Risks and Uncertainties in the Planning Phase of Offshore Wind Projects

Chapter 15 of “Optimum Decision Making in Asset Management”
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Chapter 15
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ABSTRACT

Megaprojects are large and complex projects that entail multi-actor management, non-standard technology and processes. This chapter aims to explore offshore wind projects (OWPs) as megaprojects, particular in the planning phase. Based on interviews with 26 experts from a variety of backgrounds in the offshore wind industry in The Netherlands, the risks and uncertainties in the planning phase of OWPs and key factors in the decision making process are explored. A framework is presented that depicts the planning phase of an OWP, as well as ten risks and seven uncertainties that are most common in an OWP. The role of the government and the project structure are further highlighted. The findings of this research allow practitioners to gain a better overview of the planning process of an OWP and can help to improve asset management decision making.

INTRODUCTION

In 2014 the total capacity of wind energy grew with 10.2% in the European Union (Eurobserver, 2014). This rapid growth is driven by the ambitious goals that are set by a large group of countries to increase the use of wind energy by 2020. EWEA (2011) predicts that 14% of the total European electricity demand can be covered with wind power in 2030. The largest part of that wind energy will come from offshore wind farms (EWEA, 2009). Although investment costs are considerably higher compared to

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onshore wind farms, offshore wind farms generate a greater amount of electricity due to higher wind speeds above sea (Bilgili, Yasarn & Simsek, 2010). The rapid development and deployment of this type of engineering construction is risky, which underlines a strong need for building experience, and a dedicated focus on innovation to optimize the delivery of this type of renewable energy through engineering constructions (Koch, 2012).

Offshore wind projects (OWPs) are frequently described as large and complex projects, and are often referred to as 'megaprojects'. Flyvbjerg, Bruzelius and Rothengatter (2003) describe a megaproject as a project that consists of complex engineering constructions, complex time schedules, high building costs and complicated performance measurements. Megaprojects cover all phases of the asset lifecycle until operations and maintenance, and include the delivery of, for instance, bridges, power plants and public transportation projects (Priemus, Flyvbjerg & Wee, 2008). Due to its size and complexity megaprojects often lead to cost and schedule overruns and are sometimes not finished at all (Flyvbjerg et al., 2003). Although megaprojects become more common, it seems that in practice they are still treated as standalone projects so that the knowledge and lessons learned from one project to another does not take place regularly. Successful megaprojects are therefore copied frequently and implemented in other countries with only minor adaptations to local or project-specific situations (Priemus et al., 2008). For these kinds of reasons, PM Network (2014) stresses the importance of understanding and standardizing project management practices. However, anecdotal evidence suggests that there is a lack of knowledge transfer between megaproject stakeholders after project delivery. Consequently, knowledge is available in the industry but is not generally applied. In the literature, research on standardized project management practice or procedures that can be applied to OWPs or megaprojects is lacking. Therefore, exploratory research into these issues seems essential.

The success of asset delivery is generally measured against the well-known performance measures of project management: cost, time and quality (Cooke-Davies, 2002; Thi & Swierczek, 2010; Lopez del Puerto & Shane, 2014). The first offshore wind turbine was installed about 25 years ago. Since then offshore wind has been frequently described in research, focusing mostly on cost and quality aspects of installation, construction logistics, operations and maintenance (O&M) or commissioning. Investigations into the time aspect of these kinds of megaprojects are rare. Proper project planning is crucial for safeguarding all three performance dimensions (Zwikael & Globerson, 2006). Planning provides a project with the bigger picture of deadlines, allowing to distinguish between short-term and long-term goals over time for the sake of project control. An OWP involves a series of reciprocal actions, decision making and phases that include planning with the authorities, engineers, the public and other stakeholders. Each phase in an OWP can influence successful project deployment as the interaction and decision making between the different stakeholders create complexity, uncertainties and risks (Koch, 2012). Puddicombe (2006) highlights that planning is nothing more than an ongoing process of assessing, restoring and preventing uncertainties and risks in the project. Alessandri, Ford, Lander, Leggio and Taylor (2004) state that managers need to address the critical nature of risk and uncertainty in the decision making process of a project. Without identifying and assessing the risks and uncertainties, decisions made for the project are likely to be sub-optimal (Alessandri et al., 2004). Zwikael and Sadeh (2007) add to Alessandri et al. (2004) and state that risks must be managed throughout the entire lifecycle of the project; starting with the planning phase, when risks must be identified and analyzed. According to Giezen (2012) a better overview of the risks and uncertainties will result in making a project and planning more manageable.

Surprisingly little research has been conducted on megaprojects in general or OWPs when it comes to planning, risks and uncertainties. It is expected that offshore wind energy will play a significant role in the future due to the increasing importance of sustainability and renewable energy (Kuijk, 2013). The number and size of initiated OWPs will increase over the years. As the projects get bigger, they are getting more complex which requires increased attention for decision making processes. Hence an increasing number of project managers (current and future) could encounter difficulties in managing the complexities of an OWP. Identifying the main risks and uncertainties in OWPs, therefore, is crucial as this issue receives little attention in the literature.

In light of the increasing important of offshore wind assets, this chapter aims to explore offshore wind projects (OWPs) as megaprojects, in particular the planning phase. Based on interviews with 26 experts from a variety of backgrounds in the offshore wind industry in The Netherlands, the risks and uncertainties in the planning phase of OWPs and key factors in the decision making process are explored. It is expected that the results will be theoretically and practically relevant for the offshore wind sector, as well as for megaprojects in general.

This chapter is organized as follows. The next section provides a theoretical framework on megaprojects, planning, risks and uncertainties. It concludes with a set of research questions. After that the methodology used for this research is given, followed by the presentation of the results. The results are discussed. In the final section conclusions follow, along with this study's limitations, implications, and directions for future research.

THEORETICAL FRAMEWORK AND RESEARCH QUESTIONS

Offshore Wind Projects as Megaprojects

Flyvbjerg (2009; 2011) defines a megaproject as an engineering construction project that contains complex interfaces, complex decision making and planning, a lot of risk, non-standard technology and design, a multi-actor management process with conflicting interests and costs more than hundred million dollars. According to this definition, delivery of OWPs can clearly be considered as a megaproject. As the offshore wind industry still needs to build experience and expertise OWPs show that associated companies and stakeholders frequently act independent from each other, using their own working methods (Edwards, 2011). Still, Edwards (2011) describes that a level of synergy is present between the offshore oil and gas industry and offshore wind. From a research perspective, however, previous literature about OWPs is often written from a quantitative approach (e.g., maintenance) and rarely from a qualitative approach, investigating, for instance, initiation, planning or permitting procedures.

Main Phases of Offshore Wind Projects

Gerdes, Tiedemann and Zeelenberg (2005) identified seven main phases for the realization of OWPs. See Table 1.

The processes and phases described in Table 1 are outlined as sequential steps. It must be noted though that in practice these phases and processes may run parallel to a certain degree. No literature exists on whether the phases depicted here are valid and what the effect of skipping tasks would be. Adler (1995) identified that the more complex a project is, the more difficult it is to prepare and impose a realistic structure with flexibility to the limitations of the pre-planning of a project. Thus, as more actors get involved in a project, the more difficult it becomes to make decisions, regulate and organize all interests.

Table 1. Phases in an offshore wind project

Phase	Description
Pre-planning	Pre-feasibility study, development of strategies and the project structure.
Detailed planning	Project approval procedure, site investigation, functional requirements of main elements, planning of internal controlling system, financing and insurance arrangements, tender process and the master plan.
Contracting / Financial Investment Decision	
Engineering, testing	Detailed engineering and planning, pre-testing and training.
Production & procurement	Production of elements, quality assurance and control, factory acceptance tests, interface and workflow management and transport to logistic center.
Installation & commissioning	Site preparation, pre-assembly, installation of the foundation, installation of wind turbines, installation of electrical infrastructure offshore and onshore, commissioning of supervisory control and data acquisition systems.
Full operation	Service, maintenance and environmental monitoring.
Re-powering	Replacing old with new technology that, either have a greater capacity or have more efficiency resulting in an increase of generated power (Power Partners, 2009).
Dismantling	Better referable as decommissioning; what needs to happen with the wind turbines when they have reached the end of its useful life (Ferrell & DeVuyst, 2013).

(Adjusted and summarized from Gerdes et al., 2005: 138)

This may provide an explanation why it is nearly impossible to stay within schedule. It also indicates that research into the planning phase is required in order to gain knowledge about this aspect and improve it for the future to support and improve the decision making process for an OWP.

Planning

Project management is the process of planning activities, organizing, directing and controlling resources, procedures and protocols to achieve unique goals for a project within certain time, cost and quality constraints (PMI, 2014; Lechler, Edington & Gao, 2012). Time, costs and quality are of equal importance in a project and need to be fulfilled to deliver the right scope of work (Lopez del Puerto & Shane, 2014). In the literature the contribution of these three dimensions has widely been discussed. Planning provides control over the main steps and activities that need to be performed within a project, and can have a significant contribution to the success and progress of a project (Johnson, Boucher & Robinson, 2001; Megavind, 2010). Planning provides an overview of the complete picture in terms of deadlines, and distinguishes short-term and long-term goals. Brugaard Villmo (2012) emphasizes that the assumptions made in the planning phase are essential to future outcomes and decisions, since little can be adjusted regarding these assumptions and estimations when the implementation starts. Gerdes et al. (2005) also provided a more detailed description of the planning phase, using a subdivision between pre- and detailed planning. See Table 2.

Pre-planning is essential to limit the potential for later delays and cost overruns (Johansen and Wilson, 2006). Whittaker (1999) identified a strong correlation between budget overrun and schedule overrun, indicating the relevance of planning. Although planning is not directly associated with costs, it can make a huge difference when not enough resources are allocated (Puddicombe, 2006). Duncan and Gorsha (1983) argue that project planning is needed to overcome under-costing, overspending and

Table 2. Detail description of the first two phases

Phase	Description
Pre-planning	Pre-feasibility study of: 1. Stakeholder involvement, 2. Technology to use, 3. Supply chain management, 4. Logistics, 5. Economic assessment, 6. Environmental and public impact; Development of strategies for financing, media, stakeholder involvement and approval; Project structure.
Detailed planning	Project approval procedure for the grid connection and the project itself; Site investigation of the wind speed and direction, the (ocean)graphical, chemical, geological and biological influence; Functional requirements of main elements determine the infrastructure, logistics and HSE; Planning of internal controlling system regarding the: 1. Key performance indicators, 2. Quality assurance, 3. Factory acceptance tests and 4. Reporting systems; Tender process for the preparation of documents, elaboration on proposals and negotiations with subcontractors; Financing and insurance arrangements for the financing of the entire project.

Given by Gerdes et al. (2005: 138)

late completion. Although a detailed planning at the beginning of a project does not guarantee success, a lack of planning will most probably result in guaranteed project failure (Dvir, Raz & Shenhar, 2003).

Risks and Uncertainties

Puddicombe (2006) and Kezner (2009) state that planning is an ongoing process of assessing the uncertainties, risks and trust of a project. Novel projects with a long duration, like megaprojects, are commonly plagued with fundamentally unforeseeable events and unknown interactions within the project (Loch & Pich, 2002). The variables that are unknown in advance by the planner involve uncertainty and risk (NOAA, 2014). Risk identification is concerned with recognition of factors that may make the project plan obsolete or suboptimal (Loch, DeMeyer & Pich, 2006). Risk identification can be performed by expressing the impact, the probability and the type (financial, time, quality) of risk (Loch et al., 2006). Uncertainty describes any situation that people are not completely sure about (NOAA, 2014). Uncertainty estimations are often based on the experience of the planner. However, some things are fundamentally unknowable and occur randomly (NOAA, 2014). As it is impossible to identify and treat all uncertainties at the beginning of a project, uncertainties are inevitable, regardless of how much information is gathered before the project starts (Hubbard, 2007).

Megaprojects have a high degree of complexity, especially in the beginning. Accumulating risks result in a higher likelihood of failure (Gerdes et al., 2005). The amount of risk influences the level of planning effectiveness (Zwikael et al., 2014). Within OWPs most stakeholders are not able to accept the accumulated risk alone. This results in combinations of firms and public institutions executing the project. The unique nature of an OWP results in entanglement of risk and uncertainty, since a lot activities have to start from scratch with slim resources to learn from previous experiences. This causes a threat for the optimization of the project, which is for a large part done in the planning phase. It is the primary role of the project planner to identify risks and uncertainties in the project parts that have the greatest potential to cause concern (NOAA, 2014). It is important for the planner to acknowledge the existence of the risks and uncertainties and plan and incorporate them into the analysis (NOAA, 2014).

RESEARCH QUESTIONS

Although every megaproject is unique, Giezen (2012) called for more research on megaprojects. The focus of this chapter is on Offshore Wind Projects (OWPs) as megaprojects. Current literature regarding OWPs fails to address the planning aspect, in particular the risks and uncertainties occurring in the planning of OWPs related to planning. The following research question is addressed here:

What are the risks and uncertainties in the planning phase of an offshore wind project?

This research aims at gaining better insight into the planning of an OWP and the identification of risks and uncertainties linked to the planning phase. Depicting the planning process in a framework could provide practitioners with a better overview of how, what and when phases, tasks and activities need to be performed. In this chapter, such a framework is developed first. As a second step, risks and uncertainties are identified and linked to the framework. In order to answer this main research question, supporting research questions are formulated as follows:

1. *What is the structure of the starting (planning) phase of an offshore wind project?*
    a. *What are key issues in the planning phase of an offshore wind project?*
    b. *How does the developed framework of the pre- and detailed planning fit into practice?*
2. *How do risks and uncertainties influence the planning phase of an offshore wind project?*
    a. *What are the major risks and uncertainties assessed in the planning phase offshore wind projects?*
    b. *Which factors critically influence the (role of) risks and uncertainties in the planning phase?*

As we mentioned before, there is little research on megaprojects in general or OWPs when it comes to planning, risks and uncertainties. It is our intention to contribute theoretically and practically to both the offshore wind sector, as well as megaprojects in general.

METHODOLOGY

The data required for this study has been collected by interviewing experts on their views and opinions (Handfield et al., 1998). The Delphi study is applied as an appropriate research design to describe, discover and gain insight in a research area (Handfield et al., 1998, Akkermans et al., 2003). It provides an interactive communication structure between the researcher and experts, in order to develop themes, directions or predictions about a topic (Neill, 2007). The approach of this research is therefore qualitative with an explorative nature.

Delphi Technique

The Delphi study is well suited as a consensus-building method to collect data from a panel of selected subjects (Hsu & Sandford, 2007). The feedback process in this technique allows interviewees to assess the judgements and information provided by other experts and themselves (Hsu et al., 2007). Another important characteristic of using Delphi is the ability to provide anonymity of the interviewees. The Delphi process consists of four iterative rounds in which the data is gathered. After each round the different opinions and findings regarding a specific topic are identified and summarized for the next Delphi round. The new insights are a point of discussion in the next round. The exact process of the Delphi technique is explained in more detail by Hsu and Sandford (2007).

Interviewing

In order to gather as much information as possibly a large variety of experts has been interviewed. This research captured the opinion, knowledge and expectations of 26 experts via semi-structured interviews (Emans, 2002). The 26 experts (see Table 3) based their knowledge on their (working) experience in the wind energy industry (at least three years). Additionally, the experts needed to have a background in OWPs or be involved in the development or operation of an OWP. All the interviewees are anonymized in order to ensure objectivity (Hsu et al., 2007) and mind the necessary ethical considerations (Emans, 2002).

Data Collection

The interviews are conducted in person and are collected and organized according to the guidelines and procedures of the Delphi Technique. All the interviews were held in the period between August and October 2014. Appointments with the interviewees were at their offices and set between 60 and 90 minutes, depending on the interviewees. Several documents were provided to the interviewee to guide the conversation, and a number of predetermined questions were used to start the conversation, as the interviews were attended by one researcher. The interviews were recorded in order not to lose data. This assured higher quality of the interview transcripts (Karlsson, 2009). The transcripts were completed after the interviews and provided to the interviewees in order to review and revise the transcripts if necessary.

Data Analysis Method

After reviewing and revising the transcripts by the interviewees, the transcripts were used for analysis. In order to perform a clear and efficient analysis, the answers of the interviewees were coded by means of a coding tree. Kwalitan was used as an instrument to highlight and organize the coding of the transcripts, and to get a good overview of all valuable data.

RESULTS

Interviews were held in order to investigate and describe the process up to the financial close of OWPs. In particular the risks and uncertainties during the development phase of the OWP are addressed. The data from the interviews have led to a description of the (decision making) process, a structuring of the

Table 3. Overview of the 26 interviewed experts with their characteristics

Industry	Company	Position	Background	Experience
Science	Research institute	Developer of standards	Onshore	32 years
Science	Research institute	Advisor in R&D	Onshore & Offshore	42 years
Wind energy	Wind farm contractor	Project manager	Offshore	15 years
Wind energy	Windfarm owner	Operations manager	Offshore	9 years
Construction	Contractor	Commercial manager	Offshore	9 years
Consultancy	Advisory bureau	Advisor operations & maintenance	Onshore & Offshore	30 years
Science	Research institute	Researcher in design of turbines and wind farms	Onshore & Offshore	28 years
Wind energy	Industry association	Coordinator offshore	Offshore	12 years
Public administration	Regional government	Project manager	Offshore	4 years
Wind energy	Advisory bureau	Consultant & project manager	Onshore & Offshore	8 years
Science	Research institute	Managing director	Onshore	33 years
Consultancy	Engineering consultant	Consultant asset management	Offshore	3 years
Consultancy	Engineering consultant	Consultant transport and mobility	Onshore & Offshore	3 years
Consultancy	Engineering consultant	Investment advisor	Onshore & Offshore	4 years
Consultancy	Engineering consultant	Global sector director	Offshore	5 years
Utility company	Power company	Business development manager	Offshore	4 years
Consultancy	Financial advisor	Co-owner and director	Offshore	7 years
Facility management	Government	Program manager and consultant	Offshore	7 years
Real estate	Property owner	Department head	Offshore	16 years
Public administration	Government	Project leader policies	Offshore	4 years
Utility company	Power company	Planning and risk engineer	Offshore	3 years
Science	Research institute	Chief Operating Officer (COO)	Offshore	5 years
Financial intermediation	Bank	Team leader project finance	Onshore & Offshore	7 years
Education	Research institute	Director and lecturer	Offshore	9 years
Financial intermediation	Asset consultant	Managing director	Offshore	9 years
Utility company	Power company	Project Manager	Onshore & Offshore	5 years

process and the identification and quantification of the risks and uncertainties. This is described in this section. How to read the section: Observations and interpretations of the experts are used to support the results, and literal quotes are provided in italics.

Importance of the Planning Phase

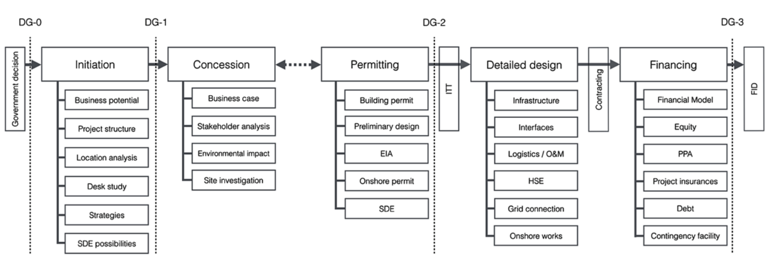
The preliminary phase is very important, since the possibility of making a mistake in the beginning could result in an offshore wind farm that will not perform optimally during its lifecycle. The first phases of the project determine the rest of the project to a large extent; it can be the decider for the project itself and its future course. Gaining a better understanding of the planning phase is therefore essential. The experts indicate that putting more effort and time in the preparation of a project results in better and more favorable risks, costs and investments. The experts indicate that currently there are a lot of unknowns regarding the development stage of an OWP. Another interviewee stresses the necessity that the first phase, the preparation, is the hardest to plan, i.e., "It is important to develop the steps of the process in advance. Because a lot of problems can be related back to insufficient preparations and insufficient decision making."

Framework

Before the interviews took place, we developed an initial framework for the development phase of an OWP. The interviewees regarded the framework a good representation of practice. Figure 1 depicts the framework that is the updated result after the interviews, illustrating the planning and decision making of an OWP from pre-initiation until financial investment decision (FID). The illustration of this framework clearly depicts to project developers what needs to be done. Experts indicated that all things in the process interweave with each other; each activity cannot be pinned and finished without the next activity in mind.

The initial step in the process of an OWP starts with a government decision. According to an interviewee "the government plays an important role in this entire process, mainly because they have set their goals and policy to generate 16% renewable energy by 2023. The process needs to start with their decision otherwise the project developer cannot even start." Megaprojects often start with a governmental ambition and decision to create an interesting investment climate that will attract long-term investors. Next the initiation phase starts with assessing the business potential, the permit options, possible locations, desk study and subsidy opportunities for renewable energy project incentivisation (SDE: stimulering duurzame energieproductie). There are some prerequisites for an OWP:

Figure 1. Developed framework for the planning process of an OWP (This framework depicts the planning process of an OWP that is initiated with a government decision and concludes with the Financial Investment Decision (FID). The boxes in the framework indicate activities or tasks that require a decision or a certain performance, in order to successfully continue the project. After particular tasks have been done, the project leader needs to decide whether the project can continue by means of decision gates (DGs))



- The location,
- The permit,
- SDE options,
- The grid connection.

These are required to secure and even start an OWP.

If this part of the project is done, the most important foundation of successful continuation of the project is established. However the next phases, commissioning and permitting, are the most prolonged phases as indicated by the interviewees: “the moment the project loses the most valuable time is in the interaction with the government for the different permits and the site investigation”. The frequent contact and decision making that is required with the different departments within the government causes the majority of delays. Also the possibility of appeals and objections on the permits adds a lot of uncertainty to the expected planning of the project. The project continues with the invitation to tender (ITT) towards contractors. This process is about issuing the request to commission the elements for the OWP. This includes managing the different interfaces, after which the detailed design phase commences by developing the details of the wind farm based on the previous (coarse) calculations, with more attention to the specifics regarding the preferred contractor. One interviewee explains that “ideally the final detailed design is drawn before FID, however certain aspects, for instance the desired quantity of steel, are unknown at that time. This results in postponing decisions or activities past FID.”

Interviewees furthermore indicated that details are essential for the FID, however details frequently become clear past FID. The main reason for this behavior is that the risk of not achieving FID is still present, and each party wants to prevent huge investments without the certainty of continuation. Before a project can continue to its final planning phase, financing, it needs to address the contracting of the (sub)contractors to provide the terms and input for the financing phase. At FID investors want to know who are contracted to check whether the parties involved have a good track record. Certainty measurements are furthermore incorporated at the final stage of financing to secure successful continuation of the project. When this is all arranged the projects moves towards the FID, which is the act of signing all the different contracts and deciding on the different terms and the financing phase. A final point is that the most important moments in a megaproject are the decisions gate(s) (DG). The experts indicated that DGs consist of a process of informed decisions to continue the huge investments for a megaproject. DGs are moments where the project developer seeks permission for commitment to the next step(s) in the project. Thus, project managers decide often on the activities and decisions necessary to get to the next DG and gain approval.

Uncertainties

An uncertain outcome of any event is completely unknown, lacks certainty and cannot be measured or guessed. The main uncertainty that flows through the entire project for an offshore wind farm is the uncertainty of continuation of the project. All the experts emphasize this, as for OWPs “everyone is trying to postpone its commitment, to not be dependent on others until the very last moment.” Subsequently, every party has to keep in mind that “showing commitment to the project provides certainty to other parties and firms.” The postponement of making decisions by the parties is explainable since the project is uncertain to continue if it does not acquire the permits and the SDE. These elements are part of the government decision and the interviewees state that “if the next government does not want to pursue the same goals as the current government, the perceived uncertainty in their decision making is increasing." Since the duration of the development of an OWP can take between four to seven years, changes of governments are possible. Another great amount of uncertainty comes from all the accompanied parties that are involved in the project. They all have to give their approval for decisions and investments.

Figure 2 illustrates the described uncertainty in decision making for successful continuation of an OWP. Alongside the uncertainty line, an investment line is drawn that indicates the increasing investments of capital expenditure (CAPEX), which includes development expenditure (DEVEX). Since the CAPEX differs a lot between megaprojects, the line only illustrates the increase without tangible values. The purpose of the figure is to illustrate the uncertainty project developers experience throughout the lifecycle of an OWP. The decision uncertainty decreases throughout the project measured at the DGs, since the project continuation is evidently decided at the DGs due to the added value. The figure also stresses the interdependency of the experienced uncertainty relative to the postponement of the CAPEX decisions. The percentages in the figure are stressed by the experts to provide an impression of the experienced remainder of uncertainty:

The experienced uncertainty throughout the planning process is high until FID is achieved. Until that moment the development investments are kept as low as possible since there is no certainty for project continuation.

A key point is that CAPEX postponement will not result in added value, thus evidently the uncertainty will not decrease. A good example explained by the interviewees is the moment "projects perform FEED studies to gain information for a better price indication. However these studies require investments, investments made while the possibility of discontinuation still exists." The more uncertainty is perceived by external parties, the more they will increase their price for the perceived risk. Thus, project developers could invest millions to ultimately discover that the site is not suitable for offshore wind. Interviewees state that "to avoid planning overruns, the project needs to decide on certain items in advance (one year before FID) despite the uncertainty whether the project will continue." If these decisions are postponed too much the project will never get started. It is explainable that every investor would behave this way, and tries to prevent early investments. However in the end someone needs to invest: entrepreneurial risk.

Figure 2. Experienced uncertainty in decision making for successful continuation of the project

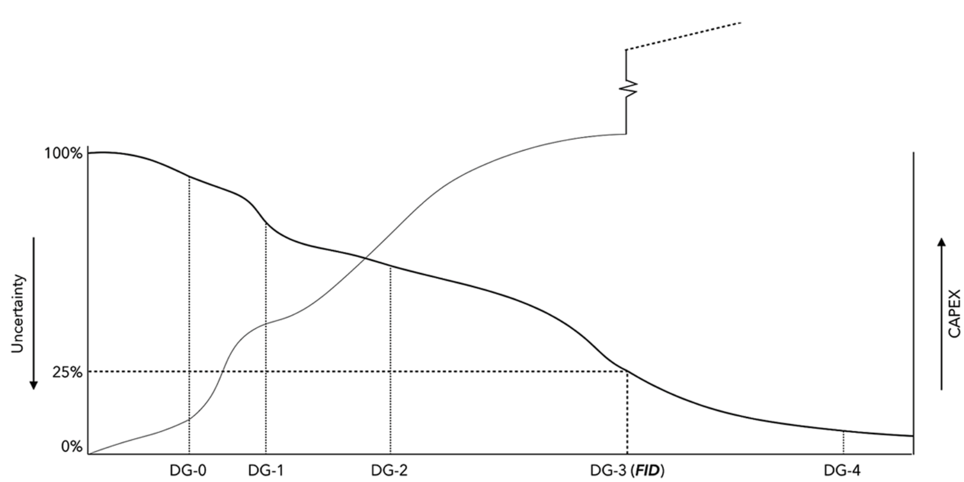


Table 4 summarizes the identified uncertainties of this research with a short explanation. The uncertainties are ranked according to the frequency at which they have been mentioned by the different experts.

These uncertainties affect the planning process in such a way that a lot of the involved stakeholders or parties remain skeptical and hesitant to commit to an OWP. The hesitation is reflected in the tender price; firms incorporate the absence of data or certainty into their price. The skepticism is a result of the postponement of investments from another party, since most investors perceive too much risk or they do not want to commit too early. This results in a vicious circle because the postponement of decisions and investments results in a slow increase of certainty, which evidently results in only a slim number of commitments, ultimately making the project more uncertain. That same uncertainty subsequently is incorporated in the price, resulting in a less beneficial investment decision.

Risks

In the previous sub-section, uncertainty was referred to as the lack of complete certainty. An uncertain outcome of any event is completely unknown and cannot be measured or guessed. Risk, on the other hand, is an uncertain event that, if it occurs, has a positive or negative effect on at least one project objective and can both be measured and guessed. Risks often occur due to underestimations of certain activities or tasks, however when they are analyzed and addressed, they are not risks anymore but events that are going to occur or not. The most underestimated activity in an OWP is interfacing. This concerns the moments in time where different contractors meet each other. If one party is delayed, all the parties having to make decisions after that are also delayed and need to postpone their decisions, investments and activities. According to an interviewee:

Table 4. Identified uncertainties

#	Uncertainty	Mentioned	Explanation
1	Return of investment	21/26	The perceived uncertainty of successful continuation of the project is high at the beginning. Therefore investors suppress their investments to a later stage, due to the increased chance of losing the investment.
2	Ordering Long-Lead Items	19/26	LLI are expensive and need to be ordered before FID to prevent huge planning overruns afterwards. LLIs are also customized for the project, making them useless if the project subsequently does not reach FID.
3	Government shift	18/26	Elections can shift the regime in a country and can result in adverse changes towards prior offshore wind decisions.
4	Not allocating all risks	16/26	Assessing and assigning unknown risks incorrectly, causing higher costs for the involved parties. This results in variation orders with higher costs for the entire project.
5	Site investigation analysis	15/26	If the assigned site is investigated and reveals that the suitability of the site is insufficient despite the huge investments.
6	Entrepreneurial risk	8/26	The postponement of investments and commitments, resulting in a power play strategy of not being dependent on one another. Causes the project to create unnecessary uncertainty due to postponements.
7	Weather conditions	5/26	Legislation for driving piles and heavy weather fluctuations limit the planning and create an intense pressure on the planning that, despite good preparations, is dependent on an uncontrollable element.

The project leader is responsible for the coordination. The more contractors a project has, the more attention it needs to pay to the interfaces and the bigger the risks are for the project with the chance of loss of time and money.

Moreover, not addressing properly who is responsible for each task and not actively sharing information are two other much-identified risks for megaprojects. "Every project is observed as a standalone project, and knowledge is not transferred. Firms are scared to share their mistakes or sensitive information". Unfortunately, no one can learn from their mistakes. It has often been argued that the wind industry lacks the willingness to copy, paste and learn from the oil and gas industry. Observing every project as a standalone project results in a high level of change of project teams. Subsequently, projects are sold to other parties and the developers are unreachable afterwards, resulting in unexplained decisions and strategies for the new management:

Parties need to be involved as early as possible in the decision making. Otherwise the result can be unsatisfying in which the development requires compromises on things that have already been developed, resulting in additional project delay.

The interviewees emphasize that late involvement of parties happens too frequently, and early involvement could reduce avoidable expenses. Otherwise parties could be unsatisfied with certain decisions, which would then require compromises from several sides as they otherwise cannot contribute to the project. This ultimately leads to delays in the project. This relates to another identified risk: insufficient preparations. The preparatory work for all kinds of activities, e.g. onshore activities, is often insufficient because of the underestimations of activities relative to the focus of completion of the project. The underestimation of durations, complexities, decisions and postponement of applications delay the project as these activities are not completed within the set timescale. Project developers tend to only pay attention to the current phase and postpone activities that are currently irrelevant.

As a project wants to control its expenses and is constrained by external factors, it requires tight planning and decision making. However, the effect is that parties expect to begin their tasks within the tight timeframe, resulting in extra costs because of foreseeable delays. This results in another risk: poor contracting. Not addressing all risks can have serious performance consequences. "Without good research the project ends up with additional work and costs. Weak project management that does not quickly enough discover possible gaps or problems will leave the project with many additional costs." Inexperienced project teams or parties negatively influence the decision making since they have no experience or knowledge about (offshore) projects. Table 5 summarizes the identified risks of this research in order of perceived importance.

Main Findings

The explanation why these ten identified risks are most prevalent for the planning phase of an OWP can be related back to the underestimation of the decisions made in a megaproject and the relative inexperience in the offshore wind industry. The corollary of the inexperience is the underestimation of the project in the interfacing, the preparations, the permits and the involvement of important parties. The elements aforementioned are identified as risks for an OWP (see Table 5). The identified uncertainty with the underlying skepticism and hesitations, contributes to the overall risks and uncertainties perceived in an

Table 5. Identified risks

#	Risk	Mentioned	Explanation
1	Poor interfacing	24/26	Certain tasks and deadlines are not correctly assigned to the different parties. Thus, the contractors have to wait for each other, which will lead to delays and cost overruns.
2	Lack information sharing	22/26	Every OWP is observed by the firms as a standalone project in which the firms are reluctant to share viable information about mistakes and lessons learned.
3	Late involvement of important parties	21/26	Choices made earlier in the process cannot be aligned with the expertise of the parties. This results in discomfort since the requirements do not match one another.
4	Long application process permit(s)	20/26	Bureaucracy causes long application processes, eventually resulting in outdated or invalid permits due to the duration between approval and fulfilment.
5	Insufficient preparations	18/26	The project underestimates the importance, complexity or duration of certain activities resulting in not completing these activities within the set timescale, thus delay.
6	Dependent in obtaining SDE	16/26	An OWP relies and requires the SDE. The approval of SDE is moreover dependent on governmental authorities; with a first come, first serve principle.
7	Tight scheduling	15/26	OWPs are often constrained by external factors and their dependencies, resulting in a planning that is too tight with a high possibility of overruns in time and costs.
8	Poor contracting	14/26	The different (sub)contractors are not analyzed on their financial and technical capabilities and as they perform bad that consequently results in delay of the project.
9	Incompetent project team	14/26	People are assigned to a project, however they lack experience, skills or knowledge to execute a megaproject in a good manner.
10	No grid connection	11/26	The commissioning is completed, however the OWP is not connected to the power grid onshore, thus it cannot provide electricity and subsequently generate revenue.

OWP. It is further noteworthy to mention that the permits, the grid connection and the site, which are considered to be basic elements of an OWP, are respectively identified as important risk factors and as an uncertainty factor. It clearly suggests that uncertainties are large during the planning phase of an OWP due to the novelty of the offshore wind industry.

DISCUSSION

This section will first elaborate on two important factors: the project structure and the role of the government. Both are hard to control and the project continuation is truly dependent on them. After that, we will present some additional reflections on the presented results.

Project Structure

The activity 'project structure' refers to the way the project is organized throughout its lifecycle (see Figure 1). The planning and decision process is dependent on the selected project structure. A project is either performed with finance on balance (FOB) or by execution of project financing (PF). Table 6 displays the differences between the two structures.

The main benefit and limitation of the different structures do not direct towards one prevailing structure. However, FOB projects can postpone a lot of activities and decisions past FID since they can better deal with delays in their planning. This is because of the backings of a FOB project, providing them with more certainty. FOB projects tend to be less focused on the economical driver as small cost overruns are not considered fatal. PF projects position most of the financial risks with other parties, which makes PF more self-protective to possible planning and cost-overruns. Thus, performing up to the task is very important to the parties involved in PF projects. Moreover, some experts indicated that PF can be subdivided into pre-construction (PrePF) and post-construction (PostPF) project finance. Figure 3 is developed to illustrate the continuum to what extent a project is financed on balance or is project financed.

Experts indicate that the project developers choose a particular structure, which does not imply that a project is, for instance, completely project financed. Experts indicate that PF projects show less innovation than FOB projects and are more focused on the bankability of the project. As mentioned, PF projects are often special purpose vehicles that are highly dependent on the requirements of the different financiers. These financiers are risk averse, which limits the initiative to introduce new methods, approaches or turbines. FOB projects have more opportunities to incorporate these innovations in their project, since they are less dependable on external parties. “The FID for FOB projects already takes place in DG-2. The project team and board make the decision to make all CAPEX available for ITT and immediately continue with commissioning.” This last statement clearly demonstrates the project structure differences and the effect the structure can have on the planning and approach throughout the process.

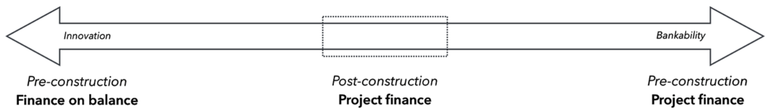
Changes in the Risk and Uncertainties for a Project Finance Structure

In the following discussion we look at the two financing structures and what their impact (decrease or increase) would be on a particular risk or uncertainty. We thereby take the perspective of a normal OWP in which a financing structure is not yet applied. Table 7 depicts the changes of the identified risks and uncertainties with regard to the PF structure. The PF structure has a noticeable increase (+) of risks and uncertainties. A PF project is more insecure at the beginning due to the lack of assets that guarantee

Table 6. Comparison between the two project structures

Finance on Balance	Project Finance
Long-term focused	Short-term focused
Technical and innovation driven	Financial and bankability driven
Complete own financing	High debt rate
Ability to postpone activities	Fast decision making required
In-house developments	External contracting
Bureaucratic	Flexible
Assets are warranty	Independent project company (SPV)
Lean & standardization	High interchangeability of project teams
Dedicated decisions due to backup	Dependent on requirements financiers
Designer-Owner-Operator (DOO) Model	Many contractual partners

Figure 3. Project structure continuum



a warranty. PFs furthermore consist of special purpose vehicles with new stakeholders, which often result in an increased risk for 'late involvement of important parties', 'incompetent project teams' and 'insufficient preparations'.

PF projects are financially driven and are characterized by their fast decision making, which stimulates the information sharing with other parties and results in improved allocation of the risks and contracting. The identified effect of poor interfacing is established as indeterminable, considering that the interviewees stress that PF in some cases contributes to tight interface management. Others indicated that the inexperience resulted in the underestimation of the interfacing, resulting in an increase of the risk. The remaining risks and uncertainties neither increase nor decrease, because they are not dependent on the PF structure.

Changes in the Risk and Uncertainties for a Finance on Balance Structure

Table 8 shows the changes of the identified risks and uncertainties with regard to the FOB structure. The FOB structure compared to the PF structure has a greater effect in (-) reductions of risks and uncertainties. The uncertainties of 'return on investment' and 'ordering long lead items' reduce in the FOB because these firms execute their FID at DG-2, which creates more certainty for the rest of the project. The disadvantages of FOBs are that they are often focused on themselves, resulting in 'late involvement of important parties' and 'poor contracting'. The uncertainties of 'return on investment' and 'ordering long lead items' reduce in the FOB because these firms execute their FID. However, some interviewees

Table 7. The identified changes in the risks and uncertainties for a project finance structure

#	Risk	Effect	#	Uncertainty	Effect
1	Poor interfacing	?	1	Return of investment	+
2	Lack information sharing	-	2	Ordering Long-Lead Items	=
3	Late involvement of important parties	+	3	Government shift	=
4	Long application process permit(s)	=	4	Not allocating all risks	-
5	Insufficient preparations	+	5	Site investigation analysis	=
6	Dependent in obtaining SDE	=	6	Entrepreneurial risk	+
7	Tight scheduling	=	7	Weather conditions	=
8	Poor contracting	-	*risk/uncertainty reduced (-)*		
9	Incompetent project team	+	*risk/uncertainty increased (+)*		
10	No grid connection	=	*risk/uncertainty dissolved (x)* *risk/uncertainty unchanged (=)* *risk/uncertainty indeterminable (?)*		

Table 8. The identified changes in the risks and uncertainties for a finance on balance structure

#	Risk	Effect	#	Uncertainty	Effect
1	Poor interfacing	=	**1**	Return of investment	-
2	Lack information sharing	+	**2**	Ordering Long-Lead Items	-
3	Late involvement of important parties	+	**3**	Government shift	=
4	Long application process permit(s)	=	**4**	Not allocating all risks	=
5	Insufficient preparations	?	**5**	Site investigation analysis	=
6	Dependent in obtaining SDE	=	**6**	Entrepreneurial risk	=
7	Tight scheduling	-	**7**	Weather conditions	=
8	Poor contracting	+	*risk/uncertainty reduced (-)*		
9	Incompetent project team	-	*risk/uncertainty increased (+)* *risk/uncertainty dissolved (x)*		
10	No grid connection	=	*risk/uncertainty unchanged (=)* *risk/uncertainty indeterminable (?)*		

indicated that this is not always the case. The remaining risks and uncertainties are neither expected to increase nor decrease, mainly because they are not dependent on the FOB structure.

Governmental Effect

The framework developed in this research starts with a government decision followed by activities that are highly dependent on the interaction with the government: the location, building permit, EIA, SDE, onshore permit and grid connection. Three of the four elements aforementioned are essential for an OWP. The government is observed as the restraining and stimulating factor at the same time, as they decide on the policies and need for renewable energy. One interviewee claims that “the government provides a starting opportunity for the project. The crux is that the support is also required after FID, since an OWP last seven years on average, and there is a high chance the project then has to deal with a new government.”

This uncertainty reflects the ignorance of the industry on how to approach this: “the government is not straight in its policy.” In the Netherlands for example, a lot is invested in permits that were provided by the government in 2007. However “the government decided to change the rules of the game at full-time (2014), evaporating all the hard work of the parties with the permits.” This behavior is sometimes seen as typical Dutch opportunism in which permits are changed so radically that a number of project developers are discarded after their effort and investments. This influences the decision making of future project developers as investors observe a possibility that the effort and investments can be worthless in an instance.

National Differences

Every country has its own government process, hence the development phase differs per country regarding, for instance, when a project developer gets assigned to a parcel or when the ITT can start. Still, “the basics of the process will be the same in every country, only the sequence differs.” Nevertheless, we only interviewed experts who have experience with especially Dutch OWPs. The experts indicated that the Dutch setting is comparable to other European countries, independent of the national legislation. Still, a successful (start of an) OWP partially depends on the government and its legislation, and if an international corporation initiates the project it is still bound to the rules of the Dutch game. Some of the risks (#4, #6, #10) and uncertainties (#3) relate to the role of the government. But the remaining identified risks and uncertainties impact the OWP, irrespective of the government's role. Therefore the results have significant practical implications.

Parallel or Linear Framework

Another important observation that needs to be discussed is the linear reproduction of the framework. Interviewees stated that "the process is not linear but parallel. All activities in the framework are repetitive, have interdependencies and are not a tick in the box. Also "every aspect mentioned in the framework is almost treated or discussed at the same time. The focus, however, shifts onwards throughout the project." This explains why this process cannot be linear in practice. Although these statements are endorsed in this research, the process is illustrated as a linear process for discussion and analysis purposes.

Puzzle Game

An aspect that contributes to the experienced uncertainty in the planning phase and decision making of an OWP is the so-called 'puzzle game'. It is described as follows: "The project deals with a high level of uncertainty at the start and throughout its process. It is part of a game, because a too dedicated project plan weakens the position of the negotiator and the continuation of the project. Thus, if everyone knows what the project desires they will demand the highest possible price because the continuation of the project depends on it." It is a big puzzle in which every party has a piece and the entire puzzle only falls into place just before the FID. Such a setting resembles a non-cooperative game, in the sense that information is held privately, and decisions are made relatively simultaneously and non-cooperatively. The dependency clearly illustrates that altering things after FID is extremely difficult as everything is set and cannot be changed. This remark stresses the essence of the framework which can provide the industry with a clear overview of the planning process.

Lessons Learned

The scope of this research is the planning of an OWP until FID has been achieved. However as has already been illustrated the entire project ultimately lasts until decommissioning. "A couple years after installation, firms often look back on the project and assess whether the things went as planned. From this they acquire lessons learned." It is important to note that it takes approximately ten years between the first and the last DG (Brockmann, 2009), which creates the possibility that another project already started, and the same mistakes are made again. A frequent argument of the experts is that there are guidelines written about project planning, decisions and developments. However, these handbooks are for internal use by the respective firms, and this contributes to the second identified risk: lack of information sharing.

Relevance of the Framework

A number of experts discussed that the OWP process is equal to a road construction project. Observations indicate that the framework is to a large extent suitable in practice for megaprojects. Compared to megaprojects from governments, the budget and time overruns of an OWP are highly visible. In OWPs there is just one project manager who either makes a profit or suffers losses and operates in slim margins. This is also frequently the case for megaprojects in general. However the effects and consequences are more hidden since they often consist of multiple project leaders who only contribute their part, and are not responsible for the entire project.

CONCLUSION

This research investigated the risks and uncertainties in the planning phase of an OWP. Current literature regarding OWPs is focused on the costs and quality aspects of a project and lacks research into the planning and decision making aspect. First a framework was developed to gain an overview of the process for an OWP, which could be used to identify the risks and uncertainties with regard to planning and decision making. This research determined that due to the novelty of the industry, a number of risks and uncertainties are the most prevalent. Novelty results in inexperience and repetitive underestimation of a megaproject like OWPs, and results in at least ten identified risks for overruns in a project. Additionally, the novelty creates an underlying skepticism and hesitation towards the initiation of an OWP as a result of the experienced uncertainty. The high dependency on the government contributes to skepticism and hesitation, since the project requires the four basic elements of an OWP (SDE, permits, grid connection and location) from the government.

Since the legislation per country differs, the influence of a government on the planning process of an OWP is significant. This results in a high variety of duration and prevalence of the process, creating interesting and less interesting countries to initiate OWPs. The project structure has been identified and discussed as an element that influences the approach and continuation of an OWP. A project can either obtain a FOB or a PF structure, with the main difference being that the project is financed by equity of the respective firm or otherwise financed mainly (70%) with debt. The latter is highly dependent on the requirement of external parties and financiers that need to be incorporated in the project, whereas the former can determine their course throughout the project. Hence, a lot can be gained in the planning process of an OWP related to the reduction of the risks and uncertainties, and improved decision making and understanding of affiliated elements and procedures.

Limitations

This research only addressed Dutch interviewees. Despite some experts having additionally international market knowledge, this research needs to acknowledge this limitation. Further research is required by performing more Delphi rounds, as the third and fourth iteration is required for the Delphi-technique to achieve international consensus (Custer, Scarcella & Stewart, 1999). Future research should take up the third round and interview a variety of international OWP experts as they can contribute to insights on the risks and uncertainties. With the fourth round we recommend to interview experts who have experience with different sorts of megaprojects (e.g., bridges or tunnels), to eventually improve generalizability of the framework. Also, with objective data of, for instance, cost overruns of different OWPs and other quantitative data, the findings can further be validated. Another limitation of this research is the linear representation of the framework. Further research is required to investigate the planning process in more detail to eventually develop a standard roll-out for an OWP that possible integrates parallel processes and could reduce costs, as indicated by Junginger et al. (2004).

Theoretical Implications

The theoretical implication of this research is that the identified risks and uncertainties, related to the performance of a project, can be identified and translated into critical success factors for an OWP. Hence, further research is needed to quantify the identified risks and uncertainties and their probability, and link this to the likelihood of success in the development of OWPs. As mentioned, a project needs to meet its three internal performance measures: costs, time and quality. This research focused on the timing aspect until FID. Since this research has only indirectly considered cost, further research on the interrelation between the performance dimensions could improve the overall optimization of OWPs. “In an OWP there is a constant optimization between the cost and the costs associated with stretching the planning.” Further research is suggested to improve the overall performance of an OWP and gain better insights into the question when project developers can postpone activities and when project costs become too determinant for the overall performance.

At a general level, this exploratory research can be considered as a first step towards theoretical understanding of how the complexities of OWPs may be approached. At the same time, as our interviewees considered the framework as being applicable for our settings as well, it is safe to conclude that our work can also advance megaprojects research in general.

Practical Implications

Throughout the research, interviewees indicated that the tasks and activities were known, while the sequence and duration were not. The framework allows stakeholders in offshore wind to gain a better overview of the planning and decision making for an OWP. Improving the preparation of OWPs and additionally make the stakeholders aware of the most common risks and uncertainties. The framework aims to reduce the experienced uncertainty in OWPs. The framework can eventually contribute to the successful completion of more, longer and complicated megaprojects. During the process, this research has identified that the planning process differs per country due to the government and its legislation. The framework can still be applied to every initiated OWP after adjusting activities and sequences to its national legislation. Interested stakeholders, developers and contractors can use this framework to anticipate on future changes and determine their position in the process of an OWP. At a more general level, the practical implications for, for instance, installation- and electricity companies could be:

1. To get involved as early and quickly as possible in the decision making to make sure everything is thought of, and
2. Create an environment in which information and knowledge is shared to gain insights faster and better.

REFERENCES

Adler, P. (1995). Interdepartmental interdependence and coordination: The case of the design/manufacturing interface. *Organization Science*, *6*(2), 147–167. doi:10.1287/orsc.6.2.147

Akkermans, H. A., Bogerd, P., Yücesan, E., & van Wassenhove, L. N. (2003). The impact of ERP on supply chain management: Exploratory findings from a European Delphi study. *European Journal of Operational Research*, *146*(2), 284–301. doi:10.1016/S0377-2217(02)00550-7

Alessandri, T. M., Ford, D. N., Lander, D. M., Leggio, K. B., & Taylor, M. (2004). Managing risk and uncertainty in complex capital projects. *The Quarterly Review of Economics and Finance*, *44*(5), 751–767. doi:10.1016/j.qref.2004.05.010

Bilgili, M., Yasar, A. & Simsek, E. (2010). Offshore wind power development in Europe and its comparison with onshore counterpart. *Renewable and Sustainable Energy Reviews,* 15(2011), 905-915.

Brockmann, C. (2009). *Mega-projects: getting the job done.* LEAD Conference 2009.

Brugaard Villmo, H. (2012). *Planning and management of megaprojects. Industrial Economics and Technology Management*. Norwegian University of Science and Technology.

Cooke-Davies, T. (2002). The "real" success factors on projects. *International Journal of Project Management*, *20*(3), 185–190. doi:10.1016/S0263-7863(01)00067-9

Custer, R. L., Scarcella, J. A., & Stewart, B. R. (1999). The modified Delphi technique: A rotational modification. *Journal of Vocational and Technical Education*, *15*(2), 1–10.

Duncan, G. L., & Gorsha, R. A. (1983). Project management: A major factor in project success. *IEEE Transactions on Power Apparatus and Systems*, *102*(11), 3701–3705. doi:10.1109/TPAS.1983.317755

Dvir, D., Raz, T., & Shenhar, A. J. (2003). An empirical analysis of the relationship between project planning and project success. *International Journal of Project Management*, *21*(2), 89–95. doi:10.1016/S0263-7863(02)00012-1

Edwards, I. (2011). *Overcoming challenges for the offshore wind industry and learning from the oil and gas industry*. Report from POWER cluster, natural power and the Interreg IVB North Sea Region Programme.

Emans, B. (2002). *Interviewen: theorie, techniek en training* (4th ed.). Groningen: Stenfert Kroese.

Eurobserver. (2014). *Wind energy barometer.*

EWEA. (2009). *Wind at Work: Wind energy and job creating in the EU.*

EWEA. (2011). *Wind in our Sails: the coming of Europe's offshore wind energy industry report.*

Flyvbjerg, B. (2009). Survival of the unfittest: Why the worst infrastructure gets built and what we can do about it. *Oxford Review of Economic Policy*, *25*(3), 344–367. doi:10.1093/oxrep/grp024

Flyvbjerg, B. (2011). Over budget, over time, over and over again: managing major projects. In Morris, P.W.G., Pinto, J.K. & Söderlund, J. (2011) The Oxford Handbook of Project Management (321–344). Oxford: Oxford University Press. doi:10.1093/oxfordhb/9780199563142.003.0014

Flyvbjerg, B., Bruzelius, N., & Rothengatter, W. (2003). *Megaprojects and risk: an anatomy of ambition*. Cambridge: Cambridge University Press. doi:10.1017/CBO9781107050891

Gerdes, G., Tiedemann, A. & Zeelenberg, S. (2005). *Case study: European offshore wind farms a survey for the analysis of the experiences and lessons learnt by developers of offshore wind farms - final report.* Report.

Giezen, M. (2012). Keeping it simple? A case study into the advantage and disadvantages of reducing complexity in megaproject planning. *International Journal of Project Management*, *30*(7), 781–790. doi:10.1016/j.ijproman.2012.01.010

Handfield, R. B., & Melnyk, S. A. (1998). The scientific theory-building process: A premier using the case of TQM. *Journal of Operations Management*, *16*(4), 312–339. doi:10.1016/S0272-6963(98)00017-5

Hsu, C.-C., & Sandford, B. A. (2007). The Delphi Technique: Making Sense of Consensus. *Practical Assessment, Research & Evaluation*, *12*(10), 1–8.

Hubbard, D. (2007). *How to measure anything: finding the value of intangibles in business*. Hoboken, NJ: Wiley.

Johansen, E., & Wilson, B. (2006). Investigating first planning in construction. *Construction Management and Economics*, *24*(December), 1305–1314. doi:10.1080/01446190600863160

Johnson, J., Karen, D., Boucher, K. C., & Robinson, J. (2001). *Collaborating on project success. Software Magazine*. February/March.

Junginger, M., Faaij, A., & Turkenburg, W. C. (2004). Cost reduction prospects for offshore wind farms. *Wind Engineering*, *28*(1), 97–118. doi:10.1260/0309524041210847

Karlsson, C. (2009). *Researching Operations Management*. New York: Routledge.

Kezner, H. (2009). *Project Management: a system approach to planning, scheduling, and controlling* (10th ed.). New York: John Wiley & Sons.

Koch, C. (2012). Contested overruns and performance of offshore wind power plants. *Construction Management and Economics*, *30*(August), 609–622. doi:10.1080/01446193.2012.687830

Lechler, T. G., Edington, B. H., & Gao, T. (2012). Challenging classic project management: Turning project uncertainties into business opportunities. *Project Management Journal*, *43*(6), 59–69. doi:10.1002/pmj.21304

Loch, C. H., DeMeyer, A., & Pich, M. T. (2006). *Managing the unknown: a new approach to managing high uncertainty and risk in projects*. New York: John Wiley & Sons. doi:10.1002/9780470172377

Loch, C.H. & Pich, M.T. (2002). Managing project uncertainty: from variation to chaos. *MIT Sloan Management Review,* Winter, 60-67.

Lopez del Puerto, C., & Shane, J. S. (2014). Keys to success in megaproject management in Mexico and the United States: Case study. *Journal of Construction Engineering and Management*, *40*(4), 1–7.

Megavind. (2010), *Denmark - Supplier of Competitive Offshore Wind Solutions report*.

Neill, J. (2007). *Delphi study: research by iterative, consultative inquiry.* Retrieved from available at http://www.wilderdom.com/delphi.html

PM Network (2014). Standardised project management practices = success. *PMI Today,* April(2014), 8-9.

NOAA. (2014). *Coastal ecosystem restoration: risk and uncertainty in environmental restoration programs*, Retrieved from http://coast.noaa.gov/archived/coastal/economics/riskinrest.htm?redirect=301ocm

PMI. (2014). *What is project management.* Retrieved from http://www.pmi.org/About-Us/About-Us-What-is-Project-Management.aspx

Priemus, H., Flyvbjerg, B., & van Wee, B. (2008). *Decision-making on mega-projects: cost–benefit analysis, planning and innovation*. Cheltenham: Edward Elgar. doi:10.4337/9781848440173

Puddicombe, M. S. (2006). The limitations of planning: The importance of learning. *Journal of Construction Engineering and Management*, *132*(9), 949–955. doi:10.1061/(ASCE)0733-9364(2006)132:9(949)

Thi, C. H., & Swierczek, F. W. (2010). Critical success factors in project management: Implication from Vietnam. *Asia Pacific Business Review*, *16*(4), 567–589. doi:10.1080/13602380903322957

van Kuijk, G. (2013), *P13-13 EUROS – Excellence in Uncertainty Reduction of Offshore wind Systems.* Retrieved from http://www.stw.nl/nl/content/p13-13-euros-%E2%80%93-excellence-uncertainty-reduction-offshore-wind- systems

Whittaker, B. (1999). What went wrong? Unsuccessful information technology projects. *Information Management & Computer Security*, *7*(1), 23–29. doi:10.1108/09685229910255160

Zwikael, O., & Globerson, S. (2006). Benchmarking of project planning and success in selected industries. *Benchmarking*. *International Journal (Toronto, Ont.)*, *13*(6), 688–700.

Zwikael, O., Pathak, R. D., Singh, G., & Ahmed, S. (2014). The moderating effect of risk on the relationship between planning and success. *International Journal of Project Management*, *32*(3), 435–441. doi:10.1016/j.ijproman.2013.07.002

Zwikael, O., & Sadeh, A. (2007). Planning effort as an effective risk management tool. *Journal of Operations Management*, *25*(4), 755–767. doi:10.1016/j.jom.2006.12.001

KEY TERMS AND DEFINITIONS

Delphi Technique: A consensus-building method that consist of four rounds in which data is collected from a selected group of specialists via their judgements. After each round the findings and opinions are summarized to identify certain elements and are then input for discussion for the next round.

Finance on Balance: This is a project funded with equity of the executing party. It often concerns major utility companies, venture capitalists or private equity firms.

Financial Investment Decision: The moment all participating parties come together and agree on the amount of money that is going to be invested in the project. Prior to this moment a.o. lawyers, accountants of the different parties identified and checked whether the involved parties have a good track record.

Megaprojects: A big project that costs more than one hundred million dollars and contains a lot of complexity regarding the interfacing, planning, decision making and non-standard technologies. Megaprojects often are linked to big construction projects for building, e.g., bridges.

Offshore Wind Projects (OWPs): An offshore wind project is the installation of a group of wind turbines far out of sea. Offshore Wind Projects are complex since they are not onshore, which results in high costs for installation, maintenance and decommissioning.

Project Finance: This is a project structure in which the executing party does not have sufficient equity to fund the entire project. Via financial institutions, private investors or SMEs they assemble a loan or a share in the project.

Project Management: The process in a project that consists of planning, organizing, directing and controlling the resources of the project to deal with the complexity of a project. The main constraints of project management are time, costs and quality.

Risks: Risks in a project are uncertainties that a recognized factors that may influence your project plan. By assessing the impact and probability of the risk, risks can be prepared for and safety-measures can be taken.

Uncertainties: Are elements in the project that no one is completely sure about and it is hard to guess if it will occur. Uncertainties are inevitable regardless of the amount of information gathered, since they include elements that are unknowable.