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# Risk and Opportunity Management for Project Selection in the Road Construction Industry

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**Abstract.** Road Construction projects failing to meet deadlines or budget costs puts burden on the construction company. The consequence may be economically unprofitable projects that significantly weaken the company's financial performance. To avoid unnecessary use of resources, the companies must identify and filter out unprofitable projects as early as possible. This paper lays out a process for use with road construction companies to improve their ability to choose profitable projects. The focus is on active management of risk and opportunity in the pre-selection phase.

The research is based on a case study at a road construction company. We interviewed key personnel to understand their main needs. We validated the proposed solution through a survey of nine employees at the same company.

Our research resulted in a new method targeted to guide construction companies through the project selection process. The developed process flow illustrates the sequence and interaction of the different process stages. The risk and opportunity process is complemented with a check list, a risk and opportunity register, and the associated risk and opportunity matrix.

## Introduction

It can be challenging to meet deadlines or budget cost in road construction projects. Lack of performance can cause project losses that significantly weaken the company's overall financial performance. A survey conducted by KPMG shows that construction companies supply a majority of successful road projects; however, the projects experiencing loss have a significant impact on the companies' financial results (Armstrong et.al, 2017). A road construction project is a project with a specified road works undertaken within a geographical boundary, in a limited timeline, and with a pre-determined resources and capacity (Veidirektoratet, 2014). All road projects have unique challenges making it difficult to treat two projects in exactly the same way. New and unknown uncertainties arise in most road projects. In this work, we see uncertainty as internal and external risk factors that affect the company's project goals positively or negatively. This definition complies with literature (Migilinskas, et.al, 2008).

A road construction project consists of several phases Tasks, ownership handover, and split of responsibility vary within the phases and companies often tailor the phases to their own needs (Samset, 2014). It is common to divide a project into at least three phases (early phase, implementation phase, and operational phase), often with associated sub-phases. The early phase deals with the identification of the overall project profitability and the development of overall plans to achieve the defined objectives. It includes all activities starting from identification of the project opportunity to deciding implementation. The early phase ends with the preparation of tenders and final contract negotiations.

The implementation phase encompasses all activities after signing the contract, including detailed planning, construction, and follow-up. The operating phase consists mainly of handover of road works, as well as operation and maintenance (Samset, 2014).

The construction industry is one of the most dynamic and risky businesses (Mills, 2001). It is crucial to uncover uncertainties before project selection to help predict the future success of the project and secure its profitability. Early-stage uncertainty analysis is particularly important for making proper project selection (Samset, 2014; Austen, et.al 2010; Jernbaneverket 2013). Ideally, the company should select for tender only the projects with high potential or profitability to reduce the time spent on bidding road projects that have high risk of loss and low performance.

There are a number of methods for dealing with risk management and project uncertainty (Hald et.al, 2008); however, there is little available theory that describes the application of risk management during the early phase of project selection, prior to the tender phase.

The INCOSE handbook outlines the Risk Management Process (Walden 2015)). The recommendation is to identify risks from on brainstorming prior experience, analyze lessons learned from similar projects, and to develop checklists. The handbook recommends that risk identification activity is applied early and continuously throughout the project life cycle. However, the handbook does not recommend risk management during the very earliest phases of the Business Management process and will therefore not necessarily provide the guidance for risk management during the project selection phase. Another important aspect highlighted in the handbook is the common neglecting by project management of external risk factors. The Handbook cites (Fossnes, 2005): “Such external risk factors are caused by or originating from the surrounding environment of the project. Project participants often have no control or influence over external risk factors, but they can learn to observe the external environment and eventually take proactive steps to minimize the impact on the project. The typical issues are time-dependent processes, rigid sequence of activities, one dominant path for success, and little slack.” Understanding the project selection criteria taken during the early phases can be crucial to develop learning in the construction company and to understand and identify the impact of external risk factors on project success.

While Risk management typically deals with the negative risks, the Opportunity management seeks to deal with “positive” risk factors. The literature is not conclusive in the guidance of opportunity management. The INCOSE handbook goes far in warning the use of “positive risk” and concept models, claiming that they serve to confuse the topic; “Projects that are subject to regulatory standards or customer requirements regarding risk management process and output must use extreme caution when integrating opportunity management with risk management” (Walden, 2015).

Early project assessment will be important in the future, as construction owners increasingly require Fully Covered contracts (Vegdirektoratet, 2017; Dahl-Hovland, 2017). In practical terms, this means that the contractors assume most of or all responsibility for the design and execution of a project, resulting in increased risk and responsibility on the construction company (Vegdirektoratet, 2017). With the contract being the form by which the contractor has the main responsibility, it will be increasingly important to handle and assess uncertainties as early as possible.

This paper addresses risk and opportunity management in Fully Covered contract projects to support the early phase project selection. The research is based on a case study at a large construction company. The aim of this work is to elucidate the problem through the following research question:

- *How can construction companies improve their ability to choose profitable road construction projects?*

The research question is elaborated through three sub-questions:

- What aspects are important for choosing profitable road projects?

- How can risk management become an active process during the early phase, prior to tender?
- How can risk and opportunities be identified and assessed during the early phases?

The purpose of the research is to develop a framework that seeks to guide road construction companies through the project selection process. The framework aims at active use of risk and opportunity management, from the projects identified until final decision of tender preparation. The purpose is to uncover risk and opportunities as early as possible and thereby enable the companies a better foundation for the decisions in the selection process. In addition, the method should be easy to use for new employees, so that they can also understand the whole and contribute to this process. The purpose is not to describe the use of the methods, as there is already literature on this, but to propose a framework that are not too resource consuming to use in the early phases or project selection, prior to the bidding phase.

Proper EHS processes are core to the success of all construction companies. The aspects of Health, Environment and Safety are beyond the scope of the paper.

## ***Project Risk Management in the Road Construction Industry***

All road projects have risk factors. The risks can range from financial aspects to quality and schedule, as well as employee health and safety. Risk factors are either internal or external factors that can affect the company goals positively or negatively (Migilinskas, et.al, 2008). In the past, the focus was only on the negative consequences of a project, the risks, but in recent times several companies have seen the importance of assessing the positive consequences as well, i.e. the opportunities (DIFI, 2019).

Risk management is the effort to keep the risks in a project within acceptable limits (Bonnema, et.al, 2017). It is about identifying, assessing, managing, and following up on events that can adversely affect goal achievement. In the case of uncertainty management, it also includes events that can have a positive impact on the project.

Although all project phases are important, some phases are more dominant and valuable to the project's overall success. The work related to the early phase has proved to be very important for the project's outcome. Hussein and Klakegg outline four important principles that are especially important during the early stages: (1) identify all success criteria, (2) avoid conflicting criteria to meet all stakeholders, (3) avoid the use of optimistic or pessimistic targets for the formulation of success criteria, and (4) communicate concrete criteria that cannot be misunderstood (Hussein, et.al, 2014).

In the initial phase of the project, it will be necessary to make preparatory studies of competitors, the market, customers, resources, laws and regulations, type of assignment and organization (Austeng et.al, 2010). This provides a better basis for future decisions in the project.

Assessment of contract form is also a central part of this process as it forms the basis of the legal contract of construction (Tryti, 2012). The contract allocates responsibility and risk between the builder and the contractor.

**Uncertainty Analysis.** It is very common to use uncertainty analysis for establishing cost estimates in construction projects, although the method is challenging and has significant pitfalls. Johansen et.al (2014) identifies five main challenges when using uncertainty analyses: First, the expected cost of the base case when estimated at the very early project phase is often not the true and correct end cost. Second, digging too deep into the details can cause a loss of the overall understanding of uncertainty. The risk when assessing the uncertainty as a calculated absolute number, the decision makers may forget to assess the broader underlying perspectives. Third, identifying the correct standard deviations for all phases of the project are difficult and it is common that projects shows an unrealistic low uncertainty in the early phases. Four, assessing uncertainty deals with human errors

and the effects of being a team and understand the effect of team decision is vital to understanding the reliability of the assessment. Lastly, there seems to be a blind spot in identifying opportunities through risk and uncertainty analysis and the number of risk identified are often 10 times more than the number of opportunities.

Lichtenberg (2016) describes four factors to achieve a successful uncertainty analysis: (1) accept uncertainty as an important and exciting problem, (2) perform objective assessments in balanced groups, (3) assess uncertainty top-down, and (4) identify and include general influences.

We see uncertainty analysis as a systematic approach to identifying, describing and calculating risks and opportunities. The process is initiated by identifying all possible uncertainties in a project, and then quantifying the probabilities of their occurrence and their outcomes. All identified risks should be assessed using various measures and mitigation plans to reduce or enable the identified risks and opportunities (Austeng, et.al, 2010).

Kalsaas (2017) presents a simple process model for early stage uncertainty analysis and evaluation. This is divided into 3 steps: (1) identify, (2) estimate, and (3) recommend.

Identifying uncertainty is the qualitative part and is about uncovering as many uncertainties as possible, often using group processes. Post-it notes are efficient means to capture ideas in combination with stakeholder and SWOT analyzes (Kalsaas, 2017).

Estimation is the quantitative part of the process model, which involves quantifying input data and analyzing uncertainty using a calculation tool. It is also common to use probability and impact matrices to assess uncertainties (Kalsaas, 2017).

The final step is recommendation, which deals with the evaluation of uncertainties and the preparation of conclusions and possible mitigations.

The *stepwise* method is recognized in the construction industry (Austeng et.al, 2010). The method is based on Lichtenberg's successive principle (Lichtenberg, 2006). The process is often carried out by consultants, where the state companies (e.g. the Norwegian Public Roads Administration and Bane NOR) only participate in workshops (Kiste, 2019).

The “step-by-step principle” (Klakegg, 1994) is divided into 7 steps: (1) goal and scope, (2) internal and external influences, (3) structure, (4) estimating, (5) calculation and evaluation, (6) iteration, and (7) conclusion.

Figure 1 shows the Klakegg method further modified by Austeng, et.al (2010). The main difference is the extension of the Action Plan after the Conclusion. The first step in Figure 1 is to define the goal and scope of the analysis. This is to ensure that everyone knows the purpose of the analysis and understands what is to be done.

The second step deals with the assessment of internal and external influence factors. The assessment is group-based and deals with the identification of all external framework conditions and internal forces that influence the project and its implementation. These are listed and sorted into either a fixed matrix with given categories or without any form of structuring.

The third step is structuring the task from an over-all view on a strategic level.

The fourth step is to make estimates of cost or time for each of the influencing factors. The cost projections are stated in quantity and cost, while the time projections are stated in an appropriate measure of time. Three estimates should be used for each activity and impact factor (cost and time). The three estimates should contain a minimum value, a maximum value and a most probable value. The calculation of the uncertainties is more complicated than the sum of the records, and therefore a

computer tool is normally used. A recognized method is Monte Carlo simulation where the estimates (minimum, maximum and most probable value) are combined with a chosen distribution function. The most widely used distribution function for the construction industry is the Erlang distribution.

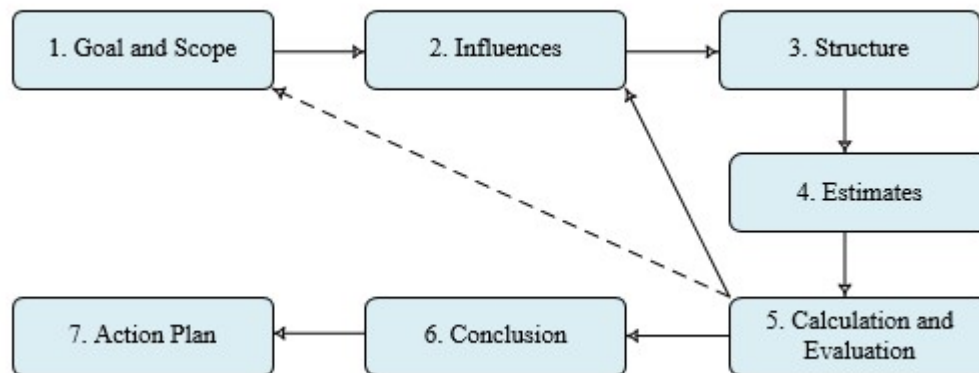


Figure 1 The Seven Stages of the Klakegg method modified by Austeng, et.al (2010).

The evaluation process is the next step. If the plan is not sufficiently detailed or the results are too uncertain, the process should be repeated.

The last two steps involve the preparation of conclusions and action plans, where the action plan aims to reduce identified risks and exploit the opportunities (Austeng, et.al, 2010).

**Methods and Tools.** There are many different tools for managing and controlling uncertainties. Bonnema et al (2017), include two different risk management tools:

- Decision tree - for quantifying risk by decision
- Risk Register - to track the number and extent of risk in a project

The decision tree is a tool used in the planning phase to ensure that the company makes good decisions for a project. The decision tree is a visual representation, often in the form of a flow chart, which shows a simple overview of expected decisions and possible outcomes / directions the project can take (Bonnema, et.al, 2017).

The risk register is a useful tool to use when the project is underway. The project updates the register periodically and discusses it in regular project meetings. Relevant elements from the decision tree are transferred to the risk register and some new elements are added. The risk register contains information on identified risk, description, owner of risk, deadline, cost influence, probability, weighted cost, status and strategy (Bonnema, 2016)). The register makes it possible to track and follow-up identified risks. Risk registers are common in the construction industry (Ståland, 2019).

Literature shows that if uncertainty management is to work well in practice, it is crucial that the methods contribute to a continuous uncertainty management process. It is therefore important to focus on business uncertainty and ensure that everyone understands the importance (Hald, et.al. 2008). Some companies have good systems and routines. However, the process ownership may be missing. It is therefore important that the company creates a culture of openness and is seeking to listen, communicate, receive feedback, and be on the lookout for uncertainties in all situations (Hald, et.al, 2008).

Sols (2018) presents a procedure for dynamic risk management. The procedure first deals with the human dimension with tips to promote the right atmosphere and then the technical dimension. The procedure consists of 10 steps. The first step in the procedure involves ensuring the right culture and atmosphere in the organization. This is by creating a working environment where employees feel

included in the risk process and where they have the opportunity to express their opinions without being afraid of making mistakes. The seventh stage includes the follow-up of risk and mitigating measures, which is very important as the risks develop over time. The project team should review and revise the risks and mitigating strategies to capture changes with time. In addition, it is necessary to identify ongoing risks in the project as risks may arise during the project run.

## ***Method***

Interview is the primary source in the paper. The purpose of this research technique is to obtain as much important information as possible, from a limited number of informants on a defined problem (Kristoffersen, et.al, 2004). The aim is to identify the various activities and processes used during the project selection and uncertainty work, and to identify possible improvements to the current processes. The research methods consist of unstructured interviews, structured interviews, and in-depth interview. All research work is done in a Norwegian road construction company.

In the early research, we conducted an unstructured group interview to identify the challenges related to project selection. We established the topic in advance of the interview but the questions were adapted to the interview situation. A project development manager and a cost estimator were part of the initial interview. After the interview, we sent the summary to the informants to ensure that the identified challenges were in line with their actual challenges.

To ensure that the questions for the in-depth interview would reveal all the necessary data, we prepared a structured group interview in advance of the in-depth interviews. The purpose was to gain an insight into the company's current processes and to create an overview of the approach related to project selection and uncertainty analysis. This contributed to the preparation of an interview guide that was to ensure a good conduct of the in-depth interviews. Prior to the interview, both topic and questions were determined at the overall level. We held the structured group interview with the same project development manager and cost estimator as the unstructured group interview. We also interviewed both of them during the in-depth interviews in the final stages of the research.

We completed five in-depth employee interviews. To reveal the necessary information and knowledge about project selection and uncertainty analysis, it was crucial to choose the right informants. To ensure reliable and credible information, we chose the informants mainly because of their position and previous experience.

We completed the in-depth interviews with all five informants within two weeks. We sent out all questions to the informants prior to the interview so that they could prepare. The researcher developed an interview guide as a guide for the in-depth interviews and tested it in two interviews to ensure the quality and to correct the questions if needed. All interviews were at the company's premises and over Skype. We asked all informants to review the transcript of their replies to verify that we had captured the information correctly.

We selected a Likert Scale survey for validating the proposed solution. The main reason for this is that the Likert Scale limits the informants to respond in a short and concise manner, as the response options are limited. A survey makes it easier to process a larger amount of data in a controlled manner (Kristoffersen, et.al 2004). We distributed the survey to 12 relevant informants, five of whom were informants from the previous interviews. The informant pool included project managers, cost estimators, tender managers, and company managers. The survey consisted of statements of which each informant had to answer on a scale of 1 to 5 (where one (1) indicated strongly disagree and five (5) indicated strongly agree). There was also the opportunity for written feedback to comment on missing aspects or to justify answers.

## ***Assessing Project Risk***

Through the in-depth interviews, we revealed eleven factors that are essential in making good project choices:

- Project timelines: assess whether the project's estimated timelines are satisfactory and whether it fits in with ongoing projects.
- Contract type: before the project is selected, responsibility and risk allocation must be considered in the project. For unknown contract forms, extra investigations must be carried out, but it is often recommended not to accept them.
- Competitiveness: assessing whether the company has a chance of winning the tender. Large resources are used to prepare tenders, and the company must therefore consider competitiveness in order to avoid the use of resources on projects that the company does not have the opportunity to win.
- Affiliates: Good collaboration is essential to a good result. Assessment of the partner and other possible partners is therefore necessary.
- Builder review: Good collaboration with the building manager / builder can be crucial for the project's result. Therefore, to consider this before project selection is necessary.
- Geographic location: consider if the area is familiar to your company. Unfamiliar areas can cause great uncertainty regarding, among other things, basic conditions.
- Economic conditions: assess the necessity of new projects their profitability.
- Resource, capacity, size: assessment of whether the company can deliver a satisfactory project within a given timeframe at the agreed price. The company must not undertake larger projects than they are able to deliver.
- Competence: assess whether the company has the competence to carry out a satisfactory project. If the company does not have the necessary expertise, other partners must be considered.
- Type of project: assessment of project type complexity. If similar projects have been carried out in the past, you have some idea of what can be expected. If a project type is unknown, it can cause considerable project uncertainty
- Group evaluations: joint assessment and decision in groups is necessary for the quality of the work. If there is a person in charge alone, there may be a danger that other employees will be "colored" by an individual's opinion.

The informants have a clear idea of what it takes to succeed, but the research work revealed some challenges in the company. The results from the in-depth interviews show that the company lacks guidelines on how to handle risk and opportunities before the bidding phase, and the informants thought the project evaluation and selection were somewhat random.

The informants had a varied understanding of the activities in each project phase, but the overall assessment of the in-depth interviews shows a clear pattern. Relevant activities prior to the tender phase were as follows: market monitoring, project portfolio preparation (the projects the company wishes to evaluate), overall assessment of the builder, contract, order reserve, resource situation, competition and prequalification. The majority of informants were aware that some of the activities were implicit and recommended formalization of the activities.

Several informants also felt that an uncertainty form adapted to all project phases would be advantageous to ensure an active uncertainty assessment. Other recommended methods were a fixed board or wall where employees can post notes with input related to risk and opportunities.

To increase efficiency and make good judgments in the uncertainty process, there was a desire to use group work in the work on uncertainties. Some of the informants had good experience with this, and others were positive to the suggestion. Today, there is one person who prepares the uncertainty analyzes for each project, which is later presented to a group that has the opportunity to correct and

provide feedback. The challenge with this is that employees can be influenced by a single person's opinion, which can cause important uncertainty elements to be overlooked. It can also put restrictions on creativity in the analysis and assessment process.

The informants also expressed that the group meetings held today do not include staff of varied background and knowledge. All people think differently and possess different knowledge and experience. The composition of the group is therefore crucial in order to uncover important elements of uncertainty and to increase the creativity of the group processes. DeBono(2017) supports that knowledge transfer is important for facilitating knowledge and experience internally within a company. In addition, it can help to promote the conditions that are unique in each project.

The in-depth interviews identified several factors for good project selection: Internal resources and capacity, project size, project type and project timeframe. Without resources and capacity, it is difficult to deliver a project that can satisfy stakeholder requirements. Without an owner who does not have the expertise to manage a project, problems can quickly have serious consequences for the company. The type of project and the project's timeframe are also seen as crucial for success.

### ***Project Selection Criteria***

Based on the qualitative research work, we developed a process flow diagram, presented in Figure 2. The process flow diagram shows how to proceed to assess projects and actively work with uncertainty. It shows the link between the uncertainty process and the remaining phases and decision points. Each step in the process flow diagram is essential to obtain sufficient knowledge of the project.

The process flow diagram consists of the main processes in the nomination and pre-qualification phase (phases before the bidding phase), and activities and sub-processes that are reviewed in these. At the top of the process, flow chart is the company's goals and strategy, which is marked with a yellow box. The goal and strategy of the company must be taken into account in all assessments made to ensure that the project choices are in accordance with the wishes and needs of the company.

The uncertainty analysis is the center of the process flow chart. This makes it possible to further develop and actively work with uncertainty throughout the life cycle of the project. The thoroughness of the uncertainty assessment depends on the project phase. We have harmonized the process flow diagram with the company business process showing the Decision Points (DP) milestones.

The first process in the nomination phase is to identify current projects on the market. The work includes market monitoring and market meetings. Identified are listed in a long-list project portfolio. The portfolio is updated regularly in include the best and most relevant projects. Identifying projects will therefore be a continuous process. Once the project portfolio has been prepared, it must be refined. The refining process is about sifting out the projects that best suit the company's strategy. The selection is based on internal analysis, external analysis, and a rough uncertainty analysis. The purpose of the internal and external analysis is to assess the company's resources and expertise, as well as competitors and partners. There are many ways to perform these analyzes, examples of which may be stakeholder (Schmeer, 1999) and SWOT analysis (Samset, 2014). The preliminary uncertainty analysis is based on these sub-processes and includes overall assessments of uncertainties that exist in the project and their consequences. A checklist ensures that the assessment team considers the most important uncertainty elements. Relevant uncertainties identified and assessed in this process are further presented in the project record.

The project portfolio is updated based on the refining process. The next step is to consider whether to pre-qualify the projects in the portfolio list. This is done through a review of the tender documents, which describe what is required to qualify for the job as well as a description of the job. At this point,



the company should have enough knowledge of the project to prepare the project objective. The nomination phase ends with a decision on which projects to prepare for pre-qualification.

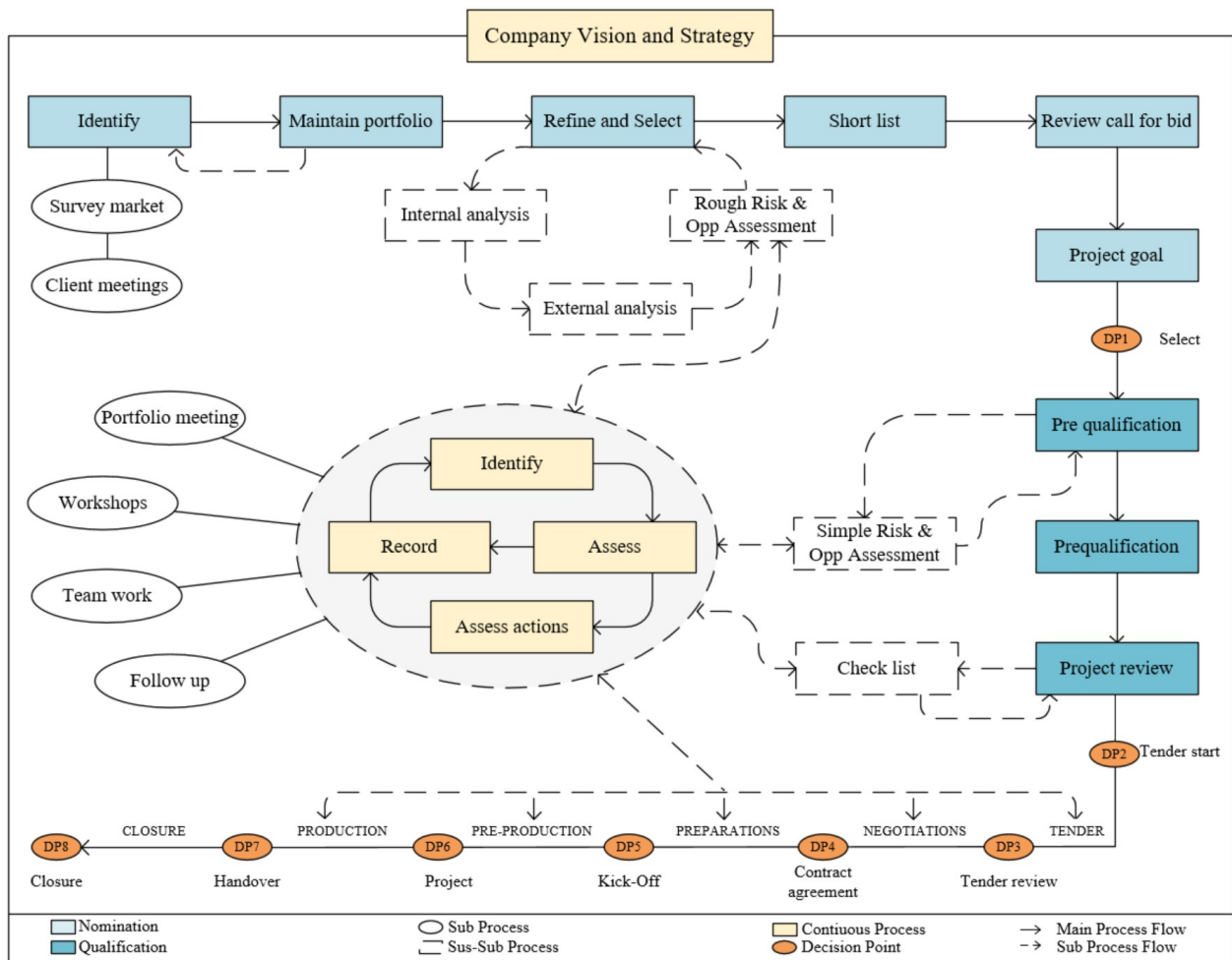


Figure 2. Process Flow Diagram Connecting the Uncertainty Process and the Business Process

The first process in the qualification phase is to prepare a pre-qualification for selected projects. The pre-qualification is initially based on what the client needs, but new analyzes of uncertainties must also be carried out as new information about the project has been revealed. Therefore, an overall uncertainty analysis is performed where the uncertainty elements from the nomination phase are further developed and new uncertainties are identified. Relevant uncertainties are transferred to the uncertainty form that further forms the basis for the offer phase. For the contractors that qualify for the job, a final assessment is made of the project's profitability, in which case the checklist can also be used.

**Check List.** It can be difficult to identify and assess uncertainties even before the bidding phase. In order to uncover a wider range of uncertainties, group processes that focus on promoting creativity can be an advantage. To prevent a checklist from restricting creativity, it can be used in a group process to check that important uncertainties have been revealed (Husby, et.al, 1999). In addition, designing a checklist of open questions can also provide guidance for new creative discussions, as well as enabling you to think outside the box and promote the uniqueness of each project. For each of the questions in the checklist, uncertainties are associated with each situation and possible outcomes.

Based on feedback from the interviews, we made a 9-category checklist for use in the risk and opportunity assessment. The check list include specific questions of the Type of Projects, Geographical Location, Economic considerations, Resources, Time, Client, Partners, Competitive ad-

vantages/disadvantages and Contract conditions. We split each category into 3-6 bullet point questions to help in the identification and assessment of potential risks and opportunities.

**Risk and Opportunity Register.** A risk and opportunity register is used to create a common routine for documenting and actively working on uncertainty in all situations. The goal was to form a framework for further development and follow-up of uncertainties during the later project phases. For this to be possible, it is important that the for register is adapted to all project phases.

We divided the risk and opportunity register into 3 steps. Step 1 involves identifying and prioritizing uncertainties based on a simple matrix, which can form the basis for project selection. It is important that the analysis is not too comprehensive, as we do not have sufficient knowledge of the project at this stage. Certainly, there will be instances where the company cannot quantify the uncertainties, as there is insufficient information available. It is therefore important to create a register that easily updates when more information is available. Based on the assessed probability and impact, the uncertainty matrix calculates an uncertainty score by multiplying the degree of consistency with the probability of the uncertainty occurring. The uncertainty score scale ranges from -16 to 16, where a negative score indicates an opportunity and a positive score indicates a risk / threat, see Figure 3. The scale forms a basis for assessing priority.

Step 1 thus provides a basis for identifying uncertainties and assessing priorities based on an overall experience-based analysis and for the initial project selection. The prioritization provides clues as to which uncertainties to further develop in Step 2. This underlies the choice of measures in Step 3. As Step 2 and Step 3 require access to a larger amount of data about the project, they are usually postponed to the later project phases when the company will have a better basis for making these assessments. It is recommended to temporarily apply the calculation theory for the stepwise process (Austeng, et.al, 2010) to further develop these steps.

Matrix		Actions (Score)	
Impact	4		
	3		
	2		
	1		
Opportunity	-1		
	-2		
	-3		
	-4		
Probability			

Figure 3. Risk and Opportunity Matrix, Actions and score

## Validation

We validated the proposed Risk and Opportunity Process including the check list, the risk and opportunity register, and the associated matrix using a survey.

The survey was distributed to 12 informants, 9 of whom responded and 1 of them thought the survey was too advanced. A graphical representation of the responses is presented in Figure 4 and 5. The response options are based on the Likert scale (Jamieson, 2019), where each informant was to assess and respond to different claims. The color green indicates strongly agree and red indicates strongly disagree.

The responses given to Claim 1 in Figure 4 show that 6 of 8 informants are positive that the Risk and Opportunity Process Flow Chart will be useful to apply before the bidding phase, and 2 informants are indifferent to its utility. Otherwise, no one was negative about the process flowchart, but two comments were given that the proposed process flowchart is somewhat advanced in use and that it contains too many elements:

*"I think the chart is too complicated. Gets too many conditions. Simple charts, routines or procedures usually work best. "*

*"There are maybe too many elements in the diagram. Usually, only a few factors are crucial, and a most of the resources will be on allocated to these factors. "*

To Claim 3 in Figure 4, the majority of informants agree that uncertainty analysis is a decisive factor in choosing profitable projects.

For Claim 4 that group processes are essential to good results, 7 out of 8 are neutral or agree and only 1 in 8 informants disagree with the claim. Claim 4 that group processes are crucial to the quality and outcome of a project is supported by professional literature carried out on the topic (Austeng, et.al, 2010; Kalsaas, 2017; DeBono, 2017; Husby, et.al 1999).

The responses to Claim 6 in Figure 4 show that 2 out of 8 informants disagree that the company's processes related to identifying early-stage uncertainties are effective, 5 out of 8 are indifferent, and only 1 in 8 agree with the claim.

On the use of check-lists, the informants largely agree or strongly agree on the use of a checklist following a creative group process. 1 in 8 disagrees with the claim.. One informant responded with a comment:

*"I thought this was a sensible approach. Our projects are very different and therefore it is natural to have different approaches to the projects. "*

The majority of informants believe that a checklist designed with open questions may be more useful than a concrete checklist, in which case 1 in 8 informants disagree with the claim. The majority of informants are indifferent to the claim a mind map is more useful than a step-by-step checklist. However, using a checklist prior to group processes can place restrictions on creativity (Husby, et.al, 1999), which is therefore something that should be avoided.

On the use of risk management forms, the overall impression of the answers given to the claims in Figure 5 is that an forms are seen as a valuable tool for actively and easily working with risk and opportunitites. There are only a few disagreements in the claims related to the uncertainty form. For example, the responses given to Claim 4 in Figure 5 show that 1 in 8 informants disagrees with the way risk and opportunity are presented in the form. This was due to the fact that the number of weeks depends on the size and construction time, and it is therefore difficult to set up a good scale distribution. The remaining informants are largely positive to this claim.

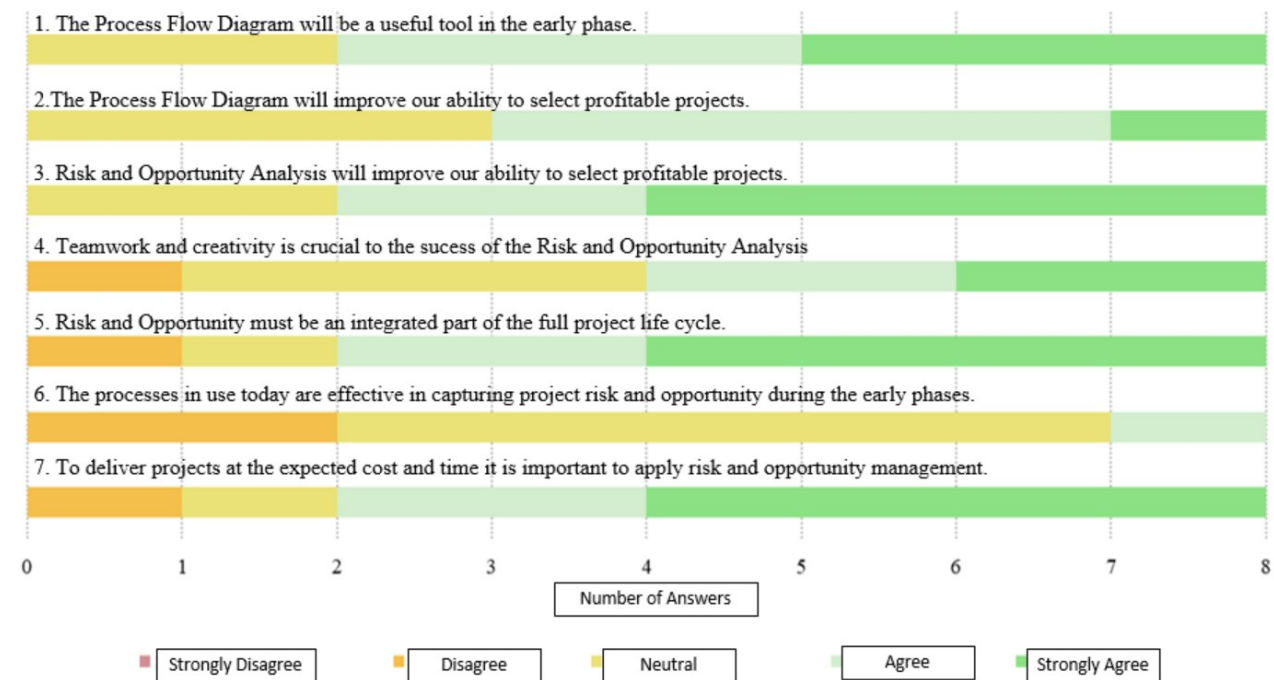


Figure 4. Process Flow Diagram Validation

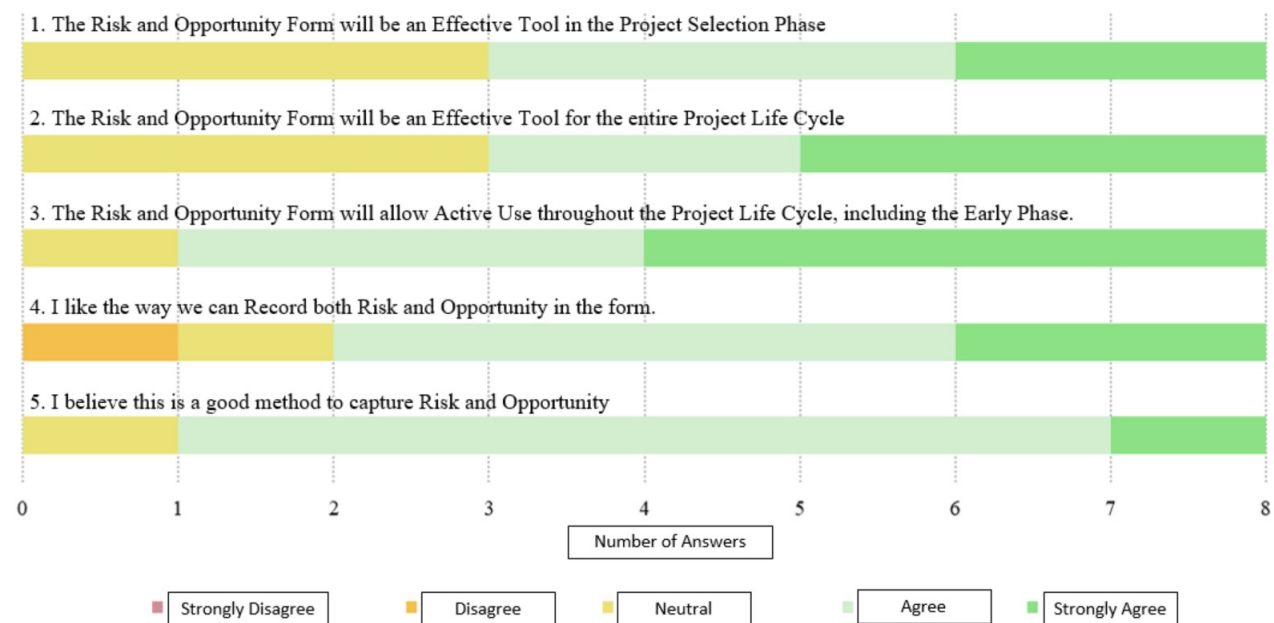


Figure 5. Risk Management Form Validation

Claim 5 in Figure 5 shows that the informants are either indifferent or positive to the methods proposed for Step 1 of the uncertainty scheme (see 5.2 Insecurity Chart). There was also several feedback that a complete uncertainty form must take into account health, the environment and safety. This is limited in the master's thesis, but this will make sense in a final form.

Overall, the results of the survey show that the majority of informants are positive about the proposed solution, but there were constructive feedback on how it should be structured and what it should include. Everyone works differently and thus has different needs, so it will be natural to have varying answers in such a survey. As there was limited access to informants and only 9 who responded, validation is somewhat impaired. Credibility, on the other hand, is good, as the informants are well

qualified to respond to the survey, as they have long relevant industry experience. There were multiple reasons why three of the informants did not respond to the survey. For example, there was a feedback that the survey was too advanced. This is considered to be one of the reasons, as some of the informants who did not respond have specialist background and thus not necessarily the overall understanding of the processes, which can make it difficult to make a decision on the claims in the survey. In addition, several of the informants have a very busy day and work outside the construction site. This was something that made it difficult to get hold of all the informants.

## ***Conclusions***

The process of select construction projects for tender preparation is both demanding and challenging. Risk and Opportunity assessment prior to the tender phase is one of the most important factors in improving the ability to choose profitable projects. The earlier the risks are identified, the sooner unprofitable road projects can be rejected. To identify uncertainties (risks and opportunities), it is recommended to use group processes that seek to foster creativity, which may contribute to the identification of multiple uncertainties.

This work highlights the importance of using pre-established routines and procedures within the company to create a common understanding of the selection process. This can help increase the likelihood of choosing profitable road projects, as well as ensure that decisions for tender preparation have the same basis for each project. In order to facilitate a common understanding of the selection process, a solution can be a process flow diagram. Such a process flow diagram illustrates the flow between different processes (eg project identification, uncertainty analysis), their sequence and interaction.

Project type, timeframe, competitiveness, partners, expertise and resource access are important factors to consider in order to choose profitable road projects. To ensure that these conditions are assessed, it is recommended to use a checklist that lists parameters that should be considered.

To assess risk and opportunities, it is recommended to use an risk and opportunity register. This register should be applicable to all project phases, as it is not possible to carry out complete analyzes before the tender preparation starts. The use of such a format can help increase the efficiency of uncertainty work for all project phases, as well as make uncertainty analysis a more natural part of all processes. The purpose is to create a form that forms the basis for further uncertainty work in later project phases and simplifies the possibility to change, update and follow up the elements of uncertainty.

## ***Future Work***

Additional research is needed to identify additional critical factors. For example, several researchers claim that group processes in the selection and uncertainty process are a decisive factor in choosing the right projects. All people think differently and possess different knowledge and experience. It is therefore important to utilize and share knowledge with each other in order to achieve creativity and to promote the conditions that are unique in each project (DeBono, 2017). It is not always the case that obvious uncertainty for some is just as obvious to others. Which elements the person associates with uncertainty are largely dependent on knowledge and experience (Husby, et.al, 1999). In order to utilize all participants' knowledge and experience, it is important to find methods and techniques to promote creativity. The Six Hats Method (DeBono, 2017) and the Post-it method (Utdanningsdirektoratet, 2017) are two recognized methods for enhancing creativity. It is recommended to focus on how group processes can improve the quality of the uncertainty analyzes, as well as how this can help increase the ability to choose profitable road projects.

Furthermore, the risk and opportunity flowchart should be tested out in actual cases in the company, this can be accomplished by testing the process flowchart in an upcoming project and update it based

on experience. The uncertainty register should be further developed for later project phases to ensure a seamless use of the risk and opportunity format during the project life cycle. The checklist prepared can also be used as a starting point, but should be expanded as new conditions are discovered. The aim of this is to develop a generic checklist that can be used in all projects in the company.

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