in the UK and the following responses have been received from the call for evidence for this report.

- All phases
    - Concept - based on desk study
    - Scheme Design - Ground Investigation – based on reviewing findings and design development.
    - Detailed design 2 or 3 options may be taken forward for scheme – discussions with contractors – risk register
    - Tender – discussions with contractors – looking at contractors alternatives – risk ownership
    - Construction – site supervision – particularly the early stage – self assessment did not work at Canary Wharf – designer supervision generally.
    - Construction – Observational method - savings – eg props and use of berms etc.
- Most phases starting at conceptual through to construction including temporary works activities. Can support an “observational approach” to both temporary and permanent works.
- Highways - At all key development stages in the life cycle of a project i.e. Inception, Development, Detailed Design, Construction, Maintenance and Decommisioning/De-trunking.
- Generally in reaction to damage events (post-construction). Site investigation to support Front-end engineering design (FEED) – the specification and timing is greatly variable amongst projects and clients, and often unsatisfactory. Occasionally at feasibility/planning stage providing opportunity to robustly characterise and investigate geo-risk.
- Generally in the preliminary and detailed design stages
- Peat landslide risk management – for planning consent

2.5 What are the results of applying GeoRM?

There appears to be a relative paucity of technical literature focussing on the value of GeoRM as compared to focussing on geotechnical design approach and solutions. Whilst this may be a reflection of writing style rather than a lack of evidence it creates a difficulty in articulating fully what the results are of applying GeoRM. However, the following consultee responses have been received.

- Effective management of Geotechnical Risks in terms of avoiding cost and time overrun, minimising geotechnical risk to construction staff, maintenance staff and the public
- Better communication of risks and risk ownership
- Evolving the design to lower risk and lower cost
- Site supervision by designer helps control construction risk and matching design.
- Testing early is important – often preliminary trials
- Monitoring is important – Observational Method applied to learning and design improvement during the work
- GeoRisk mitigation; avoidance of geohazards and unforeseen ground conditions and management of identified risks to ensure sustainable, safe designs

- The results of applying some form of risk management process can be improved programme time, costs and safety. The “D” shaped pile project at Tottenham Court Road station (part of Crossrail) provides a good example of constructing piles within the sterilised zone of a live tube line running tunnel.
- Results aimed at:
    - optimisation of construction risks and costs of mitigation (i.e. further ground investigation)
    - reduction in contractual issues and claims

2.6 What are hurdles for applying GeoRM?

Hurdles include:

- Availability of Geotechnical Specialists with appropriate competences.
- Appropriate understanding of the ground conditions and material behaviour
- Access to relevant historic data and records (inc. ground investigations, technical reports, construction records, as-built records, historic maps, previous land use, performance/condition data, etc) and in a form which can be readily assimilated.
- Quality of relevant data.
- Limited focus on opportunities as opposed to risk management. This is in part a mindset issue.
- The recognition by non-geo specialists that a consideration of ground related risks is potentially an important consideration e.g. A. The construction of new communication systems: the impact of these new works on the existing highway infrastructure – which may include pre-existing areas of risk (following earlier phases of construction, long term deterioration or the actions of a 3rd party). B. Non-Geo Renewals schemes: where the cause of a defect may be a function of the ground conditions (stability, chemistry, etc).
- Communications. All parties must be prepared to talk and understand each others points of view on risk and cost. This is about all parties understanding the risk assessment approach.
- Being prepared to put forward options that may seem very difficult / risky but may have big savings. Letting the cost review /risk process sort out options and design development / ground investigation
- Lack of time to go through the process
- Lack of ground investigation data
- Lack of construction control on site – or not spotting deviation from design expectation
- Education of client/project managers of the benefits of early GeoRM in development projects.
- Early investment in site investigation to define an engineering ground model, and geohazard risk evaluation (qualitative or quantitative).
- Client education particularly in the private developer sector. Also the “engineering” fraternity need to see the value particularly structural engineers, project managers and architects.
- The time and probable additional cost to the client is a big hurdle which is difficult to put to the Client for construction projects.
- Ground engineering risk should be part of a civil engineering degree course.
- Highways – scheme development (TD37/93) not integrated with geotechnical certification (SH4/89 and HD22/08).
- Peat landslide – reluctance to spend on surveys ahead of consent.
- An understanding of the different types of risk and under what circumstances they are best applied is required.

- Reliability/probabilistic risk assessment, being a generally quantitative approach, suffers from the difficulties of assigning probabilities and consequences where the data set is limited and consequently.

2.7 What are solutions for overcoming GeoRM hurdles?

Potential solutions include:

- Education of Geo professionals
- Education of non Geo professionals who may have to manage Geo components of schemes
- Provision of appropriate IT systems to support speedy data assimilation.
- Having an agreed understand of the design process the management contractor wants to use and his ability to price / programme work.
- Having a risk register for options.
- Being clear early on about options and risks – desk study stage.
- Testing design with the ground investigation stage
- Having time to look at contractor alternatives and working on agreeing risks.
- Preliminary testing
- Monitoring and site control by design team – making sure design is being built and looking out for changes.
- Offering Observational Method for design change.
- Education; investment. As a profession, we need to do more to influence clients/project managers of the benefits of GeoRM.
- Registration of ground engineering professionals using a peer review process. This was launched in the UK in 2011 (UK Register of Ground Engineering Professionals (^{UK}RoGEP)). This has the potential, should Clients make best use of it, to mitigate the geotechnical risk associated with employing an incompetent professional.
- Produce Client guideline documents which promote risk assessment supported by case histories of “cock ups” and lessons learned. The most obvious issue is for “engineers” not to work outside their own discipline and employ qualified and experienced ground engineers (^{UK}RoGEP).
- Probably the better use of “Baseline” type documents.
- Highways – integrate geotechnical certification (SH4/89 and HD22/08) with scheme development (TD37/93).
- Peat landslides – set clear guidelines
- Clear definition of the scope and boundaries of GeoRM. Is it a project management tool or a risk decision making tool?
- Education of clients in benefits.
- Development of better techniques for risk quantification.

3 Integration of GeoRM and ProjectRM

3.1 What is the status of GeoRM – ProjectRM integration?

The status of GeoRM – ProjectRM integration in the UK covers the whole spectrum of the TF 3 hypothesis spectrum ie:

- Full integration
- Partial integration
- No integration
- No RM

It is noteworthy, however, that even where there is considered to be full integration by published procedure this does not ensure full integration by process implementation. There is evidence of departures from formal integrated procedures both by design and by error.

Responses received from consultees to this report in respect of GeoRM – Project RM integration include:

- Integration is often poor. If GeoRM is managed outside of ProjectRM then we could be solving the wrong problem and not creating the greatest value. Indeed, the ground engineering problem we may be set to solve may have been identified without prior ground engineering specialist involvement. What we need is good quality GeoRM practiced by competent ground engineers (from whichever background ie Geologist or Engineer) where their views are heard early in the process so that effective GeoRM is embedded in subsequent ProjectRM. This way we will solve the right problems and create most value particularly if we are also funded to do the job properly.
- The status of ground engineering risk is very low in the general UK construction market despite published evidence that reports that poor understanding of the ground is probably the most significant contributor to cost and programme over-run. The civil engineering market is more likely to use ground engineering risk tools than those sectors that do not have the involvement of civil engineers.
- GeoRM is an integral process to ProjectRM within the Highways Agency.
- In my experience ad hoc, and generally not integrated, except in a few cases.
- TD37/93 (scheme assessment reporting) sets out a Staged process with increasing level of ground investigation, which is consistent with SH4/89 (HD22/08) but neither one cross references the other.
- None in BGS, but BGS provides geological, engineering geological & geotechnical information and data to clients and key stakeholders to aid in their assessment of geotechnical risk in terms of a better understanding geological uncertainty.

3.2 How contributes GeoRM to Project RM?

Responses to the call for evidence include:

- I am not aware of how this works on construction projects (ie buildings) but on civil engineering type projects (ie infrastructure) it has worked very well and has proved very effective tool in identifying, assessing and mitigating risks as part of the overall risk assessment
- Forewarned is forearmed. GeoRM should be implemented early in projects so that Project RM is informed and appropriate steps are taken to manage geo-risk in the project life cycle.

- GeoRM should be seen as part of ProjectRM, since it may influence the choice of which risk responses to adopt. Some responses may be able to deal not only with Geo risks but also with other risks at the same time.
- Highways - More significant on some schemes than others. Fairly fundamental to land-purchase requirements.
- Wind Farms – Viability of a site is impacted by likely ground conditions.
- Approaches applied to GeoRM (though possibly not originating in GeoRM?) such as the observational technique and the use of tolerable forms of construction (e.g. the use of bored piles which tolerate different ground conditions where there may be constructability issues with other piling techniques) and robust forms of construction (e.g. using a higher Factors of safety or piled foundations where ground conditions are uncertain) may have potential applications as risk control strategies in some areas of Project RM.

3.3 How is GeoRM communicated to non-geotechnical persons? (such as project managers, contract managers, public living around construction sites)

Technical people often struggle to present information in a non technical manner reverting to techno-speak and jargon that simply turns others off. Furthermore, in the field of risk management including GeoRM there is a need for cross disciplinary education but if a seminar is presented as Ground Engineering then other professions that could beneficially learn from the event will simply not turn up as it will be considered as 'not for them'.

There is an issue as how we market events and gain support for cross disciplinary training as well as learning about what to say and how to say it.

For a given piece of valuable knowledge there may be a need to present this in mathematical form (eg statistics, graphs etc) for engineers but in pictorial/diagrammatic forms to those who lead more on aesthetical and functional considerations of the same type of scheme. The choice of communication form will be informed by consideration of social styles both of individuals and more generally of different professional groups that may naturally attract people who think in a certain way and who would hence be receptive to communication in specific ways. There would therefore be value when considering the topic of communication to consider matters such as Social Styles, Neuro Linguistic Programming, Geocognition (how people perceive and understand Earth and Earth processes) and Cognitive Science which consists of multiple research disciplines, including psychology, artificial intelligence, philosophy, neuroscience, linguistics, and anthropology.

Other responses on GeoRM communication from the call for evidence focus more on the project level communication and include:

- For project teams: the technical requirements (e.g. in the Departmental Standards HD22 and HD41) are cross referenced and linked to the wider project management processes (and associated guidance). In addition, project teams are supported by in-house geotechnical specialists for more detailed and site specific advice. It is the responsibility of specialists to present the consequences of identified risks in terms that can be more widely understood e.g. impact to meeting business objective and the 'balance' to be achieved.
- ALARP (as low as reasonably possible) - again this is difficult to answer, as risk acceptability varies greatly between sectors, countries and clients. For instance, compare risk communication protocols and acceptance criteria for slopes and landslides in Hong Kong with UK.
- This is done on civil type projects by workshops, evening meetings, door knocking, promoting in local press and having a Q and A Kiosk outside the site boundary

manned by trained staff (this is not a joke as we are doing it on one of our projects in Essex.)
- Environmental Statement and Risk Registers within technical reports.
- Risk meetings ahead of tender on D&B schemes.
- Peat landslide susceptibility plans in EA/ Peat Management Plans
- Project managers, contract managers: Communication generally through use of risk registers, presentation of ground models, results of risk analyses.

The following quote has often been presented as a good articulation of risk management.

"…..there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns - - the ones we don't know we don't know……."

Former US Secretary of Defence Donald H. Rumsfeld

It is suggested that risk management is controlling the *known unknowns* and reducing risk is trying to minimise the *unknown unknowns*

However, there is one pairing of the two key words that is missing and should be added as below.

ADD: *'Furthermore, there are also unknown knowns; that is things others know that we need to know but where we don't know we need to ask them and they don't know they need to tell us'.*

The solution to the management of the *unknown knowns* is effective multidisciplinary teamwork and excellence in communication.

3.4 What are ProjectRM lessons from other industries for GeoRM?

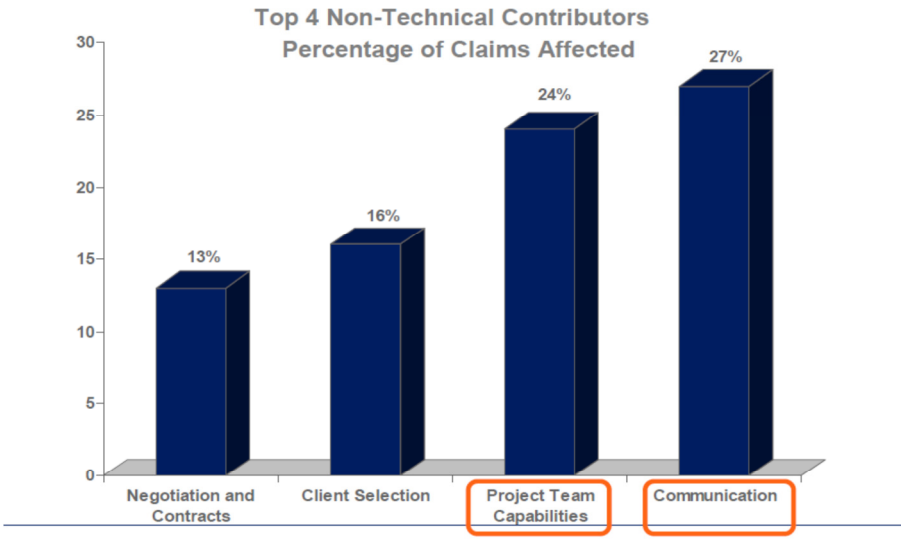
Good lessons can be learnt from the insurance industry. Details presented by Paul Hampshire of Liberty International Underwriters in the seminar entitled *Managing risk: the view of the built environment professional* held in London on 20th February 2012 can be summarised as:

The completion of a risk engineering assessment for the consideration to insure a major project is founded on 4 pillars namely:

1. **Organisation and Structure (40%)** – who (ie client, project team, procurement, contract form, pro-active risk management, codes of practice including behaviours, people, processes and communication)
2. **Technical (30%)** – what (ie project brief, prototypical designs, innovative methods or materials, design standards and norms, base data, site investigations, fitness for purpose)
3. **Natural Perils (15%)** – where (ie topography, water (rain, groundwater, flood, etc) geology, earthquake, storm, hazardous materials, dust, fire, hailstorm, etc)
4. **Program & Budget (15%)** – how (ie an independent assessment of time and cost, project master program, phasing, critical path & milestones, on and off-site logistics, project budget, spend rate, breakdown of values(WBS))

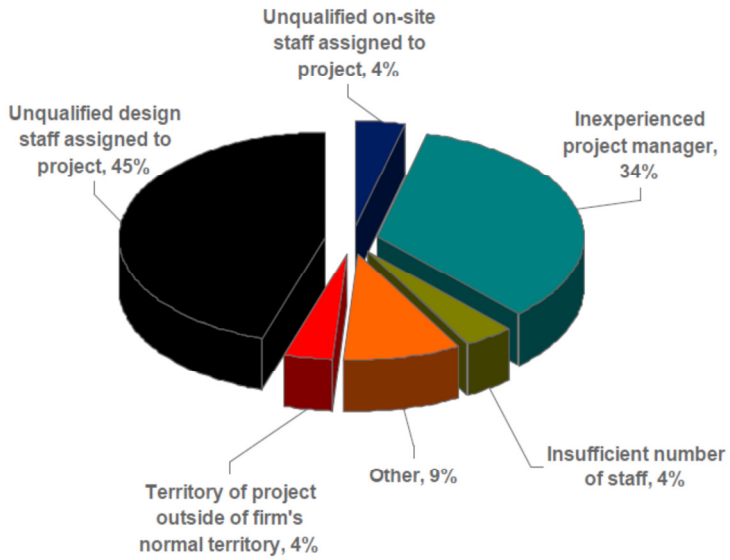
The percentage split of the risk engineering assessment between each pillar is also given above. The logic for the high focus on organisation and structure is evidenced by the following graphics.

Why focus on project management? See image below.



Source: Competitor RMI Conference, Steve Bates 2009

Looking at project team capabilities in greater detail results in the pie chart below which highlights the principal issues that have lead to insurance claims.



Put this into GeoRM context and we can conclude that in many cases we have unqualified (incompetent?) people assigned to the management of ground risks managed by inexperienced project managers who do not understand GeoRM and the value that can be captured if professionals are allowed to manage ground risks to the fullest extent focussed on the delivery of the most beneficial project outcomes.
Other consultation responses include:

- GeoRM is driven by the risks presented by the ground and the specialist understanding of these risks and their impacts. Lessons from other industries would therefore be related to the non geotechnically related areas of ProjectRM. Always willing to learn of other experiences, techniques, etc.
- There is much to learn from the chemical and nuclear industries which set good benchmarks. In the geo-sciences we are beginning to catch-up but our experience is rather ad hoc and bespoke to specific projects and circumstances.

- Probably the promotion of the value of using ground engineering risk tools. In some industries the use of risk management is more prolific e.g. the mining and rail sectors and the nuclear industry.
- In the financial services industry there is growing emphasis on Enterprise Risk Management, which emphasises the need to consider all the risks of an enterprise holistically. This suggests that it is inefficient to consider Geo risk separately from other risks.
- Make exposure to cost risks more transparent throughout scheme development
- Techniques developed for ProjectRM of general applicability to GeoRM. These techniques need to be identified and applied to GeoRM rather than reinventing the wheel and considering GeoRM as a separate area.

4 Conclusions on integrating GeoRM and ProjectRM

In conclusion the following comments apply to the integration in UK of GeoRM and ProjectRM in the 'general state of the art overview' context of this report.

- Case literature confirms that poor GeoRM costs financially, environmentally and socially. Conversely good GeoRM can beneficially influence project outcomes in all metrics.
- The hypothesis of TF3 suggests that currently GeoRM is managed exclusive to ProjectRM and that for best results GeoRM should be a subset of ProjectRM and managed accordingly. This is agreed but in UK the full spectrum exists from current to targeted position and all options of partial situations between. Indeed in some sectors there probably is no GeoRM and no ProjectRM as would be understood by many construction professionals. However, even with full procedural integration there is scope for non compliance in reality because of the human element where humans are themselves flawed.
- GeoRM and ProjectRM are both incompletely applied varying by both project scale and phase. There exist a wide variety of hurdles to effective delivery of both on all schemes and all project phases and is likely that the return on investment in some sectors may not be considered by all to reflect good value for money.
- Development of robust ground models and the associated management of identified ground hazards and geotechnical risks is crucial to effective delivery of construction and civil engineering projects. The development of robust ground models is the principal (but not sole) domain of the engineering geologist. The subsequent development of robust numeric ground models on which to base standards compliant designs is the principal (but not sole) domain of the geotechnical engineer with risk management covered jointly. Insufficient focus is put on the development of robust ground models (eg by completion of appropriate and comprehensive ground investigations) hence increasing the risk that geotechnical designs are flawed resulting in increased ground related failures and increased construction/project cost.
- Issues of terminology:
    - Both ProjectRM and GeoRM are imprecisely defined
    - Risk is inconsistently defined relating to 'loss' only in the dictionary whilst the ISO definition allows for both positive and negative outcomes.
    - Risk management should cover risk (ie minimisation of loss) and opportunity (maximising positive outcomes) management but there is scant evidence that the opportunity side of the equation is adequately addressed even on projects that proclaim to be managing risk.
    - Project is defined variously by organisations depending often on their corporate or business involvement in a scheme.
    - 'Construction projects' by some are seen as relating to buildings whilst 'civil engineering projects' refers to infrastructure whilst the 'construction industry' refers to both together.
    - Different professional bodies in construction all use the language of risk but with differing risk 'dialects'.
    - Risk management is often confused with uncertainty management with the latter relating to the lack of either data with which to fully assess a risk or lack of understanding of risk mitigation options some of which may include managing risks not manifest in the presented ground engineering problem. The first rule of risk management is 'avoid' but a lack of understanding of avoidance options means that this is often not used resulting in potentially unidentifiable cost escalation. Also try 'ask the Client' of his/her tolerance to risk and/or whether they would wish to cover the risk on a capital or revenue budget. Consider insurance too?

- Evidence:
  - There is a lack of case study evidence of the true value of the integration of GeoRM and ProjectRM
  - There is a paucity of evidence of technical literature focussing on the value of GeoRM as compared to focussing on geotechnical design approach and solutions.
  - There is a lack of *current/recent* analysis on the financial cost of ground engineering failures in the UK
  - There is a total absence of assessment of the financial (and other) cost of successfully mitigating a geotechnical risk but where doing so may not have resulted in the most beneficial project outcome (ie we successfully solved the wrong problem)
- Ground engineering standards
  - Standards are sectoral with no overarching UK risk management process
  - Standards are not focussed on value adding inputs and beneficial outcomes
  - The desire to deliver the mandatory process can result in a lack of focus on adding value. Standards should be innovated to add value but innovation must be managed by suitable competent ground engineers.
  - In many standards there is no insistence for visualisation of risks eg by presentation of geological cross sections, block diagrams etc in reports. Visualisation can often by critical to the identification of ground hazards/risks and the effective communication of them to the reader.
- Expertise and competence
  - There is a lack of trained risk managers
  - There is a lack of knowledgeable and competent people in all positions in project teams that have the ability to effectively manage project risks.
  - Registrations of ground engineers (^{UK}RoGEP) has the potentially to effectively mitigate the risk of employing an 'incompetent' ground professional
  - Competence includes for those especially (but not exclusively) in management positions understanding of social styles, leadership, communication and at least a working knowledge of all professions under their control. Without the latter there is limited scope for the manager to understand when best to involve a particular professional or specialism or to manage the *unknown knowns*.
  - Expertise and competence in teamworking is recognised by the insurance industry as a factor that can mitigate risks of failure (insurance claim).
- Training and education
  - The value that can be gained from effective management of geotechnical risks is not well understood by all clients and construction professionals.
  - Construction professionals rarely know enough about each others jobs, their needs and their drivers to work together to best effect.
  - There is a lack of cross disciplinary training
  - Tertiary education does not include effective training in risk management in many instances yet this is what construction professionals must do exceeding well if the most beneficial outcomes are to be achieved.
  - In a 2012 seminar on risk management audience members reported that 80% of what they heard on GeoRM was known to them and was recognised as good or best practice but was not being effectively applied on their jobs. Why?
- Attitude vs contract
  - Contract terms and business drivers can adversely affect individual team members behaviour
  - The correct form of contract is not always used so as to facilitate the most beneficial outcomes
  - Collaborative learning, risk sharing and incentivisation is required
  - The right attitude is needed from the Client or project manager or otherwise contracts will not be drafted in the most advantageous manner

    - The construction industry is said to be risk averse – or is it averse to management of risk?
    - Contracts must be value driven with beneficial outcomes for all stakeholders
    - The drive to lowest value tendering even in the current economic crisis will not deliver the value that society wants and needs
- Communication
    - We must understand our social styles to learn how best to communicate
    - Different professions may be dominated by people of particular social styles who will respond to different communication stimuli
    - Different professions have different risk 'dialects' which the manager must understand to communicate effectively
    - Competence in geocognition and cognitive science can assist effective geo-communication and getting the attention of fellow professionals
    - Risk registers can be valuable communication tools but they must be used as proactive risk management tools and not as records of actions taken.
    - The insurance industry has recognised the value of effective communication as a factor that can mitigate risks of failure (insurance claim).

In brief in the UK it is considered that we have not learnt and implemented good and best practice from the past and we now have:

- Fuzzy terminology
- Lack of risk focussed evidence
- Standards not focussed on value adding inputs and beneficial outcomes
- Lack of risk-competent resources
- Training and education approaches that are not ideal
- Teams where attitudes are not always right and can be negatively influenced by poorly constructed contracts
- An inability to understand our audiences and how to best communicate with them

5 Recommendations on integrating GeoRM and ProjectRM

For the most effective integration of GeoRM and ProjectRM we must:

- Learn from and with other countries
- Consolidate knowledge that GeoRM adds value
- Review costs of ineffective GeoRM in UK
- Focus on training and education
- Champion cross disciplinary actions
- Be prepared to innovate our standards to add value
- Create high performing teams and resource them well
- Learn what effective communication is – and do it

And we need to act now!

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- US Federal Highway Administration (FHWA) (2012) Risk-Based Transportation Asset Management: Evaluating Threats, Capitalizing on Opportunities **http://international.fhwa.dot.gov/scan/index.cfm**

UK Call for Evidence responses for this report submitted by:

- Chris Lewin (Independent Actuary)
- Clive Muir (URS Corporation)
- David Patterson (Highways Agency)
- Duncan Nicholson (Arup)
- Graham Barton (Halcrow – a CH2M HILL company)
- Graham Birch (Network Rail)
- Helen Reeves (British Geological Survey)
- Jim Cook (Buro Happold)

- Roger Moore (Halcrow – a CH2M HILL company)

Predominantly unpublished records linked to the UK initiative to improve the effectiveness of geotechnical risk management to add value to the UK construction industry led by EurGeol Paul Maliphant and Professor Barry Clarke (2011-2013):

- Symposium entitled *Visualising the invisible. Conceptual ground modelling: the foundation of best practice geosciences* held in Cardiff on 21st January 2009 including:
  - Presentations
- Seminar entitled *Geotechnical Risk Management: adding value to construction projects* held in Cardiff on 28 January 2011including:
  - Supporting statement by the Welsh Government
  - Lecture abstracts
  - Presentations
  - Unpublished paper *Managing Geotechnical Risk: Contemporary Challenges* (based on seminar inputs and discussions and due for publication in Urban Geology in Wales 4 in2013)
- Unpublished 'thought' paper entitled *Rising to the Carbon and Cost Challenges through more effective Geotechnical Risk Management*, EurGeol Paul C Maliphant CGeol, March 2011
- *Revolting Geologists could add more value to the construction industry*, EurGeol Paul C Maliphant CGeol, Geoscientist (September 2011)
- Unpublished Doodle Poll of geotechnical advisers attending workshop on Geotechnical Risk Management, 13th November 2011
- Seminar entitled *Managing risk: the view of the built environment professional* held in London on 20th February 2012 including:
  - Presentations
  - Unpublished seminar report
- Seminar entitled *Managing risk: the view of the built environment professional in Wales* held in Cardiff on 26th October 2012 including:
  - Presentations
  - Unpublished seminar notes

Additional unpublished records:

- Highways Agency Geo-Impuls Presentations of 16th May 2012:
  - Risk Based Asset Management
  - Managing Geotechnical Risk a Client's view.
- G P Birch (unpublished) Geotechnical risk for linear projects