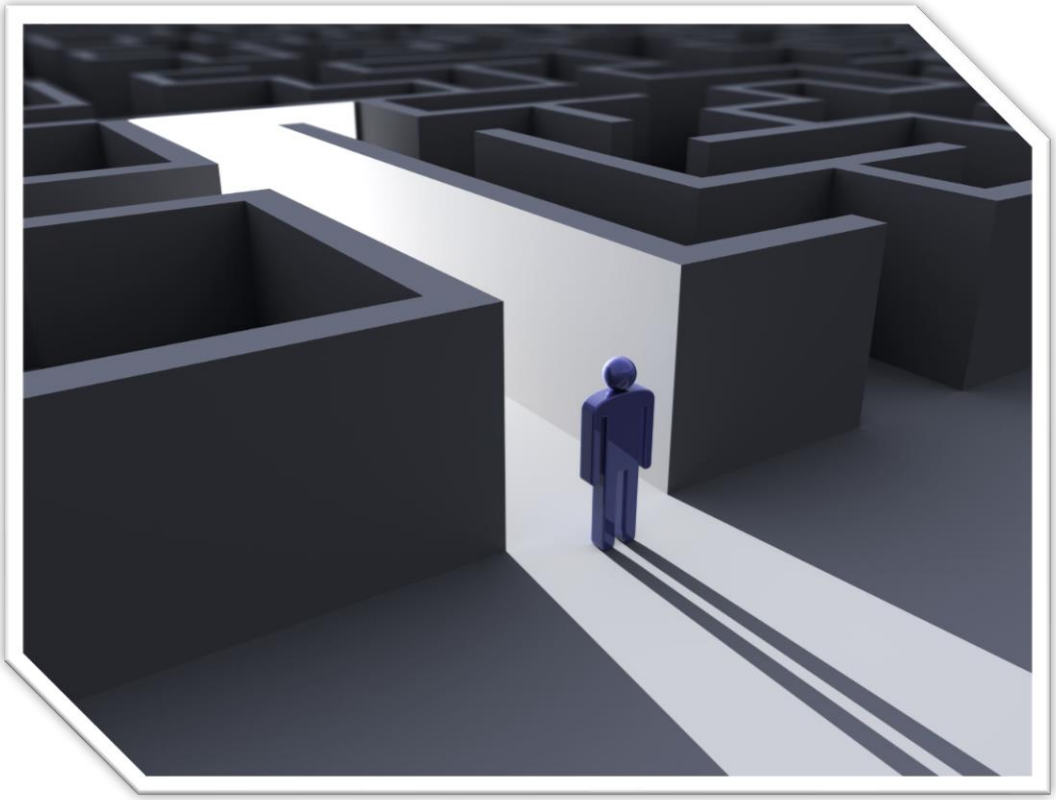

UNLOCKING INNOVATION: DEVELOPING DECISION MAKING FRAMEWORK FOR BIDDING PROCESS OF INNOVATIVE PROJECTS

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Unlocking innovation: developing decision making framework for bidding process of innovative projects

Thesis Report to obtain a Master's degree in Construction Management and Engineering at

Delft University of Technology, to be defended on the 10th June 2023 by

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Unlocking innovation: developing decision making framework for bidding process of innovative projects

Contents

Executive Summary

This master thesis is focused on developing a comprehensive decision-making framework for the bidding process of innovative projects in the EPC industry. The research explores the current literature on the bidding process, risks, uncertainties, managing risks during the bidding process, and decision-making. It identifies EPC contractors' internal and external challenges and provides insights into overcoming them. The research also assesses the risks associated with EPC contractors and provides recommendations for risk mitigation. One of the significant challenges in deciding whether to fund innovative projects is assessing the innovativeness level of the project. This assessment is crucial because more innovativeness means more unknowns and risks. Additionally, human factors play a significant role in decision-making since risks perception can vary from person to person. Therefore, a decision-making framework that encompasses all the factors involved in the bidding process for innovative projects is necessary. This thesis addresses three research questions: (1) How do you manage risks in the bidding process for innovative projects in the body of knowledge? (2) how are decisions taken during the bidding process by EPC contractors? Furthermore, (3) what are the challenges and opportunities for improving decision-making? Finally, the thesis proposes a new decision-making framework that integrates innovativeness assessment in the decision-making process by considering all the factors around such decisions. The structure of the thesis will be as follows:

Literature Review:

The literature review provides a comprehensive overview of the bidding process, risks, uncertainties, managing risks during the bidding process, and decision-making. The review identifies the key challenges and opportunities associated with bidding for innovative projects and proposes a first approach to a decision-making framework. The review also provides insights into the risks associated with innovative projects and offers recommendations for risk mitigation. What also found is that the is no decision-making framework to support the bidding process specifically for innovative projects. The literature review can be presented as a series of conclusions that can be categorized into three main sets. The first set revolves around the bidding process, risks, and innovation. The research finds that the current bidding process lacks a specific method to address new and emerging concepts in the field. Moreover, EPC Contractors face both internal and external risks that present challenges and opportunities. Unfortunately, the current system does not evaluate the degree of originality a project possesses. Thus, there is a need for a more comprehensive approach that incorporates innovative solutions into the bidding process. These findings raise further questions, such as how contractors bid for innovative projects and how EPC Contractors are being innovative. The second set of conclusions focuses on managing risks in the bidding process, emerging risks, and information. The research finds that innovation is often accompanied by a high degree of uncertainty, which in turn gives rise to unforeseen risks. Unfortunately, there is currently no established method for managing these "orphaned" or emerging risks. Furthermore, the issue of analysis paralysis can arise, preventing organizations from making informed decisions regarding potential risks. Thus, it is essential for companies to develop effective risk management tools to tackle the challenges posed by innovativeness. These findings raise further questions, such as how EPC Contractors protect the company from risks and which role innovativeness plays in the EPC Contractor’s approaches. The third set of conclusions focuses on decision-making. In making a bidding decision, several factors come into play, including firm-related factors, project-related factors, as well as market conditions and strategies. However, decision-making biases can result in the premature rejection of potentially innovative ideas when faced with uncertainty. This response to risk is influenced by individual behavioural characteristics and situational factors, leading to varied perceptions and evaluations of innovation projects. Effective risk management training, educational attainment, and role all play a

crucial role in identifying potential risks. Furthermore, fostering trial and error iterations can lead to better front-end innovation performance. Thus, to make informed decisions regarding entering new ventures, companies require a reliable decision-making framework. By minimizing the potential for emotional or miscalculated decisions, companies can create a culture that encourages trial and error, thereby incentivizing innovative ideas. Continuous improvement of the decision-making framework is achieved by utilizing an Experience Feedback Process, which allows companies to fine-tune the framework and make it even more effective.

Findings:

The empirical research is conducted through semi-structured formal interviews with relevant actors within a real multinational EPC contracting company, which for confidentiality is referred to as "ABC Company." The interviews were aimed to identify common themes and patterns from the subjective experience of the interviewees, trying to give a clear depiction of the various factors to consider when it comes to bid. And thus, giving the foundation to a universal pathway that can be applied to new case scenarios to improve the bidding process. The findings section provides a detailed analysis of the internal and external challenges faced by EPC contractors in the bidding process for innovative projects. The section also discusses the bidding process and provides insights on risk indicators to consider before bidding for a project. Additionally, the section explores approaches and tactics used by EPC contractors to overcome challenges and prepare for the future for the new market and assesses the risks associated with the innovative projects offering recommendations for risk mitigation. In conclusion, the interviews conducted revealed that the changing market and innovative projects are destabilizing the internal structures of EPC Contractors, exacerbating internal challenges with external ones. Clients, due to poor knowledge about the project, have unrealistic expectations from a technical and management point of view, and the availability of the supply chain is affected by the novelty of the project. Clients also behave in strategic ways, inviting more contractors to tender just to increase the level of competition or receive benchmarks, leading to a waste of resources for EPC contractors. To mitigate these risks, it is necessary to have open dialogue from the beginning and carefully manage and mitigate the project risks involved through the life cycle. Another way to avoid these strategic behaviours is to look out for risk indicators or red flags which are a set of indicators which give enough reason to drop a case and thus saving resources. These can be poor Invitation-to-Tender definition, no aftercare plans, the client is not interested in team composition, no gain in reputation or high reputation damage in case of failure, and so on. Empowering employees to propose solutions can serve as a catalyst for innovation in an organization, and internal competitions of fictitious innovative projects can encourage employees to think outside the box, fostering a culture of proactivity and empowering employees to propose solutions. Furthermore, this can help with the problem of dealing with unbalances in project portfolio between old market and new market but also with unbalanced teams. The reason of the unbalanced team problem is that experts need to be engaged with traditional projects since new project are just in small scale and thus easier for them. At the same time early career employees need to be trained by expertise and thus the need of balancing teams and portfolio at the same time. The success of an EPC contractor heavily relies on their ability to showcase their capabilities and recent successes through impactful advertisements, highlighting unique solutions, such as energy efficiency and clean energy innovations. EPC contractors must prioritize building a positive reputation to succeed in new sectors and projects. In sum, for a successful bid, the perfect alignment with the client lies at the core of the matter. Therefore, it is vital for an EPC contractor to assess their capabilities and resources to match the client's needs, and for all parties involved to be transparent and have a clear understanding of the potential risks and challenges associated with innovative projects to ensure successful execution.

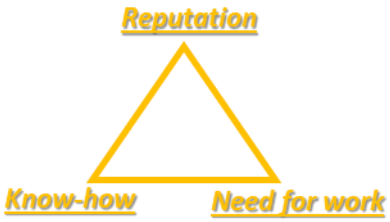
Towards a New Decision-Making Framework:

This research presents a decision-making framework for bidding on innovative projects, which represents the final milestone. The framework is designed to guide the bidding process by considering the level of innovativeness, risk perceptions, available information, and other factors that may influence the decision-making process. It provides a systematic approach to evaluating and selecting the most appropriate bids while minimizing risks and maximizing the potential for success.

The framework proposed in the literature review only gives a quick and superficial depiction of the decision-making process, and there is a need for a more comprehensive framework that considers the specific challenges faced by EPC contractors bidding on innovative projects. The bidding process in the body of knowledge involves the invitation to tender process and the bidding process, which must be carefully analyzed to determine if the company should proceed with making a proposal or halt the process to save resources. However, the authors of the framework did not consider that a company might have multiple ITTs at the same time, and also that there are many factors to consider when deciding whether to bid or not. Although other authors highlighted three main related factors such as firm-related factors, project-related factors, and market conditions and strategic considerations. The combination of the framework proposed by *Diego et al. (2012b)* and *Prajapati, Raju & Pitroda, Dr. Jayeshkumar & Bhavsar, Prof., (2015)* gives some understanding of the decision-making process, but it does not support specific innovation evaluation in the bidding process nor dives deep in the process. The research conducted in ABC Company provides a first selection criteria gathered from experts with different points of view in relation to the relative interviewees' profession. The interviews uncovered a set of unwritten "risk indicators" or "red flags" that are essential in distinguishing potential good opportunities from traps and avoiding a bid before even assessing the project per se such as a) The client does not precisely know what an EPC Contractor does. The client tries to put unrealistic responsibilities on the contractor, level of the definition of the Invitation to Tender document is poorly defined, the client does not worry about which people the contractor puts on the team, the project has no plan after completion, aftercare, or commercial plans, the client just hires the company for an early definition phase, the project will not bring reputation to the EPC Contractor, or even worse, harm its reputation, the client's lawfulness, ethics, and reputation are not aligned with values, safety is not one of the main concerns, ABC Company has zero presence in the project location, the country where the project will be done is unsafe for employees, the lump-sum contract is impossible for innovative projects with high uncertainty; thus, reimbursable is the only option. If not possible to use reimbursable, it is not wise to go through. This risk indicators are useful when an opportunity is presented because can save resources from assessing dead-end projects, this framework still assumes that the EPC Contractor is a passive actor waiting to receive the tender, whereas in the context of the innovation market, the EPC Contractor needs to be proactive and going for projects to learn. Therefore, a proposed new framework should start with an initial project opportunity generated by the company's proactivity or by the clients reaching out to the company. The opportunity shortlist is "filtered" through a "firewall" of risk indicators, a set of risk indicators to look out for. The main risk indicators are identified through the research conducted by ABC Company, and they should be included in the new framework. The framework should also consider internal challenges, the nature of the client, and other factors that may influence the decision-making process in the context of innovative projects. The new framework should provide a comprehensive guide for EPC contractors bidding on innovative projects, allowing them to maximize the potential for success while minimizing risks. From research, it is clear that careful consideration and balancing of various factors are required to make a bidding decision. While profitability is essential, it should not be the only factor considered. The acquisition of know-how and reputation through joint ventures and research and development is crucial for firms to continuously strengthen themselves, particularly in new markets.

The research illustrates the importance of a feedback loop between the strength of the firm and the need for work, emphasizing the need for a larger strategy that focuses on acquiring know-how and reputation. However, to select factors specifically for innovative projects and for gaining ground in a new market, a new Iron Triangle is proposed. The traditional Iron Triangle (time, cost, and scope) focuses on the constraints that project managers face, while the proposed triangle focuses on the factors that are crucial for strengthening the firm in a new market.

The new Iron Triangle consists of three factors: need-for-work, reputation, and know-how. Balancing these factors is essential for success in innovative projects. For instance, even if there is a strong need-for-work, a project manager may struggle to secure funding and support without a strong reputation. Similarly, even with a strong reputation, a project manager may struggle to deliver a successful project without the necessary know-how.

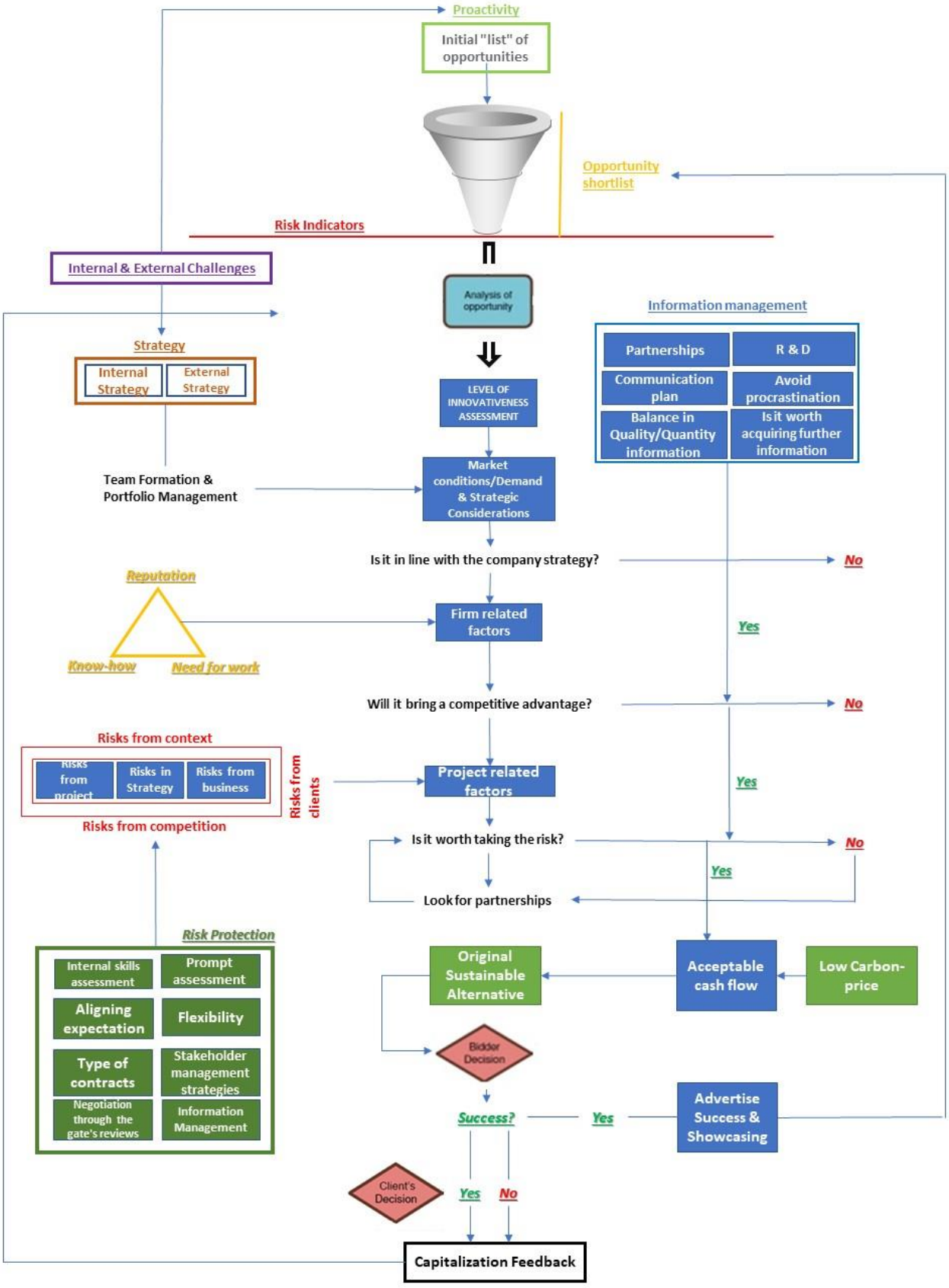


When bidding for innovative projects, both internal and external risks should be carefully managed to ensure success. External risks such as client issues, competition, and project environment can pose significant challenges. Incomplete or inaccurate client requirements, low-bidding competition, and economic, legal, geographical, and social factors in the project environment are factors that increase uncertainty around innovation. Internal risks such as strategy misalignment, insufficient budgets, and outsourcing can also impact project success. To mitigate these risks, effective risk management strategies must be implemented, including the assessment of potential risks and open communication with clients. By managing risks effectively, bidding on innovative projects can be a successful venture. Assessing risks also means weighing the ways in which the company can deal with them. The research conducted on risk protection in innovative projects provides valuable insights for companies seeking to bid on such projects. Given the high levels of uncertainty and risk involved, it is essential to adopt a rigorous and focused approach during the front-end development phase to increase the chances of project success.

Finally, if the benefits are considered advantageous enough, risks are deeply analyzed, and everything is in line with an acceptable cash-flow, confirming that the investment will bring more opportunities in the future. This can enrich the capitalization feedback, and a negative or positive outcome can be used to gain experience and apply it to future projects. Proactivity is also essential when bidding for innovative projects. It can be summarized as the initiative to go for new opportunities to develop new skills and anticipate the market and clients' needs in the future. Building strong relationships with all the actors involved, such as suppliers and clients, is essential while looking for new projects and opportunities to keep growing. Furthermore, proactivity in the case of innovative projects increasingly focuses on sustainability and carbon footprint by working closely with suppliers, competitors, and clients, thus showing commitment to the environment, and positioning the company as a key player.

The framework presented also represents a way to manage decision bias under uncertainty, which can lead to the premature rejection of uncertain ideas. It flattens the variety of the response to risk, which is influenced by behavioural characteristics of decision-makers and the situation at hand.

Different individuals perceive and evaluate innovation projects differently, but with such decision-making, everything can be clearer and at least reduce the variability of this aspect.



Conclusions:

In conclusion, this research has developed a decision-making framework for EPC contractors to consider before bidding for innovative projects. This framework provides a systematic approach to evaluating and selecting the most appropriate bids while minimizing risks and maximizing potential success. The research focuses on the initial stages of the sub-process, from receiving the invitation to tender to identifying the factors a company should consider before proceeding with making a proposal or halting the process to save resources. The research has also identified a set of risk indicators or red flags that are useful in distinguishing potential good opportunities from traps. The proposed new framework starts with an initial project opportunity generated by the company's proactivity or by clients reaching out to the company. This opportunity shortlist is "filtered" through a “firewall” of risk indicators, including the client's lack of knowledge, internal challenges, nature of the client, and market conditions & strategic considerations. The framework provides a helpful guide for decision-making, but it is essential to further analyse each aspect of the framework. Innovative projects often involve new technologies, processes, and approaches that may be unfamiliar to decision-makers. Thus, evaluating the degree of innovation and potential risks associated with each project is vital to make informed decisions. To do so, further research is needed to develop a comprehensive assessment framework that accurately measures the proposed projects' innovativeness level. This assessment should be based on a range of factors, including the proposed technology's novelty, its potential impact on the environment, the level of expertise required to implement it, and the potential risks and benefits. Each of these aspects needs to be further analyzed to improve the evaluation of the potential of each project under scrutiny - identify the most promising opportunities and allocate resources more effectively. In summary, this research has developed a decision-making framework that provides a guide for EPC contractors to consider before bidding on innovative projects. However, further analysis of each aspect of the framework is necessary, specifically a comprehensive assessment of innovativeness. The development of a robust assessment framework that considers a range of factors is essential to accurately measure the level of innovativeness of proposed projects and make informed decisions.

1. Introduction

Introduction This section introduces the context and the background of the research problem in this thesis. Most importantly, it explains which research gap this thesis covers. Thus, reaching a research question statement and, under its umbrella, sub-questions will steer the research toward a solution.

Background

Engineering, Procurement, and Construction (EPC) contractors play a vital role in the construction industry, delivering large-scale projects from conception to completion. As a result, these contractors face unique challenges, ranging from the complexity of project management to the tight deadlines and budgets required to meet client expectations. In recent years, the need for EPC contractors to innovate has become increasingly pressing due to changing market dynamics, technological advancements, and the growing demand for sustainable solutions.

The construction industry needs to adopt new technologies and processes faster, resulting in a lag in productivity and efficiency gains. However, as the industry shifts towards more sustainable practices and digitalization, the need for EPC contractors to innovate has become more urgent. Furthermore, sustainability has become a key concern for many clients, with a growing demand for environmentally friendly and energy-efficient buildings. As a result, EPC contractors must adopt innovative solutions to meet these expectations, such as green building materials, renewable energy systems, and waste reduction strategies. Failure to adapt to changing market demands could result in a loss of market share, decreased profitability, and, ultimately, the failure of the business.

Considering these challenges, this thesis explores the need for innovation in EPC contractors and the strategies that can be adopted to promote innovation within these companies. By examining the construction industry's current state, analysing case studies, and conducting interviews with industry experts, this research aims to provide valuable insights into how EPC contractors can leverage innovation to improve their competitiveness, meet client expectations, and contribute to a sustainable future. The main focus of the research is on one of the critical areas where innovation is necessary for EPC contractors is the bidding process for innovative projects. While innovation is essential for the success of EPC contractors, implementing it in the bidding process presents unique challenges. In this context, a decision-making framework is necessary to navigate the bidding process successfully. The bidding process for innovative projects involves more uncertainty and risk than traditional projects. These projects require EPC contractors to adopt new technologies, processes, and business models, which can be challenging to estimate accurately. Moreover, the cost and time required for implementing innovative solutions can be challenging to quantify, leading to uncertainty in the bid's accuracy.

A decision-making framework is necessary to guide EPC contractors in the bidding process. This framework should enable EPC contractors to evaluate the risk and uncertainty associated with innovative projects, identify the innovation potential, and determine the value of the innovation for the client and the contractor itself. This thesis aims to develop a decision-making framework for EPC contractors in the bidding process for innovative projects. The framework will incorporate risk management, innovation strategy, and value proposition elements. By examining case studies, conducting interviews with industry experts, and applying a comprehensive analysis, this research aims to develop a framework that can guide EPC contractors in the bidding process for innovative projects, enabling them to leverage innovation to improve their competitiveness, meet client expectations, and contribute to a sustainable future.

1.1 Problem Statement

The bidding process is a critical aspect of EPC projects, and numerous studies have been conducted. However, the bidding process for innovative projects is an area that has yet to be explored. Best practices for traditional EPC projects advise EPC contractors to bid only on projects that match their skills and experience. Researching and planning are necessary to determine whether the project fits well. After this, preparing the bid involves considering materials, labour, machinery, and time and estimating the total cost before submission. *(Westland, J. (2018, October 2))*, However, innovative projects pose unique challenges and require a different approach. Thus, there is a need for a comprehensive bidding process framework tailored to innovative projects.

Assessing the level of innovativeness is crucial in understanding the challenges and risks associated with innovative projects. Existing literature provides several frameworks for assessing innovativeness, which measure the degree of newness of a particular innovation *(Garcia, R. (2002))*. However, more innovativeness in projects means more unknowns and risks; According to *Lenderink et al. (2022)*, as the level of alteration and intricacy involved in creating an innovation intensifies, the uncertainty regarding the future performance of the system also rises. Consequently, there is a greater need to proactively handle the development process and the risks associated with the innovation. In addition, the need for precedent and historical data on innovative projects makes it difficult to predict the outcome, resulting in higher levels of uncertainty and risk.

Risk in innovative projects is subjective: the perception of risk can be influenced by individual factors, making it a subjective concept that needs to be evaluated on a case-by-case basis, according to *Curtis Baillie et al. (2020).* Subjectivity implies that risk perception can vary between individuals due to human factors. *Nobanee et al. (2021)* provide further explanation, defining objective risk as the difference between actual and expected loss and subjective risk as the uncertainty related to an individual's mental state. Uncertainty arises when information is insufficient to quantify risks, and the decision-makers judgment becomes crucial to address this incompleteness. Moreover, human factors play a significant role in shaping risk perceptions. The literature suggests that a lack of information at the front end of an innovative project can be beneficial as it may prevent analysis paralysis and stimulate creativity. In other words, the amount of information available during a project's initial stage heavily depends on how novel the project concept is, as stated *by Grau & Back (2015) and cited in Williams et al. (2019).* However, having a large amount of information does not necessarily guarantee the success of a project or its level of innovation, according to *Samset (2010).* Conversely, the lack of detailed information during the initial stage can provide decision-makers with focus and flexibility, which can be advantageous rather than a hindrance to project innovation and success. *Williams and Samset (2010), cited in Williams et al. (2019),* explain that during the initial stage, the crucial factor is not the quantity of information, but the type of information required. Selecting limited but relevant information can prevent "analysis paralysis," which is the overabundance of detailed information presented to decision-makers too early in the decision-making process. On the other hand, too much information can also be counterproductive, leading to an overload of data and increased uncertainty. Therefore, the right amount of information is required to make informed decisions.

1.2 Research Question

Considering what has been introduced above, a research question is:

Main Question: How to improve decision-making considering the interfaces during the bidding process for innovative projects for EPC Contractors?

The following sub-questions are used to build up the answer to the main question. Such a question has been formulated in such a way that the single answer to the question will bring more knowledge

and context around the answer and thus give an extensive depiction of the bidding process for innovative projects:

Sub-Question 1: What are the ways to manage risks in the bidding process for innovative projects in the body of knowledge?

This sub-question aims to gather knowledge on bidding processes with relative risks, opportunities, and consequences of confident choices. This question is also set to see the current state of the body of knowledge and look for methods to frame and analyse gathered data in combination with methodologies to frame the information gathered.

Sub-Question 2: How are decisions taken during the bidding process by EPC contractors?

This sub-question is to identify what a company such as "ABC Company" needs to tailor the decision-making framework for the company's needs through interviews. Therefore, aiming to set the path to tune the information gathering and thus narrow the information from the literature review. The answer will also be used to link the consequences and risks of choices made in past projects and therefore set the foundation to create a first frame for the decision-making framework.

Sub-Question 3: What are the challenges and opportunities for improving decision-making?

This sub-question discusses the difficulties and advantages of decision-making. It examines obstacles that can hinder effective decision-making and explores tools and techniques that can enhance decision-making. The goal is to provide insights into how individuals and organizations can make better decisions and achieve their goals more effectively.

Sub-question 4: How to improve decision making for innovative projects through a bidding process framework?

This question focuses on exploring the use of a bidding process framework as a tool for improving decision making in innovative projects. The sub-question seeks to identify ways in which a bidding process can be utilized to facilitate effective decision making, and to determine how the framework can be adapted to the unique needs of innovative projects.

1.3 Research Method

There is a need to understand the problem and discover ways to approach the problem of this master thesis. To do so is logical to start by creating a theoretical background; such research would be the foundation of the decision-making framework and, therefore, essential. After the selection and analysis of the relevant literature review, what is next is the empirical research which consists of semi-structured formal interviews to gather information from past experiences and possibly workshops with decision-makers to have expert guidance to set the path for the decision-making framework development. After that, there is the result analysis and final framework development. The following explains the methodology in more detail:

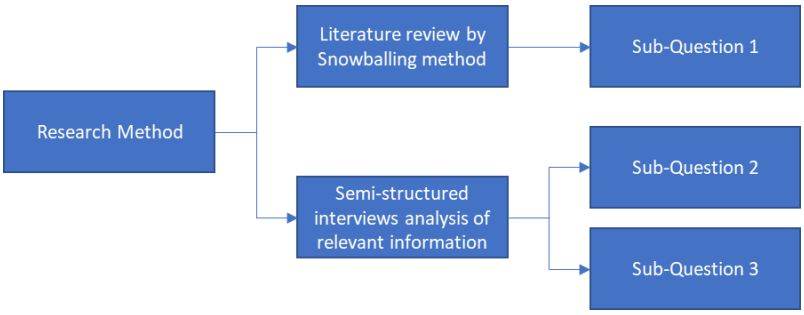


Figure 1: Research Method

1) Theoretical foundation – Sub-question 1 is answered by establishing a solid theoretical foundation through literature research and analysis. This step involves using the snowballing method, a widespread technique in academic research for identifying relevant literature on a particular topic. This approach has been decided because there was a need to analyze what was in the current body-of-knowledge, to find what was new and what was missing considering the main research question and sub-question. In order to do so, an extensive literature review needs to be done in order to scan as much as possible the body-of-knowledge. First, the snowballing method identifies vital sources, such as articles, books, or other relevant materials related to the research question. These sources serve as the starting point for the literature review. Next is examining the references cited in the key sources to identify any other relevant literature that could inform the research question. Examining the references cited in the key sources can help expand the search and identify a broader range of relevant materials. Once additional relevant sources have been identified, there is a review of the references cited in those newly identified sources to identify any further relevant literature. This process can be repeated until no new relevant sources are identified or until enough information is retrieved to understand the literature on the topic comprehensively.

2) Empirical research – To answer sub-questions 2 and 3, a research step consisting of semi-structured formal interviews with relevant actors within "ABC Company" was conducted to verify and complete with new information what is discovered in step 1. Furthermore, these interviews aimed to identify problems and opportunities for improvement in the bidding process based on the participants' experiences. The interviews were semi-structured, meaning there was no fixed set of questions but rather a general outline of topics to be covered. This procedure allowed the researcher to have the flexibility to ask follow-up questions or prefixed questions as necessary to kick-start a conversation about relevant topics for the research thesis. This approach allowed the participants to provide more detailed and personalized responses, leading to richer data. In total, 14 individuals were interviewed at least once, resulting in 17 interviews. The participants were selected based on their relevance to the bidding process and their expertise in the field. The interviews were conducted formally, ensuring the participants felt comfortable and could provide honest and open responses. The interviews were recorded and transcribed to facilitate the retrieval of information. This ensured that the data collected was accurate and reliable and allowed for detailed responses analysis. The transcripts were carefully analyzed to identify common themes and patterns in the participants' responses. This approach helped identify problems and opportunities for improvement in the bidding process based on the participants' experiences.

Following the two steps described above, it was possible to find what the candidate project has in common and what are the redundant problems and therefore design a flexible and universal pathway to be applied to new case scenarios to un-stuck the projects in the short-term and help achieve the long-term goals.

1.4 Data Gathering and Analysis

A starting point to answer such a question would be to find a way to collect information relevant to a problem or decisions that must be made, to think deliberately, carefully, and thoughtfully about possible alternative ways to tackle the problem, analyze the alternative way chosen and reassess the process and the outcome of the alternative to assess what went right and what went wrong. The process must be thoughtful decision-making because it must be deliberated, careful, and mindful in collecting and using information about a problem/issue. At the same time, reflective decision making because it must be possible to step out of the box and examine how well the decision was taken and learn from it.

More practically, the iteration would be:

1. Find candidate interviewees from relevant projects.
2. Highlight a problem that requires a decision-making process.
3. Collect data through semi-structured interviews with internal actors.

The interviews were conducted in a real EPC Contracting company, which name will be anonymized as “ABC Company” a multinational organization that specializes in engineering, procurement, construction, and installation services. To find the relevant interviewees, the focus is on finding an innovative project and the main actors involved in bidding on such projects. Once identified the interviewees an invitation to the interview is sent. Fourteen respondents were from four different projects that will not be named or mentioned in this thesis for confidentiality purposes. The interviews lasted from 30 minutes to 1 hour long. **Appendix A** shows the main questions that were asked, keeping in mind that they were also follow-up questions done at the moment of interviews and thus not pre-fixed. The interviewees were video-recorded and transcribed in order to extrapolate relevant information. The analysis involved highlighting critical words in the transcript and completing the information retrieved by asking follow-up questions in second interviews with the same candidate or from a new interviewee. In this way, it was possible to find what the candidate project has in common and the redundant problems and therefore design a flexible and universal pathway to be applied to new case scenarios to un-stuck the projects in the short-term and help achieve the long-term goals.

The analysis consists in the following steps:

1. Transcript: the first step consists in analysing data from a semi-structured interview to transcribe the interview through software or a tool; in this case, the tool used is Microsoft Teams' transcript option, converting the spoken words into a written format.
2. Familiarize: the next step is to become familiar with the data by reading through the entire transcript. This helps gain a general sense of the data and identify key themes and topics that emerged during the interview.
3. Identification: this involves identifying and highlighting keywords, phrases, and concepts related to the research questions or themes. In this way, it is also possible to better refine the questions for the following interview.
4. Analysis: the analysis can look for emerging patterns and themes. This can be done by reviewing the coded data and comparing the data to existing research or transcript.

5. Interpret: this involves making sense of the patterns and themes from the data and drawing conclusions based on the findings.

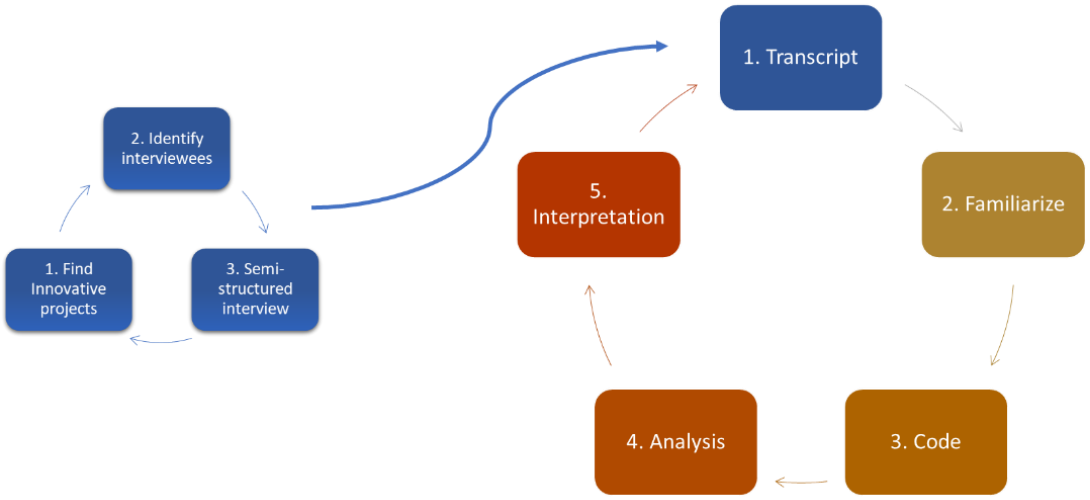


Figure 2: Data Gathering and Analysis

1.5 Thesis Outline

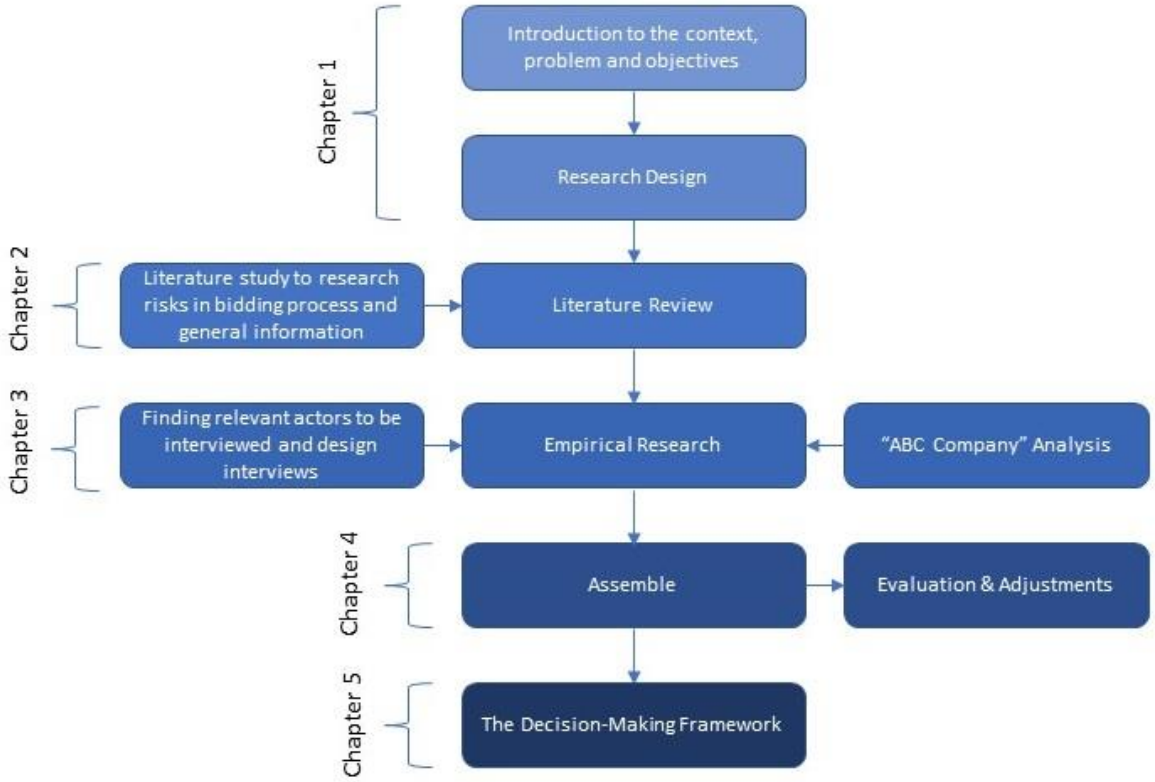


Figure 3: Thesis Outline

2. Literature Review

2.1 Introduction

In this chapter the literature review is presented. The structure of such review follows the logic of a Venn Diagram, as shown in the picture below.

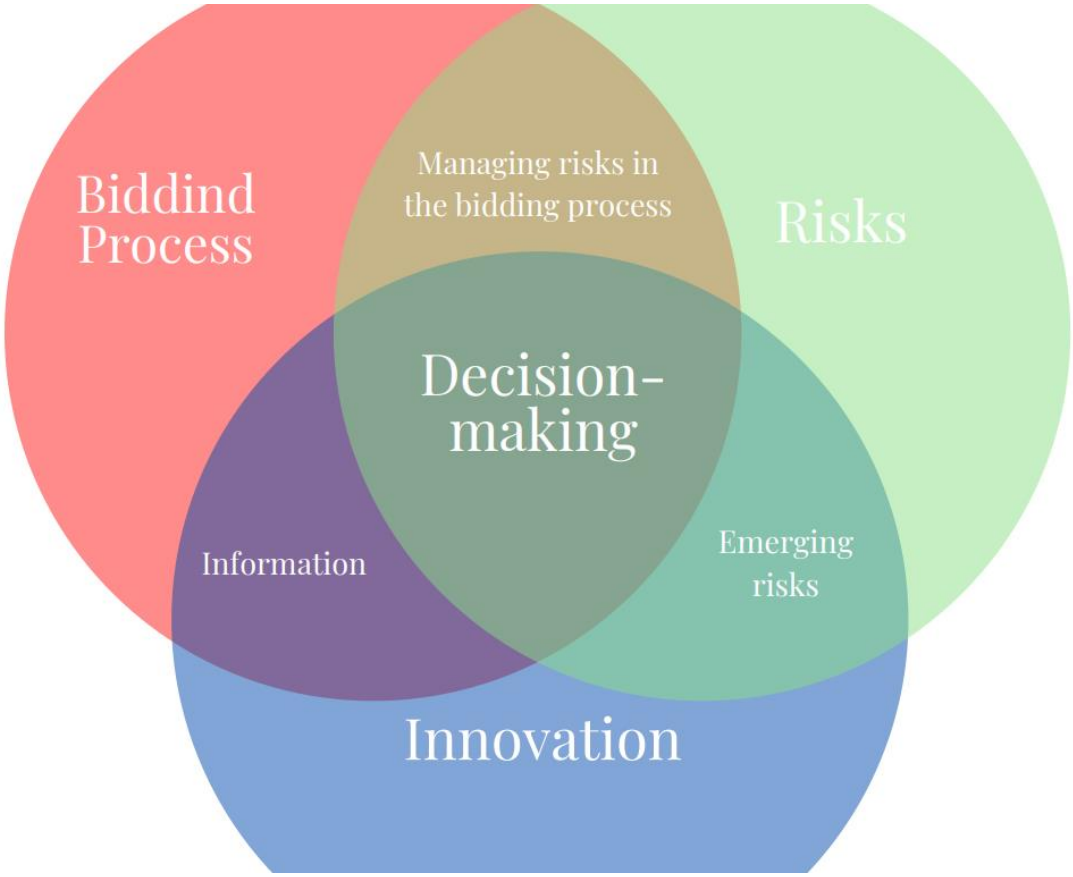


Figure 4: Venn Diagram – Literature review structure

The literature review starts with general research to understand the bidding process and introduces the contractor perspective. A general depiction of risk, uncertainties, and innovation has been searched and discussed. As shown by the diagram, these concepts are not independent. On the contrary, their intersections create sub-categories representing how these concepts relate. E.g., the bidding process sector intersects with the risks sector, and such an intersection highlights the need to look out for risks during the bidding process. The same with innovation; there is a need for information to deal with innovation; the information and risks during the bidding process are finally assessed during the decision-making process.

2.1. The Bidding Process: A General Depiction

In the bidding process, the project initiator selects the best contractor to bring the project from idea to reality. The best contractor is selected by comparing different contractors' offers using a predetermined list of prerequisites. The bidding process is one of the most delicate processes for the project initiator but also for the contractor who decides to bid (or not) – the decision is highly affected by various factors and influences and is highly reliant on specific project and macro environment (*Prajapati, Raju & Pitroda, Dr. Jayeshkumar & Bhavsar, Prof. (2015)).* During the bidding process, the project initiator and the contractor must carefully analyze what is being evaluated since it cannot be changed later. As *Dutta (2021)* explains, the project initiator needs to ensure that the project is *"the best option available at a reasonable price,"* while the contractor needs to ensure that the project is

within their capability and presents an opportunity to seize. In order to do so there are specific areas to focus on, including setting a list of prerequisites to identify the best pool of contractors to choose from, as *Sme (2018)* notes, and consequently their projects proposal. This makes the process easier and less risky while lowering eventual costs and time. The prerequisites are usually based on past performances, management objectives, how many orders the contractor has at that moment, financial capability, and firm reputation. Regarding cost and pricing, the contractor determines the former, while the latter is determined through negotiations. As *Dutta (2021)* explains, *"The bidding team prepares the cost and presents it to the top management, usually comprising the business head responsible for profit and loss of the concerned business division and his or her superiors as per the organizational norms."*

The bidding process itself, as described by *Gerardi (2022)*, involves several steps. First, the project owner issues a bidding solicitation, which can be done through different means of communication. *Sme (2018)* notes that this can take the form of a Request for Information (RFI), followed by either a Request for Quotation (RFQ) or a Request for Proposal (RFP), depending on the specific request. The company that wants to apply then submits its bid, which includes information on previous projects, management plans, track record of performances, cost estimation based on bill of quantities, blueprints, overheads, labor, equipment, and materials. After, the owner then selects the winning bid based on specific selection criteria, with the price acting as a tiebreaker. *Albert Lester (2021)* notes that different items must be compared when assessing competing bids, including essential costs, extras, delivery, and shipping cost, insurance, cost of testing and inspection, cost of documentation, cost of recommended spares, discounts, delivery period, terms of payment, and retentions guarantees. Once the requirements are met and the contractor is selected, the contract formation process begins. It involves determining the legally binding contract, which includes assessing its features, the kind of project, the contract's troubles, and the benefits and drawbacks of the agreement. As *Albert Lester (2021)* notes, the purchase order or contract document must be issued with all the same attachments that were part of the RFQ/RFI/RFP, as well as the procedure of payments and the stages for issuing interim and final acceptance certificates. Once the contract is in place, the next phase is to decide on the project delivery method, which is determined using the budget, building design, and schedule. Each delivery method has its roles and responsibility obligations, as *Watkins (2018)* explains. For example, a construction contract with an EPC project delivery method and a fixed price is the best option for projects like refineries, energy plants, or industrial facilities, depending on the type of the project and location.

The bidding process – contractor perspective

Before bidding, a contractor must check if the project suits their skill arsenal. Therefore, bidding if the requirements match the company's capabilities and experience. R**esearch and planning** steps check the grounds of such endeavour and start with preliminary planning. The next step is to **prepare the bid** and consider the bill of materials, labour cost, heavy machinery, and time and therefore estimate the total cost of the project – and then **submit the bid** *Westland, J. (2018, October 2).*

The most crucial thing the EPC contractor needs to do is find the right balance of risks and opportunities for the client and the company itself. Therefore, particular attention needs to be put on novel technologies; As mentioned, construction projects have various uncertainties now more than ever, *"and the difficulties and risk factors of the construction need to be predicted and reflected in the bid price before construction commences. Therefore, deciding the appropriate bid price is difficult because bidders need to thoroughly understand the uncertainty factors of the project before making bidding decisions." (Lee & Yi, 2017).* More specifically, uncertainties can be reflected in five types of risks to consider before and while bidding for a project: Technological risks, Organizational and societal

risks, Market risks (demand and supply), Financial risks, and Turbulence risks. These risks are essential to be considered because they can expose the contractor and directly damage its business. Therefore, the decision-makers need to assess these risks optimally and, if necessary, drop the project if it could hurt the business. Although bidding for such novel projects is not as straight forward as normal projects and thus the current bidding processes need an update. The following paragraph discusses what is defined as risk and uncertainty, highlighting the risks involved in novel technologies.

2.2 Risks and Uncertainties

In this section, what is Risk and uncertainty are discussed. It is worth starting the paragraph by mentioning *Smith, N. J. (2006): "Risk management is not about predicting the future. It is about understanding your project and making a better decision concerning the management of your project tomorrow.". "Sometimes projects need to be abandoned, sometimes different routes are taken, but in the end, decisions are made against a set of objectives, rules, and priorities determined by a set of incomplete knowledge (uncertainties). Is not possible to work with absolute certainties" Smith, N. J. (2006).* In other words, uncertainties make projects hard to predict and are always present to some degree; the focal point is not about avoiding Risk per se but deciding if the risks are worth to be taken considering the trade-off. An inadequate assessment not only means taking over too much risk but, on the other hand, dropping from projects with great opportunities for the company. In order to create a decision-making framework, therefore, it is paramount to understand the concept of risk and what does it mean for projects. For this purpose, this paragraph presents different shades of risks related to the topic of innovation and they will be considered in the following chapters.

So far, the research has given a substantial quantity of definitions and descriptions of what "risk" means. In the research from *Aven, T. (2010),* three ways of defining objective Risk are looked up to: a) risk is a measure of the probability and severity of adverse effects *Lowrance & Klerer, (1976)*, b) Risk is the combination of the probability of an event and its consequences *Purdy, G. (2010)*, c) Risk is equal to the triplet ((S_i, P_i, C_i), where is the ith scenario, S_i is the probability of that scenario, and is the consequence of the ith scenario, i=1,2, y, *Kaplan, S., & Garrick, B. J. (1981)*. In other words, what is defined as objective Risk is the measurable Risk – and therefore, if it is measurable, it is known. On the other hand, subjective Risk is the perception of a risk that is influenced by the person assessing such Risk - *"Risk is a subjective concept that needs to be viewed and quantified on an individual basis." (Curtis Baillie et al., 2020).* Subjectivity means that the perception of Risk is affected by human factors and is thus variable and different from person to person. A further description is given by Nobanee et al. (2021): *"Objective risk is the relative variation of actual loss from expected loss, while the subjective risk is the uncertainty based on a person's mental condition or state of mind." (Rejda, George E., and Michael J. McNamara give a description. (2021))* these two are "opposite" types, but they both need to be taken into consideration because very often, information is incomplete to quantify risks; this creates uncertainties, and therefore, the judgment of the decision-makers is the key component to dealing with such incompleteness. Incomplete information is strictly linked to the nature of the project. By logic, the more the innovation has a high degree of innovativeness, the more risks and uncertainties present. Risk and uncertainty seem to be the same concept. However, as mentioned above, there is a fundamental difference between them: *"Risk refers to situations in which probabilities targets can be identified for possible results. In other words, it can be quantified. Instead, uncertainty refers to situations or events with sufficient information to identify objective probabilities." (Toma et al., 2012).* Nevertheless, since these two kinds of risks are always present in risk assessment, it is safe to say that objective Risk and subjective Risk are faces of the same coin; how these two phases are approached depends on the risk adversity level of a company's policy towards novelties. However,

before going deep into the nature of risks and innovation is essential to describe further what innovation means.

2.3 Innovation & Challenges

Assessing innovation projects' innovativeness is essential in the bidding process since the extent of innovativeness in an organization can create a competitive advantage and long-term success. A degree of uncertainty is always present in innovative projects and more present than in standard projects. Uncertainty is "*the chance occurrence of some event where the probability distribution is genuinely unknown. This means that uncertainty relates to the occurrence of an event about which little is known, except the fact that it may occur" (Smith, N. et Al. (2013))* which happens when a project is new and therefore has potential for innovation. Therefore, as mentioned above, innovation brings a certain degree of discontinuity. Thus, risks are being dealt with to create discontinuity due to the uncertainties that come along with the novelty. Unknown or uncertainty relates to the occurrence of an event about which little is known, except the fact that it may occur. When novelty is applied successfully, innovation is defined as *"the development and successful implementation of new ideas, products or processes in the design and realization of new civil engineering objects" (Lenderink et al., 2020).* Another shade of such a definition is innovativeness which is used to measure the degree of newness of a particular innovation (*Garcia, R. (2002)).* Innovation needs to be put in perspective. As the research indicates, there are different perspectives from which innovation takes shape and meaning. It can be innovative from a world perspective (*M.X. Song and M.M. Montoya-Weiss (1998)),* new to the adopting unit *(John E. Ettlie, Albert H. Rubenstein (1987)),* new to the industry *(Gina Colarelli O'Connor (1998)),* new to the market *(E.J. Kleinschmidt, R.G. Cooper (1991), Meyers, P.W., Tucker, F.G. (1989))* and new to the consumer *(Kwaku Atuahene-Gima (1995)).* Garcia gives a good definition as: *"a measure of the potential discontinuity a product (process or service) can generate in the marketing or technological process"* this is because innovation usually means that something new has been created, and if highly innovative, it disrupts a current system for example, steam-powered ships represented a massive upgrade from sailing boats putting them out of use in early 1800. Nevertheless, innovation brings opportunity as it brings risks, some novelty can be a huge breakthrough, but other projects can be dead ends. Thus, the real point is to spot new risks and evaluate the trade-offs.

2.4 The Risks in Novelty

The level of innovation brings a new type of risk: **orphan risks**, defined as risks that are discarded and/or not taken into consideration willingly or not (therefore "orphaned"). "*These risks involve the often-complex dynamic between emerging technologies and society and are increasingly likely to blindside enterprises"* (*Coles, 2022*). A complementary notion to such risks is **emerging risks**. *International Risk Governance Council (IRGC)* suggested that this kind of risk emerges under two different conditions: **a)** when the technology is new (e.g., carbon capture and storage (*Wilday et al., (2011)*) or **b)** when the technology is familiar, but the context is unfamiliar. (e.g., larger volumes of LNG handled (*Paltrinieri et al. (2015)).* The following figure shows how emerging risks are affected and evolve by uncertainty.

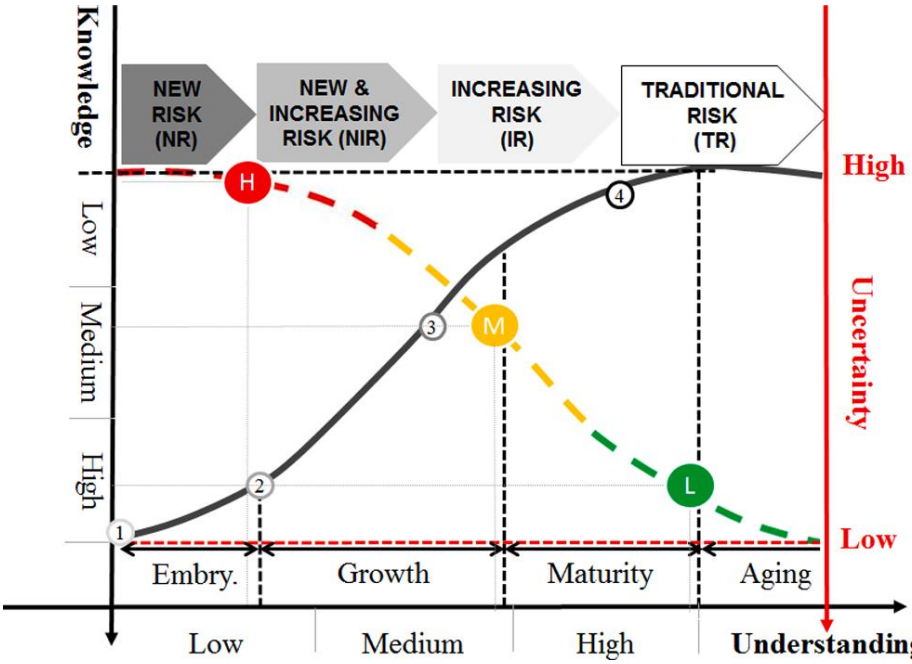


Figure 5: Incorporation of knowledge and understanding axes in the evolutionary stages of emerging risk and uncertainty curves (Brocal et al., 2017, 2019a, 2019b).

The figure 6 shows that when the knowledge is low and, therefore, the uncertainty is high, the project has the potential to be innovative, and therefore, by what was introduced in the paragraph before, prototype technology faces a high degree of emerging risks. Understanding and uncertainty need to be related to the conditions in which a project is developed. It can be noticed, as also found by *Lenderink et al. (2022),* as the magnitude of change and the complexity of developing an innovation increase, so does the uncertainty over the future performance of the system and the need to actively manage the development process and the risks associated with this innovation.

2.5 Managing Risks During the Bidding Process

As said by *Githens, G. D. & Peterson, R. J. (2001): "Projects don't fail at the end; they fail at the beginning."* Therefore, the front-end phase is the most crucial one. Assessing novelties is not an easy task: innovation means achieving what today is achievable only by state-of-the-art technologies or even more beyond our technological and organizational boundaries if the project is bounded by time, finance, or goal. Therefore, companies must push these boundaries and discover new frontiers to achieve the project goal. But what lies beyond our current horizon is **uncertainty**. A good example of innovation nowadays for EPC contractors is in mainly in energy transition projects. There are a high number of factors that make the energy transition unique. What most hits the bidding process is the shortening of such phase and a general lack of guidelines caused by the novel nature of the energy transition *(S. Toonen (2022)).*

Uncertainty is what makes decision-making slow - the problem is that along with high uncertainty comes high **risks** - the risk of embarking on something that, once it is set and running, its course cannot be changed if things are going as not expected, for example, renewable energy certificates (e.g., maintaining the same volume at the same price).

In addition, there are also internal frictions: individual managers are pushed to achieve innovation while maintaining the course of a certain project on budget and on time, while higher up in the hierarchy, people try to maximize the scope. This causes inertia in the decision-making process, therefore delaying important decisions that need to be made fast to achieve competitiveness and advantage over the competition. Therefore, what is missing in the scenario is a tool to manage and support the decision-making to guide companies in deciding if they enter into new ventures. There is a need for a map (a framework) to help companies to navigate through the uncertainty and risks of innovative projects. The bidding process is one of the most, if not the most, crucial phases of a project development cycle because what is decided in this phase will set the path for the future of the project. *Chalal, R. and Ghomari, A.R. (2006)* define the following steps of a bidding process:

- receipt of the invitation to tender and customer specifications,

- feasibility study of the different options, including primary technical and financial analysis,

- decision-making coupled with strategic business decisions to follow through,

- development of the response, scoring, and evaluation, negotiation.

Risks need to be anticipated from each phase of the project. *Diego et al. (2013)* describes a generic process step in a project lifecycle.

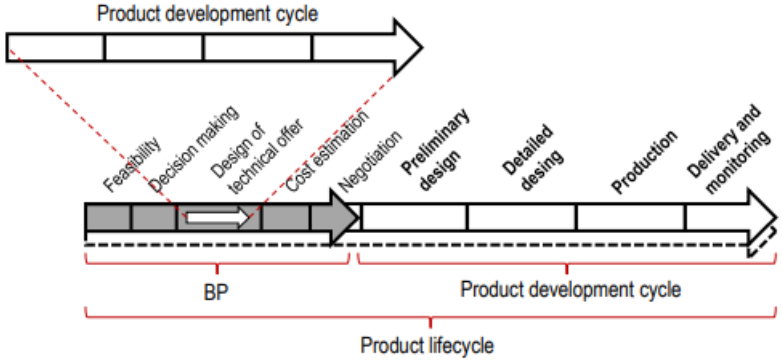


Figure 6: Bidding process as initial phase of product lifecycle (Diego et al., 2013).

As mentioned, construction projects have various uncertainties, now more than ever, *"and the difficulties and risk factors of the construction need to be predicted and reflected in the bid price before construction commences. Therefore, deciding the appropriate bid price is difficult because bidders need to thoroughly understand the uncertainty factors of the Project before making bidding decisions."* As cited before *(Yi, 2017).* From the *Directorate General for Research and Innovation (2010)* defines five types of risks to consider before and while bidding for a project:

- Technological risks: related to the non-completion, under-performance, or false performance of the procured good and services due to its innovative nature.

- Organizational and societal risks: related to under-delivery or failed procurement due to reasons linked to the organization that procures. While societal risks are related to a lack of acceptance of uptake by a possible end user.

- Market risks (demand and supply): related to external factors that may affect the market, for example, the Russia-Ukraine war.

- Financial risks: related to uncertainties in meeting target costs and the ability to secure the funds needed.

- Finally, turbulence risks: are related to large scale-projects due to unforeseen events that make the actors involved reassess their position.

A further and very extensive risk categorization is made by *Diego et al. (2013)*, which defines two main categories during the bidding process:

External risk

External risks are the ones outside the company. It consists of risks related to **the client**, which may be referred to: as incomplete/inaccurate requirements and specifications, poor information quality, image risks, non-compliance with agreements, risks related to the market and bidding process, and financial resources mismatch. Another external risk is **Competition** in particular: competitors have better knowledge or a better understanding, confidentiality risks caused by information leaks, hardening of the client caused by other bids, and malevolence risks such as competitors' malicious actions to the tender. Finally, there are the risks associated with the **Environment;** these risks can be economic risks (e.g., moving market conditions), legal risks associated with non-compliance with regulations and standards, geographical risks, project location, and consequently, social risks such as political and social instability of the area.

Internal risks

Which involves **Strategy** intended as inappropriate procedures and risk analysis, human factors risk organizational risks, management risks, human factor risks arising from poor negotiator skills, commercial risks related to order supply and its reliability, and internal policy risks. Another factor involves risks associated with the **Project**; it can involve financial risks associated with the acceptance of insufficient budget, or client's delay in payments, calendar risks such as tight deadlines, delays, etc., and development risks caused by non-verification of existing means and client needs. Finally, risks associated with the **Business;** risks related to the know-how may contribute to technical risks such as human error, lack of expertise, etc.

The following figure sums up all the risks mentioned:

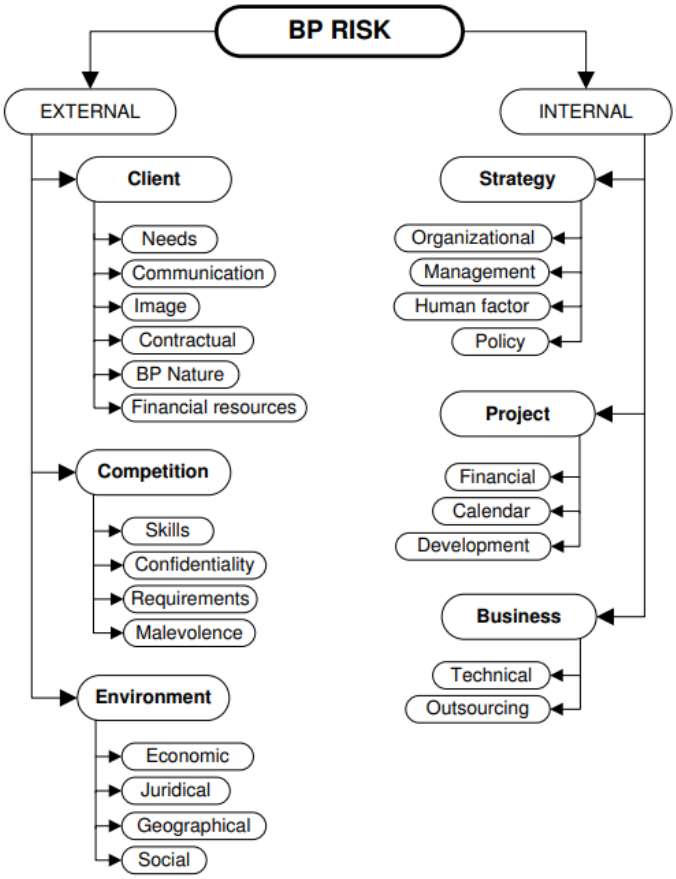


Figure 7: Bidding Process Risk Mapping (Diego et al., 2013).

To sum up, these risks all converge to the same endpoint: incorrect assessment leading to a detrimental and harmful process that could negatively affect the project life cycle and, ultimately, the company. *Diego et al. (2013)*, based on the risk mapping shown in figure 2, highlight in which phases of the lifecycle project the risks present themselves and to which bidding phase these risks can be linked to

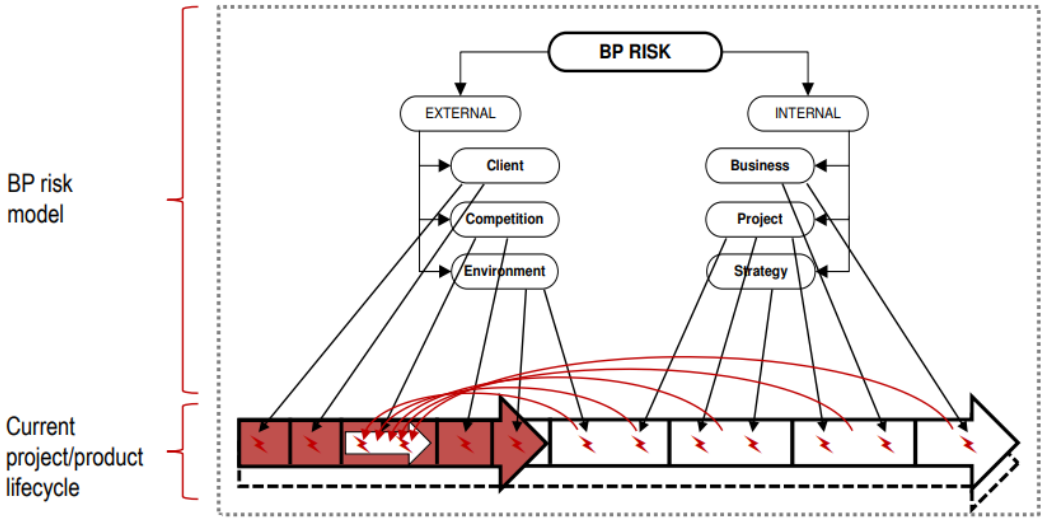


Figure 8: Risk mapping linked to the lifecycle (Diego et al. 2013)

The red sparks show unwanted events that can happen, and the red arrows relocate such risks to their source (Bidding process). It has been proven with empirical evidence that there is a strong positive correlation between front-end success and project portfolio success *Kock et al. (2016).* Therefore, it can be easily understood that what is not uncovered in such a phase will come and cause trouble when the project has started; in these cases, little can be done to avoid damages, and therefore is vital to go through the front-end phase' phases with a rigorous and focused approached and be open to new ideas.

Williams et al. (2019) made a list of the processes that are involved in the front-end development phase:

1. The initial idea emerges.
2. Complexity and underlying problems and need ought to be analyzed.
3. The first estimates of costs and benefits are made.
4. The stakeholders' preferences and incentives become visible.
5. There is very little information. (The front end is characterized by scant information available about the prospective (yet ill-defined). **Uncertainty is at its highest**.
6. The opportunity space is/should be explored.
7. The conceptual alternatives are carved out.
8. The first estimates are refined. First, estimates are refined as the concept is developed.
9. Recognizing stakeholders. The affected parties could/should have a chance to have some impact on decisions.
10. The situated project. The project should be regarded/integrated within a wider strategy/project portfolio.
11. The foundation is laid, and the main decisions are made.

One of the most crucial steps is dealing with scant information – not having information while facing a new technology, or a novelty in general, would make decision-makers blind and unaware of what the company is and will be dealing with. But also acquiring, selecting, and managing such information. Since information needs to be acquired but also selected, a huge volume of information doesn't necessarily mean that the project will be a success and vice versa. Thus, the right balance of information can indeed increase creativity and alternative solutions.

2.6 Information

The availability of information in the earliest stage of the project depends considerably on the novelty of the project concept (Grau & Back, 2015, as cited in Williams et al. (2019)) Samset, K. (2010). However, the wide availability of information doesn't necessarily lead to improved innovativeness of a project or, consequently, its success. But it is also true that information scarcity does not necessarily lead to poor project innovation or failure. On the contrary: "*the lack of detailed information during the project front end can, in fact, be a benefit rather than an obstacle in providing decision makers with concentration and pliability. According to the authors, a crucial issue during the front end is not the quantity but what type of information required. Limited but carefully selected information may help avoid "analysis paralysis," which refers to the situation when an excessive amount of detailed information is presented to decision-makers too early in the decision-making process." (Williams & Samset, 2010, p. 45) as cited in Williams et al. (2019).* To help the information management process, *Freund & Jones (2014)* created a framework in which they describe the TIRM (Total Information Risk Management) process:

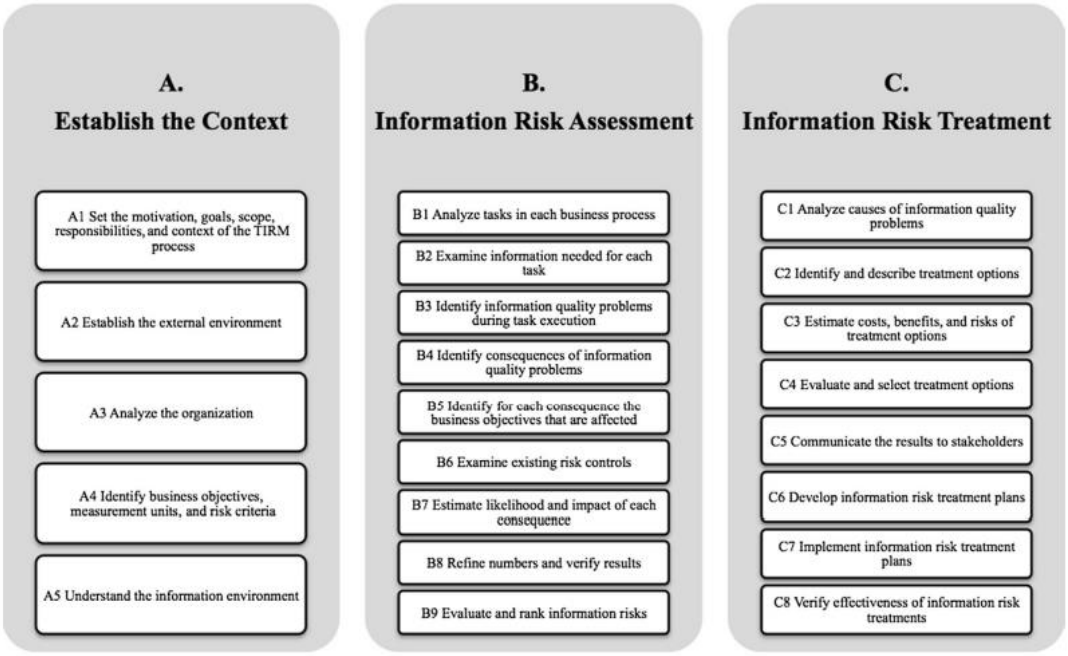


Figure 9: TIRM Process - Freund & Jones (2014)

As showed, the process consists of 3 stages. **Stage A** considers the context of the project by considering external and internal factors. This helps in understanding how the project is affected by the contractor, the project owner, and the environment and is therefore crucial to help the decision-makers to lay the first stones on the pathway of the project development. In other words, it's an exploratory process to reduce uncertainty by setting boundaries given the scenarios, system analysis, setting drivers, frameworks, and further study that may be needed. Continuing in **Stage B**, the information elaborated in stage A has highlighted the obvious risks; in this phase, further analysis is done to assess further the risk involved in the project qualitatively and quantitatively, specifically for this case, the management of risk during the bidding process. Finally, **Stage C** is the stage in which the estimation is done and where it is decided if it would be worth bidding for the project or not, given the cost, benefits, and risks.

It's important to add that communication and consulting with stakeholders would be necessary to effectively evaluate the project information, for stakeholders need to be aligned with the EPC contractor's needs and, therefore, reach a balance between the two firms. This is necessary through

all the stages. In stage A, it's important to first identify relevant stakeholders and after establishing if the stakeholders and the contractor are on the same page regarding the perception of the internal and the external environment. In stage B, it's important to develop a **communication plan** (Figure 9) prior to the stage, and when in the stage, get the additional information and make sure that the actors involved agree with the findings. Finally, in Stage C, stakeholders need to be aligned on why certain choices have been made and why the contractor has chosen a certain pathway to achieve the scope of the project.

TIRM Stage	Stakeholder	Communication and Consultation Needed	Form of Communication
Stage A: establish the context	IT executives	Explain what TIRM is and why it is important to IT executives	Presentation
...	...	...	...

Figure 10: Example of a communication plan - Freund & Jones (2014)

2.7 Decision-Making

Decision-making is defined as the *"degree to which the innovation team is exhaustive as it considers multiple approaches, courses of action, and decision criteria in its strategic decision-making" (Slotegraaf & Atuahene-Gima, 2011, p. 97*). As mentioned before, nowadays, the environment has created a market where the number of criteria to be selected by a project owner has dramatically increased. The old way to be selected was to have a competitive price with fair related quality. Nowadays, the "lowest price" criteria are not used anymore. Much more emphasis is given to quality; therefore, nowadays, there are multiple criteria to satisfy to win a bid.

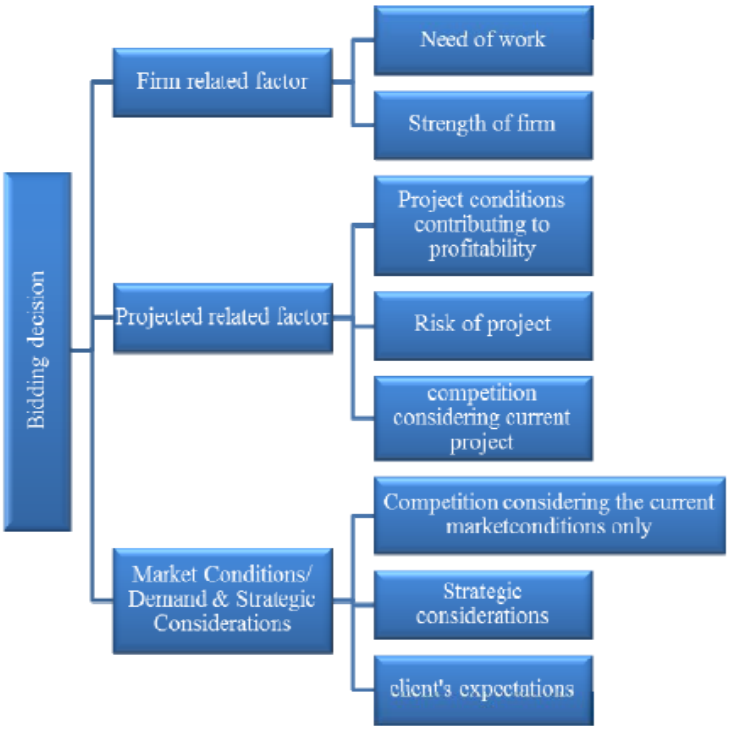


Figure 11: Factor affecting bidding decision (Prajapati, Raju & Pitroda, Dr. Jayeshkumar & Bhavsar, Prof., 2015).

Contractor needs to make strategic decision in respect of: (1) to bid or not to bid for a project and (2) if the decision is to bid, determine a competitive bid price with limited response time *(Prajapati, Raju & Pitroda, Dr. Jayeshkumar & Bhavsar, Prof., 2015)*. The Table 1 below shows which factor affects the bidding decision:

Need for work
1. Current workload of projects, relative to the capacity of your firm
2. Availability (number and size) of other projects within the market
3. Current financial situation of the company
4. Need for continuity in employment of key personnel and workforce
5. Current workload in bid preparation
Strength of firm
6. Ability to fulfill tender conditions imposed by the client
7. Financial status of your company (working cash requirement of project)
8. Experience and familiarity of your firm with this specific type of work
9. Possessing enough qualified technical staff to do the job
10. Possessing enough required plant and equipment to do the job
11. Having qualified subcontractors
12. Having qualified material supplier
13. Amount of work to be subcontracted relative to the total volume of work
14. Amount of equipment that needs to be hired and the hire rates in the market
Project conditions contributing to the profitability of the project
15. Project size (total bid value)
16. Terms of payment
17. Project type
18. Profits made in similar projects in the past
Job uncertainty
19. Uncertainty related to the construction site condition
20. Completeness of the bid documents (drawings, specifications, etc.)
Job complexity
21. Technological difficulty of the project being beyond the capability of the firm
22. Management of similar size projects in the past
Risk creating jobs and contract conditions
23. Rigidity of specifications
24. Allowed project duration being enough
25. Penalty conditions for not being able to complete the project on time
26. Payment conditions of the project creating a risky environment
27. Allowed duration for bid preparation being enough
Client and consultant of the project
28. Current financial capability of the client
29. History of client's payments in past projects (considering delays, shortages)
Availability of resources within the region
30. Availability of required qualified labor within the region
31. Availability of the required materials within the region
32. Availability of the required plant within the region
Competition (considering only the current project)
33. Possible number of competitors passing the requirements
34. Desire of qualified contractors to bid and win the project
Foreseeable future market conditions & firm's financial situation
35. Market's direction (whether it is declining, expanding, etc.)
36. Amount of possible upcoming profitable projects out for tender in near future
37. Existing financial conditions indicating a financial risk in near future
38. Ratio of your firm's current market share to the expected or aimed share
Client (considering long-term gains/losses)
39. Amount of work the client carries out regularly

40. Amount of repeat business level that the client been following
Project (considering long-term gains and losses)
41. Possible contribution to increase the contractor firm's classification
42. Possible contribution to increase the firm's identity and brand strength
43. Possible contribution in increasing firm's market share and dominance in market
44. Possible contribution in building long-term relationships with other key parties
45. Contribution in maintaining long-term relations with important influence markets
46. Possible contribution in improving your firm's staff expertise
47. Possible contribution to break into a new market with productive future
48. Contribution to firm's future due to value of the completed project to the public
Consultant firm (considering long-term gains and losses)
49. Amount of construction work the consultant has been carrying out regularly

Table 1: Factors affecting bidding decision.

But it is very difficult to meet all the factors because of time and resources limitation. Once again, a decision-making framework can help fasten the process and optimize the resources available in this phase.

2.7.1 Subjective factors

However, when speaking of the innovation project, the same is likely to be perceived and evaluated differently by different individuals *(Tobias Röth, Patrick Spieth 2019*). Another factor to consider in the innovative project is the innovation culture. In fact, it enables better firm-level performance outcomes – this idea has received substantial support *(Mohan et al., 2017*). Such an idea is reflected in decision-makers, especially in the front-end phase of a project since this phase entails activities such as idea generation, concept definition, opportunity recognition, and idea evaluation. *(Moenaert, Meyer, Souder, & Deschoolmeester, 1995; Reid & De Brentani, 2004; Smith & Reinertsen, 1998*) And therefore reflected in the decision "to bid or not to bid," which falls to the decision-makers.

Unfortunately, *Mohan et al. (2017)* found that decision-making biases under uncertainty, caused by novelty, influence managers to embrace a relatively exclusive approach by expunging uncertain ideas, often prematurely. The same article founds that in an organizational context that fosters trial and failure, front-end innovation managers are less susceptible to the fear of negative evaluation and more confident about their self-competence. Thus, they tend to perform an exhaustive and inclusive consideration of alternatives before making front-end innovation decisions. This extended decision-making process, in turn, is related to front-end innovation performance *(Mohan et al., 2017*). This brings us to another factor to consider: the response to a determined risk dictated by behavioural characteristics - indeed, *"it has frequently been demonstrated that changes in behaviour, induced by environmental pressure, can lead to a change in verbally expressed attitudes, usually in a direction which justifies the new form of behaviour." HOWARTH (1988)*. In other words, the situation affects the response of decision-makers toward risk. What is important to highlight is that risk subjective may vary from a set of attributes that have shaped the single decision-makers' professional figure. But, according to research *by Maytorena et al. (2007)*, what shapes the decision-makers is the following:

1) risk management training contributes to improving risk identification performance.

2) graduate level of educational attainment seems to contribute to a better risk identification performance.

3) role, years in a management role, and years in current job title are significantly correlated with the identification of "orphan risks" (a risk identified without any prior information acquisition or follow-up) and the use of a checklist approach.

And lastly:

There is no significant correlation between the risk identification performance measure and age, years in management, and years in job title, which are our proxies for project management experience.

But instead, continuing to add to the three points above and confirming what has been said in the previous paragraph, what seems to play an important role is:

The style of information search plays an important part in risk identification performance.

Nobel laureate Herbert Simon, known for the theory of bounded rationality, supports the idea that humans are only partially rational (*Kalantari (2010)*). He argues that humans are limited in integrating and processing all the information that would be needed to make a rational decision; in other words, the human mind is bounded by cognitive limits. Therefore, decision-makers (i.e., senior managers), in many circumstances, accept choices that are only satisfactory (*Williams et al. (2019*)).

2.8 Key takeaways From Literature Review – Towards a Decision-Making Framework

Innovativeness of a project is a crucial part, since defining such factor can give a hint of the potential of its success and the competitive advantage that the company can take away from that. But innovation brings along uncertainty and disruption, which is often very challenging to manage, on the other hand also brings breakthroughs. Innovativeness can be assessed from different perspectives: world, market, consumers or adopting segment. But all converges to evaluate the benefits of such endeavours against the risks and make informed decisions based on such evaluation. Specifically, such risks can be new - these new risks can be orphaned (not willingly taken into consideration) or can be new risks which arise from new or unfamiliar context. Another consideration to do is that as innovativeness increases the potential of emerging risks follows. Thus, these projects need to be evaluated, such evaluation is done during the bidding process. Making such project the most critical part of a project form a contractor perspective. As mentioned, uncertainties and risks are significant challenges in decision-making, and companies need a map to navigate through. A comprehensive risk categorization can help companies anticipate and reflect risks before bidding for a project. The quality of the assessments of such risks or uncertainties comes from the availability of information, keeping in mind that is not the quantity that matters rather the type of information that is needed to make informed decisions; in other words, limited but carefully selected information may be beneficial and preventing “analysis paralysis”. Methods of information management can be helpful to manage information. But not less important is the way information are communicated. Communication and consulting with stakeholders are also crucial throughout the process to endure alignment and balance between the contractor and stakeholders.

What really comes out from the literature review is the lack of a framework to encapsulate all the research. All this information can be dispersive and of little use presented in the current state. A decision-making framework could be a set of guidelines and criteria that are used to evaluate and make decisions in a structured way. For the bidding process, which is the most important part of the project, such a framework can help contractors to evaluate and weigh the various factors affecting if it is worth bidding or not to bid. Using a decision-making framework, a contractor can prioritize and rank all the factors based on their importance. The use of such a framework could increase awareness in making an informed decision and reduce reliance on intuition and subjectivity, which can also improve the use of time and resources. By considering the Venn Diagram (Figure 3), a series of conclusions can be summed up in three categories:

Main sets: bidding process, Risks, and Innovation: The current bidding process lacks a specific method to address new and emerging concepts in the field. Meanwhile, EPC Contractors must contend with

both internal and external risks that present both challenges and opportunities. Unfortunately, the current system does not evaluate the degree of originality a project possesses. As a result, there is a need for a more comprehensive approach that incorporates innovative solutions into the bidding process. These findings bring further questions, which will guide the research and used as guideline to go through this research:

How contractors bid for innovative projects?

What are the internal risks and external risks for EPC Contractors?

What are the challenges and opportunities to overcome?

Is the innovativeness level assessment really missing in the bidding process?

And finally, how the EPC Contractors are being innovative?

Intersections or **subset**: Managing risks in the bidding process, emerging risks, information: Innovation is often accompanied by a high degree of uncertainty, which in turn gives rise to unforeseen risks. Unfortunately, there is currently no established method for managing these "orphaned" or emerging risks. Furthermore, the issue of analysis paralysis can arise, preventing organizations from making informed decisions regarding potential risks. As such, it is essential for companies to develop effective risk management tools to tackle the challenges posed by innovativeness. Same as above, these findings bring further questions:

How EPC Contractors protect the company from risks?

Which role does play innovativeness in the EPC Contractor's approaches?

How EPC Contractor deal with the Analysis Paralysis problem?

And finally, the central subset which is about **Decision-Making:**

In making a bidding decision, several factors come into play, including firm-related factors such as need and strength, project-related factors like risk and profitability, as well as market conditions and strategies. However, when faced with uncertainty, decision-making biases can result in the premature rejection of potentially innovative ideas. This response to risk is influenced by individual behavioural characteristics and situational factors, leading to varied perceptions and evaluations of innovation projects. Effective risk management training, educational attainment, role, all play a crucial role in identifying potential risks, but the literature review seems to point that experience is not a factor. Moreover, fostering trial and error iterations can lead to better front-end innovation performance.

Consequently, to make informed decisions regarding entering new ventures, companies require a reliable decision-making framework. Such a tool can help to identify potential risks and highlight areas where information is lacking. Additionally, utilizing a decision-making framework can speed up the process and optimize the available resources. By minimizing the potential for emotional or miscalculated decisions, companies can create a culture that encourages trial and error, thereby incentivizing innovative ideas. Continuous improvement of the decision-making framework is achieved by utilizing an Experience Feedback Process, which allows companies to fine-tune the framework and make it even more effective.

2.9 A First Approach to a Decision-Making Framework

From the takeaway from the literature review in this paragraph it well be discussed how information can be gathered and used in order to be moulded by a decision-making framework and give a useful output.

2.9.1 Experience feedback process

Diego et al. (2012b) defined a model of the Bidding Process as a business knowledge issue in order to learn from the past and better deal with new tender through **Experience Feedback**. This means a structured approach to capitalize on information from past experiences. The information collected for reuse is what the article defines as an "experience feedback base." Two types of feedback can be distinguished:

- The activities of capitalization of the experience supply and knowledge base.

- The activities of exploitation in relation to the use of experiences in the base. The base is used when encountering a new situation or in the case of prevention or training - the experiences can be used specifically (a problem has been solved and its solution is directly applied or adapted) or generally (several problems have been resolved and it is possible to define general rules that will prevent their recurrence).

In other words, the capitalization process is the gathering of information that can be taken from a database or similar, while exploitation is the usage of such information when the time requires it.

2.9.2 The Bidding Process combined with the Experience Feedback Process

The figure below shows the invitation to tender sub-process: the bidding invitation is received, and the dedicated team will perform analysis to determine if the project suits the company and, therefore, if it's worth to further invest resources and going further with the proposal or stopping. If the proposal gets accepted, there is a capitalization of the reasons why it got accepted. On the contrary, if rejected, there is an analysis of such a decision (insignificant gain, the project not important enough, and so on) associating it with its context.

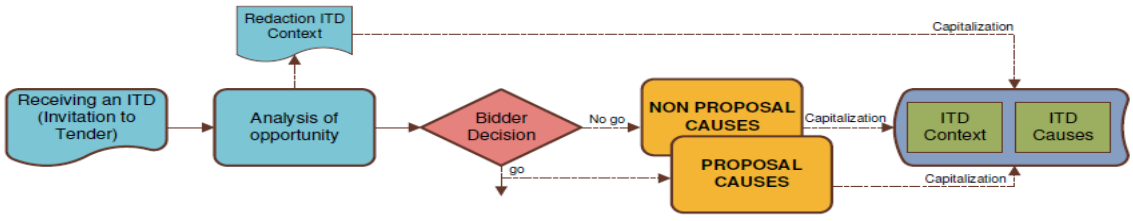


Figure 12: Invitation to tender sub-process - Diego et al. (2012b)

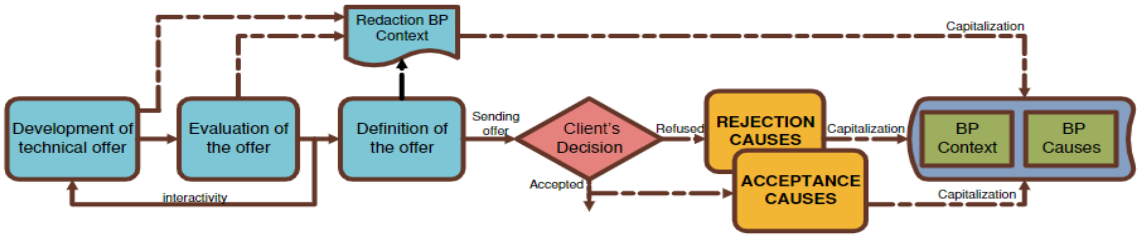


Figure 13: bidding sub-process - Diego et al. (2012b)

When the proposal is accepted, the next step is the bidding sub-process (Figure 13), where there is a definition of how to meet customer requirements. First, different design alternatives are created.

And the best one is offered to the client (all the characteristics of such a design have been discussed in previous paragraphs). Independently if the proposal is accepted or refused, there will be a capitalization process of past experiences to see the common ground of acceptance and non-acceptance so as to be reused such lessons learned in the future. After having retrieved the capitalized information, there is the exploitation of the information by using a decision-making framework. Furthermore, the suggested framework by the author only gives a glimpse of the complexity of decision-making for bidding process.

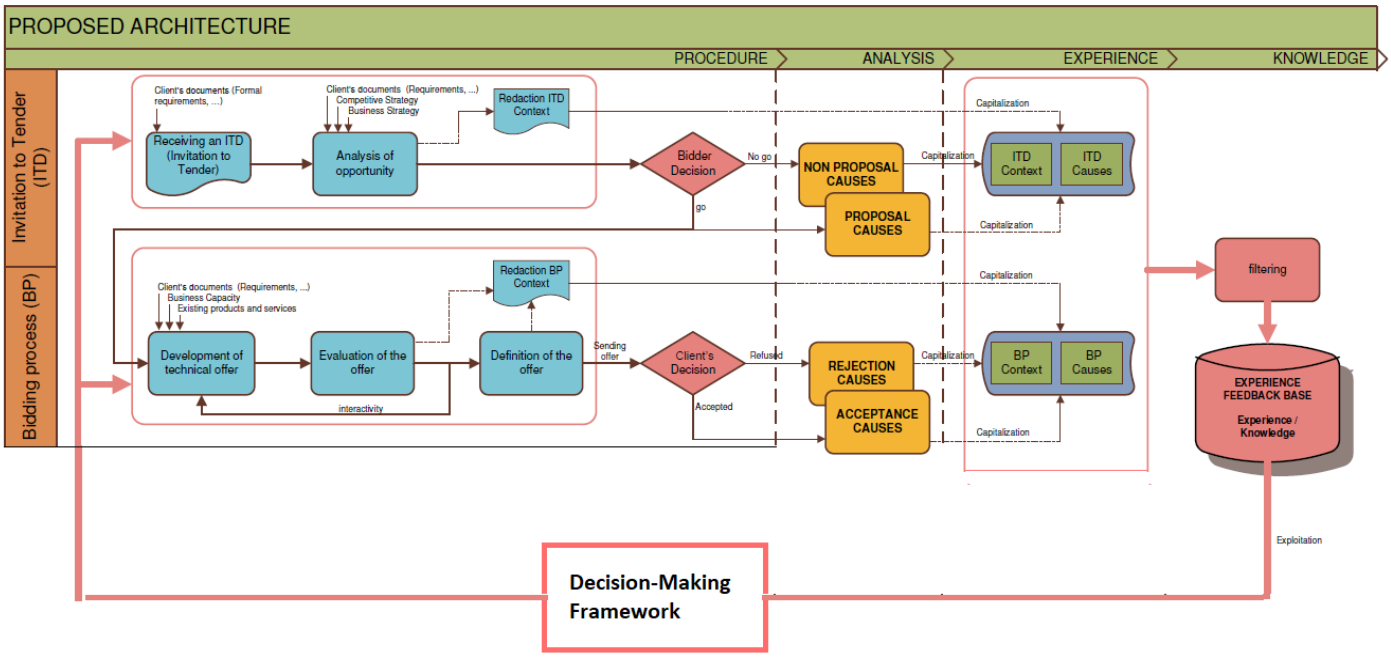


Figure 14: "Proposed architecture "Integration of experience feedback into the product lifecycle" adapted from Diego et al. (2012b).

To conclude, as also suggested by *Shokri-Ghasabeh et. Al (2010)*, such processes can create a structured evaluation of the bidding processes, but in order to do so, a company needs to create a database for the specific purpose of "feeding" the framework. Plus, it is recommended to create a system to better accommodate such learning cycles from past projects. Finally, such a system also has the potential to train recruits faster and, therefore, ready to take on major responsibilities within less time.

3. Findings

3.1 Introduction

The previous chapter provided an overview of the current state of the bidding process, the risks associated with it, and the need for a more comprehensive approach to incorporate innovation. Building upon that, this chapter will delve into the findings of the empirical research conducted to answer the questions raised in the previous chapter. The chapter will explore how EPC contractors bid for innovative projects, the internal and external risks they face, the challenges and opportunities they encounter, and the missing assessment of innovativeness level in the bidding process. Additionally, this chapter will examine the role of innovativeness in EPC contractor's approaches and how they deal with the issue of analysis paralysis. One of the central subsets of this chapter is decision-making, which plays a crucial role in making informed decisions regarding entering new ventures. Effective risk management tools, training, and education are essential for identifying potential risks, and fostering trial and error iterations can incentivize innovative ideas. The chapter will also discuss the importance of a decision-making framework and how it can help manage risks and optimize resources. Overall, this chapter aims to provide a comprehensive understanding of the empirical findings and their implications for the bidding process, risk management, and innovation.

Furthermore, in this chapter, the findings are subdivided and presented in two types of quotes: **Power Quotes** to support the argument and **Proof Quotes** (listed in the tables) which also support the argument but have less impact and are thus secondary. Finally, this chapter follows and try to answer the questions that have arisen in the literature review to indicate the domain of paragraphs; therefore, each one of them starts with the relative questions.

3.2 Research-based Premises

The interviews show that the bidding process for innovative projects can be affected by internal and external challenges. The premise is that every actor in the market is experiencing a learning curve, and there are no huge differences in expertise across the arena. The current emerging market it's in its infancy. Thus, there are plenty of opportunities to seize. Nevertheless, the old market will continue to exist for at least a period of decades, but also the old market is getting influenced, bit by bit, by current necessities (e.g., sustainability, energy transition), and thus a certain degree of innovation is also needed in the preexisting market. In other words, the nature of the industry is evolving, and along with it: teams, clients, requirements, contracts, standards, etc. This evolution creates disruptions, and therefore they are no standard means or paths to follow, leading to new challenges to face:

> *Interviewee 8 commented that the market for innovative projects is still in its early stages and will increase gradually, but traditional projects will still be required for long time. The interviewee also mentioned that each project is unique, and no two projects are the same in terms of team, clients, requirements, contracts, country, or standards.*

Thus, the bidding process is affected by this evolution, considering that this market is in its infancy. There are opportunities to seize the new market and initial changes to be made in the preexisting one.

3.3. Challenges of EPC Contractors in Balancing Traditional and Innovative Projects

What are the challenges and opportunities to overcome?

As mentioned, there are new challenges and changes to be made to face such challenges. In other words, ABC Company faces the challenge of deviating from its structured work processes and procedures. Clients make this hard by setting unrealistic expectations when tendering a project, asking

for reduced time in completion, and all the steps that must be taken to reach the scope of an uncertain project. This causes internal challenges:

"Interviewee 4 commented on the challenges of deviating from the structured work processes and procedures in ABC Company. They noted that it can be difficult to push people to deviate from these processes and that clients often provide unrealistic timeframes and unclear or overly ambitious scope descriptions."

The deviation from preexisting structures has roots in a fundamental aspect that leads to successful project completion, namely the historical perspective. This aspect is paramount in assessing project proposals based on the experience gained from preexisting projects and then using such data for new but similar projects. In other words, the existence of benchmarks makes the completion of a project smooth, cost-effective, on time, and safe. But, for innovative projects, there are no such benchmarks. Everything is uncertain, which put the most pressure on safety-related issues:

Interviewee 1 explained that safety assessments are based on historical data, which includes a use for several years, analysis of incidents, and implementation of solutions. However, there are no benchmarks or existing projects in the market for new designs in innovative alternative, that can provide sufficient data on performance and alternatives.

For this very reason, the learning curve is very steep since there is nothing to compare with and little to start from. Some people cannot deal with insecurities, and other people find these demonstrations not very challenging in terms of technical specification since these new projects now are not done on a very large scale; therefore, not very difficult to design.

Interviewee 1 stated that people working on traditional projects prefer them due to their large scale and complexity, which contrasts with smaller scale found on some innovative projects.

Therefore, there are difficulties in striking a balance between traditional and innovative projects. Experienced professionals often prefer traditional projects because they like complexity. On the other hand, all the demonstrations in the innovative sector are on a small scale and, therefore, simpler. This is a challenge that ABC Company needs to deal with: finding the balance utilizing experienced actors while pursuing innovative projects and thus having a diversified and balanced portfolio.

"Interviewee 1 stated that the lack of complexity in innovative projects is not attractive to technical professionals. This issue is not limited to one discipline and has become a problem for companies to balance the workload of experienced employees who prefer traditional projects, which are fewer in number than previous times and now being replaced by less challenging work.

Benchmark #1	*Interviewee 5 noted that there is uncertainty within innovative projects because few have reached commercialization. This is unusual in the bidding process where clients typically ask for a track-record of completed reference projects.*
Benchmark #2	*Interviewee 5 noted that some things that are unknown and/or cannot be decided immediately.*
Client #1	*Interviewee 13 noted that clients often lack knowledge about the technology involved in a project and may not be able to provide clear*

	scope descriptions, leaving it up to the contractor to figure it out.

Table 1: Proof Quote – Internal Challenges

In conclusion what is interesting is that that what found in the interviews is that changing market and innovative projects are destabilizing the internal structures of EPC Contractors, namely: the companies stuff needs to be managed in having of traditional project and innovative project. This issue exacerbates by the fact that client do not provide information about novelty projects and there are no benchmarks to look out in order to compensate the client's lack of knowledge; leading to a further frustration of experienced professionals which are more motivated to not get involved in this kind of projects.

Furthermore, internal challenges are worsened by external challenges. The latter is explained in the next paragraph.

3.4. Challenges in the EPC Industry: Dealing with Uncertainty in Clients and Supply Chain

Externally, the challenges that arise can be subdivided into two categories: **Client** and **Supply Chain**.

The **clients** bring a considerable level of uncertainties, starting from the fact that the clients usually don't know what processes are involved in a certain kind of the innovative project; therefore, their limited knowledge leads them to have unrealistic expectations believing that the project can be done quickly and with little time in planning and development. This way of thinking goes against traditional methods of increasing definition and reducing risk for a project in progressively more detailed design steps.

Interviewee 1 noted that their inexperienced clients have unrealistic expectations and fail to account for the necessary time required in the EPC process. They treat the process as a simple task of connecting equipment, which is not feasible. Without proper knowledge and experience, it is impossible to complete a project successfully within an unrealistic timeframe.

Therefore, there are challenges in doing projects for clients who are not fully aware of the complexities involved in such a project. As mentioned before, clients often just scale up the project, thinking that it would work without considering the emerging difficulties that some choices can bring. Furthermore, a further challenge is posed by the OEM (Original Equipment Manufacturer), which is not equipped for big production in this new sector. Even if the project is doable, there could be the chance that there would be no vendor available. And it's hard for ABC Company to make the client understand that the project may not be available with their configurations due to the limitations explained. Therefore, it is important to have open communication from the beginning and must important the will to do so and understand.

For example, Interviewee 1 noted that an OEM's capacity may be already fully booked, and none of the other providers on their list can meet the client's requirements. This creates a challenge in informing the client that their desired production timeline cannot be met due to the unavailability of reputable vendors.

Another tripwire is that sometimes resources can be spent to participate in a tender where there are no chances to win, and this leads to a waste of resources and missed opportunities for bidding on such projects instead of others:

"Sometimes client may only be interested in our quotation to benchmark an incumbent contractor" (Interviewee 13.)

All these factors create a very high level of uncertainty which could result in no commercial return for the winning bidder or loss of reputation if the project cannot be delivered as agreed. Also, the providers will not take an interest in the project and therefore leading to a no-go:

Interviewee 13 noted that clients will generally not accept novel technologies regardless of how attractive they seem if they have not already been proven. Clients may attempt to assign novelty risk to the EPC contractor.

Also, clients may need to be educated on innovative technologies. In other words, the client needs to be comfortable with a technology before considering putting resources into it, leading to conservatism, and potential project delays. Nevertheless, some other actors are willing to take the risk; usually, these actors are the creators of such technology.

From interviewee 12 clients will generally have pre-defined minimum technology readiness levels that they would work to.

From a supply chain perspective, as mentioned before, there is overall uncertainty among actors involved in innovative projects. Therefore, there is much potential for delays, and actors may not be willing to take the first step toward new technologies. Also, there is a minimal production capacity by the OEMs:

Interviewee 3 highlights that OEMs may have limited production capacity, and if a client requests a project to be completed in a given time period, there may not be any available OEMs who can meet that requirement due to overbooking. Plus, new products will need to be tested before they can be used in project.

The response from the interviewees indicates that, particularly for innovative projects, there are internal and external challenges to be faced. Internally, meaning within an EPC contractor, the new market section involves a need to diverge from existing structured work processes and professional thinking. The main reason is that clients and the nature of novel projects bring uncertainty and unrealistic expectations. Experienced professionals may find it challenging to deal with a lack of demonstration projects, no benchmarks, steep learning curve, and small scale. Therefore, the challenge is to strike a balance between traditional and innovative projects.

The challenges from outside an EPC contractor's operations can be divided into clients and the supply chain. Clients sometimes need to learn the project's technology, potentially leading to unclear scope definition, wishful thinking, and disappointment. On the other hand, the challenges that come from the supply chain are mainly the availability of equipment and materials, increasing costs, long delivery times, and unreliability.

Client #1	*Interviewee 5 introduced a hypothetical example where the client had unrealistic expectations for a project's duration, not understanding the extensive EPC process and equipment delivery times, leading to a misunderstanding of the project's scope and increased costs.*
Client wants lowest price #2	*Interviewee 4 explains that clients sometimes assume they can get the same quality at a lower price, but this can be risky as cheaper options can*

	result in projects that either don't work or take twice as long to complete.

Table 2: Proof Quote - External Challenges

In conclusion, as anticipated in the last paragraph the internal challenges are exacerbated by clients that, due to poor knowledge about the project, have unrealistic expectation from a technical point of view and a management point of view. Another factor is the availability of the supply chain, the more the project is new the more the OEM (Original Equipment Manufacturer) would have less availability and limited production capacity. The latter is reflected on the client expectation regarding the duration of a project or even the feasibility.

However, what most interesting is that clients also behave in strategic way, mainly by inviting to tender more contractors, even if they are sure to not chose them as such, just to increase the level of competition or to just receive some benchmarks. For EPC Contractor, this is a very dispendious and inconclusive waste of resources which needs to be avoided.

3.5 Bidding for Projects as an EPC Contractor

How contractors bid for innovative projects?

The research focused on understanding how EPC contractors evaluate project proposals and what factors they consider when deciding whether to accept or reject a project. The study found that EPC contractors typically consider a range of factors, which when comes to innovation the focus verges more on future consequences of the completion of such project. Furthermore, the research identified several risk indicators that EPC contractors consider when assessing project proposals.

3.5.1. Risk Indicators

Before bidding there is an assessment consisting of different stage gate reviews, each with its dedicated team and budget allocation. It starts with a starting budget for the first stage gate and then adds people and resources as the project idea passes through the stage gates:

Interviewee 8 noted that bids will go phase by phase and if the company goes through these gates we will bid because we have assessed that company have the means to win and execute the work successfully.

Another factor that has started to come up in the requirements to participate in a bid for a project is sustainability. Making sustainable choices is starting to be a selection criterion for clients. In a bid, this criterion and, therefore, the decision to pursue the project becomes more complex as factors such as balancing the costs and the carbon footprint can impact the final offer in the bid:

Interviewee 3 noted that an effective carbon price in a client's bid assessment is important for reducing the carbon footprint of project as it incentivizes lower emissions offerings.

Finally, as concluded during in the interview with interviewee 2:

"There is a need to strike a good value/price which works the actors involved, and value comes from clarity of information, core ethics, trust, and lawfulness."

When it comes to bidding for and developing such a project, the right mentality is to collaborate to achieve success and ensure that all parties involved are working towards a common goal. This involves protecting each actor that takes part in the project. A key to collaboration is thus openness and honest discussions to put everybody on the same page:

Interviewee 8 noted that a good approach is to discuss appropriate allocation of risk with clients such that the execution model works for all parties to the contract.

During the interview it came out that there is a list of red flags or risk indicators that decision-makers look out for. This paragraph presents the findings on risk indicators which can be related to the client, context, or scope of work of a project. First risk indicator is that it is essential and evident that client understand how EPC projects are planned and executed. Therefore, a lack of this is a risk indicator:

Interviewee 1 explained that some clients approach them without any understanding of the EPC contractor's role in a project, and they must educate them about it.

Another risk indicator is the level of definition of an Invitation to Tender (ITT). The level of definition is a crucial part of the success of a project. However, clients may put out an ITT believing that it is complete when it lacks crucial details:

"Interviewee 1 emphasized that clients must consider offtake possibilities when defining an ITT. If not, it is a potential risk and could hinder the project's success."

If the project does not show the risk indicators explained just before, there are also other risk indicator to look out for, which are more tactical reasons. These risk indicators can include the level of competitiveness in the market of the geographical area where the project will take place, the related labor cost, the regulations, and the political situation. Nevertheless, the project's size and the resources and capabilities required are.

Interviewee 13 noted that other risk indicators can be, if the market is competitive in such geographical area, if the work force there is too expensive, political factors, size of the project, and ration between effort in the proposal and the potential benefits that can be reputational, learning curve, earning and so on.

The reputation of an organization is a critical factor in its success. Poor performance of a completed project can have a significant impact on an organization's reputation, particularly in the eyes of its existing clients and potential future clients. Dissatisfied clients are likely to share their negative experience with others, which can harm the organization's reputation and make it more challenging to win future bids. Therefore, delivering high-quality work and meeting project objectives is crucial for maintaining a positive reputation and securing future business opportunities. But also, a completed project that "does not shine" is a waste of resources too.

Interviewee 12 noted that poor performance of the completed project will impact relations with existing clients and future bids.

Reputation can also be harmed if safety conditions are not taken in high consideration and most dangerous for reputation is the possibilities of accidents. On all construction projects, safety is of utmost importance. If a project is not safe enough, it is essential to discuss and collaborate with the client and take the necessary precautions to complete the project safely:

Interviewee 2 noted that if an execution strategy is deemed not to be safe engagement with the client should take place to adjust the project such that can be undertake safely.

It is essential to conduct a case-by-case analysis when deciding whether to take on a project. This means that the organization should evaluate each project individually and consider factors such as the project's scope, timeline, budget, and potential risks. By conducting a thorough analysis, the organization can determine if the project aligns with its capabilities and resources, and if it has the necessary expertise to deliver high-quality work. Ultimately, making informed decisions about project

selection can help the organization to maximize its chances of success and avoid taking on projects that may not be a good fit. What has been said, it can be reassumed by this quote by interviewee 2:

Interviewee 2 also noted that decisions about whether or not to take on a project should be based on a case-by-case analysis.

In other words, to judge the quality or value of a project based on its characteristics and achievements. If the project is deemed to be valuable the findings suggest other risks indicators lie within the matter of contracts on which the project will have foundations. On innovative projects, old ways only sometimes work and seldom work because of the uncertainty that surrounds these kinds of projects and when it comes to assess the grounds to whether bid or not bid for a project:

Interviewee 5 noted that lack of definition in the ITT can be a factor.

Another risk indicator is the type of contract the clients ask for. Uncertainties around innovative projects mean that a lump sum bid may not be appropriate, and there must be in place contingencies to mitigate the risk that comes from uncertainty:

Interviewee 4 explained that bidding on an undefined scope with a lump sum would require too much contingency, making it more expensive for the client. To mitigate this risk, reimbursable contract may offer the best balance of risk between client and contractor.

Client understanding of EPC Projects #1	*"Clients may wish to assign responsibilities to the contractor that are outside our capabilities* (Interviewee 13)
Client understanding of EPC Projects #2	*"A risk indicator is being asked to provide a performance guarantee for unfamiliar technology."* (Interviewee 12)
Client understanding of EPC Projects #3	*The interviewee 13 emphasized that limited resources may cause an EPC contractor to favour some types of work over others to maximise profits within their business model.*
Lack of definition of the project from the client #1	*Interviewee 1 noted that a good end-to-end understanding of the project and its end market is needed on the client's side.*
Reputation #1	*Interviewee 13 noted that references for similar projects are important for winning innovative projects.*
Reputation #2	*Interviewee 9 stated that ABC Company must be mindful of legal and ethical issues, and they wouldn't work with clients that are not legally allowed to operate or are under sanctions."*
Safety risk indicators #1	*Interviewee 1 noted that safety issues are paramount on EPC projects.*
***Safety risk indicators** #2*	*interviewee 8 stated that ABC Company considers safety and political stability when deciding whether to take on a project.*
Geographical risk indicator	*Interviewee 8 noted that local knowledge is an important consideration bidding for a project.*

Table 3: Proof Quote – Risk Indicators

In conclusion, the interviews revealed unwritten risk indicators or red flags that project managers consider when evaluating projects. These include the client's understanding of the EPC contractor's

role, the level of definition in the ITT, market conditions, labor costs, regulations, political factors, reputation, safety considerations, and the type of contract requested. The client also needs to prove its involvement in the project, a huge sign is the interests in the team formation assigned to the proposal, e.g., if the client does not ask for the resume of the team, it means that probably there is no plot. Another indicator is the project is a real project are the aftercare plans for a suggested project after completion and marketability of such idea. The absence of such interests indicate that the client is just testing the water and are not serious about going through it. This also is proven by the fact that interviewees highlighted the fact that the client do not know, or they just want a pre-feed evaluation.

3.6. Overcoming Challenges in EPC Projects: Approaches and Tactics of Contractors.

How the EPC Contractors are being innovative?

Which role does play innovativeness in the EPC Contractor's approaches?

How EPC Contractor deal with the Analysis Paralysis problem?

This paragraph shows potential strategy considerations, including market trends, evolving customers' needs, and the surrounding contexts from an internal-internal perspective.

"it's completely different, not comparable, those are not the same subject. You cannot build experienced based on previous job because there aren't." (Interviewee 5)

3.6.1. Internal strategy: Empowering Employees to Propose Solutions: A Catalyst for Innovation

A possible starting strategy is to create an internal pathway that constantly adapts and changes as the market and customers do. This involves finding new expertise and gradually converting the preexisting expertise. This involves finding a balance between traditional projects and innovative projects and ensuring that they have the expertise needed to manage both types of projects effectively:

Interviewee 1 noted that a separate team may need to be formed to take on new innovative projects, however there may be a challenge keeping experts in traditional area busy due to a lack of projects whose loss may be impact both types of work.

Training new expertise and preexisting expertise is essential to take initiatives and go for learning opportunities because often new projects, also involve bidding from a new point of view and finding new pathways to achieve the final scope. This piece of interview gives a good example:

Interviewee 3 discussed the company's innovative approach to finding more sustainable alternatives for bidding and projects. They give an example of a bid for a project where the customer requested an embodied carbon assessment and sustainable material. ABC Company engaged with suppliers to find alternative materials, revealing the importance of asking the right questions to explore new ways to reduce emissions in projects.

Thus, undertaking initiatives initiates and pushes people forwards in the learning curve since going for new endeavors provides a chance to acquire new knowledge and skills reusable in future projects. Furthermore, internal growth can be stimulated by organizing internal competitions:

Interviewee 2 noted that an internal competition was held to produce designs for an innovative project, which was purely internal and was not for any particular client. By taking designs to an indicated level of maturity, teams were able to identify what was important and what was not for the development of these types of projects.

Proactivity is the best approach to increasing knowledge and skills. Nevertheless, it does not stop only at this. Being proactive means looking for a relationship to build know-how and the prospect of new projects; this argument is continued in the next paragraph.

Need of two types of expertise #1	*Interviewee 8 noted that projects in traditional areas will be maintained while there is demand, and also that innovative projects are supported by more and more staff and there is a need to build experience.*
Need of two types of expertise #2	*Interviewee 1 noted the importance of business development managers having familiarity with innovative projects.*
Need of two types of expertise #3	*Interviewee 8 noted the importance of thinking outside the box and getting the right people with the right experience.*
Proactivity #1	*Interviewee 8 noted the importance of thinking about what do best as a team and as a company to attracting new work.*
Proactivity #2	*Interviewee 3 noted the importance of empowering people to propose solutions to challenging problems that arise.*

Table 4: Proof Quote – Internal strategy

In conclusion, empowering employees to propose solutions can serve as a catalyst for innovation in an organization. By providing the necessary training and resources, employees can take initiatives and pursue new learning opportunities, which in turn can lead to the development of new expertise and the ability to tackle innovative projects.

An interesting finding is about internal competitions of fictitious innovative projects encouraging then to think outside the box and encourage the growth of knowledge and skills within the company. These competitions foster a culture of proactivity and empowering employees to propose solutions, organizations can adapt and change in response to market and customer demands, ultimately leading to greater success and competitiveness. These skills and know-how can also be showcased to clients and market in general, as explained in the next chapter.

3.6.2. External strategy: The Importance of External Context for EPC Contractors

What was discussed so far was more from an internal perspective. In this paragraph, the findings show a strategy will also look at the external context. In general, what is meant by “external” are factors such as the clients, supply chain, and market trends from an internal-external perspective.

Preparing an adequate advertisement to show off capabilities and recent successes is a step towards success. The idea is to attract the market and relevant actors by selling unique solutions that the EPC contractor has done and can offer:

> *Interviewee 1 noted the importance of creating an impactful advertisement to showcase their capabilities to potential clients and vendors and highlight their recent R&D outcomes.*

A significant area of innovation is energy efficiency and new clean energy solutions. For these innovations it is paramount to look for a relationship, for example, engaging the most carbon intense suppliers:

Interviewee 3 highlighted engagement with main suppliers in high value and high-volume categories and focusing on those suppliers of high-volume carbon-intense products.

Nevertheless, at the end of the day, what is most valuable is reputation; one of the most valuable things that ABC Company has built over the years; for work in new sectors a new reputation will need to be built:

Interviewee 12 note that reputation is one of the most valuable assets of an EPC contractor.

Therefore, reputation goes a long with striving for innovation. The process ahead is about building partnerships to develop new technologies and build ABC Company's reputation as a reliable innovator. To achieve such a goal, it is important to collaborate with universities, industries, and governments and promote sustainability:

Interviewee 3 noted that collaboration between academia, industry, and government is a crucial for finding and testing sustainable solutions. In project environments, the risks are high and trialling solutions can be costly, so partnerships with industry players, competitors, and key costumers can be more beneficial.

As mentioned in the paragraph before, proactivity means looking for a relationship to build know-how and the prospect of new projects. This can also be seen as being from a passive actor, which receives the contract and executes, to be an active reactor that pursues innovation:

Interviewee 4 noted the importance of building stronger relationships with their supply chain, such that when they are bidding for projects, they can approach suppliers that they have already worked with and ask if they can provide more sustainable material to reduce the project's carbon footprint.

Relationship	*"They have people with expertise in some areas, but they may not have the necessary expertise in other areas related to sustainability."* (Interviewee 5).
Proactivity #1	*Interviewee 2 noted the importance of good relations with suppliers as well as undertaking their own initiatives.*

Table 5: Proof Quote – External Strategy

In conclusion, the success of an EPC contractor heavily relies on their ability to showcase their capabilities and recent successes through impactful advertisements. By highlighting unique solutions, such as energy efficiency and clean energy innovations, EPC contractors can attract potential clients is paramount for such companies to acquire the knowledge to anticipate clients by engaging with high-value and high-volume suppliers. However, the most asset of an EPC contractor is their reputation, which takes time to build and maintain. As such, EPC contractors must prioritize building a positive reputation to succeed in new sectors and projects.

3.7. Assessing the Risks of EPC Contractors and Risk Mitigation in Pursuing Innovative Projects

The following chapter follows Figure 7 (*Bidding Process Risk Mapping (Diego et al., 2013))* answering the following questions which was extracted as one of the conclusions in the literature review:

What are the internal risks and external risks for EPC Contractors?

3.7.1. External Risks and Uncertainties: Navigating Client Expectations in New Markets

Risk from clients

Before bidding for a project, especially for innovative with novel technology, there are considerations and relative assessments. Some of them have already been introduced in the paragraphs above, which can have outcomes in the short and long-time frame periods. For innovative projects significant risks may come from the client, since as anticipated before the client may need to learn what is needed to achieve a particular scope, a very different scenario compared to the traditional projects. Lack of knowledge is often the root of many risks, particularly in new markets:

According to Interviewee 13, clients pose the greatest risk in any project. On innovative projects, the risk is even greater because clients often lack a clear understanding of their desired outcomes, unlike traditional projects where they typically provide detailed descriptions. As the project progresses, clients may become more knowledgeable and change their requirements, creating another risk. The root cause of these risks is the client's lack of understanding of the technology being used.

As also described by Interviewee 3, the client is the most significant risk, significantly when clients change their minds. Nevertheless, for interviewee 4, this could be a threat and an opportunity since if the requested changes are executed correctly can bring more revenue from the project.

According to Interviewee 4, the greatest risk posed by a client is their tendency to change their mind. However, the interviewee acknowledges that change from clients can also be viewed as both a threat and an opportunity, as effectively managing such changes can result in more project revenue.

Interviewee 2 noted that they may choose not to bid on work if there are provisions in the contracts that they do not agree with. It is important to have a dialogue with the client to determine an acceptable balance of risk for each party and how to mitigate risks. Ultimately, managing risk is in the best interest of both the client and contractor.

Ultimately, the clients need to provide enough information for the contractor to assess potential risks. Other risks can include the level of definition of a completely new project. As such, there are no commercial plans available, nor guarantees on its success or that design works, all of which converges to no experience to deal with a completely new technology:

Interviewee 5 noted that without experience from earlier design phases and use of previous projects, it's challenging to guarantee a plan that meets all requirements and guarantees, including product specifications, waste streams, and environmental limits.

On top of that, the client may want to push more on assigning risk to the contractor, particularly for risks that the client would normally have investigated themselves before putting out an ITT (Invitation to Tender) on traditional projects. This lack of information leads to unexpected costs, especially if it brings substantial changes to the technical design. The client might also try to transfer to the contractor risks related to the supply chain or site availability.

Interviewee 2 noted the clients may try to shift risks onto contractors, such as site information or availability, which can be result in increased costs. The projects definition should have enough information to mitigate these risks. Supply chain and commodity prices are also relevant risks that need to be carefully negotiated in contracts.

The nature of novelty projects makes estimates unprecise and very volatile, for example from the bill of material: not knowing which and how much material and work hours is going to be needed makes

rough estimations which can cause to win, with a wrong estimation and then make up for it, or to lose a bid and possible opportunities. Either case is to avoid. Another risk to avoid is that uncertainty also leaves room for wishful thinking.

In summary, bidding for any project always involves considering various factors and various assessments to ensure the successful realization of any project. Nevertheless, for innovative projects, actors involved have a different perception of risks, which is a risk on its own, since it can lead to any disruption, e.g., volatile estimation, which can be on workers/hours, bill of material, or schedule. Furthermore, the absence of commercial plans and poor previous experience can effectively hinder achieving the projects' scope on schedule and cost. The lack of experience also leaves space for wishful thinking, misunderstanding, disappointment, and confusion, eventually leading to the project's suspension. Therefore, it is necessary to have open dialogue from the very beginning and, together with the actors, carefully manage and mitigate the project risks involved through the life cycle.

Risks from competitors

In this subparagraph is showed which risks are involved from the competition. As mentioned before:

Interviewee 12 noted that clients will generally award project to the lowest price technically acceptable bid. Competitors are getting more aggressive by bidding for very low price and then figure it out how to make things happen with that budget.

Nevertheless, everyone needs more clarity from the project definition done by the client leading to assumptions that affect the final price proposed. Therefore, everyone faces the same challenge; the differences are what the competitors perceive, which may affect their prices and go lower and eventually win the job. However, if some problems arise, the price can be insufficient and increase the risk of a poor project.

Interviewee 13 noted that the clarity of project definition is crucial in the bidding process as it affects the assumptions made by contractors, which in turn affects the price. If a competitor misses a problem, they may quote a lower price, but ultimately it may hurt them if the issue arises later.

In other words, the nature of innovative project may lead to cynical bidding strategies by competitors, which is common in the construction industry. As mentioned, some competitors may offer unrealistic low prices, which will not benefit the client if they later on approach the client with many changes' orders.

Risks from competitors can also be opportunities. The threat from competitors is that they might win a project that ABC Company wanted to win, which is self-evident. However, in some cases, ABC Company may collaborate with competitors to take on the entire risk profile of a project, which can be too much for one contractor to bear alone. In such cases, competitors become opportunities when they are aligned on the correct values and ethics, compliance, governance, and respect for human rights.

Interviewee 2 noted that collaborating with competitors on large projects can be an opportunity to share risk and win work that neither company could have won alone. Due diligence is important to ensure shared values around ethics and compliance."

Risks from the environment (contextual risks)

In each project the companies take on, risks are associated with external factors that cannot be directly controlled. This is, of course, magnified if the project is innovative. For example, a project may need subsidies, political support, or aligned legislation:

"Interviewee 13 is discussed the importance of assessing risks associated with projects, particularly external factors such as subsidies, legislation, and political support. They note that some projects may be less dependent on these external factors, while others may be highly vulnerable to changes in the political or economic landscape. The interviewee emphasized the need to carefully evaluate these risks before submitting a bid for a project, as they can have a significant impact on the project's likelihood of success. Additionally, they mention that while it may not be possible to fully price in these external risks, it is important to be transparent with the client about any issues that may arise and to communicate potential solutions. Overall, the interviewee highlighted the importance of due diligence and risk assessment in the bidding process for large projects".

Risk in strategy

From what was found, ABC Company will take on risks that are appropriately balanced with rewards in alignments with their business model and strategy.

Interviewee 13 noted that flexibility in evaluating project risks and rewards, and which types of innovative projects to bid on. Bidding on a project with novel technology is possible where risks and rewards are in the correct balance, and such projects will lead to an expanded portfolio.

From a relationship with the client and the risks that come from it, the main risks it is on their side because often the main reason for the client's existence is this kind of innovative project, making changing the overall strategy less risky.

Interviewee 12 noted that most clients for innovative projects are very focused in that type of technology, so there's not a big risk that the strategy is going to change. For most of the clients the strategic risk is relatively small.

Risk from unknowns #1	*Interviewee 12 noted that long term performance data is not available from vendors for some new technologies.*
Risk from unknowns #2	*Interviewee 5 noted that relatively few innovative projects have been completed and in use-phase. This means that company references for particular technologies are few or nonexistent.*
Client misunderstanding #1	*Interviewee 1 noted examples where the client misunderstood the required execution steps, including equipment and materials needed and the project schedule.*
Client misunderstanding #2	*Interviewee 1 noted that a client was unaware of the realistic schedule to execute a project and faced disappointment when realistic timelines were presented to them.*
Client misunderstanding #3	*"Within the context of bidding, the first challenge is around risk. So, we have different expectations and red lines around what we will accept for project execution risk, and these differ to what our clients might be expecting." Interviewee 2*

Clients misunderstanding #4	*Interviewee 11 noted that clients can misunderstand the full execution requirements of innovative projects, leading to disappointment. Discussions are necessary to clarify expectations, but sometimes it can still lead to project suspension and difficult conversations about timelines and budget.*

Table 6: Proof Quote – External Risks

3.7.2. Managing Internal Risks in Projects: Best Practices and Lessons Learned

Risk from project

Risks from within the project are often financial and schedule risks, and the risk might not be feasible or worthy of taking on. The risk also comes from the fact that clients might give information too late, and often the EPC contractor must act fast because it can lead to delays. Of course, for this reason, projects are constantly put under scrutiny before bidding.

Interviewee 13 noted that risks associated with project costs are present, and closely linked to the risk of delays due to the need for information from vendors or clients. Often, clients and vendors are too optimistic about their ability to provide information in a timely and sufficient manner, leading to schedule risks. Additionally, there is the risk that certain projects may not be feasible or worthwhile, and these are screened at the bidding stage.

Risk related to business.

Risk related to business can be related to outsourcing and as mentioned already in this chapter by interviewee 1:

Interviewee 1 noted that an OEM's capacity may be already fully booked, and none of the other providers on their list can meet the client's requirements. This creates a challenge in informing the client that their desired production timeline cannot be met due to the unavailability of reputable vendors.

Although from the perspective of interviewee 13, there are limited risks related to outsourcing in the context of innovative projects. The reason lies in the fact that outsourcing is mainly limited to small and specialized tasks that can be done more cost effectively by a consultant. Furthermore, most of the tasks are done within ABC Company, which reduces risk even more. However, the risk is never eliminated.

Interviewee 13 noted that the risks associated with outsourcing are minimal in innovative projects and typically tasks that are outsourced are specialized tasks, which are relatively small inscope and easy to outsource to multiple companies. Therefore, there is no significant risk associated with outsourcing these tasks. Moreover, for most aspects of the innovative project scope, ABC company has the expertise to handle them.

Also included in business other than outsourcing are technical risks: all the technical risks in this new market often are reduced to the aftermath, in other words to the operational risk. An EPC contractor may provide the end-product but is not guaranteed that the client knows how to use it exactly or that the intent use diverges from the end-product capabilities. Thus, the risk is not related if a technology works or not but whether it can be used as the client intends.

"Most technical risks in innovative projects are essentially operational risks. While the technology may work in principle, the question is whether it can perform under the specific circumstances that

the client requires and together with other items or facilities that are outside the scope of the project." (Interviewee 13)

Other technical risks are when there is a change in the project specification due to better possibilities or causes that cannot be controlled. Usually, the vendor offers alternative materials that might be easier to work with and at a lower cost but do not match the original design. So, there is a need to quickly alert the client of these possibilities before engaging in such choices.

"The technical risk is related to a vendor proposing a material that doesn't match the project's specification but is easier to work with and lower cost. Id the client doesn't have experience with that material they may be hesitant to allow the contractor to use it. The key to managing this risk is effective change management, which involves quickly alerting the client to the proposed change, getting their agreement before committing to it, and avoiding potential liability for the change." (Interviewee 2)

Thus, managing technical risk involves not only identifying potential problems but also managing changes that may affect the project's specification and outcomes.

What can be learned is that in conclusion, these quotes from various interviewees highlight the inherent risks associated with innovative projects. According to Interviewee 13, clients pose the greatest risk in any project, and the risk is even greater on innovative projects because of clients' lack of understanding of their desired outcomes and the technology being used. This lack of clarity in project definition affects assumptions made by contractors and ultimately affects the price, as noted by Interviewee 13. However, Interviewee 2 suggests that collaborating with competitors can be an opportunity to share risk and win work that neither company could have won alone, but due diligence is crucial to ensure shared values around ethics and compliance. Interviewee 5 notes that few innovative projects have been completed and in use-phase, meaning that company references for particular technologies are few or non-existent. Finally, Interviewee 12 notes that bidding on innovative projects requires careful consideration of risk, as different expectations exist between contractors and clients. Therefore, it is important for all parties involved to be transparent and have a clear understanding of the potential risks and challenges associated with innovative projects to ensure successful execution.

3.8. Risk Mitigation

How EPC Contractors protect the company from risks?

First, what is preliminary is to check the capabilities of the company and matching these capabilities with the ability to meet the client's expectation:

Interviewee 2 noted that importance of checking the project scope against the contractor's ability to perform that scope, as there will be penalties if the project isn't delivered as agreed, including financial penalties.

Also, the preliminary check of capabilities and skills and feasibility of the project need to be done in a short time because these checks consume resources:

Interviewee 12 noted that bidding efforts are more expensive the longer they go on for, so the contractor must evaluate if it is worth acquiring a particular information. You must constantly weight the risk of not having a certain information."

To assess a project idea and therefore decide to bid for it, there are stage gate reviews, as also mentioned before. Furthermore, once it has been decided is essential to be clear with the client and

perfectly align expectations with the possibilities. In other words, align visions. A way to do that is to offer the client different paths for the solutions:

Interviewee 2 noted that some project executing and reporting approaches are offered as standard may not have been considered from client's side as a possibility, for example setting key performance indicator and implementing different solutions to improve them.

To find and propose different solutions there is a need of flexibility:

"So, there must be a lot of flexibility from the team and to be able to accept the unknowns and just continue with the bidding process." (Interviewee 5)

Flexibility needs to be eased by the type of contract, and a lump-sum but contract may not be the best approach:

Interviewee 7 noted that risk sharing is not straightforward in a lump sum contract. Investment capital may be available for the project, although investors may require an assessment of project risks.

Interviewee 12 noted that innovative projects require on agile approach and people who can deal with uncertainty and switching from lump sum contract to fully reimbursable contracts.

Once the project team has decided to bid, the team is set, and the contract is ready to be signed, the client might want to procrastinate to gain time for their decision for multiple reasons; in these cases, it is essential to "force" the decision:

Interviewee 12 noted that sometimes it may be beneficial to include a validity period in the submitted tender such that the client is time-limited to award the contract.

Furthermore, once a project has been awarded and is in construction phase an essential part is getting the know-how to increase further the possibilities to win and execute future projects. Thus, it is imperative to have intellectual property on it:

Interviewee 13 noted that there might be tension between contractor and client if there is not a clearly agreed point of handover of the completed project.

Thus, it all comes down to assessing the tradeoff between risk and reward, and each party has its negotiating parameters. For example, the client will have limits on the risks they are willing to accept and the rewards they will give to the contractor. Similarly, contractors have their parameters around how they need to be reimbursed for the risks they are taking. Thus, negotiation is finding a balance between contractor and client parameters.

Interviewee 2 noted that project risk involves finding a balance between risk and reward that satisfies both the client and the contractor. Both parties have their own parameters for what they are willing to risk and what reward they expect. Understanding each other's position is key to finding a mutually beneficial balance.

In sum, for a successful bid, the perfect alignment with the client lies at the core of the matter. Therefore, it is vital for an EPC contractor to assess their capabilities and resources to match the client's needs. As found already before for the proposal, it is essential to propose different solutions or pathways for the same client's goal but more strategically find original aspects that the competitors would not find. Continuing, the nature of the innovative projects needs more flexibility, and agile approach, and a team that is not susceptible to uncertainties. Finally, the contract needs to be defined

to disincentivize procrastination, proper risk allocation, and responsibilities, plus protection and ownership of intellectual property of the newly developed technology.

Finally, from the interviews an interesting point was made by Interviewee 13:

Project execution today is not as fast or as cheap as it was a number of years ago, and much more than inflation levels would suggest. A lot of research has been done but it's still not very clear.

Contract Solution #1	*Interviewee 5 noted that risks of cost escalation are very high, and a potential solution is to execute on a reimbursable basis and not lump sum.*

Table 7: Proof Quote – Risk Mitigation

In conclusion, these quotes from various interviewees highlight the challenges associated with bidding on and executing innovative projects. Interviewee 12 notes that bidding efforts can become expensive, so it's essential to evaluate the worth of acquiring certain information and weigh the risks of not having it. Interviewee 2 notes that standard project executing and reporting approaches may not always be considered as a possibility by clients. Interviewee 7 highlights that risk sharing is not straightforward in lump sum contracts, and investors may require an assessment of project risks. Furthermore, Interviewee 12 suggests that innovative projects require an agile approach and people who can deal with uncertainty and switching between different types of contracts. Finally, Interviewee 13 notes that tension can arise between contractors and clients if there is not a clearly agreed point of handover for the completed project. These challenges underscore the importance of clear communication and collaboration between all parties involved in innovative projects to ensure successful execution.

4. Considerations towards a new decision-making framework

4.1 Introduction

This chapter aims to analyze the research findings to reach an updated decision-making framework. Findings have highlighted common and new factors such as challenges and risks related to achieving innovation an EPC Contractor perspective, specifically in the bidding process for innovative projects. Innovation is difficult to achieve due to boundaries imposed by time, finance, and technology; this is also true of "traditional" projects but the more the level of innovativeness is high the more it exacerbates such boundaries. Notwithstanding such considerations, companies must push boundaries and discover new frontiers to achieve innovation. Innovation brings uncertainties and risks, and decision-making can be slowed down due to internal friction and high uncertainty. What was discovered during the literature review is the need for a framework that encompasses all these challenges to be used as a map to navigate through new market. This research aims to create such a tool for the bidding process since it is the most crucial phase of a project development cycle as it sets the path for the projects' future. The bidding process is where the decision-makers decide whether the project is worth or not worth bidding on, considering the project's risk-benefit. The point is that there is a need for information that, in innovative projects, often needs to be improved. Thus, lack of information brings uncertainty and risks, which can be categorized differently. These risks converge to the same endpoint: incorrect assessment of a harmful process that could negatively affect the project cycle and the company.

4.2 The Feedback Framework

The literature review found a simple framework (paragraph 2.7.2. - *"Proposed architecture "Integration of experience feedback into the product lifecycle" adapted from Diego et al. (2012b)*.) which suggested an experience feedback process as a structured approach to capitalize information from past experiences, and which could potentially be used in the decision-making framework.

Two types of feedback were identified: **capitalization**, which is the gathering of information, and **exploitation**, which is the usage of the information when required.

From the interviews, the project's innovativeness level is mostly very high. Thus, there is still a substantial need for demonstration projects and relevant benchmarks (Interviewee 1, 5), thus the learning curve to an immature level to use **exploitation** feedback. Since there is no current information do exploit, at this very moment, **only the capitalization feedback** makes the most sense, because it consists of creating a database to be filled with the information gained from future projects. This means that the complete Experience Feedback Process is premature at this time and thus not used in its entirety in developing the decision-making framework.

4.3 The Need to Grow: Challenges and Opportunities

The findings of the empirical research suggest that there are both internal and external challenges to overcome when bidding for innovative projects in the new market. The following is the discussion of the findings.

The research focused on the topics of risk, uncertainty, and innovation, depicting different definitions of risk and the importance of considering both objective and subjective risks in decision-making. Understanding risk related to the level of innovativeness is crucial for successful project management, mainly when dealing with incomplete information and uncertainty as also mentioned "*the chance occurrence of some event where the probability distribution is genuinely unknown. This means that uncertainty relates to the occurrence of an event about which little is known, except the fact that it*

may occur" (Smith, N. et Al. (2013)) this is reflected on EPC Contractors as internal struggles to bid for new projects because of two main reasons:

- The projects are too uncertain – meaning that some expert might not be able to deal with uncertainty as better explained by HOWARTH (1988): *"it has frequently been demonstrated that changes in behaviour, induced by environmental pressure, can lead to a change in verbally expressed attitudes, usually in a direction which justifies the new form of behaviour."*
- The projects are in an early development phase, thus simpler than typical projects.

This highlights the impact of decision-making biases caused by uncertainty and novelty on the evaluation of innovative ideas in a project's front-end phase, which has consequences in the existing organizational culture that needs to foster trial and failure and can lead to more inclusive consideration alternatives and better front-end innovation performance.

The empirical research confirms what was found in the literature: decision-makers response to risk is influenced by their behavioral characteristics, the situation, and their level of risk management, but contrary to the literature review: *"There is no significant correlation between the risk identification performance measure and age, years in management, and years in job title, which are our proxies for project management experience." Maytorena et al. (2007),* experience does play a role in decision makers being able to deal with risks related to bidding process, in most cases. Additionally, the style of information search plays a vital role in risk identification performance *Maytorena et al. (2007)*, and decision-makers may have limitations by cognitive limits and accept only good choices. For this reason, companies strive to balance their portfolio between traditional projects and innovative projects, which will take some time to achieve. The balance intends to transfer knowledge from experts to people earlier in their careers while having both experienced and facing innovative projects, thus generating know-how for future projects.

Furthermore, external challenges to the company are connected to internal challenges; mainly, they come from Client and Supply Chain challenges, as seen clients bring uncertainties due to their limited knowledge of the processes involved in innovative projects, which leads to unrealistic expectations and a lack of understanding of the time and planning required for the development *(Diego et al., 2013)*. This can result, for example, in clients scaling up projects without considering the complexities and difficulties such a choice brings. OEMs, which may not be equipped for significant production in a new sector, also pose a challenge, as there may be no vendors available for scalable projects. Another external challenge is posed by aggressive competition in bidding for projects, often leading to contracts awarded for the lowest bid possible. This trend creates a challenge to remain competitive while still delivering high-quality results. Even if ABC Company wins the bid, the high uncertainty brings a possible no commercial return, damaging its reputation and reducing interest from providers. From a supply chain perspective, there needs to be more clarity among actors involved in innovative projects, leading to procrastination and a limited production capacity by OEMs. Availability of equipment and materials can also be challenging, increasing costs, long delivery times, and unreliability. Therefore, balancing traditional and innovative projects while dealing with uncertainties from the supply chain and clients is essential. Internally, new market section requires ABC Company to diverge from existing structured work processes and professional thinking.

The research highlights the importance of considering internal and external challenges when bidding for innovative projects. For example, decision-making biases caused by uncertainty and novelty can impact the evaluation of innovative ideas. External challenges from clients and the supply chain

compound the difficulties companies face. Therefore, it is crucial to incorporate these considerations into the decision-making framework for successful outcomes.

4.4 Risk Indicators to Consider Before Bidding for a Project

Before bidding for a project, ABC Company needs to decide if the project is worth undertaking, considering the trade-off between risk and reward. As also mentioned in the literature review from *Smith (2006)*: *"risk management is not about predicting the future but rather about understanding the project and making better decisions regarding its management".* With innovative projects, uncertainties are very present to a high degree, making projects challenging to predict. Thus, decision-makers focus on whether the risks are worth considering the trade-offs. Although before even considering assessing the risks is vital to look out for risk indicators to save resources in projects assessments. The empirical research showed the following risk indicators which have been collected and complementary to each other, which are a series of unwritten signs – matured by experienced employees in their career - to look out for before sending a proposal to the client. It is essential to mention that this assessment is prior to considering substantial risks related to the project:

a) The client does not precisely know what an EPC Contractor does.

b) The client tries to put unrealistic responsibilities on the contractor.

c) Level of the definition of the Invitation to Tender document is poorly defined.

d) The client does not worry about which people the contractor puts on the team.

e) The project has no plan after completion, aftercare, or commercial plans.

f) The client just hires the company for an early definition phase.

g) The project will not bring reputation to the EPC Contractor, or even worse, harm its reputation.

h) The client's lawfulness, ethics, and reputation are not aligned with values.

i) Safety is not one of the main concerns.

j) ABC Company has zero presence in the project location.

k) The country where the project will be done is unsafe for employees.

l) The lump-sum contract is impossible for innovative projects with high uncertainty; thus, reimbursable is the only option. If not possible to use reimbursable, it is not wise to go through.

If there are no risk indicators or some points have been resolved, what is found in the literature review is the **assessment of the level of innovativeness which** *"is crucial in understanding the challenges and risks associated with innovative projects. Existing literature provides several frameworks for assessing innovativeness, which measure the degree of newness of a particular innovation (Garcia, R. (2002))* and thus it could be an excellent way to look at a project also considering the risk indicators; for example: if a very high innovative project is a success, such project would be very beneficial for an EPC Contractor.

4.5 The Importance of Innovativeness and Managing Risks

Which role does play innovativeness in the EPC Contractor's approaches?

The importance of innovativeness is discussed in depth. Innovativeness is vital because it creates an organization's competitive advantage and long-term success. However, innovativeness brings about a degree of discontinuity, and risks are being dealt with to create discontinuity due to the uncertainties

that come along with the novelty: *"These risks involve the often-complex dynamic between emerging technologies and society and are increasingly likely to blindside enterprises" (Coles, 2022)*. Uncertainty relates to the occurrence of an event about which little is known, except the fact that it may occur. The extent of innovativeness in an organization can be measured by its degree of newness. As the research indicates, there are different perspectives from which innovation takes shape and meaning. It can be innovative from a world perspective, new to the adopting unit, new to the industry, or new to the market.

Risk and uncertainty are always present in any innovation project. However, it is not about avoiding risk per se but deciding if the risks are worth taking, considering the trade-off. A poor assessment means taking over too much risk or dropping projects with great opportunities for the company. Therefore, to create a decision-making framework, it is paramount to understand risk. Incomplete information is strictly linked to the nature of the project, and the higher the degree of innovativeness, the more risks, and uncertainties present.

Objective risk is measurable, and subjective risk is the perception of risk influenced by the person assessing the risk. Both types of risks need to be considered because, very often, information is incomplete to quantify risks; this creates uncertainties, and therefore, the judgment of the decision-makers is the key component to dealing with such incompleteness. In summary, innovativeness is crucial for organizations, but risks and uncertainties must be considered when making decisions.

4.5.1 Analysis Paralysis: Balancing the Need for Information and Efficient Decision-Making

How EPC Contractor deal with the Analysis Paralysis problem?

As also mentioned by the literature review, scant information needs to be dealt with because when the information is negligible, the uncertainty is high. Thus, hidden risks may be neglected. The availability of information during the earliest stage of a project is highly dependent on the novelty of the project and its scope. The literature review highlighted that while a wide availability of information does not lead to improved risk protection and decision-making, information scarcity does not lead to poor risk protection or failure. As mentioned by interviewee 13, a question is needed to be asked at some point: is it worth pursuing such information? Will it take more time and effort than the benefit of knowing such data? A trade-off between the value of that information and the process to achieve that information must be done promptly*. Williams and Samset (2010), as mentioned in Williams et al. (2019)*, state that in the early stages of decision-making, it's not the amount of information that is important but rather the kind of information needed. Opting for a narrow yet appropriate set of information can avoid "analysis paralysis," which refers to the excessive number of specific details provided to decision-makers at an early stage of the decision-making process.

There are different ways to manage information, and the literature review found that one of them could be the TIRM (Total Information Management) process consists of three stages, which in short, involves.

- understanding the context of the project by considering internal and external factors,
- analysing risks,
- estimating the trade-off between risk and reward before bidding.

As shown before, this perfectly aligns with ABC Company's way of doing. A communication plan could not be found in ABC Company's information management. As suggested by the literature review, the

communication *(Freud & Jones (2014))* plan involves identifying relevant stakeholders needing information and ensuring that only one project vision is out. A communication plan is created and agreed upon by every stakeholder involved. Stakeholders will be thus aligned on why confident choices have been made and why the contractor has chosen a particular pathway to achieve the project's scope.

Thus, from the literature review and the empirical research, the hinge keeping the project rolling is information and its management. First, information needs to be acquired effectively: in the correct quality/quantity and fast, thus avoiding procrastination. After that, information needs to be communicated, through an agreed communication plan, to the relevant stakeholder, who will use that information with the opportune context around the information.

4.5.2 Factors Affecting Bidding Decisions for Innovative Projects in the EPC Industry: How reputation is the key player in the decision-making.

An interesting finding from the empirical research is how an EPC Contractor can still undertake a highly innovative project, thus risky, and still protect itself from a downfall. Furthermore, an EPC contractor can still acquire reputation and know-how from joint ventures to research and develop new technologies, e.g., from intense carbon suppliers. This aspect will be further discussed in the following paragraphs.

Contractors need to make strategic decisions about whether to bid for a project and how determine a competitive bid price within a limited response time. The factors that affect bidding decisions include the contractor's current workload, financial situation, strength, project conditions contributing to profitability, job uncertainty and complexity, risk, client and consultant factors, availability of resources within the region, competition, and foreseeable future market conditions and financial situation.

It can be challenging to meet all the factors due to time and resource limitations. Nevertheless, as suggested by the interviews now, acquiring know-how and reputation need to be weighed against profitability of a project. Therefore, the following is an adaptation of the *Factor affecting bidding decisions (Prajapati, Raju & Pitroda, Dr. Jayeshkumar & Bhavsar; Prof., 2015):*

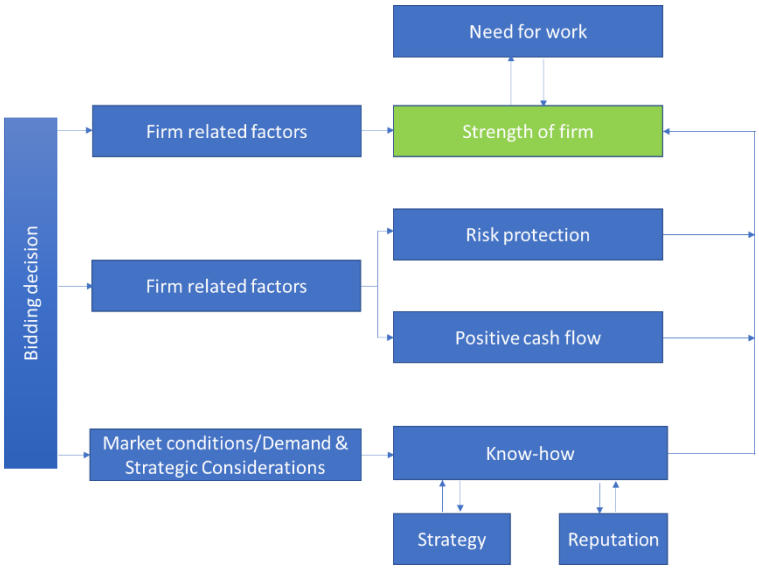


Figure 15: Adaptation from "factor affecting bidding decision" (Prajapati, Raju & Pitroda, Dr. Jayeshkumar & Bhavsar, Prof., 2015).

The figure shows what are the factors that affect the bidding decision, as shown in the literature, by firm-related factors, project-related factors, market conditions/demands & strategic considerations. This adaptation shows that in the case of innovative projects - and the context that come along with such projects - decision-makers need to focus their attention on strengthening the firm by acquiring know-how as part of a larger strategy (which will be explained later in the chapter) and by doing that achieving a renewed reputation in the new market. The arrow shows that there is a double path (back and forth) from "Strength of firm" and "Need for work," creating a feedback loop. More precisely, the straightening of the firm bounds to the need for work and satisfying the need for work strengthens the firm to start to loop over again. Pursuing what is explained is vital to manage project-related factors, namely managing the risks while maintaining an acceptable cash flow.

In conclusion, the decision-making process for bidding on innovative projects is complex and involves various factors, such as the contractor's workload, financial situation, project conditions, risk, and competition. However, empirical research suggests that acquiring know-how and reputation is essential, particularly for EPC Contractors undertaking highly innovative projects. Although profitability remains crucial, it is not the only factor to consider. By acquiring know-how and reputation through joint ventures and research and development, decision-makers can strengthen their firms and achieve a renewed reputation in the new sector. As the figure shows, there is a feedback loop between the strength of the firm and the need for work, emphasizing the importance of a larger strategy that focuses on acquiring know-how and reputation to strengthen the firm continuously.

4.5.3 The Need of Understanding and Managing External and Internal Risks During the Bidding Process

As mentioned in *Bidding Process Risk Mapping (Diego et al., 2013)* there are two types of risks: external and internal risks during the bidding process. External risks are the ones outside the company and Internal risks are referred to the company.

External risks

External risks include risks from **the client,** which may be referred to: as incomplete/inaccurate requirements and specifications, poor information quality, image risks, non-compliance with agreements, risks related to the market and bidding process, and financial resources mismatch. What was found in the empirical research has confirmed the literature research findings, but compared to the other external risks, the "Client variable" seems to be the most critical risk to control and the most dangerous one. In fact, the interviews have confirmed that, especially in innovative projects, the client has a substantial lack of knowledge on the projects, thus leading to incomplete/inaccurate requirements and specifications and poor information quality. These complications are a risk because they may lead to changes in project requirements in the middle of a project, making it harder to meet client expectations. Also, there could be a financial resources mismatch caused by the client that might try to put more responsibilities, such as geotechnical information or weather factors, on the contractor, which is unacceptable from a contractor's perspective.

Furthermore, what was found in the literature review is that the decision-making process for project bidding has become more complex as multiple criteria are now used to evaluate bids, with more emphasis on quality rather than just the lowest price. However, from the findings, competitors bid for a meagre price, which is also encouraged by many clients that ABC Company deals with, warding their projects to the cheapest technically acceptable bid. Although, once a project is taken, it is vital to negotiate fiercely on this because such uncontrollable events can lead to unexpected costs and substantial changes to technical design. Findings suggest that the success of a project is highly

dependent on the client providing enough information for the contractor to assess the potential risks. Nevertheless, also be open to dialogue to try to find a balance between risks for all the actors involved.

Another external risk is **competition** in particular: literature review describes competitors to have better knowledge or a better understanding, confidentiality risks caused by information leaks, hardening of the client caused by other bids, and malevolence risks such as competitors' malicious actions to the tender. What was found during the interviews is that usually, the competition does not pose a high threat to the company per se. However, it may engage in tactical low bidding, which is also not discouraged by most new clients in new markets. The interviewees did not mention another kind of risk highlighted in the literature review related to the competitors. However, the exciting finding is that competitors may be opportunities in large projects where collaboration can help spread the risk. Thus, EPC contractors such as ABC Company can engage with competitors by ensuring that potential partners have the correct values, ethics, compliance, and governance beforehand.

Finally, there are the risks associated with the **Environment** intended as the context in which the project sits**;** these risks can be economical (e.g., moving market condition), legal risks associated with non-compliance of regulations and standards, geographical risks, project location and consequently social risks such as political and social instability of the area. For example, recent conflicts have proven the moving market condition lately, which made companies to renounce some projects and offices in affected areas. Nevertheless, more in-depth companies always assess any likelihood of the project going ahead in a particular country. However, it is impossible to assess any risks and thus price these external risks fully, and specific clients could be exposed depending on their financial and political situation. The company can flag any potential issues to the client, but in the end, these risks are not controllable, and thus the actors have to accept them and try to mitigate them to the best of their possibilities.

Internal Risks

Internal risks involve **Strategies** intended as inappropriate procedures and risk analysis. Human factors risk organizational risks, management risks, human factors arising from poor negotiator skills, commercial risks related to order supply and its reliability, and internal policy risks. The literature describes these risks, although the empirical research added that other well-positioned EPC contractors may have well-established experiences in these single factors. More specifically, the main risks for ABC Company are small because flexibility is allowed for taking on new projects, with proper assessment. Thus, the strategy may not limit growth opportunities. But, once again, the main risks may come when the strategy of a company does not fit with the overall strategy of the client and thus hinders the very reason for the existence of some projects.

Another factor involves risks associated with the **Project**; the literature review found that these risks can involve financial risks associated with the acceptance of insufficient budget or clients' delay in payments, calendar risks such as tight deadlines, delays, and more, development risks caused by non-verification of existing means and client needs. The literature review confirms the exact risk of the nature of the project. However, a substantial additional risk has been found in the empirical research, which is the risk related to the client that might not provide enough information promptly and thus leading to delays. Usually, EPC Contractors, such as ABC Company, scrutinize projects before bidding on them, whether they are feasible and worthy of pursuing. Companies will try to assess any potential hidden in a project before making the final decision.

Finally, risks associated with the **Business;** risks related to the know-how may contribute to technical risks such as human error, lack of expertise, and more Interviewees confirmed this section, although

they highlighted that outsourcing could in some cases, pose a risk to the Business, mainly if the chosen vendor is overbooked and cannot fulfil the project requirements. Nevertheless, even so, risks related to outsourcing in the context of innovative projects are limited because the outsourced tasks are small and specialized (e.g., quantitative risk assessments). This means that most of the tasks are done within ABC Company, which reduces the risk even further. However, risks can never be eliminated. Other than outsourcing, there are also technical risks that can hinder the Business. Technical risks are not just about whether a technology works but also whether it can be used as the client intended use. If there is a mismatch, this can harm the relationship with clients and reputations. Thus, technical risks often boil down to operational risks.

Nevertheless, pure technical risks can arise during the realization of a project, such as a change in specification due to better possibilities or causes that cannot be controlled. In such cases, vendors could offer better materials or methods that may be more efficient but not match the client's original design. Thus, in these cases, clients need to be informed of these potential changes and get their agreement before committing to them to avoid potential liability but also agree on discussing any change during the negotiation phases in such a way to make this process smoother.

In conclusion, bidding for innovative projects involves various internal and external risks that must be anticipated, understood, and managed to ensure success. External risks include client issues, competition, and the project environment. Clients can pose a significant risk due to incomplete or inaccurate requirements, specifications, and financial resources mismatch. Competition can engage in tactical low-bidding, and the project environment can present economic, legal, geographical, and social risks. Internal risks involve strategy, project, and business risks. For example, strategies that do not align with clients' overall goals can hinder project success, and insufficient budgets or clients' payment delays can cause financial risks. Outsourcing can also pose risks to the business if the chosen vendor is overbooked and cannot fulfill project requirements. Therefore, assessing potential risks, implementing effective risk management strategies, and maintaining open communication with clients to ensure project success is crucial.

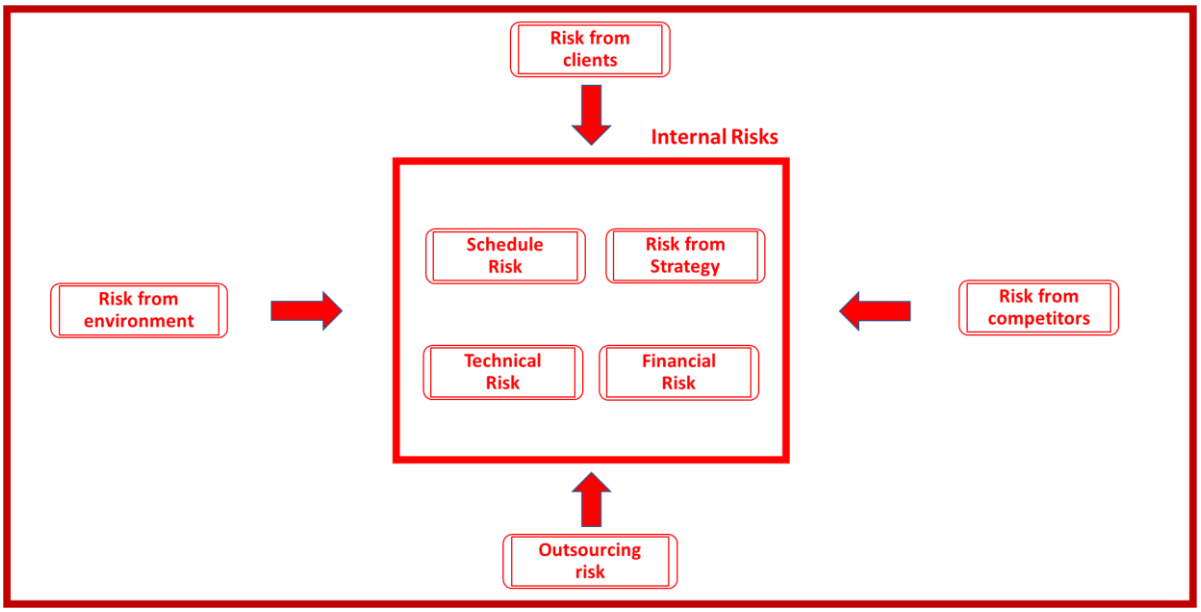


Figure 16: Relation between external and internal risks

4.5.4 Risk Protection in Innovative Projects: Key Findings for Front-End Development

Risk protection in innovative projects starts from the project front-end development; the literature review showed evidence of a strong positive correlation between front-end success and project

portfolio success. Therefore, it is vital to go through the front-end phase' phases with a rigorous and focused approach and be open to new ideas, especially in innovative projects.

The literature research showed that: "*it has been proven with empirical evidence that there is a strong positive correlation between front-end success and project portfolio success" Kock et al. (2016*). It all starts with the emergence of an initial idea, followed by an analysis of the complexity and underlying problems that need to be addressed. The first estimates of costs and benefits are then made, and stakeholders' preferences and incentives become visible. The front-end phase is characterized by scant information about the prospective project, leading to high uncertainty *Williams et al. 2019*. However, this is also an opportunity to explore the space and carve out conceptual alternatives. As the concept is developed, the first estimates are refined. It is crucial to recognize stakeholders and give affected parties a chance to have some impact on decisions. The project should be regarded and integrated into a broader strategy or project portfolio. Finally, the foundation is laid, and significant decisions are made, paving the way for the next development phase.

During these steps, the empirical research has brought to light eight key findings to protect the company from risk when going for an innovative project:

1. Assess the capabilities of the EPC Contractor. In this case, ABC Company assesses its capabilities and skills and checks if they match the client's expectations to avoid financial penalties or other consequences during and after the project completion.
2. Short time should be taken to assess the feasibility of the project and the respective companies' capabilities to avoid falling into a rabbit hole with unnecessary use of resources.
3. Aligning expectations with the client and offering solutions to reduce risks and uncertainties.
4. Flexibility is paramount in innovative projects, thus requiring a more agile approach to deal with uncertainties.
5. Assessing the type of contracts to execute and deliver the project. Either lump sum or reimbursable in-line with company strategy.
6. Clients may procrastinate decisions, thus sometimes, strategy to speed up decisions may be necessary to speed up the process (e.g., creating a sense of urgency).
7. Once created, technology is vital to secure the developed project's intellectual property for future projects.
8. Negotiation is about balancing the contractor and the client's parameters around risks and rewards – a successful bid depends on good alignment with the client.
9. Competitors may be opportunities in large projects where collaboration can help spread the risk.

The findings discussed in this research on risk protection in innovative projects are crucial for companies to bid for such projects. With high levels of uncertainty and risk involved, a rigorous and focused approach during the front-end development phase can significantly increase the chances of project success. Companies can identify potential risks and uncertainties early in the bidding process by assessing their capabilities and aligning expectations with clients. Being flexible and choosing the right contract type can help mitigate these risks, and securing intellectual property ensures the project's future potential. In addition, negotiating to balance risks and rewards with clients is essential for a successful bid, and collaborating with competitors can help spread the risk in larger projects.

Incorporating these findings into the decision-making framework for bidding on innovative projects can help companies make informed decisions and increase their chances of success. Ultimately, taking a strategic and informed approach during the bidding process can lead to greater profitability and long-term success in the innovative project market.

4.5.5 Strategies for Future Success: Internal and External Approaches for EPC Contractors

This paragraph highlights possible strategies for EPC contractors to ensure their future success. The strategy can be subdivided into two parts, internal and external strategies. In other words, what do EPC contractors do from within and outside the company and externally to prepare for the future in new markets? The research aimed to analyse the methods involved into a decision-making framework.

Internally, strategy involves creating an internal pathway that adapts and changes as the market and customers do. EPC contractors can find new expertise and convert pre-existing expertise to ensure a balance between traditional projects and innovative projects. Thus, training some employees to fill the gap in new areas where they lack expertise and providing opportunities for growth and specialization. However, companies need to recognize the importance of satisfying specialized employees in traditional projects, which can be challenging when there is not enough work for them. In other words, there is a need for two types of expertise: those who are happy managing innovative projects and those who are happy managing traditional projects. Interviewees suggested getting people earlier in their career involved innovative projects. In contrast, other interviewees suggested hiring business development experts familiar with the new markets to strengthen the team.

The literature review suggests that *"there is no significant correlation between the risk identification performance measure and age, years in management, and years in job title, which are our proxies for project management experience." Maytorena et al. (2007)* furthermore the empirical research encourages and provides evidence that early career individuals, particularly those with higher educational attainment, can contribute to innovativeness in project management. For example, the literature review shows that graduate education is associated with no impairment in risk identification performance, indicating that individuals who have recently completed their studies may have the knowledge and skills to identify and mitigate risks successfully. Additionally, the role of an individual and their years of experience in a management position is correlated with identifying orphan risks and using a checklist approach. This identification could be improved with individuals at their early career in teams who have recently entered management roles bringing a fresh perspective to risk management. Therefore, it is safe to assume that organizations prioritizing recruiting and development opportunities may benefit from increased innovativeness and improved risk management performance.

Nevertheless, what found through the interviews is the importance of thinking outside the box and getting the right people with the right experience to ensure project success. This brings the importance of undertaking initiatives and going for learning opportunities. An example was provided to explain this aspect better. On one occasion, there was a bid where the customer requested the use of more sustainable materials. ABC Company engaged with suppliers to see if there were materials or if it was possible to create one. It found that, with surprise, there were already alternatives, providing a chance to learn and acquire new knowledge and skills. This further stress the importance of being courageous and looking for an alternative solution, not only when the client asks for them but also autonomously. Additionally, internal competitions can be organized to stimulate internal growth and encourage innovation.

When bidding for a project, there is also the need to look long-term in the future. In other words, keeping in mind the adaptation of Figure 16, the decision-making framework should not only aim to safe project completion for the EPC Contractors but also look at the consequences of the completion of such a project internally involving the development of new expertise, keeping specialized employees satisfied, thinking outside the box and encouraging the development of innovative mentalities.

Externally, the empirical research suggests that EPC Contractors should focus on the external context to consider innovation when looking to move to new markets. In other words, companies need to build a new reputation for delivering in new markets as they did in traditional markets. To achieve this goal, advertising can be used to showcase a company's capabilities and recent successes. This will attract the market and relevant actors by showcasing and thus selling unique solutions that an EPC contractor has developed and can offer. For example, after doing R&D, the research outcome should be part of the advertising message to the world that communicates the most recent capabilities. Continuing, it is crucial also to build relationships with key suppliers, of intense carbon products, so that products can be tailored better to client sustainability requirements.

Moreover, thus, collaborating with suppliers can help a company increase their reputation and acquire new know-how for innovative projects. Furthermore, universities, industries, and governments can create other partnerships to promote innovation. Finally, what has been found through the interviews is that companies should also aim to anticipate future market trends and key players.

To conclude, external strategies must be considered when deciding to bid for innovative projects. This means that before bidding for an innovative project, the consequences of completing this project should reflect the internal and external strategies discussed before. In this way, EPC contractors' current and future interests are guarded. Nevertheless, also, this can have consequences on the market overall. Hypothetically, if every company strives for projects that align with these strategies, clients will propose only worthwhile projects to get the attention of the EPC Contractors. Ideally, this should also incentivize the client to award the project for quality in the short and long term instead of short-term low-price criteria.

It is worth observing that what is found in the empirical research regarding risks, especially when speaking of **Strategic Risks**, is that being open to learning and being flexible is a good strategy. However, aligning the company strategy with the client strategy is always essential.

Furthermore, The Factor affecting bidding decisions listed in paragraph 2.7 align with the empirical findings. However, as mentioned in the same paragraph, such a list is more of a general depiction of what usually is considered, and it is impossible to consider all the factors. Thus, the empirical research helped to narrow down such factors for the decision-making for the bidding process. To conclude, the strategies discussed in this paragraph are essential to consider when bidding for innovative projects. The internal strategy involves creating an internal pathway that adapts and changes as the market and customers do. This requires finding new expertise and converting pre-existing expertise to balance traditional and innovative projects. The importance of thinking outside the box and getting the right people with the right experience and the need to undertake initiatives and go for learning opportunities is stressed. The external strategy involves focusing on the external context to consider innovation regarding sustainability and eco-friendly solutions. This involves building a new reputation as a reliable innovator, showcasing unique solutions, and building relationships with key suppliers. The empirical research suggests that EPC Contractors should anticipate future market trends and key players when bidding for innovative projects. Ultimately, aligning the company strategy with the client strategy is essential. The empirical findings help to narrow down the factors to consider in the

decision-making process for the bidding process, highlighting the importance of being open to learning and being flexible in a rapidly changing market. Finally, this can help start to unlock the analysis paralysis problem. By giving more sense of direction in the information required.

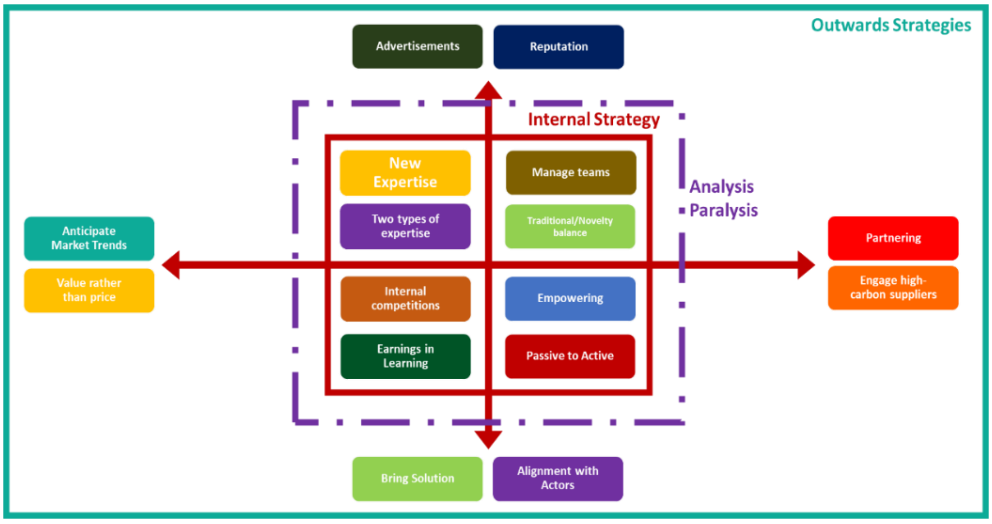


Figure 17: Relation between internal strategy and external strategy.

4.6 The Decision-Making Framework

In the light of the facts, the Decision-making framework presented here represents the final milestone of this research; the framework depicts - in chronological and logical order - the steps to consider before bidding for an innovative project. Given the high levels of uncertainty and risks associated with innovative projects, there is a need for a decision-making framework to guide the bidding process. The framework should start with considering level of innovativeness, risk perceptions, available information, and other factors that may influence the decision-making process. The framework should provide a systematic approach to evaluating and selecting the most appropriate bids while minimizing risks and maximizing the potential for success.

As described by *Diego et al. (2012b)* in the literature review, there are two processes one is the "invitation to tender process" and the second one is the "bidding process". As showed by the figures, the first. The initial stage of the sub-process involves receiving the invitation to tender (ITD) along with relevant documents such as terms of reference and appendices that contain normative references and product specifications. Upon receiving the bid, it must be carefully analyzed to determine if the company should proceed with making a proposal or halt the process to save resources. This analysis takes into consideration customer requirements, competitive strategy, and overall business goals. Based on this assessment, the company will decide on whether to continue or terminate the bidding process. After the ITT Process, the bidding process involves defining proposals for solutions that meet customer requirements. This phase includes the preliminary design, where designers create solutions based on specifications. The development of the technical offer involves considering design alternatives, evaluating risks, and selecting the most viable alternative. The company may propose multiple bids based on capacity and customer requirements. Risks associated with alternative choices need to be identified to avoid potential project incidents. Once the offer is sent to the customer, it may be accepted or refused. In case of refusal, a process of analysing the causes of non-acceptance is initiated for future reference. The bidding process serves as the first planning stage, facilitating

detailed design and project planning. Using the same modelling framework for preliminary and detailed design can save time and reduce iterations in the detailed design phase.

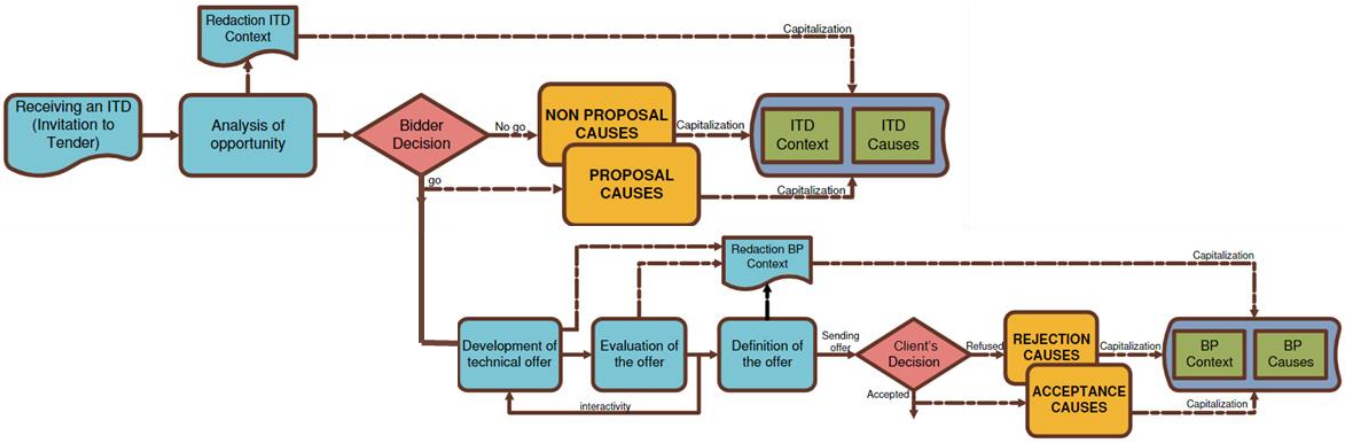


Figure 18: Adaptation of the decision-making process (Diego et al. (2012b)

The frameworks proposed by the author only gives a quick and superficial depiction of what is happening during this phase. The empirical research though dives in every aspect of such decision process. In the first place, the framework proposed does not consider that a company might have multiple ITT at the same time; an EPC Contractors such as ABC Company cannot take on every single project for resources and time constraints, so the company must choose from a list of project opportunities. *(Prajapati, Raju & Pitroda, Dr. Jayeshkumar & Bhavsar, Prof., 2015)* highlighted all the factors that a company might consider when deciding if going for a bid or not which are summed up in three groups: firm related factors, projected related factors, and market conditions & strategic considerations - together these three groups contains 49 factors; however it is only an overview of the factors that might be considered. The author also stated that is not possible to consider every single one of them and the factors to consider are affected by the company objectives. Thus, a framework that describes how and what in general line is in the body-of-knowledge, however nothing specific for EPC Contractors and more specifically for innovative projects context (e.g., internal challenges, nature of the client, etc.).

However, these two models *(Diego at, al. 2012b)* and *(Prajapati, Raju & Pitroda, Dr. Jayeshkumar & Bhavsar, Prof., 2015)* have been used in combination with each other to help setting a general starting framework:

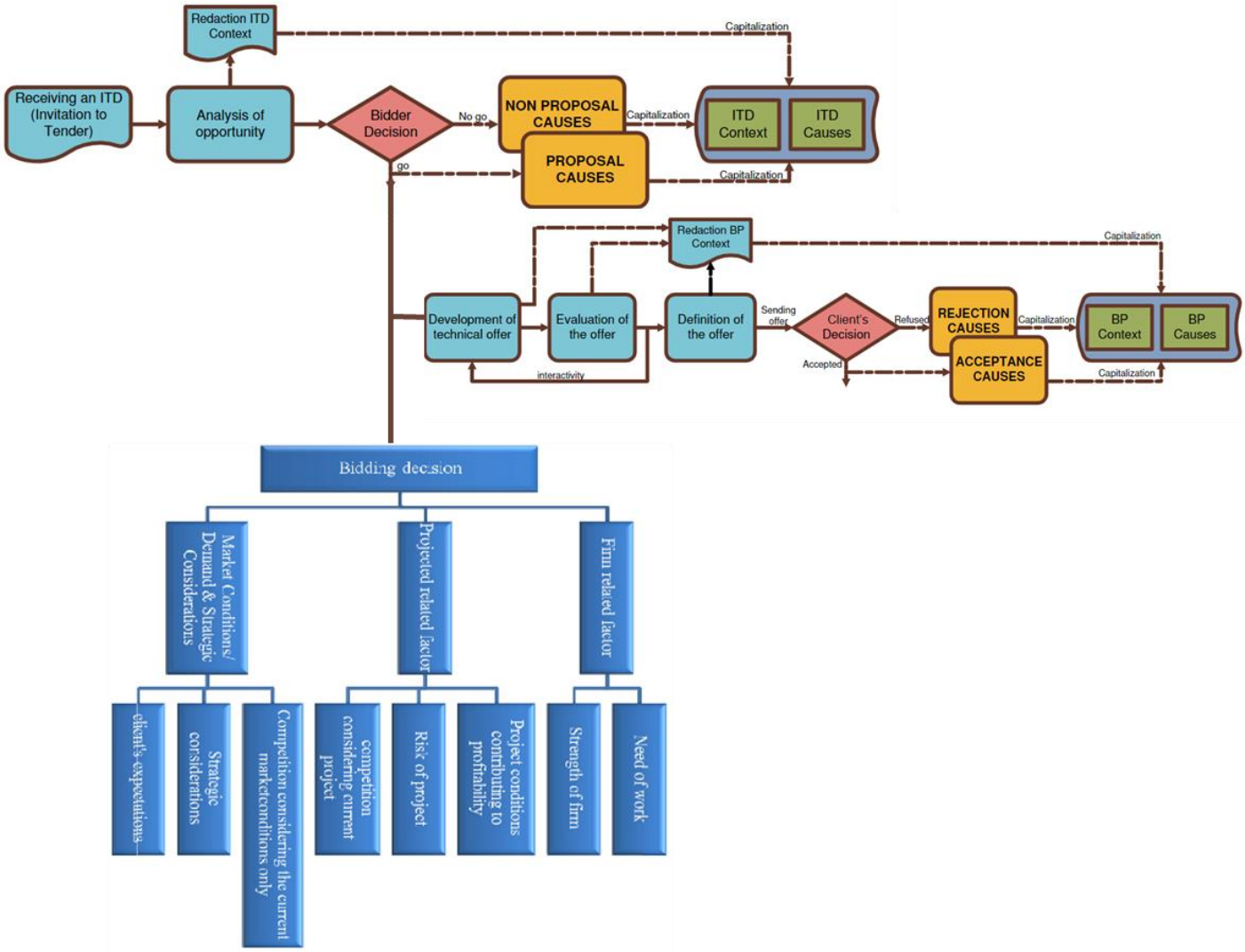


Figure 19: Combination of (Diego et al. (2012b)) and (Prajapati, Raju & Pitroda, Dr. Jayeshkumar & Bhavsar, Prof., 2015).

This combination gives some sort of understanding on the process affecting the decision-making process. Although only superficial and does not support any specific innovation evaluation in the process. At this point the interviewees will be used to integrate the findings in the model and finally give a complete outlook for practitioners and improving what is inside the body-of-knowledge.

The research in ABC Company gives a first selection criteria gathered from experts with different point of view in relation to the relative interviewees' profession. The interviews uncovered a set of unwritten "risk indicators" or "red flags", which may vary depending on the profession and experience of the employee interviewed as also stated in 2.7.1. and thus, in contrast with *Maytorena et al. (2007)* there is indeed a correlation between experience and risk identification performance in the context of bidding process. Continuing, the risks indicators highlighted in 3.2.1. are essential in distinguishing potential good opportunities from traps and as a consequence avoiding a bid before even assessing the project per se. This risk indicators thus are useful when an opportunity is presented such as "Receiving an invitation to tender" in Figure 15. Another observation that goes in contrast with the findings is that this framework still assumes that the EPC Contractor is a passive actor waiting to

receive the tender. While in the contest of innovation market, the EPC Contractor needs to be proactive and going for projects in order to learn. Therefore, a proposed new framework should start with an initial project opportunity generated by the company's proactivity or by the clients reaching out to the company. The opportunity shortlist is "filtered" through a “firewall” of risk indicators, a set of risk indicators to look out for. The main risk indicators are the client's lack of knowledge, poor communication by unrealistic expectations, and poorly defined tender documents, which can suggest they may not have a clear idea of the project's requirements. These factors can be further exacerbated if the client has some degree of indifference towards the team components that will work on the project and poor safety considerations, which raise concerns and the overall commitment to the project per se. In other words, if the client is only interested in the early definition phase, there might be no interest in a long-term commitment, and thus, the project does not plot.

The combined framework in Figure 16 quickly states that there is “analysis of opportunity” and just after that goes to the bidding decision. From an innovative project perspective, is this face more factors should be highlighted, and describing how to assess such opportunity. But most important, Figure 16 does not include nor is mentioned in the relative research that the level of innovativeness needs to be assessed, consequently such framework is not up to the new market. The level of innovativeness in this case needs to be assessed in order to check if the innovation is very disruptive or not. Is important to know it, because it gives a first depiction of what is to be expected from such project. The level of innovativeness needs to be assessed considering three main factors, which are, as mentioned by *(Prajapati, Raju & Pitroda, Dr. Jayeshkumar & Bhavsar, Prof., 2015),* firm related factors, projected related factors, market & strategy conditions.

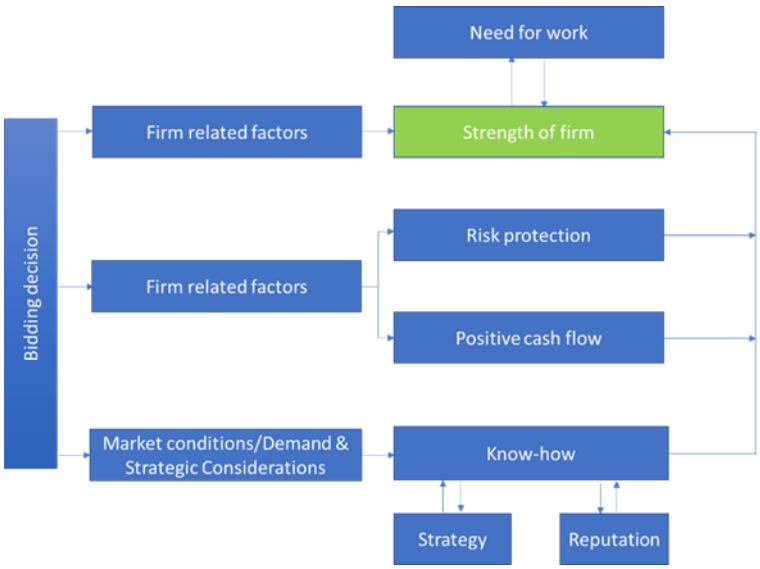


Figure 20: Adaptation from the (Prajapati, Raju & Pitroda, Dr. Jayeshkumar & Bhavsar, Prof., 2015)

Evaluating a project's market conditions and strategic fit is essential for success. This involves considering both internal and external strategies, such as determining whether the project aligns with the company's expertise and if it will bring more projects on the innovative side on balancing the portfolio and whether it brings new innovative and competitive designs to the market. Implementing internal competitions for innovative projects can encourage employees to think creatively and develop new skills, fostering a proactive culture that can adapt to market demands. Showcasing these skills and knowledge through impactful advertisements can attract potential clients, particularly in sectors such as energy efficiency and clean energy innovation. Therefore, a decision-making framework should highlight if there is a fit for the company to the project, and possibly take the chance

to organize internal competitions in case there is no knowledge, however this means that the project could be dropped.

However, the proposed factors do not highlight many other shades: overall, from the research, the bidding decision for an EPC Contractor undertaking an innovative project requires careful consideration and balancing of various factors. While profitability is essential, it should not be the only factor considered. The acquisition of know-how and reputation through joint ventures and research and development is crucial for firms to strengthen themselves continuously, particularly in new markets. The figure presented in the text illustrates the importance of a feedback loop between the strength of the firm and the need for work, emphasizing the need for a larger strategy that focuses on acquiring know-how and reputation. However, a selection of factors aimed for innovative projects and for gaining ground in the new market, there is a need of a further and new Iron Triangle: while the traditional Iron Triangle (time, cost, and scope) focuses on the constraints that project managers face, a proposed triangle focuses on the factors that are crucial for strengthening the firm in a new market; or in another words for a "Feasible Innovation". The **need-for-work** represents the demand for the project and the project's viability. **Reputation** refers to the perceived competence, reliability, and trustworthiness of the project manager and their team, which can be critical in securing funding and support for innovative projects. **Know-how** refers to the specialized skills, knowledge, and expertise required to successfully execute an innovative project. Balancing, these three factors is essential for success in innovative projects. For example, even if there is a strong need-for-work, a project manager may struggle to secure funding and support without a strong reputation. Similarly, even with a strong reputation, a project manager may struggle to deliver a successful project without the necessary know-how.

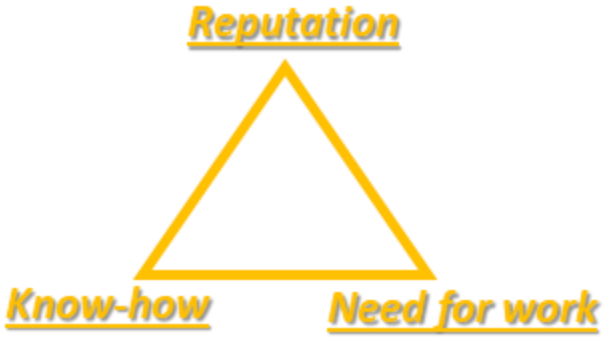


Figure 21: Proposed Iron Triangle for Feasible Innovation

If the benefits are considered advantageous enough, the risks are deeply analyzed, considering external and internal risks *(Diego et al. (2013))* that the project will face and the company. When bidding for innovative projects, both internal and external risks should be carefully managed to ensure success. External risks, such as client issues, competition, and project environment, can pose significant challenges. Incomplete or inaccurate client requirements, low-bidding competition, and economic, legal, geographical, and social factors in the project environment are factors that increase uncertainty around innovation. Internal risks, such as strategy misalignment, insufficient budgets, and outsourcing, can also impact project success. To mitigate these risks, effective risk management strategies must be implemented, including the assessment of potential risks and open communication with clients. It's important to identify potential risks and address them proactively to avoid negative consequences. By managing risks effectively, bidding on innovative projects can be a successful venture. Assessing risks, also means weighting the ways in which the company can deal with it. The research conducted on risk protection in innovative projects provides valuable insights for companies seeking to bid on such projects. Given the high levels of uncertainty and risk involved *(Lenderink et al.*

(2022)), it is essential to adopt a rigorous and focused approach during the front-end development phase to increase the chances of project success. This involves identifying potential risks and uncertainties early on by assessing capabilities and aligning expectations with clients. Companies can also mitigate risks by being flexible in choosing the right contract type and securing intellectual property. Moreover, negotiating with clients to balance risks and rewards is crucial, and collaborating with competitors can help spread risks in larger projects. Incorporating these findings into the decision-making framework for bidding on innovative projects can enable companies to make informed decisions and increase their chances of success.

Finally, the project needs to be original and with a low carbon price which needs to be within an acceptable cash-flow and thus confirming that the investment will bring more projects opportunities in the future and enrich the capitalization feedback, as a negative or positive outcome will enrich the experience and be used for the next projects. This is adapted from the capitalization feedback by *(Diego et al. 2012b).* Furthermore, the project success needs to be advertised and showcased to clients and other significant actors in order to increase reputations and increase the chances of new opportunities.

Another aspect to consider is positioned at the start of the framework: proactivity, which can be summarized as the initiative to go for new opportunities to develop new skills and anticipate the market and clients' needs in the future. Therefore, building strong relationships with all the actors involved, like suppliers and clients, is essential while looking for new projects and opportunities to keep growing. Furthermore, proactivity in the case of innovative projects is more and more looking at sustainability and carbon footprint by working closely with suppliers, competitors, and clients, thus showing commitment to the environment, and positioning the company as a key player.

The framework also represents a way to manage decisions bias under uncertainty which can lead to premature rejection of uncertain ideas *(Moenaert, Meyer, Souder, & Deschoolmeester, 1995; Reid & De Brentani, 2004; Smith & Reinertsen, 1998).* It flattens the response variability to risk influenced by behavioural characteristics of decision-makers; meaning that different individuals perceive and evaluate innovation projects differently, but with such decision-making everything can be clearer and thus at least reducing variability of this aspect. Finally, it can be a bridge between early career employees which have everything to learn and experts which might consider some aspects obvious or neglecting others.

Finally, the existing framework have been expanded from an "the analysis of opportunity" in *(Diego et. Al 2012b)* and incorporated with the three main factors that affect bidding process taken from *(Prajapati, Raju & Pitroda, Dr. Jayeshkumar & Bhavsar, Prof., 2015).* The factors have been updated to face innovation from EPC Contractor perspective.

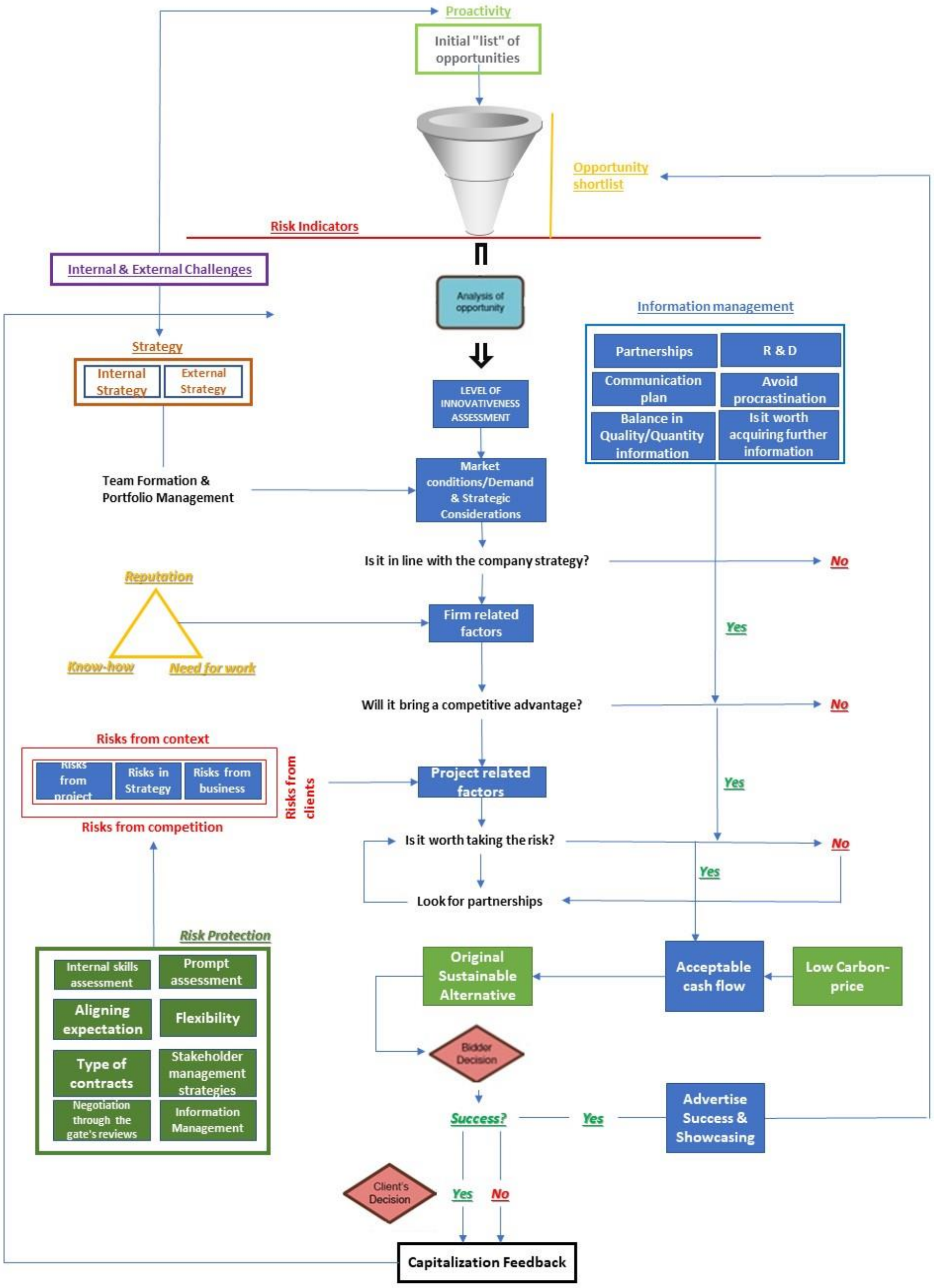


Figure 22: The Decision-Making Framework

5. Conclusions

This master thesis seeks to develop a comprehensive decision-making framework incorporating risk management, innovation strategy, and value proposition features for EPC contractors to navigate the bidding process for innovative projects successfully. The framework has been developed by examining case studies, conducting discussions with industry experts, and applying a thorough analysis to guide EPC contractors in leveraging innovation to enhance competitiveness, fulfill client expectations, and contribute to an innovative future. Such research has been structured around the following research questions:

a) *Sub-Question 1: What are the ways to manage risks in the bidding process for innovative projects in the body of knowledge?*

The research started with an overlook on the bidding processes and what it means for EPC contractor. What found in particular is the concept of innovativeness: *"a measure of the potential discontinuity a product (process or service) can generate in the marketing or technological process" Garcia, R. (2002)*; innovativeness of a project is critical since it can provide insight into its potential success and the competitive advantage it can offer a company. However, innovation also brings uncertainty and disruption, which can be challenging to manage, but it can also lead to breakthroughs. Innovativeness can be evaluated from different perspectives, such as the world, market, consumers, or adopting segment. However, the goal is to assess the benefits against the risks and make informed decisions. These risks can be new and arise from new or unfamiliar contexts. As innovativeness increases, so does the potential for emerging risks *(Lenderink et al. (2022))*, which must be evaluated during the bidding process. Uncertainties and risks are significant challenges in decision-making, so a comprehensive risk categorization can help anticipate and reflect on risks before bidding for a project. The quality of the risk assessments depends on the availability of information. However, it is not the quantity of information that is important but rather the type of information needed to make informed decisions and thus there is need to find a balance between quantity and quality of information *(Grau & Back, 2015, as cited in Williams et al. (2019)) Samset, K. (2010)*. Information management methods can be helpful, but communication and consulting with stakeholders are also crucial to ensure alignment and balance. However, there is a lack of a detailed framework to encapsulate all the research and thus making the findings so fare difficult to be used in a practical way. An updated decision-making framework could be a set of guidelines and criteria used to evaluate and make decisions in a structured way *(S. Toonen (2022)).* Such a framework could help contractors to evaluate and weigh various factors affecting whether or not to bid on a project and prioritize and rank all the factors based on their importance. Using such a framework could increase awareness in making an informed decision, reduce reliance on intuition and subjectivity, and improve the use of time and resources.

b) *Sub-Question 2: How are decision taken during the bidding process by EPC Contractors?*

Several factors can affect decision-making during the bidding process for innovative projects by EPC contractors. One key factor is the risk of novelty, as bidding for creative projects comes with high uncertainty and potential for failure. This means that EPC contractors must carefully consider whether they have the capabilities, expertise, and resources to undertake such projects successfully. Although the companies must avoid the trap of analysis paralysis *(Williams & Samset, 2010, p. 45) as cited in Williams et al. (2019)*, in other words, the company needs to find the right amount of information in order to assess the project. Analysis paralysis can hinder the bid because of the project's complexity, and the potential for cost overruns and delays also needs to be considered during the decision-making process. Another factor that impacts decision-making is the level of innovation involved in the project. The research found that the innovativeness level of the project in EPC contracts is often remarkably high. Therefore, EPC contractors must have the expertise and knowledge to bid on such projects

successfully. However, there is no pilot project, and thus, not is very rare to have or find experts for innovative projects. Consequently, creating the need to search for pilot projects to train the expertise (old and new) and create relevant benchmarks to help EPC contractors bid fast and cost-effectively.

c) *Sub-Question 3: What are the challenges and opportunities to overcome for improving decision-making?*

Sub-Question 3 focuses on the challenges and opportunities for improving decision-making. The research found that there are both internal and external challenges that need to be overcome. Improving decision-making within a company requires overcoming several internal challenges. One such challenge is developing a balanced portfolio between traditional and innovative projects *(Interviewee 1)*. While traditional projects are often tried and tested, innovative projects may lead to significant growth opportunities. However, they may also expose the company to higher risks. Therefore, it is essential to balance the portfolio between traditional projects and innovative projects. Another challenge is fostering a culture of trial and failure. Many organizations need help to avoid failure, leading to reluctance to try new things. Instead, companies must develop a trial-and-error mentality to take risks and experiment with new ideas to develop better decisions but also innovative solutions. Such actions will lead to more inclusive consideration of alternatives, with employees feeling comfortable presenting innovative ideas and alternatives that may not be successful. Finally, developing new expertise within the company is another challenge that can impact decision-making. New skills and expertise are required to stay competitive as industries and markets evolve. By searching for training and development opportunities employees have the chance to develop the necessary skills and knowledge to make informed decisions. These internal challenges also represent opportunities for EPC contractors to improve their decision-making for innovative projects, leading to increased growth and consequently a new profitable sector.

Regarding external challenges, the empirical research found that unrealistic client expectations can pressure contractors to deliver beyond their capabilities, leading to project delays, cost overruns, and unsatisfied clients. On top of that, the availability of vendors for scalable projects is another challenge, as the contractors may require specialized vendors for specific project components but finding them in a timely and cost-effective manner can take time and effort, or in some cases, is simply not possible. In addition, aggressive competition - exacerbated by the clients looking for the lowest price - in project bidding can lead to underbidding and undervaluing the project, resulting in reduced profits and quality compromises. Finally, a lack of clarity among actors involved in the project, such as unclear roles and responsibilities, can also cause delays and misunderstandings. To overcome these challenges, the contractors must develop strategies to adapt and anticipate changing market demands. EPC contractors must build a reputation for innovation and establish relationships with key suppliers who can help them find solutions to reduce carbon-intensive products, thus exchanging know-how and distributing risks among the actors involved. Thus, collaboration with key suppliers can lead to co-innovation and help achieve sustainable outcomes. The research also found that risk indicators can be an effective way to identify potential issues with the project before bidding and thus deciding the worth of the project's risk-reward before considering developing a project proposal. This can help the contractors save resources and avoid bidding on projects with a high risk of failure. Additionally, EPC contractors can develop an internal pathway that fosters innovation and improves decision-making. This can be achieved by creating a culture of continuous improvement, investing in employee development, organizing internal competitions, and encouraging collaboration and knowledge sharing among team members.

- **Main Question: How to improve decision-making considering the interfaces during the bidding process for innovative projects for EPC Contractors?**

The main research question aimed to create a decision-making process encompassing literature consideration and real case knowledge and thus create a picture of what needs to be done to make better decisions before bidding for innovative projects. Moreover, it deepens a superficial representation that was currently in the body of knowledge and propose a new façade of the pre-analysis of innovative opportunities before deciding to bid. More extensively, a decision-making framework that capitalizes on experience feedback *(Diego et al. (2012b))*. The research highlighted new aspects that might be useful to consider. The first new aspect is the need of balancing projects portfolio; between traditional projects and innovative projects while doing so, also by balancing teams with early career employees and experts by doing projects together and internal competition within the company to develop new skills. Most importantly keeping the experts satisfied with their job by feeding them both types. Furthermore, it provides a way for mitigating bias in decision-making when faced with uncertainty, thereby preventing hasty dismissal of potentially valuable ideas. It standardizes the response to risk, considering the behavioral traits of decision-makers and the context in which decisions are made. While different individuals may view and assess innovative projects differently, this framework can reduce variability and improve clarity in decision-making. Additionally, it can serve as a bridge between novice employees who have much to learn and seasoned experts who may overlook certain aspects or take others for granted. The present framework has been expanded from its initial emphasis on examining opportunities (as presented in *Diego et al., 2012b*) to include three significant factors that impact the bidding process (as explained in *Prajapati, Raju & Pitroda, Dr. Jayeshkumar & Bhavsar, Prof., 2015*). These factors have been adapted to specifically tackle innovation from the viewpoint of an EPC Contractor. The adaptation brought to the need for a new Iron Triangle that is specifically tailored to innovative projects and gaining a foothold in new markets. While the conventional Iron Triangle focuses on the constraints that project managers face, the proposed triangle focuses on the key factors that are critical for strengthening a firm in a new market. This new triangle consists of three crucial factors: need-for-work, reputation, and know-how. Need-for-work denotes the demand for the project and its feasibility. Reputation refers to the perceived competence, reliability, and trustworthiness of the project manager and their team, which is essential in securing funding and support for innovative projects. Know-how refers to the specialized skills, knowledge, and expertise required to execute an innovative project successfully. Achieving a balance between these three factors is crucial for the success of innovative projects. For instance, even with a strong need-for-work, a project manager may face difficulties in securing funding and support without a solid reputation. Likewise, a project manager may struggle to deliver a successful project without the necessary know-how, even with a strong reputation. It also suggests that the company main objective is not having a profit margin as big as possible, but to gain the knowledge and a foothold to future projects.

5.1 Limitations

The thesis discovered critical aspects of the decision-making for innovative projects creating a framework that provides a helpful guide for decision-making; it is essential to further analyze each aspect of the framework. Innovative projects often involve new technologies, processes, and approaches that may be unfamiliar to decision-makers. Thus, evaluating the degree of innovation and potential risks associated with each project is vital to make informed decisions. Therefore, further research is needed to develop a comprehensive assessment framework that accurately measures the proposed projects' innovativeness level. This assessment should be based on a range of factors, including the proposed technology's novelty, its potential impact on the environment, the level of expertise required to implement it, and the potential risks and benefits. Each of these aspects needs to be further analyzed to improve the evaluation of the potential of each project under scrutiny - identify the most promising opportunities and allocate resources more effectively.

While the decision-making framework for innovative projects provides a guide, there is a need for further analysis of each aspect of the framework. Specifically, a comprehensive assessment of innovativeness is essential to fully evaluate the potential of each project and make informed decisions. This would require the development of a robust assessment framework that considers a range of factors to measure the level of innovativeness of proposed projects accurately.

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7. Appendix A: Interview information

Version 1: Project specific

1) **Can you talk about the *X project* and what were your responsibilities?**
2) **Can you explain how the bidding process was conducted for the *X project*?**
   a) Was it any different from a standard project? Can you give an example?
   b) What were the challenges? Can you give an example?
   c) Which of these challenges were unique and which one were standard?
   d) How does the contractor/client relation be affected by these unique challenges?
3) **How can you integrate innovation in the bidding process as active actor instead or a reactive actor?**
   a) How does the client react to it?
   b) Can you give an example?
   c) Is there any risk that you must be aware for this overall strategy?
4) **What are the are the common key factors and criteria that will affect the success of an innovative project vs a common project?**
   a) How do you discover them?
   b) How does the client participate in this?
   c) Can you give example?
5) **How have you dealt with risks associated to uncertainty?**
   a) why did you decide that was worth to take on such risks?
   b) Have you ever faced a new kind of risk? Did you notice it in time? How have you dealt with it? Can you give an example?
6) **How did you manage to win the bid?**
   a) What were the winning factors that made the company win the tender?
   b) Have you ever encountered such factors in common projects or are those unique?
7) **Has ABC company ever experienced failures or troubles linked to a wrong decision made during the bidding process?**
   a) How have you dealt with it?
   b) What were the lesson learned from it? Example of the lesson learned.
8) **What is the most important aspect of the bidding process in your experience?**
   a) What makes ABC Company a good EPC?
   b) How does this affect ABC Company?
   c) Example

Version 2: Non-project-specific

1 **Can you talk about your responsibilities?**
2 **Have you ever been involved in an innovative project, what were your responsibilities?**
   a) Example
   b) Did you participate in the bidding process?
3 **Can you explain how the bidding process is conducted to achieve innovative objectives?**

4.a) Can you explain how did you apply and achieve innovation in such projects?

   a) In which way is different from a standard project? Can you give an example?
   b) What are the challenges? Can you give an example?
   c) Have you ever encountered unique challenges and how did they differ?
   d) How does the contractor/client relation be affected by these unique challenges?

4 **How can you integrate innovation in the bidding process as active actor instead or a reactive actor?**
   a) How does the client react to it?
   b) Can you give an example?
   c) Is there any risk that you must be aware for this overall strategy?
5 **What are the are the common key factors and criteria that will affect the success of an innovative project vs a common project?**
   a) How do you discover new one of them?
   b) How does the client participate in this?
   c) Can you give example?
6 **How have you dealt with risks associated to uncertainty in the past innovative projects?**
   a) why did you decide that was worth to take on such risks?
   b) Have you ever faced a new kind of risk? Did you notice it in time? How have you dealt with it? Can you give an example?
7 **How did you manage to win the bid for innovative projects?**
   a) What was the strategy?
   b) What were the winning factors that made the company win the tender?
   c) Have you ever encountered such factors in common projects or are those unique?
   d) What do you think ABC Company was the better player compared to its competitors?
8 **Has ABC Company ever experienced failures or troubles linked to a wrong decision made (during the bidding process)?**
   a) How have you dealt with it?
   b) What were the lesson learned from it? Example of the lesson learned.
   c) Did you have any risk indicator that got ignored, underestimated, or not detected?
   d) What changed in the strategy approach after that?
   e) Example
9 **What is the most important aspect of the bidding process in your experience?**
   a) How does this affect ABC company?
   b) What is needed to be improved to face future challenges?
   c) What are the risk and opportunities that you foresee for the company?

FURTHER QUESTIONS

1) **What are the main resistances in the innovative projects? And internally?**
2) **How do you gather information before bidding?**
3) **How do you detect a "false client"? E.g.: opportunistic behaviour**
4) **How do assess new clients?**
5) **How do you deal with conflicts among actors? To see if there is a real project behind their request.**
6) **What are the risk indicators?**
7) **What is the timeframe given to a client?**
8) **Can you explain the gate reviews?**
9) **Why did you not get the bid?**
10) **What is license and what are their role?**
11) **How do you find a balance between risk/reward? Example**
12) **what is the discussion around risks that are brought during workshops/meetings?**
13) **How do you "de-risk" a project?**
14) **How did you lose a tender?**

Interviewee	Date	Duration
Interviewee 1 – JB A	09/12/2022	1h
	13/12/2022	15min
Interviewee 2 – JB D	13/12/2022	1h
	25/02/2023	30min
Interviewee 3 – JB C	14/12/2022	1h
Interviewee 4 – JB A	19/22/2022	45min
Interviewee 5 – JB B	19/12/2022	1h
Interviewee 6 – JB D	10/01/2022	1h
Interviewee 7 – JB A	28/01/2023	1h
Interviewee 8 – JB A	16/01/2023	30 min
Interviewee 9 – JB A	11/01/2023	30 min
Interviewee 10 – JB B	25/02/2023	45 min
Interviewee 11 – JB E	30/01/2023	1h
Interviewee 12 – JB A	17/01/2023	1h
	15/02/2023	15min
Interviewee 13 – JB A	20/01/2023	45min
Interviewee 14 – JB B	20/01/2023	30 min

Job Title A: Managerial position related.

Job Title B: Technical position related.

Job Title C: Directorial position related.

Job Title D: Sustainability position related.

Job Title E: Business position related.