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Effective Opportunity management in a Megaproject

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Abstract

This paper has investigated how the new national museum in Oslo has managed uncertainty over a three-year period (2016-2018). A combined approach was chosen for this study, using both a qualitative and a quantitative data collection method. We have collected data from the risk registers at two phases of the project – the planning phase (2010-12) and the construction phase (2013-18). Separate opportunity workshops as one the changes that made the project come back on track in terms of time and cost. Focusing on opportunity register for each of the contracts that is monitored and update every month had been quite successful and resulted in a balanced uncertainty register with 160 opportunities (estimated value 60 Mill. USD +/- 1.0 Mill. USD) and 166 threats (estimated value 78 Mill. USD +/- 10 Mill. USD) in the construction phase. The actual outcome on the opportunities/threats cannot be established at this point since the project is still running for one more year. But we will suggest that this approach most likely will bring much more opportunities in to the project and that the cost saving effect is considerable.

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1. Introduction

Megaproject are known to often be *delivered late, over budget, deliver short of their original specifications and revenue targets* [1]. According to Flyvbjerg, a main cause of such overruns is a lack of realism in initial cost estimates. The duration and cost of delays are underestimated, contingencies are set too low, changes in project specifications and designs are not sufficiently considered. Further, fluctuations in currency exchange rates and price changes are undervalued, as are expropriation costs, and safety and environmental demands. Many megaprojects also contain a large element of technological innovation with its high associated risk of cost increases, which are often not adequately accounted for initial cost estimates. As a consequence, megaprojects are sometimes characterized by conflict and uncertainty and poor cooperation between partners [2] Davis et al claims that in most industries it is widely understood that improvements in performance depend on innovation whereas in the world of megaprojects innovation is often avoided because of its association with uncertainty and increasing costs [3]. Sponsors, clients, and contractors are reluctant to introduce novel ideas and innovative approaches and often seek to minimize the risks involved by relying on tried-and-tested techniques, established routines, and proven technologies. They prefer to select the lowest-price bid, transfer risks to contractors, freeze the design as early as possible, and rigidly stick to the original plan. The duration of a megaproject is typically beyond 10 years from project intention to project delivery. The length of the project makes the megaprojects challenging to succeed with in itself. The original idea is often lost and the demands and the customers' needs changes before the project is delivered. This means that there is a high degree of uncertainty inherent to megaprojects and that uncertainty management plays a vital role in the project management of a megaproject.

In 2009, the Norwegian Directorate of Public Construction and Property Management (Statsbygg), started the development of a new National museum in Oslo, the largest Nordic museum to date (54 600 m²). The new museum is built in the city center with a demanding construction and site logistics, and a lot of stakeholders that need to be addressed. The building contains more than 1100 rooms, and because of the art that will be exhibited and stored the building is it equipped with state of the art, advanced alarm and monitoring systems and lot of other sophisticated technical systems. More than 50 HVAC systems maintain the right air flow in the building and over 600 technical system needs to work together to maintain temperature, water level, light, and humidity in the air during cold winters and hot summer days. The architectural and technical design is state of the art, including several innovative solutions co-developed in the project; including sea-water pipe for heat exchange in combination with district heating; a large double-glassed hall with integrated, controllable LED façade lighting; novel steel structural components for wall solutions in the exhibition halls. This has added a significant research and development component in the engineering and construction of the project, with both known and unknown risks. The target cost is 5.85 Billion NOK (approx. 725 mill. USD) and the project delivery date is 2019. Current expectation and projections (May 2018) is that project will deliver *on time and on cost*.

This study is the report of the uncertainty management of a large construction project, tracking the development in uncertainty register from planning and through construction. Additionally, we enrich the study by investigating the harvesting/mitigating actions taken to handle and actively manage the uncertainty in the project.

2. Theoretical background – Uncertainty management in a megaproject

Most projects have traditionally strived towards predictability and to keep all critical factors under control. However, for large and complex projects, such predictability does not exist in reality[6]. Uncertainties play a large role in important areas, as developing the right concept, managing multi-cultured organizations estimating cost and time, defining the project objectives, manage new demands from stakeholders, manage multiple ownership. Especially under such conditions, it may not be a good strategy to strive for maximum predictability, but rather to choose a strategy of flexibility in the project, in order to be able to face changes in a better way[7]. In this paper, we adopt the term uncertainty to include both the positive effects (opportunities) and the negative effects (threats/risk) in the execution of projects. We have no ambition of presenting a complete and exhaustive model for uncertainty management. We are just mentioning the steps in what we consider as more or less generic uncertainty management process so that reader of this paper can understand what type of proses we have analyzed the maturity of. Several authors have covered the subject uncertainty management process the last years Simister[8], Hillson[9] and

Johansen et.al [4, 10-13]. The findings from these authors can be summarized in the following Generic Uncertainty Management Process (cf Table 1)

Table 1 Generic Uncertainty management process

Step	Description
Initiation - Establishing the context	Define objectives for the uncertainty management process Some standard/text books use the term initiate or identify the context Some make a link between objectives and stakeholders
Identification key stakeholders	Identifying key stakeholders
Identification and assessment	Identify relevant uncertainties Quantify the probability and the possible impact on the projects objectives
Evaluate and prioritize	Finding the "top ten" opportunities and threats
Planning response	Develop response; allocate responsibility and time frame for execution of the response
Implementation response	Execution of agreed response Exploit, share or enhance the opportunities- take advantage of opportunities that will benefit the owner, his customers or the project itself. Avoid transfer or mitigate on the threats - reduce the likely hood or the impact of negative events that if they occur will have negative effect on the objective, scope, resources, frame conditions, etc
Review	Control – did the response have the desired effect?
Follow –up and reporting	Updating the Uncertainty register (UR) Assessments of the uncertainties in the uncertainty register Take out opportunities and threats that is not valued any more Identify new opportunities and threats Plan and execution of new response

This generic process describes nine steps that should be included in a continuous and iterative uncertainty management process. The order of the steps or a generic “process model” is illustrated in Figure 1.

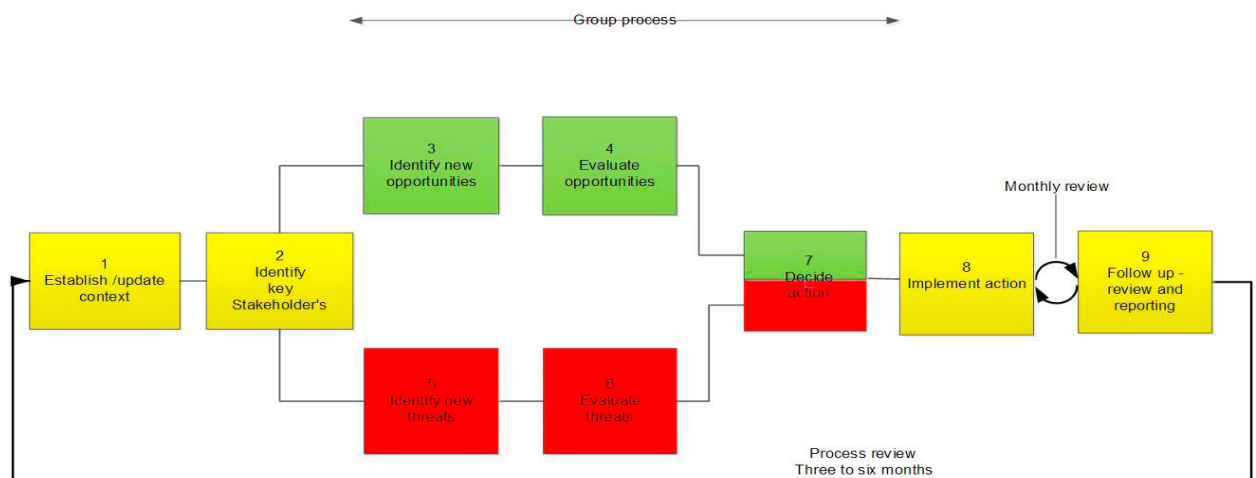


Figure 1 - Practical uncertainty management (Johansen et al 2013) [12]

The basis for and the main elements in this process are briefly presented in the following. Simister [14] has developed a generic risk management model based on publications from national standards associations (British Standards Institute, Canada Standards Association, and Standards Australia), professional institutions (Institution of Civil Engineers (ICE, 1998), Japan Project Management Forum (2002), Project Management Institute (2008), and Association of Project Management), and government departments (U.S. DoD (2003), and the UK OGC (2002)). His risk model presents the basic idea of having a continuous, repetitive and iterative process; the idea that risk management is more than isolated exercises and analyses

Simister underlines the importance of undertaking risk management as a structured, formal process aligned with the overall project management approach. The Norwegian research project "Practical uncertainty management in a project owner's perspective" proposes a similar model and the project also suggests that opportunities and threats should be analyzed and managed through the whole project lifecycle (see Figure 2)).

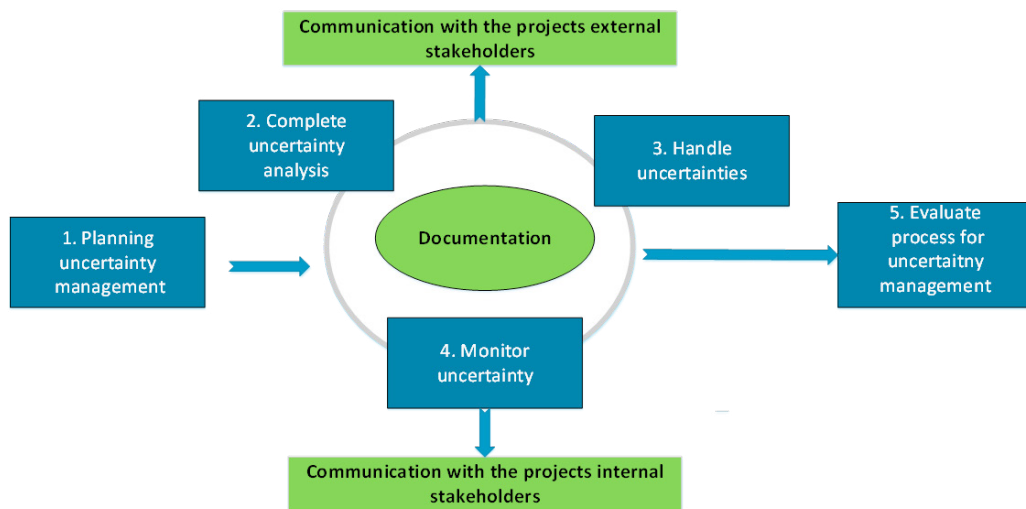


Figure 2 Practical Uncertainty Management process – (PUS web: www.nsp.ntnu.no/PUS/)

The New National Museum (PNN) followed this generic uncertainty management process presented in figure 1 and 2. The process includes all the necessary and continuous steps like planning, handling, monitoring and evaluating uncertainties. The system includes risk register containing both opportunities and risk, but one year in to the construction phase (2015) only 3 opportunities was present in the uncertainty matrix. During spring 2016 the alarm bells started to ring- the project had huge problems at the construction site, was behind schedule and the prognoses for the end cost signaled a possible cost overrun. Architect and engineering in two separate contracts turned out to be challenging- a lot of the drawings and specifications had faults or they were delivered late to the construction site. The Glass hall – the signature part of the project, turned out to have design faults and it need to be re- designed using other types of materials – The new solution that the project owner came up with was something the responsible architecture strongly disapproved – it was "ugly and it would ruin the design" – and the responsible architecture suggest another and much more expensive solutions, that PM turned down as not feasible and production of the glass in time started to rise as major risk. In the same period it became more and more clear that coordinating 27 construction contacts – with different focus- some in the startup some in the end phase was demanding for the project management team and the change orders, claims and disputes started to rise. In spring 2016 two events took place - the project owner in Statsbygg decided to change the project management team. And the project re-designed the Uncertainty management process to get project back on track.

The two big questions was - was it too late to start hunting opportunities and could they turn the project back on track? Two problems needed to be solved, how to chase opportunities in the execution phase and how to achieve commitment in all levels of the organization to new UM approach?

The risk and quality manager in the National museum developed five new concepts, all of them had a much stronger focus on identifying and handling opportunities. (see figure 3)

1. Contract management, combining cost – and uncertainty management
2. Introduction of opportunity studies on project level and contract level
3. Quarterly internal cost analysis- continuous focus and involvement of the four levels of Project Management organization
4. Improvement of the external cost analysis process
5. Time analysis under uncertainty – focusing on critical time and optimization on time schedule. External facilitators in co-operation with project management and planners

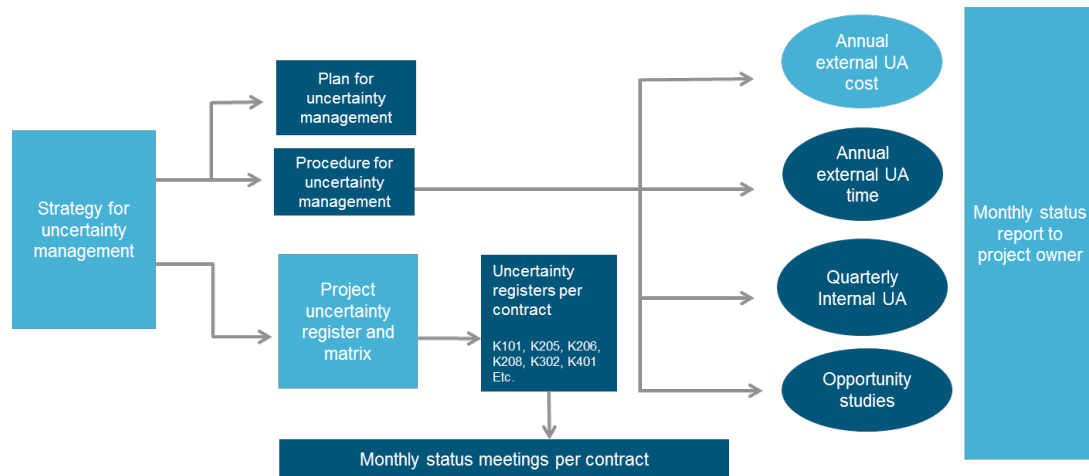


Figure 3 New and existing UM process/concepts.

The light blue one existed in the project as a part of Statsbyggs UM process. The dark blue process /concepts has been developed or been improved as part of the UM process in the PNN project. By implementing these five new concepts PNN have managed to identify about 160 opportunities since the first opportunity study in June 2016. Some of them small and easy to harvest, and some of them big and more difficult to harvest but the opportunity price even bigger. In June 2016 the first “opportunity study” was introduced– 20 people participated including project director and three levels of project managers. In January 2018 PNN introduced opportunity studies on contract level for the biggest contracts – in this brainstorming sessions the contractors also have been participating. The result is that, despite some conflicts in some of the contracts, because the participants were not allowed to focus on problems and threats - there have been several successful events where both the Project managers team from Statsbygg and the contractors have identified opportunities and actions to harvest the opportunities. In a follow-up session each contract presented the most important opportunities harvested and the effects on the contract. Because several contracts were represented in this session they all could learn from each other and afterwards in a workshop evaluate and update the contracts opportunity register that Project managers team from Statsbygg and the contractors own together. The New National museum had already in 2015 established uncertainty management on contract level with monthly reporting in status meetings. Together with the external facilitators they decided in November 2016 to try out a different process. Instead of inviting the whole PM team in one long time consuming process over several days - they decided to divide the process in smaller parts and have one meeting for each contract where they went through status on the opportunities and threats and triple estimating the cost consequence. This way everyone had the knowledge and commitment needed for a good process. The scenario process with about 20 people was done in one day and the participants could concentrate on discussing general uncertainty factors for the whole project. In this way four levels of project managers were involved in the process. The result from this effort is quite unique- instead of risk register for the construction phase with only 3 opportunities in 2015, the project developed a balanced uncertainty register with 160 opportunities (estimated value 60 Mill. USD +/- 1.0 Mill. USD)

and 166 threats (estimated value 78 Mill. USD +/- 10 Mill. USD). Out of these 106 opportunities and 117 threats were connected to the 29 different contracts.

3. Method and research design – a single study approach

This paper has investigated how the new national museum in Oslo has managed uncertainty over a three year period (2016-2018). A combined approach was chosen for this study, using both a qualitative and a quantitative data collection method. We have collected data from the risk registers at two phases of the project – the planning phase (2010-12) and the construction phase (2013-18). We have conducted a study of project documentation and we have followed the annual (externally facilitated) updates of the cost and time uncertainty in the investigation period. The project granted us unrestricted access to their documentation system (Interaxo) where steering document, contracts, change orders, monthly reports, annual uncertainty reports, etc, is stored and could be accessed as part of the inquiry. Data has also been harvested in the annually Uncertainty management workshops - focusing on cost uncertainty or time uncertainty. Annually 4 – 6 workshops, 6 to 8 hours, with 8 – 15 people from the project management team involved.

The research design used in this study is an action research approach, where one of the authors has been in charge and running of the uncertainty management process of the project and two of the authors has been involved in the project as external risk management experts in the investigation period - leading the annual process on updating the cost and time estimates under uncertainty. A part of the investigation has been how the project management team has worked with identifying and manage opportunities. To get a picture of this we followed the same research approach as the study[4] that was conducted by Krane, Johansen et al. They established a set of criteria that made it possible to categorize risks based on info in the risk register. These criteria was developed based on a study of the literature dealing with project objectives with short- and long-term perspectives and a categorization into opportunities and threats – also called positive and negative risks[5]. The third aspect that we used in to in our research was the utilization of tools and techniques involved in uncertainty management for analyzing, estimating and structuring the response and follow-up of each uncertainty element. Examples of what we consider as techniques are: brainstorming, checklists, interviews, delphi methods, expert opinion etc. Examples of what we consider as tools are: cost estimation (Full Monte, Crystal ball etc), risk registers, uncertainty matrix, situation map, risk cubes and Boston charts, just to mention a few.

4. Results and findings – harvesting opportunities as part of the uncertainty management process

The size and cost of the New National Museum means that the project is subject to a special quality insurance regime. Projects of this size are required to follow an official cost estimation regime and provide plans for how to handle the associated uncertainty. They must regularly (typical annually) update the cost estimate, and reports on large threats and opportunities monthly. The New National Museum has a high ambition on handling uncertainty and conducts the official annual external uncertainty updates of cost and time estimates, as well as quarterly internal updates. They have a dedicated full-time risk and quality manager to keep track of the processes and structured and well-documented processes for managing uncertainty. The project follows an annual plan that shows when and what types of uncertainty analyses should be conducted. They have "living uncertainty registers" that shows what are the top opportunities and threats at any given time. The register shows also a list of actions, who is responsible and due date for all opportunities and threats. They also follow up and report on the uncertainty monthly per contract levels and aggregated at the project level. For the four of the contracts which were considered to subjectively contain "most opportunity", separate opportunity workshops were conducted in order to identify possible opportunities. The first official version of the uncertainty register was established in 2010 (with 6 opportunities and 6 threats per December 2010). The last update of the uncertainty register, at the end of the planning phase, had 11 opportunities and 20 threats/risk (year 2012). The last update version of the register from the construction phase (May 2018) had 40 opportunities and 49 threats/risk at the project level (with 160 opportunities and 166 threats summing at the individual contract level), see Table 2 for more details. Out of the 160 opportunities, 86 were identified in the four contracts that was the focus of separate opportunity workshops.

Table 2 Number of Opportunities and risk - planning and Construction phase

Planning phase	Nr	Estimated Cost consequence
Opportunities	11	17.3 Mill. USD +/- 1.8 Mill. USD
Threats	20	92.8 Mill. USD +/- 12.3 Mill. USD
Construction phase		
Opportunities	160	60.0 mill. USD +/- 1.0 mill. USD
Threats	166	77.9 mill. USD +/- 9.9 mill. USD

The actual outcome on the opportunities/threats cannot be established at this point since the project is still running. The numbers in Table 2 represents new unique opportunities/threats for the planning and construction phase. The estimated consequence represents what the project management team has estimated for the possible outcome if the opportunity is harvested or the threats occurs with full potential. In reality, only some of the opportunities that has been identified can and may be harvested and the cost consequence may also be lower/higher than estimated in the register. The same goes for the threats. Normally not all of them will occur, and the cost consequence of those that occur can be both higher and lower than project team estimated. We interviewed the project management team – what are the largest opportunities that project has exploited and harvest and what been the consequence in terms of time (saving) and/or cost (saving or increased value for the project). The largest opportunities that has been harvested (so fare) are listed in Table 3.

Table 3. The largest opportunities in the construction phase

Opportunities harvested	Estimated time consequence	Estimated Cost consequence
Changing the construction of the Office building - Going from site-cast production to pre-fabrication	3-5 month	0.650 – 1.25 Mill USD
Simplified ceiling and overlight solution in the glass hall	n/a	0.250 Mill. USD
“Reduced” quality of finish in the office/workshop areas (to “office standard”)	1 – 3 weeks	1 Mill. USD
Change of materials in classrooms/workshop	2 – 4 weeks	0.050 – 0.125 Mill. USD
Triggered additional energy-efficiency savings grant	n/a	2.2 Mill. USD

Regardless of the accuracy of the estimation, both ante- and ex-post, the fact remains: The New National Museum project has identified and harvested a lot more opportunities in the construction phase, than the planning phase. They have been successful in harvesting opportunities that has saved the project both time and cost. This is contrary to established literature on the subject. And the change of the process played an important part in getting the project back on track.

5. Discussion and Concluding remarks

We were interested in finding out if prior studies that suggests that harvesting opportunities in the construction phase is impossible still was valid. To answer this question, we made a similar investigation of the uncertainty register of the New National Museum in April/May 2018 and found some rather different results. The investigation revealed that New National Museum project management team had high focus on identifying and harvesting opportunities in the construction phase. It is possible to harvest rather large opportunities in the construction phase if you have the need, power, and the authority do so. In 2016, the project was facing some huge challenges – the annual cost and time analysis pointed way over the budget and a possible delay in the construction phase of 3 to 5 months. The PNN project had challenges with two of the contractors, and they had not solved how to build the glass hall on top of the building that was the “signature of the building”. This resulted in major changes in the project management team and they started to turn every stone that could get the project back on track. Separate opportunity

workshops as one the changes that made the project come back on track in terms of time and cost and focusing on opportunity register for each of the contracts that is monitored and update every month had been quite successful and resulted in a balanced uncertainty register with 160 opportunities (est. value 60 Mill. USD) and 166 threats (est. value 78 Mill. USD). The actual outcome on the opportunities/threats cannot be established at this point since the project is still running for one more year. We suggest that this approach most likely will bring much more opportunities in to the project and that the cost saving effect is considerable. Without this approach and use of uncertainty management, The New National Museum would have been just another megaproject with huge time and cost overrun.

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