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A RISK MANAGEMENT STRATEGY FOR EFFECTIVE PLANNING AND BUDGETING FOR NEW BUILD NUCLEAR POWER PLANT CONSTRUCTION: RESEARCH METHODOLOGY AND IMPLEMENTATION OF THE OLKILUOTO 3 PROJECT

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The purpose of this thesis was to understand the delicate concept of project success and the factors which contribute to it. Nuclear new build industry faces tremendous challenges to make the construction of new power plant accepted by the people and the politics. Public acceptance after Fukushima disaster is more than ever a necessity to undertake successfully such major construction. As well, the question of nuclear wastes will involve generation and generation of people and therefore add costs and uncertainties. A construction of a new nuclear power plant faces a lot of uncertainty due to technical complexity and many other factors. Among those factors, certainly managerial factors contribute to success or non-success of the project. All these factors constitute risks for the project. Without any doubts, risks are actually not new for the nuclear industry. More than any other industry, the nuclear industry has gained an extraordinary level of knowledge of their operating risks such as seismic risk or core melt risk. However, the researcher built this research based on a previous research finding, that there is a correlation between risk management and project success during the project phase. Firstly the research attempted to define metrics to measure the project success. Based on previous research, the researcher identified that six project metrics was to be measured in order to grade the project success. The research conducted was a case study of Olkiluoto 3. The research used a quantitative survey to determine first the project success rate and secondly to estimate the level of risk of identified managerial factors. The researcher identified six managerial factors which can influence the project success if not managed. The research aimed to estimate the probability of residual risk after mitigation by estimating the actual level of likelihood of occurrence and by estimating the actual level of significance. The research found first that the project success was found moderate. The research found that there is no statistical correlation between managers and non-managers in the perception of the project success. Lastly the research found that the actual level of risks is very high. This showed that mitigation measures were not sufficient.

CONTENTS

1 INTRODUCTION

Why projects fail? Or simply why projects are not successful? And what cause them to not achieve their goals?

Late 2003, the Consortium AREVA-SIEMENS and TVO signed a turn-key contract for construction of the biggest industry project in Finland. The project was to build a generation III+ nuclear power plant. This was the fifth reactor to be built in Finland. In 2005, the construction started for an initial completion scheduled for 2009.

In 2015, the project is not yet finished and there is an on-going arbitration for several billions euros claim. In other words, the initial budget has doubled hitting eight billion euros and the estimated end of completion for 2016, which makes around eleven years of construction. However, this is not clearly evident without any tangible data to state a prima facie that such a project is a total failure. The research aimed to determine a true project success measure for the Olkiluoto 3 project by using a quantitative research and aimed to display the managerial factors which influenced the project success.

This research project is made for the company Dekra Industrial Oy the author is working for as of this writing. Jérôme Desavelle has indeed gained eight years' experience on Olkiluoto 3 project working for inspection organizations, which justify the need to deepen the managerial understanding and cross-cultural aspect of such projects.

Dekra Industrial Oy is one of the three approved Inspection Organization. It does a conformity assessment on nuclear pressure equipment according to nuclear regulations. Dekra Industrial Oy is part of Dekra SE which head office is based in Stuggart in Germany. The company is operating worldwide with around thirty thousand employees.

The conceptual understanding of project success is still in its early days (Shenhar, Tishler, Dvir, Lipovetsky & Lechler 2002, 111).

The criteria or metrics to measure project success are various. Budget and time schedule are obvious indicators but this is admitted by previous research that this is too a narrow view. First it is important to agree on what project success means. The theoretical part will attempt to review the objective and subjective project success criteria. The literature review will complete the traditional view to see project suc-

cess through the prism of budget, schedule and achieving a reasonable level of performance.

The research will also take into account the fact the projects differs from each other. Their nature is different. Their goals and stakeholders are different. Thus, there is not a single applicable framework and a unique set of techniques for project management and this certainly contributes to not have successful projects. Furthermore, complex and global projects are exposed to high-risk and uncertainty. These particularities will part of our framework research to explain why residual risks must be evaluated before and during the project.

The project research sought contributing to explain the non-successful of large cutting edge industrial projects. The expected outcome of the research project is to display a project management strategy based on a risk management framework.

To summarize the thesis' goals, the focus was to research the phenomena affecting such project and the impact on inspection organizations services. Otherwise stated, the research objectives were:

- To identify the possible sources of failures of large project implementation.
- To determine if the different managerial factors give positive or negative influence to planning and budgeting

The case of the particular socio-cultural factor which has been pointed out by the media will be discussed in the light of the results obtained.

Meeting the first of our research questions begins with a survey to measure the project success.

The second part of the project will be to display the most important factors which influenced this non-success. This will constitute the actual level risk.

After mitigating the risks, will remain residual risks factors. I will identify the gravity and the likelihood by qualitative risk analysis using a risk mapping.

To answer the research objectives, I will propose a factor of correction to be used in budget preparation as bad debt.

In the light of what I just introduced I shall try to reformulate the research questions, with which I started this introduction and for which the thesis will attempt to answer:

- How effective planning and budgeting contributes to success of large projects?

- Can the socio-cultural environment (i.e. complex project network) explain the difficulties of planning and budgeting? As said before, this is an attempt to answer a particular factor, but is it the only one?

To conclude the objectives, I formulate the hypothesis that the managers and the non-managers have a different perception on the project success. The second hypothesis is that the residual risks were underestimated and has contributed to have to project failed. The assumption is made by the researcher that the managerial factors contribute the most to a project success.

2 ROAD MAP: OUTLINE OF THE THESIS

In order for the reader to understand this thesis, the author proposes here to give the red line of the story and offers a road map to help the reader to navigate into the chapters. To reformulate in a more comprehensive way the purpose of the thesis, the goal was to:

i: Understand the main difficulties encountered in Olkiluoto 3 project
ii: Before any treatment, make the diagnostic: Is it a total failure? Is it half-success?
iii. Understand the implication of the socio-cultural factor. And is it the only one?
iv: Propose the managers to recognize the potential financial losses; quantify it and incorporate it into their budgets

The research does not deal with the different costs of construction of such project. They were estimated during the bidding phase. The costs due to project implementation which were not seen will eventually appear via the managerial functions. The research tries to observe them through this prim. It is clear that all the costs cannot be seen. They can only be estimated.
The roadmap depicted below in the figure 1 has four steps.

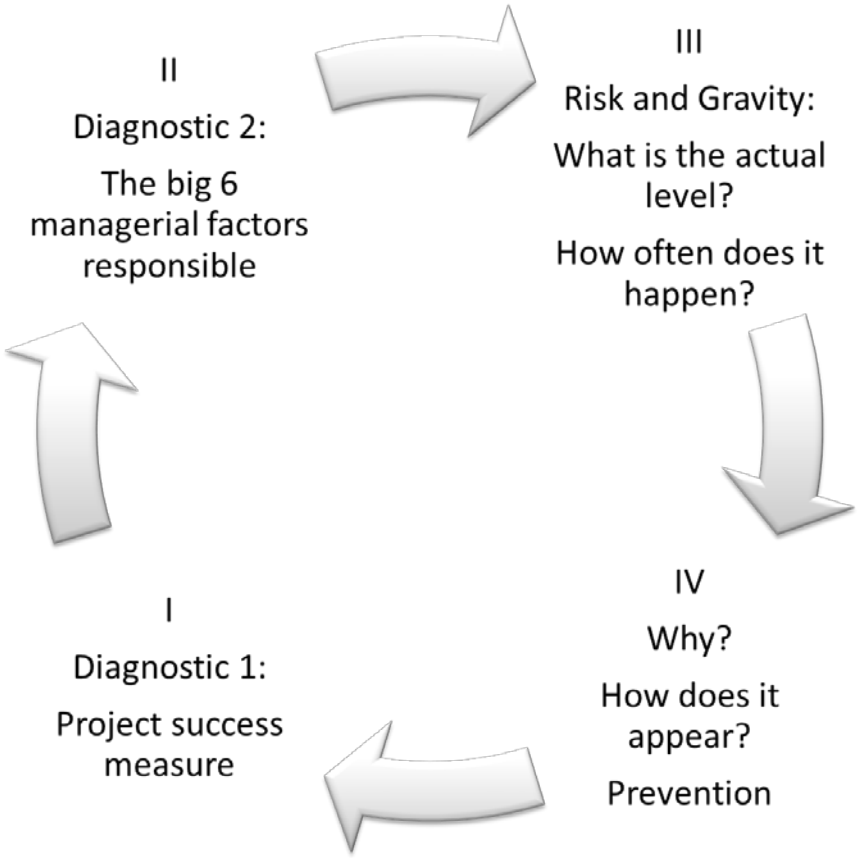

Figure 1. The thesis roadmap (Desavelle 2015)

Phase I

This phase will give an attempt to measure truly the perception of the project success. Guessing is not enough. The research needed to measure it thanks to practical metrics. For that, previous research will help to define six metrics.

Time; Budget; Project efficiency; Business Success; Future potential and Performance

Phase II

The researcher will consider 6 big managerial group through which the costs will appear. Their nature is:

Socio-cultural; Economical; Political/Legal/Technological/Environmental; Network governance; Ethical and Communication

Phase III

The researcher will ask a sample to say how important those factors are. Are they important? How often do they appear?

Phase IV

This phase will give some models to see how this works.

The best examples are to represent the managerial factors like color balls. Red for the socio-cultural, blue for the economical, etc…

All the balls are in a box. During the projects, all the parties do their work and interact normally. The box is constantly with the parties. This illustrates the probability of the risks to occur. An invisible hand picks a ball every now and then (the mitigation procedures affects how often the hand pick a ball). Once a ball appears, the risk occurs and there is a failure. It can be minor or it can be catastrophic (that is the severity rate).

A simple model:

The invisible hand picks one ball: the factor occurs – **failure**.

A more elaborated model (the Benoulli process):

The invisible hand picks one ball, put it back. Picks one more ball, etc….

This is how I try to explain how the factors can be combined to cause a failure. This is unknown and need further research. How many factors need to be combined to cause a failure? It can be one, or two, or three…

Last model (the conditional probability)

Here the model proposes to say that once a ball is picked up, it affects the chance for another ball to be picked up.

This model is more realistic. In practice, it is possible that say the socio-cultural factor occurs, the economical factor occurs more easily and the two combined cause a failure.

Again, further research is needed to observe the statistical relationship between them.

To conclude, the managers can estimate a potential financial loss and include an estimate as doubtful debts in their budget.

3 CONCEPTUAL FRAMEWORK

3.1 Generalities

The central idea of the research framework is built around the fact that research has shown that there is a correlation between risk management and project success (Raz, Shenhar, & Dvir 2002, 107).

Besides, strategy is a key area in project management just like it is for driving a company. Strategy is defined as a set of planned actions in order to achieve some desired objectives. The research will take a particular angle through a risk management framework. Projects differ from each other due to very unique nature. As any human breakthrough, no one can avoid risks even in most regulated industry, the nuclear industry. This is the very nature of our technological progress. This fact is also acknowledged in the introduction of the ISO standard for risk management. All activities of an organization involve risk (ISO, ISO 31000 - Risk management. Principles and guidelines, 2009, 7).

Project risks are defined (Raz, Shenhar, & Dvir 2002, 101) as undesired events that may cause delays, excessive spending, unsatisfactory project results safety or environmental hazards, and even total failure.

However, if this is clear that a part of risk cannot be avoided, it is also clear that everything must be done to minimize or mitigate the risks.

3.2 Project management

Just like management, project management can be seen as complex set of integrated management function, that usually are planning, control, reporting, communication, and conflicts resolution.

The guide to the project management Body of Knowledge offers the following definition:

Project management is the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements (PMI 2008).

The research aims to discover what managerial functions make the project fail, or potentially fail. There are certainly a lot of factors involved. One of the first aspects to be considered in project management is planning.

Planning is considered as an essential part of project management. This factor will be tested in the questionnaire. The first question is, does the project meet initial schedule? In fact, poor planning is a great risk for the project. This seems obvious, but this can be remained here, that complex projects need accurate planning. The questionnaire also tested the planning milestones. Essentially, long projects are driven by intermediate points to reach. Besides, a common mistake would be to think that all projects are the same and can be managed with the same processes. As a matter of fact, previous research in project management demonstrated that there is no one framework applicable for all projects. Besides, organizations must recognize that projects can be seen as ‘’temporary organizations with organizations’’ (Shenhar, Dvir, Milosevic, Mulenburg, Jerry, & et al. 2005, 2). Now, the project management body of knowledge (PMBOK) philosophy one-fits-for-all approach is certainly not adapted.

Global project are unique and have their own characteristics.

What is a global project then?

Scott (2012, 27-135) defines a global project as a temporary endeavor where multiple actors seek to optimize outcomes by combining resources from multiple sites, organizations, cultures, and geographies through a combination of contractual, hierarchical, and network-based modes of organization.

Besides, what seem important for success are collaboration, transparency and network-based approach. This will be grouped in ethical factors where trust appeared to be playing an important role within project actors.

As introduced earlier, the classical approach of project management is mainly process-oriented with classical management approach which contains:

- Budgeting
- Planning
- Execution
- Control
- Efficiency
- Hit budget goals

Again, it seems that further characteristics of project management need to be considered. This is idea is supported by research which suggests us that due to complexity, global project nature more features shall be taken into account. For instance it must include as we have already discussed before, a strategic thinking as seeing, a risk management strategy, a network-based approach, a human side understanding, a dynamic environment view, and integrate the rapid changes in technology

It goes without saying that tasks or work coordination implies communication. Communication is the most natural feature of human beings yet it remains a source of conflicts and failure in many projects; especially in cross-cultural projects. That's precisely the reason why the research has tried to also focus on evaluating the impact of communication for the perceived non-success of the project. As an example, the respondents were asked to rate the influence of the communication on project success. The question asked was:

''Communication of information between project actors have a great influence on the overall project success''

The reader will find the complete questionnaires in the appendixes.

According to Project Management Body of Knowledge (PMBOK), a project communication management plan shall contain (Aarseth, Rolstadås & Andersen 2014, 109):

- Identify stakeholders
- Plan communication with stakeholders
- Distribute information
- Manage stakeholders' expectations
- Report performance

Communication is complex phenomena among human beings. To introduce briefly the communication process, we will display an eight-step simplified model (Bovée & Thill 2010, 39).

1. Sender has an idea
2. Sender encodes the idea in a message

3. Sender produces the message in a medium
4. Sender transmits message through a channel
5. Audience receives the message
6. Audience decodes the message
7. Audience responds to the message
8. Audience provides feedback to the sender

Clearly part of project management, communicating the difficulties but also the achievements are important.
In project communication, a project manager or a risk manager will pay attention to cultural differences, avoid the filters which pollute messages. He will rephrase the messages if necessary, check frequently for comprehension and clarify the actions.
The language barrier constitutes a well understood filter in the communication process. The messages are subject to interpretation, they are not well understood. This causes high level of high in such project. The requirements may be not well understood and may cause additional delays and additional costs. The way of writing official letters, but most importantly the unofficial emails can cause miscommunication issues. Low-context culture values much the written form. They consider the written form binding agreement. Finland for example can be considered at least a lower-context culture than France. Therefore, for low-context culture, people emphasizes more explicit instructions and expected actions.
This supports the hypothesis that communication is essential in bringing project to success.

Risk management is also part of the project management function which contributes to bring the objectives attained. This will constitute the main driver of the research.
One of the eight areas of PMI Project Management Body of Knowledge (PMBOK) is in fact risk management.

3.3 Risk management framework

3.3.1 Definitions

Identify and manage the risks

Risks are broadly defined as possibility or probability of damages. They are undesired events that cause delays, excessive spending and poor performance.
As an example, cultural differences may increase the operational risks.

As an example, risk management is confronting to cultural differences. Another important definition is risk aversion; or the level what company are able to cope with depends on company culture. Ethics and moral reasoning are for instance part of risks aversion. Moral reasoning is deeply rooted into cultural, religious, and historical beliefs. Therefore, some culture may have different approach on what the moral tolerate or not.
Culture is a dynamic process and plays a greater role in social-relationships that we might even think. In a global project such as Olkiluoto 3, the implication of cultural clashes does affect the project efficiency. In fact, culture affects the understanding of the meaning of trust. Hence, this makes it very complex to manage in an orderly manner.
Even though, it seems clear to all persons that unacceptable risks are dreadful, immoral and catastrophic, a minority may disagree in some details.
According to the OECD, in some countries the levels of individual risks above 10-4 per year are considered unacceptable for voluntary risks (i.e. risks to workers or workplace risks). Risks above 10-5 per year are unacceptable for involuntary risks (Arben 2006, 29). This shows that risk is strongly shaped by human minds and cultures (HSE 2001) (Arben 2006, 40).

Another definition important to underline is the risk tolerance.
The public risk tolerance is a function of different factors including the perception of risk, judgments, aversion, willingness and benefits (Arben 2006, 40).

There are several definitions for risks. It can be first defined broadly as an exposure to losses in a project (Ahmed, Kayis, & Amornsawadwatana 2007, 23). Risks are linked to uncertainties. They may have one or several causes. As well the consequences are deviations from planned events. Deviations may include additional costs, additional delays, occupational accidents or loss of performance.
Therefore, we see that risks are dynamics. They evaluate along the project life. They must re-assessed during the project.

3.3.2 An approach towards residual risks

The risk assessment:

A risk assessment is the process of risk analysis and risk evaluation. (Arben 2006, 16).
A risk management framework is a process which includes risk assessment, risk characterization, risk communication, and risk policy making. (Arben 2006, 16). Of course, this is not only limited to that. A risk analysis is the use of quantitative and qualitative techniques based on engineering and mathematical techniques (Arben 2006, 16). It is used to quantify the level of risk to analyze it.

As just seen, a more complete view would be to see risk management as a formal process for managing risks. It consists of system definition, hazard identification, identification of accident scenarios, quantification of probabilities and consequences, assessment of risk, identification of risk control options, and decision on implementation, identification and management of residual risk (Arben 2006, 16).
Risk analysis identifies probability of achievement and identification of remaining uncertainties.

Prior to risk analysis, the risks must be sought and identified. Risk identification techniques may use checklists, cause and effect analyses, influence diagrams, and hazard and operability studies.

Now this seems reasonable to think that considering the identified risks, a project team need to handle the risks. Project managers and senior executives need to find an adequate response. The notion of risk mitigation is here introduced. The suitable response for each risk should be specified and recorded in a risk register (Bowers & Khorakian 2014, 30).

Risk has been defined as a measure of the probability, the severity, and the exposure of all hazards of an activity (Jannadi & Almishari 2003, 492-500). This proves the research methodology to evaluate the managerial factors as a probability. A probability is defined simply as a chance that something will happen. The probability concept is very powerful approach for theorizing the behavior of natural phenomena. It tells that the forces or phenomena have a chance to appear and play a role or not.
A situation where it is not possible to attach a probability of occurrence to an event is defined as uncertainty (Ahmed, Kayis, & Amornsawadwatana 2007, 23). While uncertainty is not measurable, it can be estimated through subjective assessment techniques (Ahmed, Kayis, & Amornsawadwatana 2007, 23). It is defined as the overall process of risk identification, risk analysis and risk evaluation (ISO, ISO 31000 - Risk management. Principles and guidelines, 2009, 17).

The risk analysis:

Traditionally risk factors analysis has two techniques:

- Qualitative (often sufficient, relies on human judgment), risk mapping, ETA (event tree analysis), FMEA (failure mode and effect analysis)
- Quantitative (more rigorous but requires large amount of data, estimate uncertainties) Monte Carlo simulation

Risk analysis is a process where risks are examined in details. Qualitative or quantitative method can be used.
The main stages of risk analysis are:

- Preparation for analysis
- Risk analysis process
- Conclusions and recommendations

(Arben 2006, 20)

The risk analysis phase should identify the hazards; analyze the degree of exposure and the consequences through severity rates.
Detailed analysis is based on two parameters:

- Probability
- Impact

Risk analysis techniques allow estimating the likelihood and risk gravity.
Risks can be graded and ranked.
The risk response:

The consequences of the risks must be weighed against mitigating measures. A notion of risk acceptance threshold is set. Risk management seeks for criteria for risk acceptance. Generally the threshold value may be set around the boundaries of ALARP (As Low As Reasonably Practicable) region.

The residual risks must be however monitored and not to be considered as non-relevant. Along the project life, additional measures can be taken decreasing the level of risks lower and lower.
A risk manager or a project management usually uses four main strategies in order to manage the risk response. Arben (2006, 42) describes the four strategies as (1) Avoid, (2) Reduce, (3) Transfer, or (4) Accept.

We will therefore define the principle of mitigation rate by the risk management strategies offered by Arben (2006, 49) and also by referring to ISO 31000:2009 guidelines. Mitigation measures contain, reduce likelihood, reduce consequences, avoid the risk, remove the risk source, share or transfer the risk with another party or retain the risk by informed decision (accept). This is in fact a central idea in the research. The level of actual of risk is the purpose of the research. The mitigation measures if not at reasonable level will let the risk threshold too high.

The risk framework:

To go back to the risk management definition, which is a formal and orderly process of systematically identifying, analyzing, and responding to risks throughout the life-cycle of a project to obtain the optimum degree of risk elimination, mitigation and/or

control (Wang et al. 2004, 238), I have chosen for the research to follow in particular a main methodology consisting of a risk management framework, focus on the idea that a part of risk will always remain. Indeed, despite the effort to give a unified view of project management, projects are in fact all different (Dvir, Sadeh, & Malach-Pines 2006, 36-48). Also, the willingness to take risks is different for every project stakeholders. West and Prendergast (2008, 1458) write that managers and owners have different risks preference. This supports my hypothesis that the risks were underestimated.
To better quantify the residual risks can help to manage the large projects. The methodology has been further described in the figure 2.

Project manager's target is to bring to project completion on time, on budget and within the requirements. It has already been identified that planning is an essential task in project management. As well, planning has also been used as fundamental measure as supported by Project Management Body of Knowledge.

Planning reduces uncertainty and increase chances of success (Divr, Raz, & Shenhar 2003, 94).
Now, it is also recognized by risk management is part of project management.
Despite the energy spent in planning and all the effort to eliminate the risks, a part of residual risk is inevitable to every project.
However it seems that even large project with high uncertainty risk management practices are often left aside. Complex projects are indeed exposed to uncertainty, high risk and imperfect information (Lau & Rowlinson 2011, 633).

Previous research shows that there is a high correlation between risk management and success of high technological project (Raz, Shenhar, & Dvir 2002, 107).

I have therefore based this framework on the Shenhar and Dvir's framework – technological uncertainty and complexity, and considered the managerial factors which made the project deviate from success. As the research will show this, the managerial factors are derived from Porter's forces in competitive strategy.

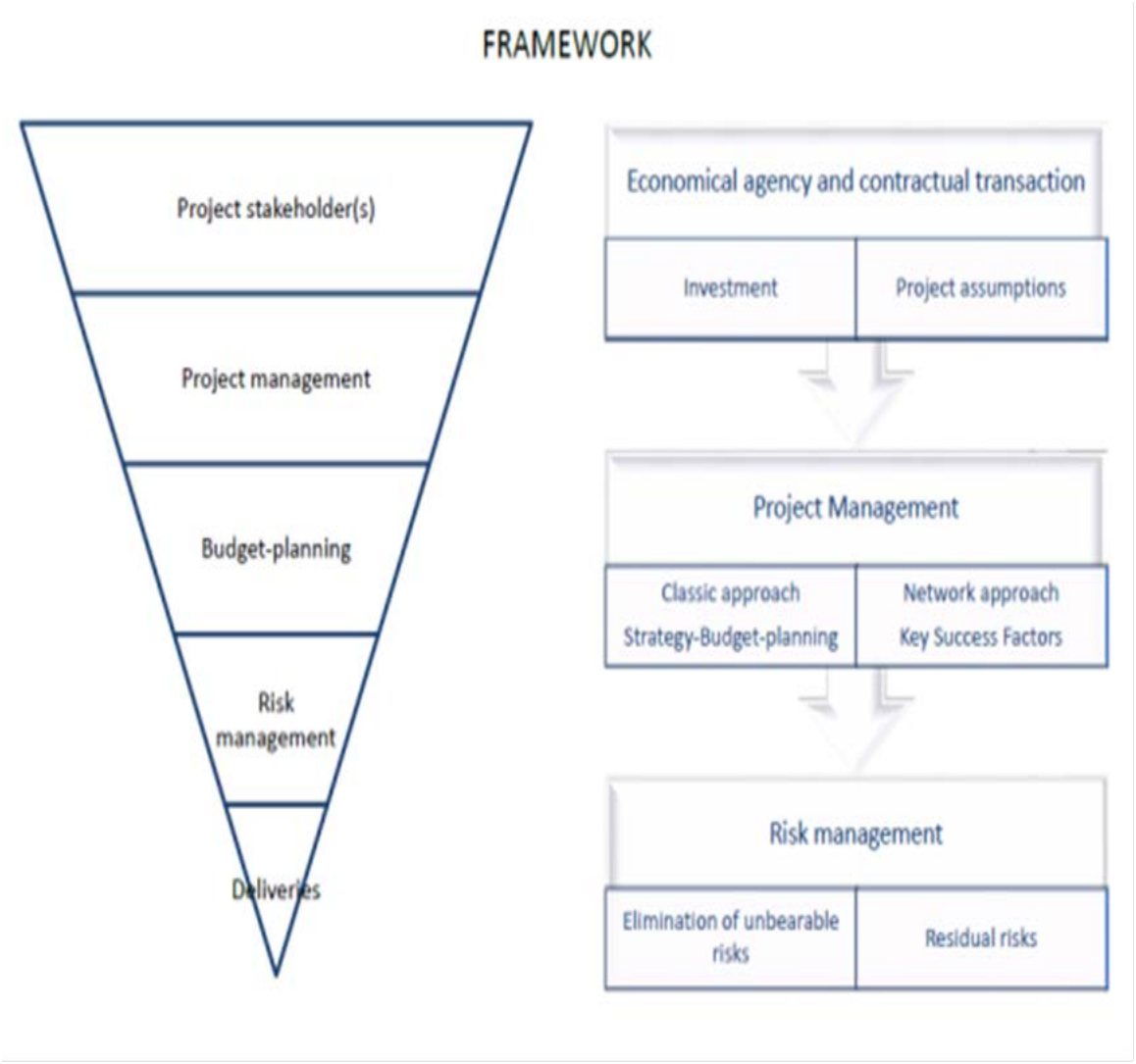

Figure 2. General research framework (Desavelle 2015)

Michael Porter and his book competitive strategy have brought considerable insights for the managerial practices. He suggested that five forces shape the competitive advantage of the firms. In a large extent, the Porter's forces are a strategic advantage for driving a firm in a competitive environment. A project manager will have the same target as any executives. A project manager will have to maximize his shareholder's interest. He has to plan the right resources, coordinate different managerial functions to hit his goals. The competitive forces are discussed later in 3.6.

The managerial functions I based my focus on, have been supported by previous research (Shenhar, Tishler, Dvir, Lipovetsky & Lechler 2002, 112) and highlight the following:

- Design consideration
- Design freeze stage
- Use of detailed work breakdown structure (WBS)
- Documents and reports
- Skill level of project teams

The diamond NTCP framework proposed by Shenhar and Dvir (1996, 2005) proposes to classify projects along with four dimensions, technology, complexity, pace and novelty. This model guide project managers in selecting their project management style (Dvir, Sadeh, & Malach-Pines 2006, 38). The projects are defined by four attributes. A complexity attribute, a novelty attribute, a technology attribute and a pace attribute.

I suggest that classification is highly dependent on the evaluator's experience and intuition. The author based on this model made the hypothesis that actual level risks were high and without any strong mitigation, the residual risks were still too high. I supposed due to the fact that this project is a first-of-kind with uncertain budget assumptions that the project characteristics are:

- Super-High-Tech
- New to Market
- Array (complexity)
- Time-Critical

This supports in fact my proposal of managerial factors to constitute the main risks.

Business relationships are based on trust and contractual transactions. The mechanism for conducting business affairs is based on budget assumptions and forecast. Budget framework is well codified and regulated. Firms' financial accounts are scrutinizes by financial market and audited by third parties. Therefore, the tools for managing risks must be converted into budgets. The way to update and reassess the risks must be done during forecast processes. Usually, firms follow a quarterly budget process, and managers are often asked to produce updated forecast. The concept of project network and lifecycle is a well described model in the literature. The network contribution is discussed further in chapter 5. The project stakeholder is discussed in the chapter 3.4, whereas the lifecycle model is to be found in table 1.

Lastly we calculated the risks as the probability of likelihood and gravity. This is in line with a qualitative risk analysis strategy (Raz, Shenhar & Dvir 2002, 101-109).
In the context of construction industry risks could be the likelihood of the occurrence of a definite event/factor or combination of events/factor which occur during the whole process of construction to the detriment of the project (Wang, Dulaimi, & Aguria 2004, 238).

The implication of a strategic thinking for a project manager:
As stated in beginning of this chapter, strategy consists of planning a set of measures in order to attain one or several objectives. Project management is primarily concerned by hitting time schedule and meet budgets. Raz, Shenhar and Dvir (2002, 102) point out that especially for high uncertainty project, risk management techniques should be implemented and be part of the strategy to bring the project to success.
This is in fact close to Mintzberg's (1991, 21) thought to think strategy as seeing.

Mintzberg tells that companies and in this present case project manager should not apply strategy like a ready-made recipe, rather project managers must in fact see strategic thinking as a process which is characterized by participation, interaction, enthusiasm, dedication and mutual trust (Hansén 1991, 129). The author however believes at least in the area of project management, the strategic process requires planning and scenario making. Thus the emergent strategic thinking (Mintzberg 2003, 415) as Mintzberg would suggest seem not valid for a risk management framework. This does not invalidate any of the strategic theory. On the contrary, strategy is embedded in planning and screening of every opportunity and change in the competitive landscape. In the case of project management, staying competitive means finding the right tactics and tools to coordinate the activities and foresee the difficulties. Strategic planning takes the right sense in putting all efforts to attain goals and objectives.
Every project manager must include a part of strategy to achieve stakeholder's goals. Risk appetite is part of the strategy. As stated in the beginning, the notion of risk appetite may explain the attitude of the firms.

In order to clarify the framework followed for this research, the main ideas are summarized hereafter:

Project management consists of achieving certain objectives. The success of the project depends on metrics proposed to be measured. The area of project management requires a strategic thinking as any other managers responsible for a business unit or department.
Project Risk Management (PRM) process contains basically two phases (Raz & Michael 2001, 9); a risk assessment and a risk response. The managerial factors will be identified and evaluate with the help of a risk mapping. This is a risk assessment phase. The risk response consists of mitigating the risk and accepts the residual risk and converts it into budget calculation.

To complete the review of risk management, other literature offer more detailed thoughts.
A project risk management strategy includes generally a risk assessment with identification of risks, analysis and prioritization, risk control with risk management planning, risk resolution and risk monitoring planning, tracking and corrective actions and a risk communication policy.
Other literature sources see it with:

- Identify risk factors
- Assess risk probabilities and effects
- Develop strategies to mitigate identified risks
- Monitor risk factors
- Invoke a contingency plan
- Manage the crisis
- Recover from the crisis

(Bowers & Khorakian 2014, 25-40).

Similar risk management process can also be found in ISO 31000:2009 standard. It proposes the following activities:

- Establishing the context
- Risk assessment which include risk identification, a risk analysis, and a risk evaluation
- Risk treatment

Along those sub-processes, risk management should include a monitoring and review part as well with risk communication strategy.

3.4 Project stakeholders

Aaltonen et al (2010, 382) defines typically stakeholders between internal and external.

Internal stakeholders are the stakeholders who are formally members of the project coalition and hence usually support the project. They are often referred as primary stakeholders or business actors. External stakeholders are not formal members of the project coalition, but may affect or be affected by the project. For instance the public is an external stakeholder. In the case of nuclear new build project, due to very complex process for licensing a nuclear power plant, public acceptance plays a great role.

Stakeholders are all the actors involved in the project. Just like the firm's stakeholder theory, key people are to be seen as project stakeholders. The term stakeholder may be defined original by Freeman in 1984, by the group of people who can affect, or who are affected, by the activities of the firm (Aaltonen & Kujala, 2010, 382). Remarkable research has been made on stakeholder theory. Donaldson and Preston (1985) suggest that stakeholder theory is ultimately managerial. Stakeholder theory implies that eventually the firms or the project actors have an obligation to all stakeholders. Managers have a responsibility to their primary shareholders, and eventually should act in their shareholders' interests. We may think of hitting budgets, or maximizing profits of the firms.

In a large project such new nuclear build with a lot uncertainty, implication of stakeholders' theory in building trust and confidence is in fact a key success factor.

The project organization of the Olkiluoto 3 project is presented in the figure 3.

We recognize that the licensee holder, the public, the Authorities, the vendors and the main contractors are all stakeholders in the project.

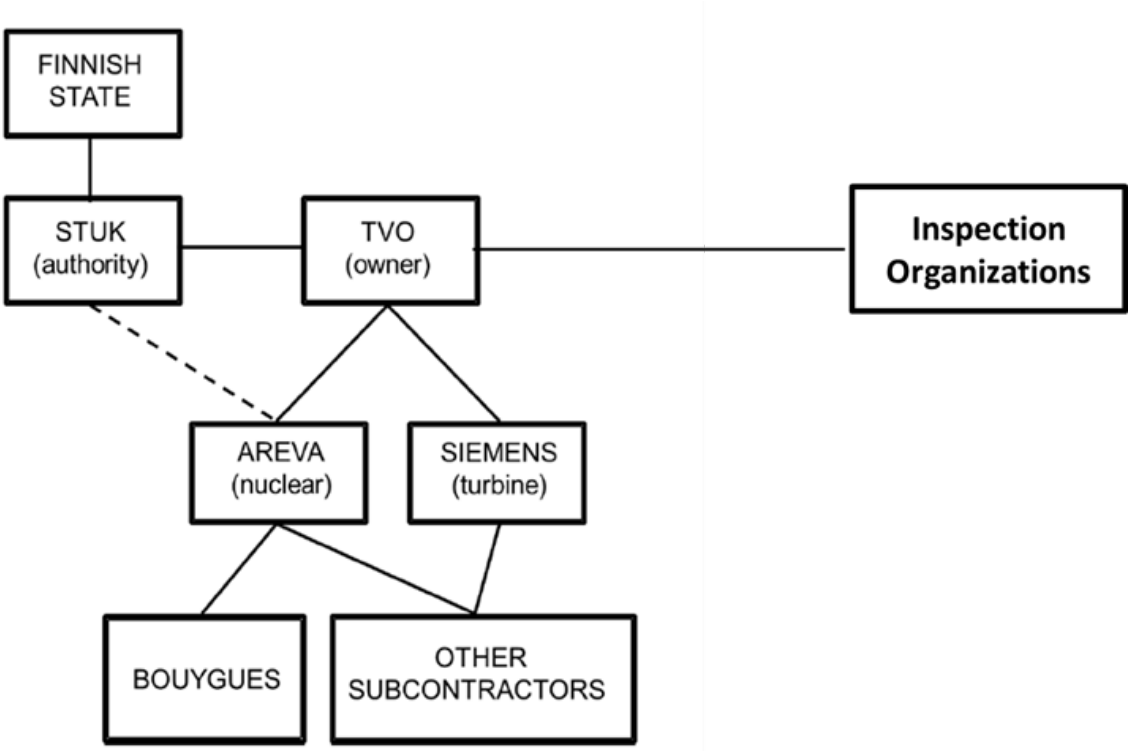

Figure 3. The supply network of the Olkiluoto 3 project
Adapted from (Ruuska, Ahola, Artto, Locatelli & Mancini 2011)

3.5 Budget and planning

Drafting a budget requires planning.

Financial performance means excellent planning and to master all the costs. Nuclear projects require a tremendous amount of investment and thus constitute an intolerable risk if not managed. This, based on the present case study of Olkiluoto 3 and also from Flamanville 3 in France, the construction costs of a new nuclear power plant constitutes very uncertain investment.

Investment in nuclear power entails a large and diverse set of risks that cannot be captured by the standard levelized cost methodology (Kessides 2010, 3857).

This actually is a break in future investment in nuclear new build.

The investors are project stakeholders and due this very fact, the financial performance must be met.

The project assumptions must be defined when the decision is made to invest in such large projects. This is in fact very risky by nature. Partly due to loss of past experi-

ence on similar construction, the budget assumptions have been clearly under-evaluated. AREVA, according to the French media, has underestimated the price of the EPR in order to win the tender, thus underestimating the credit insurance given by Coface (10) (Ruuska, Ahola, Artto, Locatelli & Mancini 2011, 16).

In Olkiluoto 3, the original budget of 3 billion Euros has already been exceeded at least by 50 per cent (23) (Ruuska, Ahola, Artto, Locatelli & Mancini 2011, 21).

In 2014, the adjusted budget was eight billion euros for estimated end of construction in 2018 (Russell 2014).
This constitutes a tremendous risk even if the author acknowledges that a certain residual risk remains always.

Budget control:

To achieve success in a project, this is commonly acknowledged that the function control is essential. Find for the deviations as early as possible and correct them.
Cost control does not promise the end to the problem however (Parker 1993, 1).
Once a budget for a project is established, the task is to control cost to stay within the budget (Parker 1993, 2)

Budget and financials are powerful means to control and monitor project progress. Oftentimes project manager tend to rely too much on forecast. Risk management must help to quantify the residual risk into figures and data. I propose in this research framework to evaluate the residual risk as bad debt or doubtful debts in budget preparation.

Budget models:

Management accounting requires preparation of budgets. Budgets allow quantifying targets and objectives into financial measurements. It allows efficient planning and control activities.

Budgets can be prepared for different time span, yearly, quarterly or monthly. Budgets are generally a financial plan for the short term. A budget defines precise targets for (Atrill & McLaney 2001, 231).

- Sales and expenses
- Cash receipts and payments
- Short-term credits to be given or taken
- Stock-in-trade requirements
- Personal requirements

However, this is clear that for such construction project, the different budgets are interrelated and serve the long-term financial project plan. This can be also called master budget.
They are numerous types of budget. Most common are financial related such as sales budget or cash budget.

A proposed simplified budget model using a profit and loss account statement is depicted in the figure 4 where the doubtful debts are shown into the budget.

The attention of the reader is made that, this is not based on an activity-based costing (ABC) methodology. This is a model aiming to illustrate the research findings of bad debts and doubtful debts in the budgeting process.

The calculation of doubtful debts and overheads can also be assessed with an activity-based costing method. This point is discussed in 6.6.

There are endless possibilities for a project manager to control the costs and expenditure. The documents do not need to comply with financial and accounting standards. The official documents are prepared by the financial department and sometimes audited by a third party. In project management, the uses of the documents are not regulated and the project manager is free to use as many as documents he or she finds necessary.
Therefore there are surely numerous budgets to be prepared. The experience of the author tells however that the use of a profit and loss template is useful in inspection

organization business. It identifies the trend; it is useful to control the costs and to maximize the profits. Furthermore, as said before, it serves the research purpose by identifying the residual risks (doubtful debts).
Lastly a point is often forgotten in project management. This is discussed later in the risk appetite section. Just like in financial accounting, the project manager and the senior executives must be prudent when establishing budgets. The point is not to deceive shareholders but in fact to minimize the risks. Tiffin (2007, 146) in his text book explains that provision should be made for all known liabilities (related to expenses and present of future losses) whether the amount of these is known with certainty or is a best estimate in the light of the information available.

This point is crucial for the validity of the research. Knowing the risks and try to quantify them is the duty of any senior project executive.

When the costs are not known with certainty, it is essential for the project manager to use any other techniques to estimate them with the best precision. One can think for example of benchmarking, or experience of past similar projects.

Moreover, the use of similar language of accountants and financial professionals help the project manager to be efficient. It helps the managers to be understood by the upper management. Indeed, in order to approve supplementary costs, expenditure, or delays, speaking with financial metrics appear to be essential.

The project manager is however not an accountant. There are numerous figures produced every day. The project manager must keep in mind to stay focus on essential figures and have a reasonable amount of accuracy. This is not the point to work with accuracy as for an accountant. A project manager will have several other tasks to cope with every day.

		€	€
INCOME	Sales revenue		
	Other revenue		
COSTS			
	Variable production costs		
	Feature costs		
	Opening stock (beginning inventory)		
	Add: purchases		
	Less: closing stock (ending inventory)		
	Transportation and tariffs		
	Third party inspection		
	Calibration costs		
	R&D		
	Promotion		
	Administration		
	Costs and expenses total		
	Bad debts		
	Increase/Decrease in provision for doubtful debts		
	Audit fees		
	Salaries and wages		
	Insurance costs		
OPERATING PROFIT BEFORE DEPR. (EBITDA)			
EXPENSES & OVERHEADS			
	Depreciation from fixed assets		
	Misc. Variable expenses		
	Misc. Fixed expenses		
	Overhead costs		
OPERATING PROFIT (EBIT)			
OTHER EXPENSES			
	Net financing expenses		
	Receivable interest		
	Payable interest		
PROFIT BEFORE TAXES			
TAXES AND RETAINED PROFIT	Income taxes		
	Dividends		
	Transfer to general reserve		
NET PROFIT (LOSS)			

Figure 4. Simplified budget model (Desavelle 2015) adapted from Pinson (2008), Sittle and Wearing (2008) and Atrill and McLaney (2001)

3.6 Network approach

Successful project management is grounded on a balance of formal and informal structures upon a framework of working relationships (Lau & Rowlinson 2011, 634).

A network attributes describe the distance in the relationships among the actors in the whole project network. They include social, physical, cultural, attitudinal, behavioral, or temporal types of distance (Ruuska, Artto & Lehtonen 2009, 144).

Large and complex project must be seen as nexus of high level of relationships. To achieve the goals, project actors must reach a certain level of collaboration and coordination.
Winch (2001) has developed a conceptual framework for understanding project governance across the project life-cycle and argued that the greatest difference between traditional subcontracting and quasi-firms relates to transfer and sharing of risk between main contractor and subcontractors (Ruuska, Ahola, Artto, Locatelli & Mancini 2011, 7).
Life-cycle of network follow a similar curve profile described in the table below:

Table 1. Life-cycle in networks

Porter	Peelen	Hollensen- Dwyer et al.
Birth	Exploration	Awareness
Growth	Growth	Exploration
Maturity	Saturation	Expansion
Decline	Decline	Commitment
		Dissolution

Time is in fact a critical variable. The status of the network varies with time indeed. The length of the project constitute of potential risk. Resources may leave suddenly, the material availability decreases and this is in fact in line with Porter's competitive forces, for instance the bargaining power of suppliers.

3.7 Risk mapping

A risk mapping is a typical tool for qualitative risk analysis. Quantitative analysis is hard to achieve and need considerable amount of data. Qualitative risk analysis technique provides usually a sufficient and acceptable level of information.
Risk mapping can also be called impact grids. Probability and impact grids provide a simple format for showing relative importance of risk event (Ahmed, Kayis, & Amornsawadwatana 2007, 28).

3.8 Bad debts and doubtful debts

Eventually all budgets assumptions including the risks must be converted into numbers. For service companies, the term bad debt refers to a risk that customers will not pay the amount due. The reasons being poor service performance or poor quality. Where it is reasonably certain that the customer will not pay, the debt is considered ‘’bad’’. This is taken into account into financial statements. Bad debt is used to increase the expenses. The matching convention requires that the bad debt is written off in the same period as that in which the sale that gave rise to the debt is recognized. The recognition of probability of risks is an estimate and is first recognized as doubtful debts. The amount which proves to be bad will be the actual financial losses and will be probably different from the estimate. The risk assessment will usually follow the accounting period as the doubtful debts (risk of non-payment) must be recognized in the appropriate accounting period.

Financial accounting literature defines bad debts when incurred when it is reasonably certain that a debtor to a business will not be paying. Bad debts are written off in the profit and loss account. If a business operates with a high risk of failure, it might be prudent to consider a portion of debtors to be classified as doubtful. The reader understands here, that this means a part of the invoices will be not paid due to failure of the business.

4 CASE STUDY

4.1 Generalities

The research strategy will consist of a case study. A case study is well adapted for empirical investigation and display phenomena in real context. A case study can generate new hypothesis. Case study is suitable for answering questions such as why and how. The general methodology is depicted in the graph 3. This is used to find a solution to an applied problem. In the present research, the case study is unique and single. Usually case study can generate a lot of data. The research is descriptive and exploratory. In fact, the topic being vast and very complex, it can be used prior to other investigation.

4.2 Project description

The notion of complexity of a project was discussed in 2.4.2. Olkiluoto 3 project is a project started in 2005. It is the construction of a fifth nuclear reactor in Finland on Olkiluoto island. The site operated by Teollisuuden Voima Oy has already two running power plant. The technology slight differs as the reactors are designed as boiling water reactors.

Olkiluoto 3 is pressure water reactor. The design is an updated generation of reactors taken into consideration decades of operating feed-back. The NTCP model introduced in 2.4.2 depicts the project along four dimensions. Olkiluoto 3 due to its features and characteristics fit the super-high-tech, new to market, complexity and time-critical. This brief analysis shows that the project concentrate specific challenges which explain the lack of awareness of risks. The Chernobyl disaster in 1986 had caused a profound shock for the nuclear industry. The pressure from Authorities and public has been enormous to ensure a maximum security level. Despite all the efforts, the nuclear industry has a lot of difficulties to convince of the economic viability of such construction. However, due to the need of reducing carbon dioxide and green-houses gases plus the need of more energy, the nuclear industry began a so-

called ‘’renaissance’’ in the 2000s. However, managerial and technical capabilities for undertake such major construction were somewhat lost.

4.3 Methodology

The general research method proposed for this research is a case study. Case study collects empirical data. Observation is done from actual experience.
The figure 5 walks the reader through the phases the research will be carried out. The data will be collected through questionnaires to measure the project success and determine the threshold of actual risks. The expected outcome is to produce findings to the research questions and objectives mentioned earlier in this thesis.

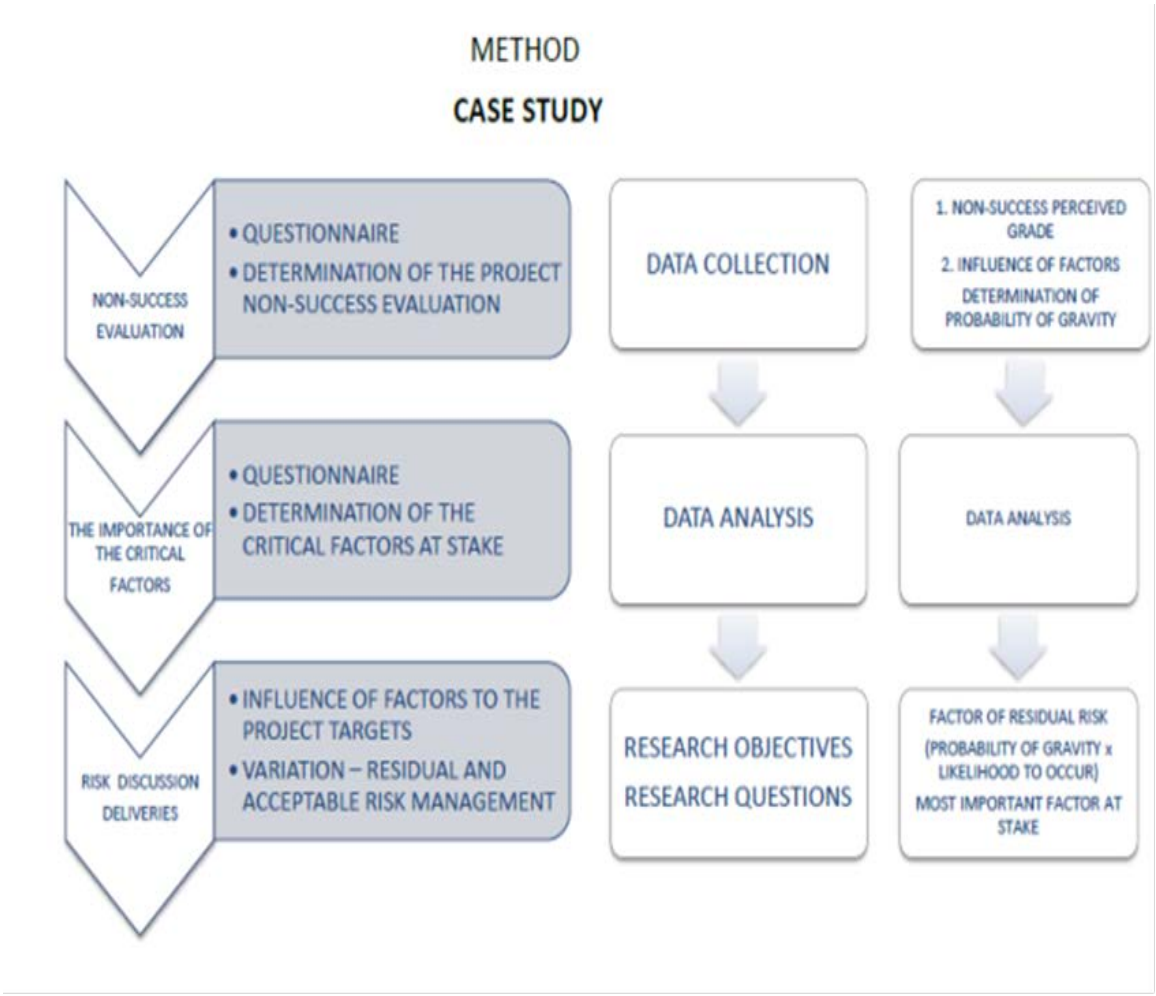

Figure 5. The case study method (Desavelle 2015)

The research reminds that in order to calculate the probability of the factors to influence the success of the project, I will calculate this probability by multiplying the

level of significance (S) of the factors by the likelihood of occurrence (L) of the factors. To measure risk magnitude, probability and consequence of a risk event needs to be determined (Ahmed, Kayis & Amornsawadwatana 2007, 28).

This methodology is described in the figure 6. This is a practical and useful approach to identify the level of risk.

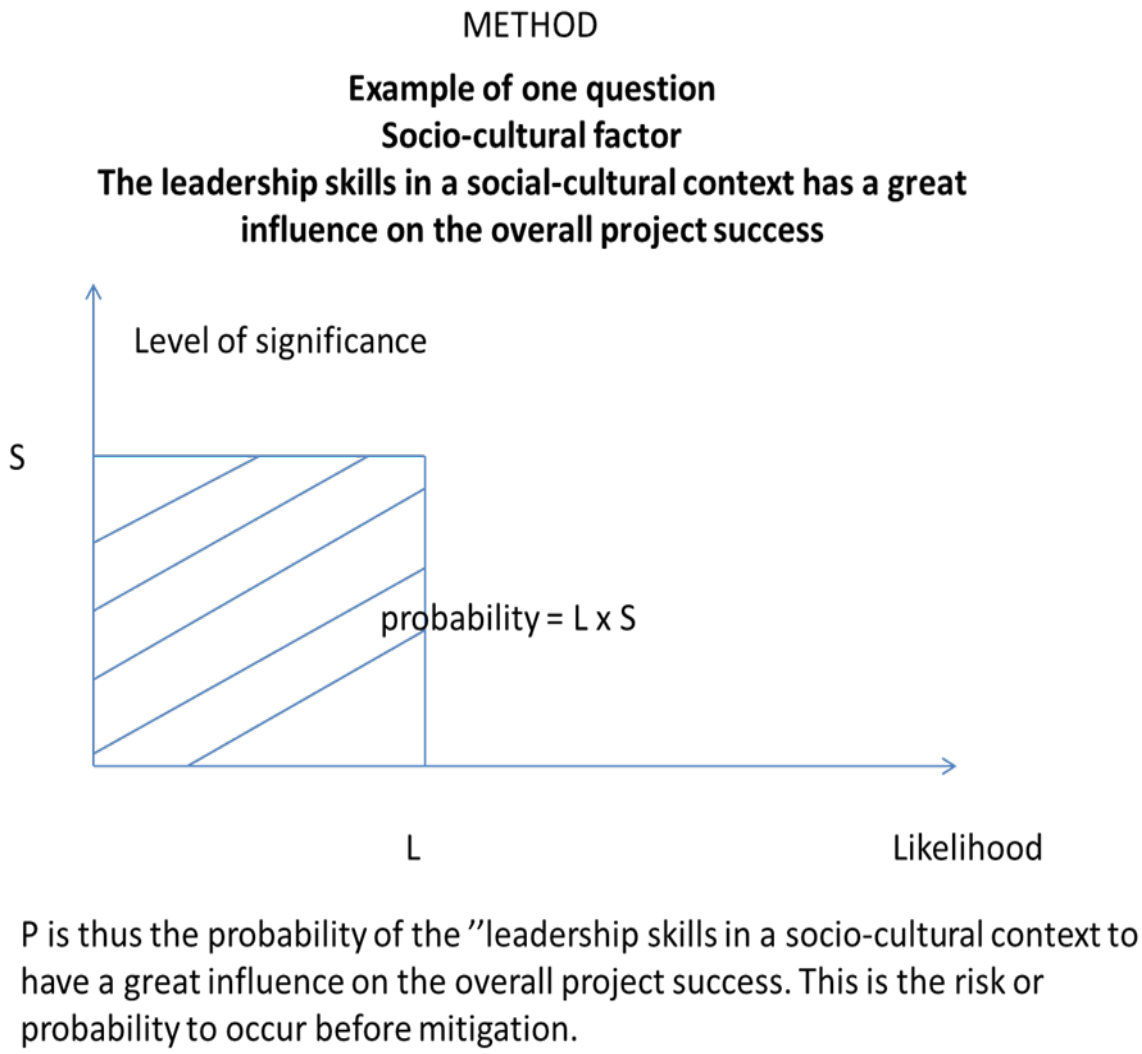

Figure 6. The calculation method of probability of risk (Desavelle 2015)

The researcher argues that managerial factor is associated broadly with a level of risk. In fact, the managerial factors are the main components of other risks.
The nature of risks are political, compliance, reporting or operational. The risks are various and have many causes. Risks have a consequence to produce other risks. In

other words, the researcher has simplified the model by taking managerial risks as the source of plenty of other risks.

The research strategy is a case study, descriptive, trying to find solutions to an applied problem.

The research project methodology will consist of the following phases:

- Determine a true project success rate
- Determine the probability (P) of risk factors to influence the project. P will be calculated by multiplying the level of significance (S) of the factors by the level of occurrence (L) of the factors

This is supported by the definition of a risk measured as using two parameters – risk probability and risk consequence (Ahmed, Kayis, & Amornsawadwatana 2007, 27).

- A residual risk (RR) is determined after mitigation measures. This is illustrated by doing a risk mapping
- The residual risks are to be converted into potential financial losses. This is proposed to be budgeted using a bad debt figure.

Bad debts are proposed to be calculated by multiplying the residual risk by the revenues and by a severity rate. The severity rate represents the negative impact on the business. It is the consequence or impact on the business affairs. It is a number between 0 and 1.

Bad debt = Residual Risks * Revenues * Severity Rate

The second part of the survey will help us to collect empirical probability. In the empirical probability approach, the probabilities are based on observed data, not on prior knowledge of a process. Surveys are often used to generate empirical probabilities (Levine, Krehbiel & Berenson 2010, 127).

4.4 Data collection

The data has been collected by using quantitative questionnaires based on closed-end questions on a Likert scale. The respondents were asked to rate the degree of success, ranging from -2 (‘strongly disagree’) to +2 (‘strongly agree’). Some researchers use

the Likert scale with a seven-point scale. I however chose to do the questionnaire on a five-point scale which is usually used and valid. The seven-point scale may give more granularities and more accuracy. However the research believes that using a five-point scale does not produce any forced answers and thus provide reliable data.
The researcher wanted to make a direct observation on the project success. Likert scale is used in questionnaires to obtain a degree of preference or a degree of agreement. The data obtained are ordinal data. The position is important.
A case study is meant for exploratory studies, for having an overview of phenomena.
The questionnaires were self-administrated with an on-line tool. The sampling technique used was nonprobability using a judgment sampling process.

4.5 Data analysis

What is the hypothesis?
Mathematically the value we expect to find as an average is called the expected value or central tendency. In case of a normal distribution, this value corresponds to the mean. This value in statistics represents the value that occur the most frequently. They could be seen as common, middling or average (Saunders et al. 2003, 352)
The standard deviation of this expected value will be also determined by statistical method.

If we consider that we have tested two groups, the manager group and the non-manager group, we are going to test if there is a statistical significance between the two groups in perception of the project success. This is to eliminate the possible managerial myopia. The statistical test done was a t-test and a Mann-Whitney U test on the first variable. Mann-Whitney U test is a non-parametric test. It is also known under Mann-Whitney-Wilcoxon test.

My first hypothesis to be tested formulated in the introduction was that the managers and the non-managers have a different perception on the project success. Otherwise stated this constitutes the null hypothesis H0 to be tested. The notion of managerial myopia is to be understood as a managerial failure as Theodore Levitt (1960, 45-56)

has first introduced the notion. He, at the time of the article, argued that declining of railroad industry was more a result of error of analysis (Levitt 1960, 46) rather than lack of opportunity. In the case of managerial myopia, the reader understands that due to many complex attributes of such project, an error of judgment may occur between managers and non-managers.

The null hypothesis H0 to be tested is:

‘’There is no difference between managers and non-managers in perception of project success’’.

The questionnaire was a self-administrated questionnaire sent on-line via LinkedIn (N=62) and emails to 41 (N=43). It was sent out on 16.02.2015 and 17.02.2015.

Tests were conducted during two days starting on 12.02.2015. One month was given to the respondents to fill the survey.

I have obtained 27 (N=27) responses to the questionnaire.

The population in this research is all the persons who work or have worked on Olkiluoto 3 project. Sampling represents the whole population. I have used a nonprobability sampling technique with a judgment sampling process. A nonprobability sampling means that the individuals in the given population do not have the same chance to be selected. However, because the sample was based on people whom the research has contact with, has sufficient experience, the sample is considered reliable for the research purpose which is a case study. However it is certain that this sample cannot be considered to be statistically representative (Saunders, Lewis & Thornhill 2003, 169). The sample to be representative was chosen with persons representing all the main project stakeholders, different nationalities (8), both managers and non-managers, different work area, and different gender. A probability sampling technique is out of reach, the entire population being all the people past and present involved on the project started nine years ago and geographically scattered. This makes approximately 35,000 thousand people who have been at least once on the site.

4.6 Project success

The classical approach of measurement of a project success is grounded in the classic objectives success metrics: cost, schedule, performance and safety (Hughes & Tip-

pett, 2004, 31). Beside these essential metrics, further research proposed to measure the success of a project by adding more subjective metrics. Even though subjective metrics are in fact more difficult to quantify, they are determinants of construction project success. I have estimated for the research that six metrics was consistent with project success measurement. This can be justified by adapting to the project complexity. The project is first-of-a-kind, a new generation of nuclear reactor referred to gen III+. This generation of reactor includes several improvements from previous operating reactors such as N4 in France and Konvoi in Germany. According to NCTP model, the project is characterized by being Super-High-Tech, New to Market, Complex and Time-Critical. Shenhar et al. (2002, 112) explains because project outcome is assessed differently by various stakeholders, success criteria must reflect different interests and viewpoints.

Baker, Murphy and Fisher (Hughes & Tippett 2004, 32) have proposed the following definition of project success:

‘’If the project meets the technical performance specifications and/or mission to be performed, and if there is a high level of satisfaction concerning the project outcome among key people on the project team, and key users or clientele of the project effort, the project is considered an overall success’’.

The research will referred to the term ‘’perceived project success’’. By accepting that a project success is also measured by subjective metrics, perception plays a strong role in determining the project success (Hughes & Tippett 2004, 32).

The principal difficult to agree on common definition and common metrics is coming from the very fact that a project is not a universal set of functions and activities.

Projects differ from each other. A project can contain a lot of technological features; it can be long or short. A project is characterized by uncertainties. Uncertainties are linked to risks. Therefore this shows the link between risks, technological complexity, time, budget and project management. Project management being the processes by which the goals are achieved.

To measure project success by only considering schedule, budget and technical requirements met is not enough. The author has extensively reviewed the work of Dvir, Raz and Shenhar to build precise metrics for our project success rate.
The first part of the questionnaire the allocation of data was done:

Table 2. Allocation of data

Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
-2	-1	0	+1	+2
Failure	Poor success	Moderate success	Good success	Complete success
< - 1.5	-0.5; -1.5	-0.5;0.5	0.5;1.5	> 1.5

Indeed, the typical approach for project management goal is to bring a project to completion on time, within the budget cost, and to meet the planned performance of end-product goals (Dvir, Raz, & Shenhar 2003, 89).
The project success rate was calculated as follow:
However, Shenhar and Dvir (2002, 111) in their research to 127 questionnaires have identified four distinct success factors.
To measure success of the project, we test the overall planning but also we want to test to milestones performance. A milestone is defined as a result to be achieved (Divr, Raz, & Shenhar 2003, 90).

Six factors have been identified based on the research of (Shenhar and Dvir 2002, 116).

1. Time
2. Budget
3. Project efficiency
4. Business Success
5. Future potential
6. Performance

To justify the factor of performance, I will link it to end-user satisfaction. Performance reflects the operational mind-set also of project management (Dvir et al., 2006, 39). In the end, one of the most important factors is client satisfaction. This echoes Pinto and Mantel's findings that identified that one aspect of project performance is client satisfaction with the result (Dvir et al., 2006, 39).

In the case of Olkiluoto 3, it is obvious that eventually, the most important is to have the plant running. Performance is also identified by other authors such as Freeman and Beale as criteria for measuring the success of projects (Shenhar & Levy 1997, 3).

Project success is perceived differently from different stakeholders. Engineers, shareholders, public, financial accountant, chief executive may see the success with different metrics. The six metrics used for this research is thus considered to be complete to generate reliable data.

4.7 Level of risks

To evaluate the risks, the risks and source of hazards must be identified. In a broad sense, forces and managerial factors constitute the main contributors. The research is built on a simplified model considering six managerial factors constituting the main risk drivers.

As seen previously, a project risk management starts with risk identification. As a matter of fact, the risks must be assessed regularly along the project life-cycle; not only in the beginning.

As written earlier, the main managerial risks have been identified based on forces or factors.

Ethical consideration

Business ethics is concerned about the study of moral norms and in a given business situation, the right and wrong. Business decisions often require ethical inputs.

In firms' code of ethics, transparency and trust are usually the most referred terms. As a matter of fact, hiding information contributes to unacceptable increase of risks

for stakeholders. Lack of transparency also constitutes a form of deception for stakeholders. As an example, the respondents were asked to rate the influence of ethical factor with a following question:

‘’Transparent relationships between actors have a great influence on the overall project success’’

To determine the factors which have influenced the project success, I started to identify the factors from the PESTEL analysis framework added with Porter’s competitive forces. Porter (1988) has identified five plus one forces which shape the competition. They are the bargaining power of suppliers, the threat of new entrants, and the industry rivalry existing among firms, the bargaining power of buyers and the threat of substitute products or services.

The identification of risks is an important step in risk assessment and generally in risk management. The source of risks are multiple, they may change over time. The identification of risks can be done through several ways. Risk manager can use check-lists, use brainstorming technique, Delphi technique or do a SWOT analysis.
The managerial factors have been identified based on previous research done on project management and also on Porter’s (Porter 1988) competitive forces.

Economic factors are grounded in the classic view of project management, for instance time, budget control and managing resources.

The political, legal, technological and environmental the research aimed to evaluate are derived from PESTEL framework analysis.

The socio-cultural factors in this research have been identified thanks to Hofstede’s work (Hofstede et al. 1990, 286-316).
Lau and Rowlinson (2011, 643) explain that in project management, the client’s involvement is significant. The reasons may be that problems are not always purely technical, but also economical and socio-cultural. Both project success rate and influencing factors have taken user’s involvement into consideration.

The work of Ruuska, Artto and Lehtonen (2010, 142) has greatly contributed to determine the role of network as an influencing factor. They are very explicit about network and project. They state that projects are temporary networks consisting of several organizations or actors. Their paper underlines also the role of communication in project success. The following quote is very clear:
‘’Communication is important for clarifying the various goals, interests and identities of different actors related to the project.’’.

They argued that the developed distance framework offers a holistic view to analyze complex multi-firm project networks and their management.
The network attributes found in their research are (1) misaligned objectives, (2) unclear roles and responsibilities, (3) lack of trust between parties, (4) action or inaction based on assumptions, (5) no previous joint working experience and diversity of actors.
They argued that increased distance in network project actors cause uncertainties. Distance can be seen as social, physical, cultural, attitudinal, behavioral, or temporal (Ruuska, Artto, Lehtonen 2009, 144).

Hence, the six factors to be analyzed to create a risk mapping are the following:

1. Economical (budget, planning, resources)
2. Socio-cultural
3. Political, Legal, Technological and Environmental
4. Network governance (project size)
5. Ethical (trust and transparency)
6. Communication

4.8 Synthesis of the methodology

The research strategy is proposing to answer the research questions by considering the sources of project failure as hidden costs which can be observed thanks to managerial factors. To achieve this, the methodology is to use a risk management frame-

work. The risk is simply quantified by two variables, the gravity and the likelihood of occurrence. The illustrative theory has identified six managerial factors around which the research is built on. Before that, the researcher wanted to understand the true perception of a project success to have a clear ground for discussing the results.
The methodology is therefore constructed around the notion of residual costs. In the end, the managers have the duty to have a strategy to meet stakeholder's expectation. By estimating the residual risks, managers have one more tool to leverage their efficiency.

5 THEORETICAL CONTRIBUTIONS

5.1 The economic agent

The principles of economic thinking in the modern world are based on rational behavior and scarcity.
Rational behavior means that firms or economic agents reach decisions trying to achieve their goals, which are to maximize utility, fulfill needs and objectives.
Scarcity means that in our world that there is limited capital, limited raw material, a limited supply of resources. The information is not perfect and choices are to be made.
An economic agent who is sometimes an individual, household, a firm or a nation goes into a contractual transaction to exchange products, services or goods.
This means that invested capital must be maximized and the economic agents must reach this goal knowing that there is not perfection information in economic transactions.
Risk becomes relevant if information is imperfect (Demsetz 1997, 428). Contracting is the principal means by which we conduct our economic affairs and structure economic relations (Boatright 2002, 39).
Such large projects are also risky when firms enter into long-term relation from which they cannot easily withdraw (Boatright 2002, 41).

5.2 The cost of construction

The costs of nuclear power comprise of four major components (Kessides 2010, 3851):

- Capital or construction costs
- Operation and maintenance
- Fuel costs
- Back-end costs

Investing in a nuclear new build will require a large part of risk taking, more than it was during the last period of construction. Most of the utilities was state-owned and could finance their investment needs with implicit or explicit government guarantee (Kessides 2010, 3855).

The economic agency theory often neglect that the firms actually operate in a context where information are incomplete and imperfect. This absence of full knowledge generates risks for the business owners. Management are thus necessarily concerned with allocation of resources and be cost-effective.

Such major risks include (Kessides 2010, 3855):

- Factors that influence the demand for electricity and impact the supply of capital and labor
- Regulatory controls (economic and non-economic) and political risks that generally affect revenues, costs, and financing conditions
- Price and volume risks in the electricity market
- Risks arising from the financing of investment

The change to liberalized market has produced the effect that a big part of risks are now shifted from consumers to investors.

This shows the necessity for tighter business owner control to undertake such risks. This is especially true now where nuclear projects are financed by several owners. One can think of Hanhikivi 1 project, Hinkley point C and Moorside project in the UK.

For the Hanhikivi 1 project, the investors are Finnish companies along with Rosatom which owns a 34% equity stake in the capital (Fennovoima website 2015).

In the case of Hinkley point C, the NNB Gen Co (Nuclear New Build Generation Company) which conducts the project, is a joint venture between EDF energy (a wholly owned EDF Group subsidiary), Areva and Chinese nuclear operators (CGN and CNNC). According to a press document from 2013 released by EDF Group (EDF Group update on Hinkley Point C project transcript 2013), EDF energy owns a 45%-50% equity stake, CGN and CNNC owns a 30%-40% equity stake, Areva owns a 10% equity stake and other investors up to 15%.

For the construction of three AP1000 in the UK at Moorside, the NuGen owner is a joint venture between GDF Suez, Iberdrola and Toshiba.

The incomplete contracts theory offers a support of this hypothesis. However, no complete answers can be provided where the boundaries of such sunk costs are. Obviously the different ownership structures must be examined.

The initial construction cost figures should also be viewed with some skepticism because vendors of nuclear power plants might have incentives to misrepresent their costs to maximize their chances of commercial success—e.g., as part of their commercial strategy (DTI 2007) (Kessides 2010, 3850).

The observation of complete costs from actual construction will surely have the uncertainties declined. Then the contractual parties can enter into agreement where searching for complete information will lead to an equilibrium (Aghion & Holden 2011, 190). This will lead to less incomplete contracts thanks to reference points. The relationship between residual risks and unknown costs is not farfetched. The fact that Olkiluoto 3 project was a first-of-a-kind construction with totally unknown cost structure surely contributed to non-awareness of residual costs (risks). A recent study by the University of California tends to prove the same. The authors write that as many units are built, the lost costs become more certain and buyers will face lower risks (Rong & Victor 2012, 20-21). They also acknowledge that gen III+ reactors' construction costs estimates are still uncertain.

5.3 Network governance

However, the researchers suggest that in the governance of large projects, any these approaches – market, hierarchy, or hybrid –are not as such adequate when the analysis is limited to a dyadic setting. Large projects face the challenge of governing a project's internal complex supply chain of multiple firms, and of simultaneously governing the network of external stakeholders (Ruuska, Ahola, Artto, Locatelli & Mancini 2011, 2).

5.3.1 Self-regulation

Secondly, the researchers suggest that their conception of project governance and the underlying mechanisms of coordination should shift from simplistic governance carried out by either the price mechanism or administrative fiat towards mechanisms that emphasize relationships and self-regulation in networks
(Ruuska, Ahola, Artto, Locatelli & Mancini 2011, 7).

5.3.2 Incorporations by actors

Thirdly, the researchers suggest that both research and practice should shift from viewing a multi-firm project as a temporary endeavor with a clearly limited life cycle, to viewing a project as something incorporated in the business interests of participating actors over much longer period of time than that of a mere project's duration.
(Ruuska, Ahola, Artto, Locatelli & Mancini 2011, 31).

5.3.3 Open system

Lastly, the researchers suggest that the focus should shift from a narrow view which conceptualizes the project as a hierarchical management system, towards an open system view on managing projects that are embedded and interwoven with challenging institutional environments.
(Ruuska, Ahola, Artto, Locatelli & Mancini 2011, 31).

5.4 Implication of trust

Trust means one believes in, and is willing to depend on, another party and a willingness to be vulnerable (Lau & Rowlinson 2011, 635).

Trust is a necessity for bringing project to success. Trust is a therefore a factor of success, thus it is a factor of risk. It is a necessary risk, which has to be mitigated also. Contractual relationships offer a certain amount of mitigation measures. Technical requirements, expected output can be written in a contract. However, there will be always a certain amount of trust which constitutes a residual risk.

6 RESULTS

6.1 How the costs are observed?

The research focuses on observing the residual risks which are in fact costs. Where are they coming from? Initially, the costs have been evaluated during the bidding process but the researcher argued that a great amount of risks are hidden and appears during the construction through managerial factor. To illustrate how the costs appear, the figure 7 gives clarification how the observation of the costs are made.

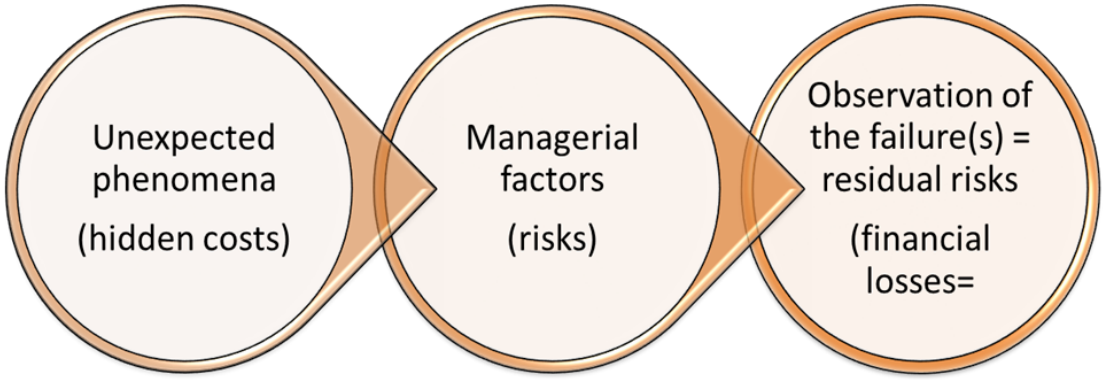

Figure 7. Appearance and observation of hidden costs (Desavelle 2015)

6.2 Presentation of the data obtained

The descriptive statistics were carried out by using Statistica 2009 software.
The data has been collected with on-line self-administrated questionnaire. The answers were collected using Excel table. The table was directly treatable with Statistica 2009 software.

6.3 Project success rate

The questionnaire was a quantitative research using Likert closed-end questions. The respondents were asked to rate the degree of success, ranging from -2 (‘strongly disagree’) to +2 (‘strongly agree’).
Statistical tests, t-test and Mann-Whitney U test were done to confirm the consistency of the results.
The result presented of project success rate in the table 3 was surprising as the respondents did not find the project as a total failure.

Table 3. Project success result

Valid N (numbers of respondents)	Min	Max	Mean
27	-2	2	-0.396

The statistical test found the value of the mean as -0.396. Thus, the project success rate found is ‘’moderate success’’.

The overall results by variable are presented in the table 4

Table 4. Overall results by variable

Question (variable)	Valid N (manager)	Valid N (others)	Mean	Std. deviation	p
The project meets the initial overall schedule	16	11	-1.44	0.9337	0.0844*
Material availability was well managed	16	11	-0.74	0.7121	0.5383
Labor availability was well managed	16	11	-0.11	0.8006	0.9159
The project' milestones are or were accurate throughout the life of the project	16	11	-1.11	0.9337	0.2516
Rework time schedules were well managed	16	11	-0.96	1.0554	0.2123
The project is in line with budget	16	11	-1.77	0.5063	0.7383
The profit exceeded plans	16	11	-1.29	1.0675	0.5336
The profits exceeded similar projects	16	11	-1.07	0.8286	0.9323

Table 4. (continued)

Question (variable)	Valid N (manager)	Valid N (others)	Mean	Std. deviation	p
The project has realistic budget assumptions	16	11	-1.22	0.8006	0.4575
The project is managed in an efficient manner	16	11	-0.96	0.9798	0.8180
Project performance metrics were in good alignment with customer feedback	16	11	-0.52	0.8931	0.8996
The project contributes to increase business success of the project actors	16	11	-0.44	1.0500	0.6869
The project created new market penetration	16	11	0.03	0.9398	0.8104
The project contributes to well-being of the society	16	11	0.18	1.0755	0.4855
The project developed new knowledge and expertise	16	11	1.15	0.7698	0.8548
The project generated positive reputation	16	11	-0.41	1.1522	0.6154
The project meets high-performance and quality	16	11	0.22	1.0127	0.5864
The end-user is to be satisfied with the end-product (output)	16	11	0.44	0.7511	0.6520
The project meets high performance on workers' health and safety	16	11	1.07	0.6751	0.6456
The project meets high performance on environmental standards	16	11	1.03	0.5871	0.3579

The level of significance p is higher than 0.05 except for the first variable where p* is close to the level of significance and furthermore p-Levene (0.002997) show that this variable is not normally distributed.

The other variables are considered close enough to a normal distribution.

However, the Mann-Whitney U test as presented in table 5, shows that there are no statistical differences between managers and non-managers in the perception of the OL3 project success.

The Mann-Whitney U test is used to test if the variable coming from two populations, the manager and non-manager follow the same probability distribution.

As a conclusion, we can accept the null hypothesis H0, and conclude there are no statistical differences between managers and non-managers in the perception of the OL3 project success for all the variables. This answers our first hypothesis I formulated. There is no managerial myopia and both managers and non-managers see the success of the project with no difference. This gives indication that managerial factors are not correlated to a particular population of the project.

Table 5. Mann-Whitney U test result for the first variable

Question (variable)	Valid N (manager)	Valid N (others)	p
The project meets the initial overall schedule	16	11	0.1995

6.4 Level of risk

The overall marginal risk level found is presented in the table 6 by variable.

The lowest risk level is found for the variable: ‘’the technological and environmental factors have a great influence on the overall project success’’; this can be explained by the confidence of the nuclear industry in the technique. The reader will be provided a summary in the box 1.

Table 6. Result of probability of risk by factor of influence

Factor of influence	Probability of risk (actual level found) P
The leadership skills in a socio-cultural context has a great influence on the overall project success	0.53
The relationship between leader and followers in a cross-cultural situation has a great influence on the overall project success	0.43
The hierarchy structure (power distance) within organizations has a great influence on the overall project success	0.44
The cross-cultural communication has a great influence on the overall project success	0.46
The proper preparation of the planning has a great influence on the overall project success	0.52
The clear statement of the requirements has a great influence on the overall project success	0.49
Realistic expectations have a great influence on the overall project success	0.46
Sufficient resources have a great influence on the overall project success	0.47
The involvement of the user have a great influence of the overall project success	0.46
The distance between project actors have a great influence on the overall project success (distance can be seen as social, physical, cultural or temporal)	0.44
The support of the executive management have a great influence on the overall project success	0.43

Table 6. (continued)

Factor of influence	Probability of risk (actual level found) P
The legal requirements have influenced the time frame	0.47
The technological and environmental factors have a great influence on the overall project success	0.39
Communication of a clear vision and precise objectives have a great influence on the overall project success	0.42
Communication of information between project actors have a great influence on the overall project success	0.49
Transparent relationships between actors have a great influence on the overall project success	0.45
Trust between project actors have a great influence on the overall project success	0.49

6.5 Risk mapping

A risk mapping is a form of qualitative risk analysis method. It can be referred in other research as probability and impact grid (Ahmed, Kayis, & Amornsawadwatana, 2007, 28).

The graphical representation presented in figure 8 of the risk mapping shows how the risk mitigation decreases the level of risk.

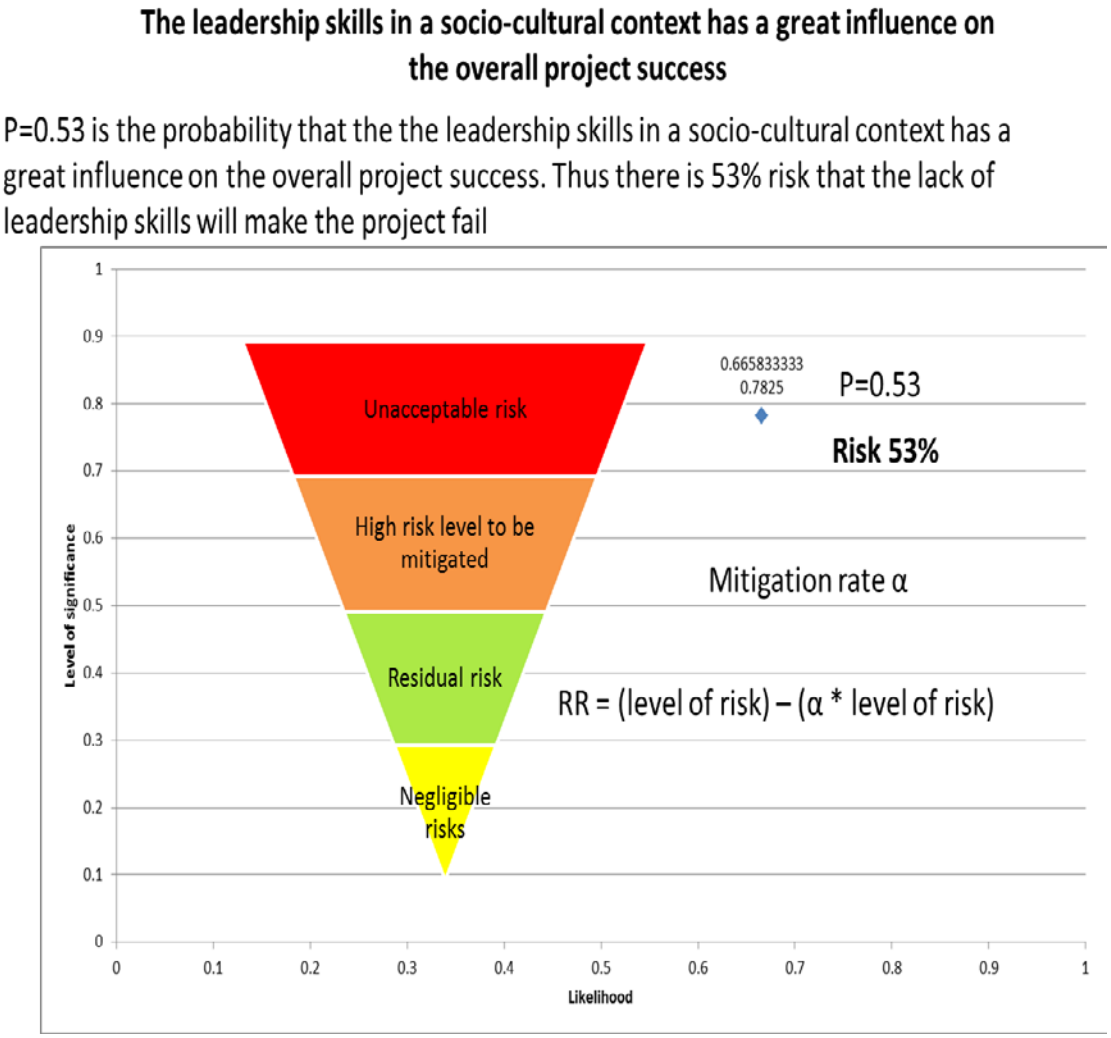

Figure 8. Example of a risk mapping for the factor ‘’the leadership skills in a socio-cultural context has a great influence on the overall project success’’.

For instance, the reader can retrieve the value of 0.53 from the first line of the table 6. The probability value (0.53) is obtained by multiplying the collected data from the survey 0.6658 (the frequency or occurrence) by 0.7825 (the level of gravity).

6.6 Bad debts and residual risks

The table 5 shows a theoretical example. The probability of financial losses is calculated with a 0.3 severity rate as an example.

The results show an extremely high actual level of risk. Thus the probabilities of financial losses displayed in the table 7 are found at a really high level.

Table 7. Result of Residual risk and bad debt by risk factor

Risk factor	RR	Bad debt or doubtful debt In euros for a 100 euros revenue
Socio-cultural	0.4669	14.01 euros
Economical	0.4879	14.64 euros
Political, Legal, Technological and Environmental	0.4494	13.48 euros
Network governance	0.4365	13.09 euros
Ethical	0.4580	13.74 euros
Communication	0.4694	14.08 euros

6.7 Summary and key findings

The reader will be provided in this section with the key ideas which are deducted from the data obtained.

Box 1 What do the results tell us? Key findings

- ✓ The project success is found as MODERATE SUCCESS
- ✓ The traditional project success metrics such as budget and schedule are pushing are pulling without any surprise the project success perception to a negative score. But the high quality outcome and know-how developed from the project are counter balancing the perception of the project success

Box 1 (continued)

- ✓ The marginal risk is found high for each factor. The values are found close to 0.5. This should be read like there are 50% chances for each factor to have an impact and have the project (or sub-project within the project) fail.
- ✓ There is no statistical differences between managers and non-managers in the perception of project success
- ✓ The financial losses (doubtful debts) are proposed to be converted by calculating them like:
  residual risk * revenues * severity rate
- ✓ That is to say for the socio-cultural factor, there is a probability of 14.01 euros to have financial losses for every 100 euros revenues considering a severity rate of 0.3. 0.3 may be considered as minor, 0.1 would be considered as trivial and 1 as catastrophic or fatal to the business.

7 DISCUSSION OF THE RESULTS

7.1 Project success

The project success was found moderate success. This confirms the fact that the project is indeed behind many obvious indicators. In fact the budget and time metrics were very negative. This is no surprise. This is a clear failure. However the labor availability and new market penetration we around zero. This emphasizes two things. First that the Kyoto protocol brought confidence to the market that nuclear new build was a good option to reduce carbon dioxide emission and cope with electricity demand and second that despite that the impression that competence were lost, this is not actually totally accurate. However, Fukushima event has clearly impacted severely the nuclear industry. Lastly, the score for the end-user is to be satisfied with the end-product shows that after that something which counts in measuring the success of such project. This echoes the fact that this type of reactor is built to be operated for sixty years and therefore must be safe for the public for sixty years.

However, we recognize that taking a more comprehension view, the project is perceived positively by stakeholders. This is specific to nuclear new build which is obviously very long-term oriented. The modern reactors are design to be operated for sixty years.

7.2 Probability of risk of the influencing factors

We found by an empirical method the probabilities of each managerial factor to occur. Each of this managerial constitutes an event. We will be considering different cases in the conclusion.
This depends on the events are considered.
We may consider that the events are independent or dependent, joint events or disjoints events.
Independent event mean that the occurrence of one event does not affect the probability of the other to occur, dependent event occur on conditional basis upon other events.
Mutually exclusive means that the events are disjoints. They cannot occur simultaneously.
Event that is not mutually exclusive means they can occur simultaneously, they are joint events.
They may constitute or not a collective exhaustive set of events. This means can one of event must occur. In this research, it has not however been proven that the managerial factor must occur. We have shown that if they occur, the probability of make the inspection fail is about 0.5.
This corresponds to the marginal probability of each factor to occur.

7.3 Mitigation procedures

The mitigation rate α is to be achieved by the firms. The main objective for the firms is to manage the risks. It can include risk removal, risk transfer or reduce the likeli-

hood and the potential consequences. The more control of one mitigation measure on one risk the more effective the measure is (Wang, Dulaimi & Aguria 2004, 239).
Each risk factor can be first mitigated differently and combined with a different severity rate between 0 and 1. Risk consequence, severity or impact represents an outcome generated from the risk event. Risk magnitude is the product of risk probability and consequence (Ahmed, Kayis & Amornsawadwatana 2007, 28). This is the risk assessment function.

Then the risk is converted into a bad debt in budget and forecast. This constitutes eventually potential financial losses when risks occur. Naturally, the higher the residual risks are, the higher the potential of financial losses are.

Mitigation procedures as explained earlier are a matter of strategy. As a matter of fact, strategies, to be efficient, have to be supported by top executives.

Unlike strategies put in place to achieve operational and financial results, mitigation procedures often require costs. This indicates the nature of contradiction that top managers may face. The risk appetite may blind their vision and offer a dilemma between investing in costs to avoid risks and avoid costs and maximize the gains.

However, firms must invest in mitigation measures and monitor their effectiveness. Managers who are responsible for mitigation measures should follow the principles of avoid the risks, reduce the risks, transfer the risks or accept the risks.
As mitigation measures, one can for example think of appointing a risk manager, have the whole supply chain assess their own risks, or implement an effective work supervision strategy for critical components. As well, mitigation measures could be approved at corporate level, such as reasonable budget assumptions, insurance strategy (risk transfer), third party supervision, reasonable expectations on profit margin by including the residual risks as doubtful debts. Liability risk, operate in a country which has not ratified the Vienna convention on civil liability for nuclear damage constitute a residual risk which must be documented in budget calculation.
The contribution from human resources professionals is often neglected in risk management, but they have a great role to play in effective organization. Human re-

sources are to add value within organizations and be a strategic partner to achieve company's target.

In a competitive market, firms are generally encouraged to take risks hoping to generate gains and successes. However, the risk appetite is a strategy. Corporate leaders should be accountable for the risk appetite.

7.4 Risk appetite

The risk appetite is the amount of risk, on a broad level, an organization is willing to accept in pursuit of value. The reader may recall the managers had four strategies to manage the risks. One of them was to accept the risks. This is where risk appetite takes its source.

Each organization pursues various objectives to add value and should broadly understand the risk it is willing to undertake in doing so (Rittenberg & Martens 2012, 1). This may be in fact part of a strategy. A company might be willing to accept taking a certain amount of risks in order to obtain tangible results. Previous research showed that top executives are not too keen on taking tremendous risks. Most organizations in their budgeting phase are willing to take risks only if they are measured and managed

This can explain why the awareness of risks is in fact not at level.

7.5 Awareness of residual risks

The research could only show that the actual level of risks was still high. One explanation is perhaps due to lack of experience of similar projects.

The risk appetite and the risk mitigation were perhaps not well appreciated during budget assumption phases. In fact, developing a risk appetite is not a wrong approach. It is about managing the organization, hit objectives and bring potential dividends to shareholders. However for that, the mitigation procedures must be evaluated on a regular basis to avoid any pitfalls.

7.6 Cost drivers

Detailed budgets for large projects must be effective to control the costs, coordinate the activities across the units, for effective planning, and for profits (return of investment).
Cost of ownership can be defined as cost of control. They are the costs to mitigate the risks. The costs of ownership are related to (1) contracting costs, (2) the decision making costs, and (3) the risk-bearing costs. In fact, the residual risks discussed in this research can be associated to the costs of ownership. Managing the costs can be also an effective way to reduce the risks.
Ellram (1993, 49) explains that total cost of ownership (TCO) represents a philosophy which aims at understanding the total cost of a purchase from a particular supplier. Hence the understanding of the cost of ownership for a nuclear vendor or supplier is essential for the supply chain to be effective.
She proposes a framework to implement TCO methodology. Ellram is also very explicit: she stated clearly that effective implementation of total cost of ownership modeling depends heavily on the use of activity-based costing methodologies.

The total cost of ownership methodology proposed by Ellram (1993, 53) is an eight-stage framework as shown in the figure 9.
The stage four is essential. It is made of cost identification, a selection of critical costs, gathering and developing cost data, and documentation.
Ellram (1993, 54) explains that selection of critical costs are related to cost of maintenance, cost of follow-up, cost of re-servicing, cost of rework, of cost of lost time due to defect correction.

This framework can link to the management of the supply chain. In case of the Olkiluoto 3 project but in general all new nuclear new build require a huge amount of equipment. The management of suppliers is a well-known aspect for new construction. As a matter of fact, the residual costs can appear as well at the suppliers' workshop where many of the components are produced. Similar risk management approach seems to be useful for managing and controlling the numerous sub-projects. The biggest challenge remains to aggregate all the sub-projects data into a manageable framework to drive the entire project to completion. This is easier said than done.

However, the nuclear industry seems confident that the learning curve has been now integrated among the professionals.

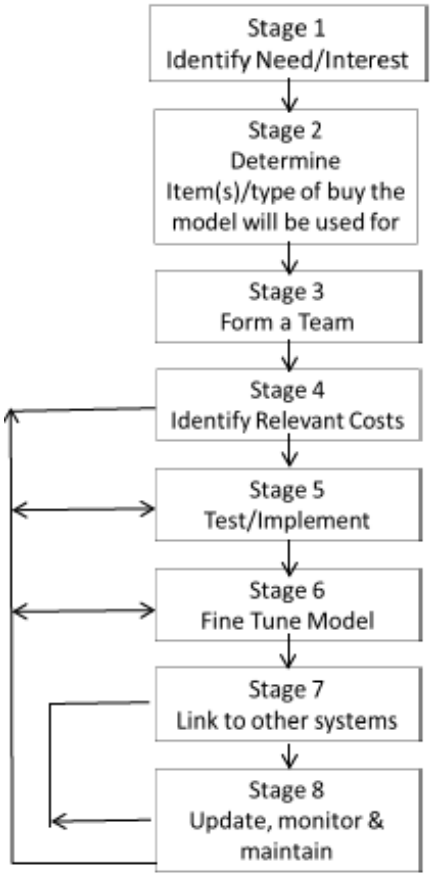

Figure 9. TCO methodology framework (Ellram 1993)

A Pareto approach could be used for example to group the costs in order to have something manageable. Now, in order to make this understandable for the reader, this research focuses on risk bearing costs. They are associated in this research to residual management risk factors. The cost drivers proposed here constitutes here surely a non-comprehensive list. It is meant to have a general understanding of the cost of ownership derived from the residual risks.

Instead, the author proposes simplified cost drivers overview presented in the table 8.

Table 8. Relationship between residual risks and costs driver

Residual risk / Factor	Cost driver
Socio-cultural	Training costs Labor rate
Economical	Raw material prices Depreciation Liability costs Inspection costs Taxes
Political, Legal, Technological and Environmental	Warehousing costs Shipping costs Tooling costs Redesign costs Rework costs Spare parts Repair costs Long-term maintenance costs Preventive maintenance costs Life of product costs
Network governance	Chain of decision costs Overheads (indirect costs) Advising costs Insurance costs Payment term
Ethical	Training costs Rejection costs Salaries/Benefits Safety costs Cost to change supplier (trust)

Table 8. (continued)

Residual risk / Factor	Cost driver
Communication	Translation fees Work efficiency costs (Rejection and re-work)

The labor cost is in fact a strong driver for cost of construction but as a residual risk. The labor costs very a lot between countries. A wrong estimate of labor costs can have dramatic impact on residual risks for instance re-work on components which require complicated manufacturing processes. According to the U.S. Bureau of Labor Statistics (United-States Department of Labor 2012), the hourly pay in 2012 for time worked in Finland is 23.06 euros, 18.89 euros an hour in France, about 1.84 euros an hour in China, 22.04 euros in the United-States and 24.36 euros in Germany. It is difficult to compare the figures between for instance China and Europe due to statistical method technique and the need for correction due to labor quality. It is worth noting however that in Poland, the hourly pay in 2012 is 4.69 euros. This short review of labor wages show that firms might be tempted to absorb part of the labor costs arising from residual risks by using cheaper labor force from cheaper European countries. Further research would be necessary to verify if cost adjustments is necessary due to sunken costs such as accommodation.

Geiger (1999) defined cost driver as a measure that is used to proportionally distribute the cost of activities to cost objects. He argued that effective selection of cost drivers can focus management attention on the process attributes that create cost. It is a factor that causes or related to a change in the cost of an activity.

Finally to complete the point discussed in 4.2, that complete observation of the cost of construction will allow better contracting terms, the residual risks will be reduced. The idea that better cost management including the cost of ownership derived from residual risks can be associated to better management practice. Be attentive to costs and budgets is a core aspect for project managers. However, oftentimes, top management associate costs with poor performance. That’s the reason why, the costs are not always evaluate correctly and underestimated. This can be explained by the too

short-term vision of top executives. I introduced in my hypothesis the notion of managerial myopia. This idea is also sometimes described in the groupthink syndrome. Top managers can be so persuaded that initial budget assumptions are correct, that true costs may simply be forgotten. Velasquez (2006, ii) explains that cost consciousness have been also associated to negative outcomes. He says, that cost consciousness positive result of being cost consciousness (1) enhance the evaluation of alternatives in terms of financial outcomes, (2) provoke a better monitoring of spending behavior of managers, (3) make management accountable in financial terms, (3) increase capabilities to rationalize and codify activities, (4) make a better understanding of costs, (5) improve the different capabilities associated with varying degrees of readiness.

7.7 Presentation of model of probability distribution

Now that we have found empirically the probability of each factor to occur, we will review the estimation of the marginal probability of the inspection to fail.
Let a sample space be Ω. Ω is the set of possibilities. Inspection fails or do not fail.
Let event H be the managerial factors to occur. Let the event A the failure of inspection.
P (Ω) = 1
The probability found P (Hi), is indeed the probability that the managerial factor occur and fail the inspection.
The author will review simplified cases to discuss possible probability distribution models.

Table 9. Probability of main factors Hi

Risk factor Hi	Probability (actual level of risk)
Socio-cultural	0.47
Economical	0.49

Table 9 (continued)

Risk factor Hi	Probability (actual level of risk)
Political, Legal, Technological and Environmental	0.45
Network governance	0.44
Ethical	0.46
Communication	0.47

7.7.1 Hypothetical case of an independent event, mutually exclusive and collectively exhaustive

We could typically use a probability tree generator here. The probability of events is defined by being the possibility of the condition 'OR'.

$$P(A) = \sum P(Hi)$$

In this particular hypothetical case, we estimate that in order for the event A to occur; only one factor has to occur. We consider six possibilities corresponding to the six factors and one corresponding to our observation made on radiographic inspection. The probability calculation would be as follow:

$$P(\text{inspection fails}) = \sum P(\text{influencing factors})$$

The numerical calculation is presented below:

$$P(\text{inspection fails}) = \frac{1}{6} * 0.47 + \frac{1}{6} * 0.49 + \frac{1}{6} * 0.45 + \frac{1}{6} * 0.44 + \frac{1}{6} * 0.46 + \frac{1}{6} * 0.47$$

Thus,

P (inspection fails) = 0.4633

The probability for the inspection to fail is the sum of probabilities of each occurring, thus 46.3%. This is a purely hypothetical case. In practice, the factors can occur at the same time and may influence or each other or not. In this case, the factor has equally the same chance to be distributed. In this case also, the events are collectively exhaustive meaning that one factor must occur. This is not the case in practice. There is a chance that no managerial factor occurs during the inspection.

7.7.2 Hypothetical case of an independent event, mutually exclusive, collectively exhaustive: Bernoulli distribution process

The socio-cultural factor, the economical factor, the technological, environmental, political or legal factor, the network governance factor, the ethical factor or the communication factor are independent, mutually exclusive (disjoint factors).
Mutually exclusive means that one or several factors cannot occur at the same time.
However, one occurrence is enough to have the inspection fails. The inspection can fail also if the all the events occur at the same time. In this case, we make the hypothesis that the factors can be combined in order to have the inspection failed. We model this by repeating the process like in the Bernoulli process.
They are still independent, if one factor occurs, it does not affect another factor to occur. The probability for the inspection to fail is the reunion of one or several factors combined with the probability of occurrence of only one factor.
As we found six managerial factors, there are sixty-three (63) possible combinations.

$$C_6^1 + C_6^2 + C_6^3 + C_6^4 + C_6^5 + C_6^6$$

Each of the managerial factors (events) can be mitigated of course.
As the events are independent we are allowed to write that:

P (socio-cultural factor and economical factor) = P (socio-cultural factor) * P (economical factor)

It is important to mention once more, that this case is a model. We suppose that the events (factors) are independent, mutually exclusive and exhaustive collectively. We suppose that the factors may be combined in order to have the inspection fail. The

process of distribution is repeated in order to apply the binomial distribution formula hereafter.

$$(x+a)^n = \sum_{k=0}^{n} \binom{n}{k} x^k a^{n-k}$$

A numerical example would be:

$$\text{P (A)} = C_6^2 * P\,(socio - cultural\ factor\ and\ economical\ factor)^2 * (1 - P\,(socio - cultural\ factor\ and\ economical\ factor))^{6-2}$$

Without any further mitigation

$$\text{P (A)} = 15 * 0.0530 * 0.3510 = 0.279$$

There is 27.9 % chance that the combination of socio-cultural and economical factor make the inspection fails.
If we consider a 0.3 severity rate, we obtain 8.40 euros bad debts as a residual risk for every 100 euros revenues.
With a 0.75 additional mitigation rate
P (A) = 15 * 0.0002072 * 0.9436 = 0.002933

There is 0.29% chance that the combination of socio-cultural and economical factor make the inspection fails.
If we consider a 0.3 severity rate, we obtain 0.0879 euros bad debts as a residual risk for every 100 euros revenues.

As a third example and to illustrate the findings in the conclusion part, the probability for the combination of three factors, a socio-cultural factor, a network governance factor and an ethical factor to occur and have the inspection fail is calculated as follow:

$$\text{P(A)} = C_6^3 * P(socio - cultural\ factor\ and\ network\ governance\ and\ ethical)^2 * (1 - P\,(socio - cultural\ factor\ and\ network\ governance\ and\ ethical))^{6-3}$$

The numerical calculation is:

P (A) = 20 * 0.0090 * 0.7409
P (A) = 0.1341

Thus, there are 13.4% chances that the combination of the three factors makes the inspection fails.

7.7.3 Dependent events

We could by using practical observation on radiographic inspection, take a defect rate of 0.5%.
Therefore, we can state that P (A) = 0.005. Conversely P ($\bar{A}$) = 1-005 = 0.995
Dependent events imply that the condition of occurrence of one event may depend upon the occurrence of another event. We have to introduce the notion of conditional probability. For instance:

$$P\ (\text{socio-cultural} \mid \text{economical}) = \frac{P\ (scocio{-}cultural\ and\ economical)}{P\ (economical)}$$

The probability of a socio-cultural factor given the economical factor equals the probability of both events to occur divided by the marginal probability of the economical factor to occur.

7.7.4 Dependent event and probability of the cause

We can calculate by using the Bayes' formula the probability of the cause.
In order to validate the results, the mitigation rate could be evaluated by the numbers of hours lost collected by experience.
Let's take for instance the example of inspection of a non-destructive inspection using radiographic inspection method.
The nature of risks can be a combination of:

Socio-cultural

Economic

Technological

Network governance

Communication

Ethical

The Bayes' formula states:

$$P(A_i \mid A) = \frac{P(A_i)\,P(A \mid A_i)}{\sum_{j=1}^{N} P(A_j)\,P(A \mid A_j)}$$

P (socio-cultural factor | inspection fail) = P (socio-cultural factor) * P (inspection fails | socio-cultural factor) / ∑ P (influencing factors) * P (inspection fails | influencing factors)

We may approximate:

P (inspection fails | socio-cultural factor) = P (inspection fails) = 0.005

The probability of each cause is summarized below in the table 10.

Table 10. Probability of each cause

Factors Hi	P (Hi)	P (Hi | A)
Socio-cultural	0.47	15%
Economical	0.49	15%
Political, Legal, Technological, Environmental	0.45	14%
Network governance	0.44	14%
Ethical	0.46	14%
Communication	0.47	15%

7.8 Summary and key findings

Box 2 What do the discussions tell us? Key findings

- ✓ Three models of distribution of probabilities (risks) have been discussed:
  - i. A simple random distribution of the risks: there is 46.3% that one a the factor cause a failure
  - ii. The probability distribution of the risks is the result of a combination of one or several factors. For instance for the combination of socio-cultural with network governance and an ethical factor, there is 13.4% chance that this combination cause a failure. Further research is needed to observe what combination of risks cause the failure
  - iii. A third model which introduce a cause and effect among factors. Further research is needed to observe the statistical correlation between the managerial factors.
  - iv. The model seems to limit the loss of net margin to the marginal value of the risk. This is explained by the rational behavior of the economic actors. If the financial losses are above, the factors must be sought in firms' (under) capabilities.

7.9 Further research

The estimation of probability of each cause may be lead to further research. We have estimated in the validity and reliability the probability of the event A (inspection fails) would require to estimate the actual probability of the inspection to fail factor by factor. I have estimated the residual risk based on mitigation rate common in industry practice should be much lower. This is obvious that the residual risk were

much higher. The research allowed us to determine the actual level of risk factor by factor.
This constituted a level of risk to mitigate. Mitigation is done factor by factor. The Bayes' formula has shown without any surprise an equal amount of risk by factors given the knowledge of A. This is due to the fact that the mitigation rate was taken in model based on industry practices. The true mitigation rate could be deducted by observing the actual probability of risk of each factor. The Bayes' formula will allow deducting the mitigation rate.

Bayes' formula is used to revise previously calculated probabilities based on new information (Levine, Krehbiel & Berenson 2010, 166). The formula is developed from the conditional probabilities. It is used to find the posterior distribution given the prior distribution (and likelihood).

Furthermore further studies could be carried out to seek for the probability of the managerial factors to occur given the knowledge of one to occur. Prior to this, statistical correlation between occurrences of the factors must be sought.

7.10 Cross-cultural and corporate culture

The project has been impacted without any doubt by cross-cultural issues. The research only showed that the actual level of risk is also high. As stated before, further research could be undertaken to measure the actual level of risk. We may find that mitigation measures were not actually sufficient.
Cross-cultural issues and corporate culture are rooted in Hofstede's research. Hofstede was a pioneer and build a powerful framework to better understand cultural differences. This is still very valid in the business world.
We may refer here to power distance or uncertainty avoidance dimensions to explain the need for risk management in further project.

7.11 Network governance

The network governance has been introduced by Ruuska, Artto and Lehtonen (2009, 142-153).
Network follows its own life-cycle. We must recognize that project networks could decline due to disturbances. Relationships decline and may lead to create distances between project actors. Project practices lead then to incomplete information, lack of trust, miscommunication and inappropriate decisions.

We see that implication ethics as managerial factors is at the same level of other factors. This may be surprising for a project such like that. In fact Lau and Rowlinson (2011, 633-659) showed in their research that cost, quality and time can be effectively managed with the help of trust relations. For example, Lau and Rowlinson's research pointed that commitment by all levels, quick answers, providing technical feasible solutions, getting paid for changes were situations which displayed trust.

7.12 Lessons learned

Many events caused risks, many rounds of inspections and over costs.
The reasons may be due to unachieved detailed design, too ambitious original schedule (not realistic project assumptions), inadequate completion of design and engineering work prior to start of construction. The technological uncertainty was enhanced by a lack of experience.

To quote Laaksonen (2010), TVO's key persons had worked in expert duties during construction and commissioning of the operating units but none of them had hands-on-experience from management of a large construction project. It is evident that before signing the main contract, none of the two parties, Areva and TVO, adequately appreciated the key role of an experience construction company for the success of the project. Furthermore, it seems that TVO was not adequately aware of the limitations in the capabilities of the potential vendors and the actual status of the available designs. Target set for the construction time in the call for bids was therefore not realistic.

Lastly our research showed that there were no statistical evidence that how managers and non-managers perceived the project success. This is in fact good news as the future of nuclear new build projects need consistency and strong team spirit.

7.13 Validity and reliability of the research

In scientific research, the question of validity can be tested by posing the assertability question.
Firstly what evidence would justify me in asserting the conclusion I made?
Secondly, could the premises be true and the conclusion false?

The particularity of a case study can introduce valid questions regarding the validity and reliability of the research. Indeed, one can argue that because the data were gathered on one single case the conclusions cannot be generalized. The delicate question of construct validity of the research is posed once the grounds of the research are failing to justify the theory.

However, I argue that data were gathered from a primary source of data and are considered as precise and detailed as the case study can be.

Merriam (1985) offers several suggestions for how case study researchers might actively combat the popular attacks on the validity, reliability, and generalizability of case studies:

- Prolong the processes of data gathering
- Use of variety of data sources
- Collect referential materials
- Engage in peer consultation

To consider this research as valid and reliable, one must evaluate the criteria of overall significance, relevance, impact and usefulness of the research findings.

Once can argue that validity and reliability can be solidity of the observations, verification of the findings and logic of the argumentation.
The data are considered reliable solid as the case study allow collecting data from living and active projects. The sample even though small, it can be considered strong enough to be representative of the population.

The conclusions of this study are justified and obtain with logical deduction.
The theory has been gathered by academic papers and books. A scientific method has been followed to measure the project success. The method was proven to be reliable from previous research.
Reliability may be seen weak if the sources employed are not multiple. The questionnaire may have been biased or redundant. As well, critically the answers may be have been obvious or forced. The respondent rate was 26% which is in line with regular academic research. Also, the researcher acknowledges that the managerial factors are a simplified framework to generalize any findings. However, the results offer a useful approach for project managers to integrate in their managerial practices.
Lastly errors may have occurred in the sample selection, but results found to be consistent.

Further, to prove that the research is valid and reliable, the researcher has eight experiences on this project and thus has gathered a deep understanding on managerial forces.

Validity of the reasoning

Going back to assertability questions, I will try to test the conclusion by answering:
What evidence would justify me in asserting the conclusion I made?
The findings of the research are that the level of risks of found very high, and in fact almost not mitigated at all. Can this result be generalized? Certainly not. But the evidence is clearly that the project has doubled its budget and that the schedule went from four years to ten years of construction.
Secondly, could the premises be true and the conclusion false?
As already stated, the model, in fact the managerial factors, was simplified. It is likely possible that the risk factors are too simplified. A true reasoning does not guaran-

tee a valid conclusion; also true premises do not guarantee a valid conclusion. To answer the second question, given the managerial factors, the conclusion being the residual risks are high and have not been mitigated to a reasonable level cannot be false.

The results show that all the factors are a potential risk, and this is not a surprise. This is the nature of industrial venture.

If ten years ago, one would have said that in fact the costs will be double and the construction time would be ten years, no project would have been undertaken.

This statement is valid for all industrial projects that human beings have undertaken. This is our very nature: to take risks, step into uncertain ventures, to innovate. That is our very particular ability to make decisions which make our civilization to evolve.

To conclude the validity and reliability part, the reader must be aware that the current project used for this case study is obviously subject to particular disputes and therefore a lot of information remains confidential. Of course, conducting qualitative interviews could have brought more validity to the conclusions, but the researcher was convinced that this type of data gathering was ethically challenging as many of the information cannot be disclosed.

8 CONCLUSIONS

The objectives of this research presented in the introduction were to identify the possible sources of failures of large project implementation and to determine if the socio-cultural factor gives positive or negative influence to planning and budgeting. The result of the research showed that the project success is in fact made of objective and subjective metrics. It has proven that at least for high complexity projects, the customer satisfaction criterion was essential. Despite enormous delays and over cost, the project success was found moderate. The result of the statistical analysis on the data showed also that there were no statistical correlation between managers and non-managers in the perception of the project. Thus, the conclusion can be made that the level of managerial risks which remains are not the result of any managerial myopia. This invalidates the first hypothesis. The first of my research questions was

how effective planning and budgeting contributes to success of large projects? The first variable tested was found to contribute largely to the success of the project. In this case, quite negatively. After statistical test, the first variable is found in fact to not follow a normal distribution. This shows clearly that there is a consensus to state that budgeting and planning contribute mostly to the project success. However, other criteria counts and contribute to find the project success moderate. For instance, the contribution to the future well-being of the society. The research showed also that the level of residual risks was high and therefore the correlation between project success and managerial factors was established. However, the research could not prove that the socio-cultural factor was the only contributor to the non-success of the project. Similarly, the communication factor is obviously interacting with socio-cultural factor. Both factors are found to have a marginal residual risk high. The combination of the two factors has a different probability to contribute to non-success of the project. Further studies will be necessary to quantify this combination.

Lastly a model is proposed to estimate the distribution of the risks by acknowledging the fact that the variables are dependent. The occurrence of one variable may influence in particular another variable. Further research can be done to determine the statistical correlation between the managerial factors and project success. Thus, a combination of specific factors may contribute strongly to non-success of the project. The overall conclusion which can be deducted is that the marginal risk of all factors is found at the same level and high. The deduction then can be made that that they are all equally important as marginal risk, and all the factors were not mitigated a sufficient level to avoid the failure of the success. The combination of three factors (socio-cultural, network governance and ethical) was for example by using a binomial distribution, found that there is 13.4% chance that this combination provokes a failure. The notion of severity is also introduced to discuss how severe the failure is. A minor failure is perhaps ‘’rather normal’’ is industrial project. However, a fatal severity can have a serious financial impact on the firms. The example showed also, that with a 75% mitigation rate, which is a very good figure, the probability drops quite significantly. This proves that since the marginal risks are high in a cutting-edge project such Olkiluoto 3, stronger efforts to mitigate risks would pay off.

Certainly, the result of the moderate success however found may be surprising for the reader. As said earlier, the explanation lies in the fact that the project meets high quality requirements for the project actors. This is proven by the positive score of the

two variables tested (i) the project meets high performance and quality and (ii) the end-used is to be satisfied with the end-product (output). The responsibility of such project towards public and environment is extremely high. This behavior is actually the result of high level of consciousness of nuclear safety from the project actors. In others words, the result showed that the level of attitude towards quality is at right level.

Reflective examples and managerial suggestions

Based on the research findings, some practical implications will be here analyzed and some managerial propositions will be formulated.

One of the examples mentioned by Laaksonen (2010) was that detailed design was not yet achieved when the constructed started. This has caused due to socio-cultural factor and technological factor much over costs and delays. The level of understanding about the outcome was polluted by misunderstandings caused by culture differences. The sufficient level of technical and business English was a major factor. The leadership skills for cross-cultural situation were missing. For instance in high assertive country type such as Latin Europe, the business relationships are aggressive and conflictive. This is in total opposition to the Nordic countries which score low on assertiveness according to Hofstede's studies. The relationship between leaders and followers must be adapted to the socio-cultural context. Some culture value most the leaders who are task-oriented. Some culture value most the leaders who are people-oriented. Kirkpatrick and Locke (1991) propose a set of skills that a leader should have in order to be efficient. Those are drive, motivation, integrity, confidence, cognitive ability and task knowledge.

A second reflective example shows implication of network governance and socio-cultural factor. Corporate governance of large companies affects the overall strategy and risk appetite. German firms have at first glance a stakeholders' oriented approach. Their top managers will be equally interested and competent in production processes and financial statement. However top managers working in French firms are more shareholders' oriented. That is to say, that French top managers are primary focused on financial statements and maximize shareholders' interests.

A review of a last example shows that a lot of additional work causing delays and over costs have been done due to several factors. One can think of poor communication of requirements along the supply chain, lack of leadership skills in a complex socio-cultural environment. The poor requirements along the chain have caused for example fabrication delays.

Network governance performance has also suffered due to extremely long time schedule. This is actually a consequence of previous causes.
According to Porter, network life-cycle follow several state from birth, growth, maturity and decline. Not surprisingly to recover from a network decline is very delicate.
The complexity of such major constructions obviously necessity not standardized cost methodology. The purpose of the research was to propose a first understanding of a risk approach strategy during the construction of new nuclear power plant.

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APPENDIX 1

Annex 1. Questionnaire

OL3 case study - Success rate and factors of performance v.2

Introduction

Dear Sir or Madam, I am an MBA student at SAMK. I am seeking your cooperation for my project research on OL3 case study. This will take about 15 minutes. The project seeks to determine strategies for risk management in planning and budgeting Third Party Inspections for large cutting edge industrial projects. This survey will be accessible until 16.03.2015
Yours Sincerely Jérôme Desavelle

OL3 Project success performanc...

Time schedule
Please respond to the following statements by indicating the extent to which you agree or disagree with the statement. Tick the appropriate answer that most closely corresponds to your choice.

Time schedule: The project meets the initial overall schedule*

○ Strongly Disagree ○ Disagree ○ Neither agree nor disagree ○ Agree ○ Strongly Agree

Time schedule: Material availability was well managed*

○ Strongly Disagree ○ Disagree ○ Neither agree nor disagree ○ Agree ○ Strongly Agree

Time schedule: Labor availability was well managed*

○ Strongly Disagree ○ Disagree ○ Neither agree nor disagree ○ Agree ○ Strongly Agree

Time schedule: The project' milestones are or were accurate throughout the life of the project*

○ Strongly Disagree ○ Disagree ○ Neither agree nor disagree ○ Agree ○ Strongly Agree

Time schedule: Rework time schedules were well managed*

○ Strongly Disagree ○ Disagree ○ Neither agree nor disagree ○ Agree ○ Strongly Agree

OL3 Project success performanc...

Budget
Please respond to the following statements by indicating the extent to which you agree or disagree with the statement. Tick the appropriate answer that most closely corresponds to your choice.

Budget: The project is in line with budget*

○ Strongly Disagree ○ Disagree ○ Neither agree nor disagree ○ Agree ○ Strongly Agree

Budget: The profit exceeded plans*

○ Strongly Disagree ○ Disagree ○ Neither agree nor disagree ○ Agree ○ Strongly Agree

Budget: The profits exceeded similar projects*

○ Strongly Disagree ○ Disagree ○ Neither agree nor disagree ○ Agree ○ Strongly Agree

Budget: The project has realistic budget assumptions*

Strongly Disagree Disagree Neither agree nor disagree Agree Strongly Agree

OL3 Project success performanc...

Project Efficiency
Please respond to the following statements by indicating the extent to which you agree or disagree with the statement. Tick the appropriate answer that most closely corresponds to your choice.

Project Efficiency: The project is managed in a efficient manner*

Strongly Disagree Disagree Neither agree nor disagree Agree Strongly Agree

Project Efficiency: Project performance metrics were in good alignment with customer feedback*

Strongly Disagree Disagree Neither agree nor disagree Agree Strongly Agree

OL3 Project success performanc...

Business Success
Please respond to the following statements by indicating the extent to which you agree or disagree with the statement. Tick the appropriate answer that most closely corresponds to your choice.

Business Success: The project contributes to increase business success of the project actors*

Strongly Disagree Disagree Neither agree nor disagree Agree Strongly Agree

Business success: The project created new market penetration*

Strongly Disagree Disagree Neither agree nor disagree Agree Strongly Agree

OL3 Project success performanc...

Futur potential
Please respond to the following statements by indicating the extent to which you agree or disagree with the statement. Tick the appropriate answer that most closely corresponds to your choice.

Futur potential: The project contributes to well being of the society*

Strongly Disagree Disagree Neither agree nor disagree Agree Strongly Agree

Futur potential: The project developped new knowledge and expertise*

Strongly Disagree Disagree Neither agree nor disagree Agree Strongly Agree

Futur potential: The project generated positive reputation*

Strongly Disagree Disagree Neither agree nor disagree Agree Strongly Agree

OL3 Project success performanc...

Performance, quality and safety
Please respond to the following statements by indicating the extent to which you agree or disagree with the statement. Tick the appropriate answer that most closely corresponds to your choice.

Performance: The project meets high performance and quality*

Strongly Disagree Disagree Neither agree nor disagree Agree Strongly Agree

Performance: The end-user is to be satisfied with the end-product (output)*

Strongly Disagree | Disagree | Neither agree nor disagree | Agree | Strongly Agree

Performance: The project meets high performance on workers' health and safety*

Strongly Disagree | Disagree | Neither agree nor disagree | Agree | Strongly Agree

Performance: The project meets high performance on environmental standards*

Strongly Disagree | Disagree | Neither agree nor disagree | Agree | Strongly Agree

Can you tell about your group?

Are you ?*

- Manager
- Other

Influencing factors - Socio-Cu...

Using your experience

Socio-cultural,
The leadership skills in a socio-cultural context has a great influence on the overall project success (Rank the importance of influence of the statement in regards to the project success)*

- no influence at all
- very unlikely to influence
- unlikely to influence
- the chance of the factor to influence or not is exactly the same
- likely to influence
- highly likely to influence
- systematic influence

Socio-cultural,
The leadership skills in a socio-cultural context has a great influence on the overall project success (Rank the chance that the statement in the project context fails)*

- never happens
- not very likely to happen
- not likely to happen
- the chance of occurence of the statement to never happen and to always happen is the same
- likely to happen
- very likely to happen
- always happen

Socio-cultural,
The relationship between leader and followers in a cross-cultural situation has a great influence on the overall project success
(Rank the importance of influence of the statement in regards to the project success)*

- no influence at all
- very unlikely to influence
- unlikely to influence
- the chance of the factor to influence or not is exactly the same
- likely to influence
- highly likely to influence
- systematic influence

Socio-cultural,
The relationship between leader and followers in a cross-cultural situation has a great influence on the overall project success
(Rank the chance that the statement in the project context fails)*

- never happens
- not very likely to happen
- not likely to happen
- the chance of occurence of the statement to never happen and to always happen is the same
- likely to happen
- very likely to happen
- always happen

Socio-cultural,
The hierarchy structure (power distance) within organizations has a great influence on the overall project success
(Rank the importance of influence of the statement in regards to the project success)*

- no influence at all
- very unlikely to influence
- unlikely to influence
- the chance of the factor to influence or not is exactly the same
- likely to influence
- highly likely to influence
- systematic influence

Socio-cultural,
The hierarchy structure (power distance) within organizations has a great influence on the overall project

success
(Rank the chance that the statement in the project context fails)*

- never happens
- not very likely to happen
- not likely to happen
- the chance of occurence of the statement to never happen and to always happen is the same
- likely to happen
- very likely to happen
- always happen

Socio-cultural
The cross-cultural communication has a great influence on the overall project success
(Rank the importance of influence of the statement in regards to the project success)*

- no influence at all
- very unlikely to influence
- unlikely to influence
- the chance of the factor to influence or not is exactly the same
- likely to influence
- highly likely to influence
- systematic influence

Socio-cultural
The cross-cultural communication has a great influence on the overall project success
(Rank the chance that the statement in the project context fails)*

- never happens
- not very likely to happen
- not likely to happen
- the chance of occurence of the statement to never happen and to always happen is the same
- likely to happen
- very likely to happen
- always happen

Influencing factors - Economic...

From your experience,

Economical (budget, planning, resources)
The proper preparation of the planning has a great influence on the overall project success
(Rank the importance of influence of the statement in regards to the project success)*

- no influence at all

- very unlikely to influence
- unlikely to influence
- the chance of the factor to influence or not is exactly the same
- likely to influence
- highly likely to influence
- systematic influence

Economical (budget, planning, resources)
The proper preparation of the planning has a great influence on the overall project success (Rank the chance that the statement in the project context fails)*

- never happens
- not very likely to happen
- not likely to happen
- the chance of occurence of the statement to never happen and to always happen is the same
- likely to happen
- very likely to happen
- always happen

Economical (budget, planning, resources)
The clear statement of the requirements has a great influence on the overall project success (Rank the importance of influence of the statement in regards to the project success)*

- no influence at all
- very unlikely to influence
- unlikely to influence
- the chance of the factor to influence or not is exactly the same
- likely to influence
- highly likely to influence
- systematic influence

Economical (budget, planning, resources)
The clear statement of the requirements has a great influence on the overall project success (Rank the chance that the statement in the project context fails)*

- never happens
- not very likely to happen
- not likely to happen
- the chance of occurence of the statement to never happen and to always happen is the same
- likely to happen
- very likely to happen

- always happen

Economical (budget, planning, resources)
Realistic expectations have a great influence on the overall project success
(Rank the importance of influence of the statement in regards to the project success)*

- no influence at all
- very unlikely to influence
- unlikely to influence
- the chance of the factor to influence or not is exactly the same
- likely to influence
- highly likely to influence
- systematic influence

Economical (budget, planning, resources)
Realistic expectations have a great influence on the overall project success
(Rank the chance that the statement in the project context fails)*

- never happens
- not very likely to happen
- not likely to happen
- the chance of occurence of the statement to never happen and to always happen is the same
- likely to happen
- very likely to happen
- always happen

Economical (budget, planning, resources)
Sufficient resources have a great influence on the overall project success
(Rank the importance of influence of the statement in regards to the project success)*

- no influence at all
- very unlikely to influence
- unlikely to influence
- the chance of the factor to influence or not is exactly the same
- likely to influence
- highly likely to influence
- systematic influence

Economical (budget, planning, resources)
Sufficient resources have a great influence on the overall project success
(Rank the chance that the statement in the project context fails)*

- never happens

- not very likely to happen
- not likely to happen
- the chance of occurence of the statement to never happen and to always happen is the same
- likely to happen
- very likely to happen
- always happen

Influencing factors - Network ...

From your experience,

Network governance (project size)
The involvement of the user have a great influence on the overall project success
(Rank the importance of influence of the statement in regards to the project success)*

- no influence at all
- very unlikely to influence
- unlikely to influence
- the chance of the factor to influence or not is exactly the same
- likely to influence
- highly likely to influence
- systematic influence

Network governance (project size)
The involvement of the user have a great influence on the overall project success
(Rank the chance that the statement in the project context fails)*

- never happens
- not very likely to happen
- not likely to happen
- the chance of occurence of the statement to never happen and to always happen is the same
- likely to happen
- very likely to happen
- always happen

Network governance (project size)
The distance between project actors have a great influence on the overall project success
(distance can be seen as social, physical, cultural or temporal)
(Rank the importance of influence of the statement in regards to the project success)*

- no influence at all
- very unlikely to influence
- unlikely to influence

- the chance of the factor to influence or not is exactly the same
- likely to influence
- highly likely to influence
- systematic influence

Network governance (project size)
The distance between project actors have a great influence on the overall project success (distance can be seen as social, physical, cultural or temporal)
(Rank the chance that the statement in the project context fails)*

- never happens
- not very likely to happen
- not likely to happen
- the chance of occurence of the statement to never happen and to always happen is the same
- likely to happen
- very likely to happen
- always happen

Network governance (project size)
The support of the executive management have a great influence on the overall project success
(Rank the importance of influence of the statement in regards to the project success)*

- no influence at all
- very unlikely to influence
- unlikely to influence
- the chance of the factor to influence or not is exactly the same
- likely to influence
- highly likely to influence
- systematic influence

Network governance (project size)
The support of the executive management have a great influence on the overall project success
(Rank the chance that the statement in the project context fails))*

- never happens
- not very likely to happen
- not likely to happen
- the chance of occurence of the statement to never happen and to always happen is the same
- likely to happen
- very likely to happen
- always happen

Influencing factors - Politica...

From your experience,

Political, Legal, Technological and Environmental
The legal requirements have influenced the time frame
(Rank the importance of influence of the statement in regards to the project success)*

- no influence at all
- very unlikely to influence
- unlikely to influence
- the chance of the factor to influence or not is exactly the same
- likely to influence
- highly likely to influence
- systematic influence

Political, Legal, Technological and Environmental
The legal requirements have influenced the time frame
(Rank the chance that the statement in the project context fails)*

- never happens
- not very likely to happen
- not likely to happen
- the chance of occurence of the statement to never happen and to always happen is the same
- likely to happen
- very likely to happen
- always happen

Political, Legal, Technological and Environmental
The technological and environmental factors have a great influence on the overall project success
(Rank the importance of influence of the statement in regards to the project success)*

- no influence at all
- very unlikely to influence
- unlikely to influence
- the chance of the factor to influence or not is exactly the same
- likely to influence
- highly likely to influence
- systematic influence

Political, Legal, Technological and Environmental
The technological and environmental factors have a great influence on the overall project success
(Rank the chance that the statement in the project context fails)*

- never happens
- not very likely to happen
- not likely to happen
- the chance of occurence of the statement to never happen and to always happen is the same
- likely to happen
- very likely to happen
- always happen

Influencing factors - Communic...

From your experience,

Communication

Communication of a clear vision and precise objectives have a great influence on the overall project success (Rank the importance of influence of the statement in regards to the project success)*

- no influence at all
- very unlikely to influence
- unlikely to influence
- the chance of the factor to influence or not is exactly the same
- likely to influence
- highly likely to influence
- systematic influence

Communication

Communication of a clear vision and precise objectives have a great influence on the overall project success (Rank the chance that the statement in the project context fails)*

- never happens
- not very likely to happen
- not likely to happen
- the chance of occurence of the statement to never happen and to always happen is the same
- likely to happen
- very likely to happen
- always happen

Communication

Communication of information between project actors have a great influence on the overall project success (Rank the importance of influence of the statement in regards to the project success)*

- no influence at all
- very unlikely to influence
- unlikely to influence

- the chance of the factor to influence or not is exactly the same
- likely to influence
- highly likely to influence
- systematic influence

Communication

Communication of information between project actors have a great influence on the overall project success (Rank the chance that the statement in the project context fails)*

- never happens
- not very likely to happen
- not likely to happen
- the chance of occurence of the statement to never happen and to always happen is the same
- likely to happen
- very likely to happen
- always happen

Influencing factors - Ethical

From your experience,

Ethical

Transparent relationships between actors have a great influence on the overall project success (Rank the importance of influence of the statement in regards to the project success)*

- no influence at all
- very unlikely to influence
- unlikely to influence
- the chance of the factor to influence or not is exactly the same
- likely to influence
- highly likely to influence
- systematic influence

Ethical

Transparent relationships between actors have a great influence on the overall project success (Rank the chance that the statement in the project context fails)*

- never happens
- not very likely to happen
- not likely to happen
- the chance of occurence of the statement to never happen and to always happen is the same
- likely to happen
- very likely to happen

- always happen

Ethical

Trust between project actors have a great influence on the overall project success (Rank the importance of influence of the statement in regards to the project success)*

- no influence at all
- very unlikely to influence
- unlikely to influence
- the chance of the factor to influence or not is exactly the same
- likely to influence
- highly likely to influence
- systematic influence

Ethical

Trust between project actors have a great influence on the overall project success (Rank the chance that the statement in the project context fails)*

- never happens
- not very likely to happen
- not likely to happen
- the chance of occurence of the statement to never happen and to always happen is the same
- likely to happen
- very likely to happen
- always happen

APPENDIX 2

Results of the descriptive statistical tests

Table 11. Descriptive statistics part 1

Variable	Descriptive Statistics OL3			
	Valid N	Mean	Minimum	Maximum
The project meets the initial overall schedule	27	-1,44444	-2,00000	1,000000
Material availability was well managed	27	-0,74074	-2,00000	1,000000
Labor availability was well managed	27	-0,11111	-2,00000	1,000000
The project' milestones are or were accurate throughout the life of the project	27	-1,11111	-2,00000	1,000000
Rework time schedules were well managed	27	-0,96296	-2,00000	1,000000
The project is in line with budget	27	-1,77778	-2,00000	0,000000
The profit exceeded plans	27	-1,29630	-2,00000	2,000000
The profits exceeded similar projects	27	-1,07407	-2,00000	1,000000
The project has realistic budget assumptions	27	-1,22222	-2,00000	1,000000
The project is managed in a efficient manner	27	-0,96296	-2,00000	1,000000
Project performance metrics were in good alignment with customer feedback	27	-0,51852	-2,00000	1,000000
The project contributes to increase business success of the project actors	27	-0,44444	-2,00000	2,000000
The project created new market penetration	27	0,03704	-1,00000	2,000000
The project contributes to well being of the society	27	0,18519	-2,00000	2,000000
The project developped new knowledge and expertise	27	1,14815	-1,00000	2,000000
The project generated positive reputation	27	-0,40741	-2,00000	2,000000
The project meets high performance and quality	27	0,22222	-2,00000	2,000000
The end-user is to be satisfied with the end-product (output)	27	0,44444	-1,00000	2,000000
The project meets high performance on workers' health and safety	27	1,07407	-1,00000	2,000000
The project meets high performance on environmental standards	27	1,03704	-1,00000	2,000000

Table 12. Descriptive statistics part 2

Variable	Descriptive Statistics (OL3)		
	Std.Dev.	Skewness	Kurtosis
The project meets the initial overall schedule	0,933700	1,66321	1,85014
Material availability was well managed	0,712125	0,26160	0,23840
Labor availability was well managed	0,800641	-0,27578	-0,28454
The project' milestones are or were accurate throughout the life of the project	0,933700	0,84673	-0,02024
Rework time schedules were well managed	1,055443	0,76951	-0,50822
The project is in line with budget	0,506370	2,32241	5,10120
The profit exceeded plans	1,067521	1,67444	2,52729
The profits exceeded similar projects	0,828619	0,58248	-0,11361
The project has realistic budget assumptions	0,800641	0,92326	0,76378
The project is managed in a efficient manner	0,979854	0,71639	-0,31030
Project performance metrics were in good alignment with customer feedback	0,893152	-0,11500	-0,60046
The project contributes to increase business success of the project actors	1,050031	0,38006	-0,27842
The project created new market penetration	0,939782	0,22256	-1,25819
The project contributes to well being of the society	1,075498	-0,59700	-0,69878
The project developped new knowledge and expertise	0,769800	-1,35999	3,07969
The project generated positive reputation	1,152231	0,24479	-0,88983
The project meets high performance and quality	1,012739	-0,72279	-0,05850
The end-user is to be satisfied with the end-product (output)	0,751068	-0,38491	-0,25140
The project meets high performance on workers' health and safety	0,675160	-0,89683	2,58533
The project meets high performance on environmental standards	0,587137	-1,23079	5,51589

Table 13. Descriptive statistics part 3

Variable	T-tests; Grouping: Are you? Group 1: Manager Group 2: Other Mean Manager	Mean Other	t-value	df	p	Valid N Manager	Valid N Other
The project meets the initial overall schedule	-1,18750	-1,81818	1,796964	25	0,084434	16	11
Material availability was well managed	-0,81250	-0,63636	-0,624032	25	0,538260	16	11
Labor availability was well managed	-0,12500	-0,09091	-0,106625	25	0,915938	16	11
The project' milestones are or were accurate throughout the life of the project	-0,93750	-1,36364	1,173670	25	0,251588	16	11
Rework time schedules were well managed	-0,75000	-1,27273	1,279913	25	0,212326	16	11
The project is in line with budget	-1,75000	-1,81818	0,337869	25	0,738283	16	11
The profit exceeded plans	-1,18750	-1,45455	0,631248	25	0,533608	16	11
The profits exceeded similar projects	-1,06250	-1,09091	0,085847	25	0,932272	16	11
The project has realistic budget assumptions	-1,12500	-1,36364	0,754654	25	0,457507	16	11
The project is managed in a efficient manner	-1,00000	-0,90909	-0,232527	25	0,818022	16	11
Project performance metrics were in good alignment with customer feedback	-0,50000	-0,54545	0,127453	25	0,899601	16	11
The project contributes to increase business success of the project actors	-0,37500	-0,54545	0,407759	25	0,686921	16	11
The project created new market penetration	0,00000	0,09091	-0,242464	25	0,810399	16	11
The project contributes to well being of the society	0,06250	0,36364	-0,707982	25	0,485505	16	11
The project developped new knowledge and expertise	1,12500	1,18182	-0,184911	25	0,854790	16	11
The project generated positive reputation	-0,31250	-0,54545	0,508776	25	0,615370	16	11
The project meets high performance and quality	0,31250	0,09091	0,551105	25	0,586454	16	11
The end-user is to be satisfied with the end-product (output)	0,50000	0,36364	0,456435	25	0,652018	16	11
The project meets high performance on workers' health and safety	1,12500	1,00000	0,465517	25	0,645591	16	11
The project meets high performance on environmental standards	1,12500	0,90909	0,936654	25	0,357897	16	11

Table 14. Descriptive statistics part 4

variable	Mann-Whitney U Test (OL3 measure of project success and influencing factors_02-24_27 answers v2.sta) By variable Are you? Marked tests are significant at p <,05000 Rank Sum Manager	Rank Sum Other	U	Z	p-value	Z adjusted	p-value	Valid N Manager	Valid N Other	2*1sided exact p
The project meets the initial overall schedule	250,5000	127,5000	61,50000	1,283006	0,199491	1,536234	0,124482	16	11	0,194506

Table 15. Descriptive statistics part 5

Variable	T-tests; Grouping: Are you? Group 1: Manager Group 2: Other Std.Dev. Manager	Std.Dev. Other	F-ratio Variances	p Variances	Levene F(1,df)	df Levene	p Levene
The project meets the initial overall schedule	1,108678	0,404520	7,511574	0,002785	10,80708	25	0,002997
Material availability was well managed	0,655108	0,809040	1,525154	0,445577	0,71172	25	0,406873
Labor availability was well managed	0,806226	0,831209	1,062937	0,886524	0,49013	25	0,490332
The project' milestones are or were accurate throughout the life of the project	0,997914	0,809040	1,521412	0,508446	0,01239	25	0,912250
Rework time schedules were well managed	1,064581	1,009050	1,113095	0,886881	0,04661	25	0,830817
The project is in line with budget	0,577350	0,404520	2,037037	0,258363	0,63750	25	0,432136
The profit exceeded plans	1,223043	0,820200	2,223536	0,204933	0,75048	25	0,394564
The profits exceeded similar projects	0,771902	0,943880	1,495232	0,466246	0,12221	25	0,729583
The project has realistic budget assumptions	0,718795	0,924416	1,653959	0,366591	0,56978	25	0,457399
The project is managed in a efficient manner	0,894427	1,136182	1,613636	0,389665	0,85083	25	0,365134
Project performance metrics were in good alignment with customer feedback	0,894427	0,934199	1,090909	0,851667	0,02310	25	0,880408
The project contributes to increase business success of the project actors	0,957427	1,213560	1,606612	0,393833	0,40211	25	0,531762
The project created new market penetration	0,894427	1,044466	1,363636	0,568861	0,23122	25	0,634799
The project contributes to well being of the society	1,236595	0,809040	2,336227	0,178821	3,61214	25	0,068950
The project developped new knowledge and expertise	0,718795	0,873863	1,478006	0,478572	0,47984	25	0,494878
The project generated positive reputation	1,302242	0,934199	1,943142	0,291151	2,26149	25	0,145155
The project meets high performance and quality	1,014479	1,044466	1,059993	0,890257	0,00383	25	0,951131
The end-user is to be satisfied with the end-product (output)	0,816497	0,674200	1,466667	0,547693	0,58631	25	0,451017
The project meets high performance on workers' health and safety	0,806226	0,447214	3,250000	0,065377	3,28993	25	0,081728
The project meets high performance on environmental standards	0,500000	0,700649	1,963636	0,230358	0,01047	25	0,919335