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Risks and risk management in construction projects

A product life cycle approach

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Abstract

The construction industry often operates with important and expensive projects that should meet deadlines and various regulations and at the same time avoid risks associated with the phases of the construction projects. This thesis reviews risks by a project life cycle (PLC) and the risk management used in construction projects by interviewing different construction project stakeholders such as hotel owners in Belgium and construction specialists. Hence, this study aims to find what the different risks are in the different phases of the construction projects life cycles and how risks are managed in these construction projects. The project life cycle framework developed especially for construction projects and used in this study consists of the conceptualization phase, the planning and design phase, the contractor selection phase, the contractor mobilization phase, the operational phase, and finally the project closeout and termination phase. The results of this study indicate that there are many risks existing in the construction projects that were part of this study. During the planning phase of construction projects, some of the identified risks were communication-related risks, design risks, estimation risks, budgeting risks, financial risks, site conditions and unknown geological condition risks, socio-political risks, government relation risks, and economic risks. During the contractor selection phase, the main risks that were identified were owners appointing the wrong contractor responsible for the construction of the building. During the operational phase of the PLC, some of the risks existing were communication-related risks, risks of late deliveries of materials, risks of a shortage of materials, risks of poor quality of workmanship, cost related risks, site safety risks, risks of disagreements in the teams, delays risks, risks of unavailability of funds and financial failure, risks of inadequate managerial skills, risks of improper coordination between teams, risks of insufficiently skilled staff or subcontractors, weather, and seasonal implications risks, site conditions and unknown geological condition risks, theft risks, subcontractors don't deliver materials in time and subcontractors bankruptcy. During the project closeout and termination phase, some of the risks were cost related risks, risks that the project end is delayed, quality concerns risks, and risks of scope and design changes. Further, this study shows that the owner/client of construction projects tend to mitigate different risks of the construction projects by transferring these risks to outside parties such as the contractors. Another finding from this study is that non-computerized risk management tools were preferred instead of tools that use computerised software. Examples of such non-computerized tools were risk matrices, brainstorming, use of past experiences of construction projects, expert interviews, divide and conquer method, and own judgement.

Content

1 Introduction

The construction industry and its various projects are filled with risks. Therefore, an understanding of different risks within construction projects becomes a necessity to be able to meet the objectives of a construction project and furthermore manage and mitigate identified risks. However, risks occur at different phases of a construction project and some risks have a larger impact on some stakeholders in comparison to others throughout a construction project. For example, risks related to finance or politics might not be as obvious to a contractor as it is to a banker or institution providing a loan for a construction project.
There is therefore a need to first discuss and anchor our understanding of the various existing risk in relation to construction projects. Once the anchoring of risk classification has been made, this paper will use the concept of *project life* to differentiate and classify risks of construction projects into a set of distinct activities as the project life cycle of a construction project represents each activity of the construction process from the beginning to the end of a construction project. I believe that this understanding and the use of a project life cycle for risk classification in construction projects is beneficial because it gives project owners, decision-makers, the client(s), project leader(s), contractors, and academics the opportunity to understand at which phase of the construction project certain risks in comparison to others are likely to occur.

In addition, this study aims to find out how different risks in construction projects are managed and this is where we will discuss in more detail the concept of risk management in theory and in practice. Therefore, the first part of this study will deal with identified risks with a focus on the concept of the project life cycle in construction projects while the second part of this study will explore the concept of risk management. Hence, by combining risk management and risk classification in a PLC setting, the research question of this study is: *what are the Risks and how is risk Management used in construction projects in a PLC approach*? To answer the research question of this study, secondary data will be collected from the construction risk literature and primary data will be collected from five different project managers and one risk expert who have been involved in different hotel construction projects in Belgium.

1.1 Purpose

This study first aimed at reviewing risks in construction projects and in which of the phases of a construction life cycle different risks were likely to occur and thereafter embarked on the topic of risk management. By identifying different risks within the scope of a project life cycle phases developed by Bennet (2003, p. 7), in combination with a risk management model presented by Smith et al. (2009, p. 40), this study may offer insights into the classification of risks in a PLCS. The study presented is based on two parts namely risks classification in a "PLC" and "Risk Management in a PLC". Hence, I divided the broad research question into: *What are the risks* and *how is risk management used in construction projects in a PLC* into the two subcategories shown below where each individual part needs to be reviewed separately to come to a coherent end conclusion for this study:

- What are the risks in the different phases of construction projects PLC?
- How are risks managed in construction projects and in the PLC?

Each sub-category aimed to give clarification to the research question as well as guide the reader throughout the study. Secondary data was also used in conjunction with the primary data of this study to give some clarity on existing risks in construction projects and what type of classification exists to classify risks. In comparison, the primary data was first used to answer the first sub-research question and to find out what risks exist in construction projects, especially for hotel construction projects with a focus on the PLC framework.
The risks found from the primary data were later compared with the risks found from the secondary data with the aim to identify which of the risks found from the primary data were also identified as being existent risks in construction projects from the secondary data. The primary data were also used to answer the second and last part of our research question which aims to find out how the different existent risks were managed in the PLC.

1.2 Delimitation of the Study

The construction industry is heterogeneous and complex. Besides a broad range of stakeholders being involved in construction projects, there are several major and different risk classifications and risk taxonomies used when researching the literature. In addition, the structure of construction projects can differ markedly from one another: Housing, non-residential building, highway and/or utility construction, and industrial and airport construction (Banaitiene & Banaitis, 2012, p. 431). It is further important to say that different risks exist in construction projects depending on the origin of the construction projects where some risks are more or less likely to occur, and the impact of these risks may differ depending on the geographical location of the construction projects. This same principle may hold true for the use of risk management in construction projects where risk management may be used differently in practice depending on the type of construction project, the size of the project, and the geographical origin of the project.

For these three reasons and to limit this study's attention to a tangible format, this study focused on a few construction projects located in Belgium where the study focused solely on construction projects that were relatively of the same size, the same types, and of the same costs. The construction projects chosen for this study were construction projects with 70 to 100 operational workers working daily on the construction sites for 4 to 6 months and where the overall cost of the projects was approximately 15 million euros. The Hotel contraction projects that were chosen for this study were owned by the company Wan de Walk and the project was in Verviers, Mons, and Charleroi.

2 Background and literature review

The research question of this study aims to answer *What are the risks and how is risk management used in construction projects in a PLC approach*. Therefore, the first part (2.1 and 2.2) and, focus of this background review will be to give a quick overview and introduction to the concept of risks and risk management in construction projects.

The second part (2.3 and 2.4) of the background review will give a detailed overview of the different construction project stages by presenting the project life cycle developed by Bennet (2003, p. 7).

And the third part (2.5 and 2.6) of the background and literature review will present the concept of risk management and the different stages of risk management by presenting the framework of Smith et al. (2009, p. 40).

2.1 Introduction to construction projects

Many authors from the literature explain that the construction industry in comparison to other industries faces more risks because of the unique and complex features that construction projects represent. Such complex features are to name a few long periods of construction time, complicated processes, a difficult construction environment, financial intensity, and a dynamic organization structure (Zou et al., 2008, p. 1). According to Baiden et al. (2006, p. 14), conflicts are inevitable in construction projects because of the divergent interests and goals of different stakeholders. Yates (1999, p. 1) argues that conflicts in the construction industry are most likely to produce very high direct and indirect costs. Direct costs could be the involvement of lawyers, and consultants, and loss of management time, which obviously increases costs and creates delays in the completion of the construction projects. Indirect costs could be everything from degeneration of working relationships, emotional frustration, time wasted, and mistrust between the participants involved in the project (Yates, 1999, p. 2).

In addition, construction projects are often over-timed, over-budgeted, and in certain cases shut down because bad forecasting estimates were made at the beginning of the project, hence having a negative effect on the cost, scope, and time for the completion of the construction project. In a study made by Ismail et al. (2014, p. 1), the authors found that the amount lost in cost overruns was five to ten percent for large construction projects while for smaller projects it ranged from ten to fifteen percent above the estimated cost of the project. The same authors further found that out of 308 projects in the public sector, only 20% of the projects were completed on time and 46.8 % of the projects were completed on budget. Alameri et al. (2021, p 01) indicate that the nine major challenges in construction projects are resource allocation, time, cost, quality, safety, project complexity, changes, uncertainties and communication. The examples above show reasons why proper and early risk management is important which is also illustrated by Beckers et al. (2013, p. 2) where the authors explain that direct losses in large scales projects are due to an under-management of risks, which account for a total loss of a sum of over 1.5 trillion dollars per year in the United States.

Ehsan et al. (2010, p. 1) explain that the track record of the construction industry in relation to satisfactory risk management is very poor, resulting in the failure of many projects to meet their objectives and schedules at the pre-set budget. Beckers et al. (2013, p. 2) justify that failure to meet the construction project objectives is due to a lack of a forward-looking risk management process. Beckers et al. (2013) further state that "A true understanding of stakeholders' capabilities and willingness —the risk-ownership structure—and the respective allocation and pricing of these risks would be a logical next step. In addition, strategy and risk-related processes need to be strengthened, and the governance and organization—as well as the risk cultures—of all stakeholders, need to be enhanced" (p. 4).
In addition, strategy and risk-related processes need to be strengthened and the governance and organization as well as the risk cultures of all stakeholders need to be enhanced. However, it is also important to notice that time and assets can be wasted if stakeholders of the project put too much emphasis on risk management and try to manage risks that are unlikely to occur during the construction project (Ehsan et al., 2010, p. 5).

2.2 Risks in construction projects and risk classification

As the purpose of this study explains, the aim is to use a PLC framework to classify risks. Therefore, when researching risks in construction projects from different risk classifications, the risks that are found from these classifications will be taken out of the latter and further analyzed for potential classification in a PLC setting. This was done to be able to classify these risks within the framework used for this study which is the PLC.

Speaking about the actual word *risk* and its meanings, many definitions of the notion of *risk* in the literature exist in relation to the construction industry and projects. For example, the list below shows some definitions of the terms risk that can be found in the risk literature:

- A risk is an uncertain event or condition that, if it occurs, has a positive or negative effect on a project objective (PMI guide, 2008, p. 446)
- Risk is the likelihood of a detrimental event occurring to the construction projects, and since objectives in a construction project are usually stated in cost, time, and quality the most dominant factors of risk will therefore not be able to meet one of these targets (Baloi and Price, 2003, p. 262)
- Risk is the combination of a random event with negative consequences for human life, health, or the environment and the probability of that event occurring (Sjöberg & Thedéen, 2009, p. 8)

Zou et al. (2006, p. 65) identified key risks from construction projects and classified these key risks in a PLC setting consisting of feasibility, design, construction, and operations. Ismail et al. (2014, p. 14) performed a literature review of different risks by also classifying these risks in a PLC setting and by interviewing experts in the construction industry. The authors claim that the operational phase is the most critical phase compared to other phases, where this phase in comparison to the other phases of the PLC, had the maximum number of risk factors identified. As explained above only a few authors use the whole PLC lifecycle to classify risks meaning that each stage of the project is analyzed for risks from the beginning to the end of the project. As such, in comparison to Ismail et al. (2014, p. 12) and Zou et al. (2006, p. 64), some authors from the literature focused on only those stages of the life cycle of construction projects instead of all the life cycle stages. One perfect example of this is the research of Polat et al. (2014, p. 430) where they concentrated on several stages of the life cycle of various construction projects instead of risks that exist in every stage of the life cycle.

In addition, Uher and Toakley (1999, p. 161) identified risks solely from the conceptual/pre-project phase of construction projects, while Chapman (2001, p. 150) focused on risks that are the most likely to exist in the design phase of the construction life cycle. In comparison, Schieg (2006, p. 78) used six process steps to identify construction risks, especially with a focus on the implementation and realization phase of the life cycle of construction projects.
As seen from the explanation above, authors tend to focus their risk research on one or more specific parts of construction projects. It became further interesting to mention that some authors chose to focus on a specific set of stakeholders when investigating risks in construction projects. According to Karim et al. (2012, p. 339), contractors are the major actors performing construction works and are directly involved in the physical activities of various construction projects. Hence, according to the authors, contractors are required to control the risks that occur during construction and ensure the successful delivery of the project. These authors decided to conduct their study on risks by investigating existing risks in construction projects from a contractor perspective only.

The literature also shows that the PLC is not necessarily the framework of choice when categorizing risks in construction projects and there is a wide number of other types of risk classifications used for classifying risks in construction projects. For example, Renuka et al. (2014, p. 33) performed a literature review of different risks and decided to classify these risks into “non-engineering risks” and “engineering risks” classification, meaning risks that are predictable and risks that are non-predictable and cannot be as easily identified during the projects. Baloi and Price (2003, p. 264) used yet another way of presenting risks and they explain in their research paper that risks can be subdivided into three parts namely: the Inner layer/internal environment, operational environment, and outer layer/general environment. On a similar note, Perry and Hayes (1985) assure that both the general and operational environments are external environments, and the general environment is broader in scope that comprises five basic domains namely technological, social, physical, economic, and political (p. 512).

Zou et al. (2006, p. 72) show that some of the risks that exist in projects are the tight project schedules and inadequate program scheduling, hereunder variation of the construction program, variation by the client, lack of coordination between teams, inaccurate cost estimates, unavailability of skilled labour, dispute, price inflation of materials, lack of competency and external factors such as governments enforcing regulations on the project. According to Schieg (2006, p. 79), personal risks are common risks in construction projects where these risks often relate to a lack of skills that is required by the stakeholders or disagreement within the construction teams. Cost-related risks are also present in construction projects because of planning changes, complicated project conditions, or customers′ failure to pay their subcontractors in time.

In addition, in construction projects, set end date deviations and missed deadlines often occur because there is not a well-managed handover of the project in good time or simply because the project end is delayed. Risks of strategic decisions also exist in construction projects because there are often failures to recognize chances and a lack of ability to adapt to change from the various stakeholders working on the construction projects.
Ehsan et al. (2010, p. 18), explained in their paper that technical risks exist in construction projects and the root causes of the latter are linked to inadequate site conditions, and incomplete design, and specification of the project. The same authors further explain that the logistical risks that exist and that are present in construction projects are often related to the availability of transportation facilities. In addition to the explanation given above, there are some risks that are likely to be present in construction projects because of the relationship that the workforce has with each other, and this is also something mentioned by Ehsan et al. (2010). The same authors explain that poor upper management and different behaviours by the workforce could have a negative impact on the productivity of the stockholders working on the project affecting the outcome of the project undesirably (2010, p. 17).
There are many different stakeholders in a construction project. These stakeholders need to have effective communication with each other during the construction project since inefficient communication between participants could result in communication-related risks, which could hinder meeting the different objectives of the construction project (Karim et al., 2012, p. 340). The construction industry is one of the most hazardous industries that exist, and safety risks are therefore an important part of the operational phase of construction projects (Karim, et al., 2012, p. 340).

In a study made in Spain of all fatal accidents that happened in the country between the years 2000 and 2006, most accidents occurred in the construction industry, resulting in the death of approximately 350 persons a year (Gangolells et al., 2010, p. 7). Bennett (2003, p. 223) argues that it is very important for the contractor and the owner to be aware of the most common type

of safety risks that exist in construction. Various studies suggest that most accidents in construction projects are workers falling from elevated places, workers being struck by falling or moving objects, and workers being hurt by vehicles. The second most important safety risk is workers being trapped by something collapsing (Bennett, 2003, p. 223). Bennett (2003) further points out that accidents in construction projects can have very high hidden indirect costs in relation to direct costs, where the indirect costs are more difficult to measure.
According to Bennett (2003), the ratio between the direct and indirect costs for accidents is approximately 1:4 (p. 223). During the project operation phase, the contractor and the owner also need to make sure that all the criterias that have been set up from the previous design and planning stage are respected. These criteria range from materials and equipment utilization to logistical procedures and cost management. During the operation phase, there are logistical processes that need to be put in place, since materials are needed for the construction of the project. The risk literature in relation to construction projects has shown that within the area of logistics, there are risks for shortages of materials and late deliveries of materials, but also that some of the material delivered does not meet the mandatory requirement or quality (Karim et al., 2012, p. 340). The outcome of such risks, if they occur, would create a delay in the construction project if the workmanship cannot be allocated somewhere else during the time required for new materials to arrive.
As mentioned earlier, choosing the right contractor for a construction project is important because some contractors will be more suited and have more experience than others. This can further be accentuated by the risk literature showing that there is a very common risk factor of poor quality of workmanship and lack of managerial expertise in construction projects (Karim et al., 2012, p. 340; Renuka et al., 2014, p. 33; Schieg, 2006, p. 79).

Further risks that are likely to be present in construction projects are due to different environmental factors. These environmental factors are often classified as external to the project because the likelihood of occurrence of these risks is more difficult to influence. Environmental risks in construction projects often relate to weather, natural disaster, and other seasonal implications.
Other common risks likely to be present in construction projects are linked to financial risks where the root cause of these financial risks could be everything from the exchange rate, delays in payment, monetary inflation, and financial taxation. Ehsan et al. (2010, p.18) explain that socio-political risks exist in construction projects and according to the authors, these socio-political risks are due to clients and project owners not being able to get the right employment and skilled staff for the projects.

Polat et al. (2014, p. 433) found from their research that most construction projects that had severe cost overruns have these because of various reasons, but one of the most prominent reasons for the cost overruns was design problems such as sudden design changes, constructability problems and delays in design approvals. Karim et al. (2012, p. 339) further showed by their research paper that the most common risks existing in construction projects are shortage of materials, hereunder late deliveries of materials, insufficient or poor technology, financial cash flow difficulties, and poor quality of workmanship. Sharan Kumar and Narayanan (2020, p. 1145) indicate that the main risks for cost overruns in construction are linked to management, financials and environmental. The later finding is like what Adeleke et al. (2019, p. 938) indicate, that technology, political and financial are likely to risk in construction projects. Karim et al. (2012, p. 339) also found other risks to be present in construction projects and linked to contracting such as time constraints related, cost-related, quality-related, resource-related, and lastly communication-related. Karim et al. (2012, p. 339) explain that all the risks found in their study were imminent to have a negative impact on the projects and affected one or more of the main crucial outcomes of construction projects, such as the scope, time, and cost.

2.3 Bennett´s project life cycle (PLC)

As mentioned in the introduction and in the purpose section of this paper, the second part of this study aims to classify risks using a project life cycle. Hence an overview of the different risks that exist in construction projects, and the different risk classifications as deducted from the literature was explained in the previous chapter. The risks that are later found from the primary data and classified with the PLC framework of this study will further act as a bridge to link this first part of the study with the next part of this study which is risk management in a PLC setting. Since the first part of the research question for this study aims for the classification of project risks using a PLC approach and for this to be feasible, it became crucial to explain the different stages of the construction life cycle. The project life cycle is a good way to understand the structure of a project over time as it represents a sequence of phases for which a construction project must pass before the project comes to completion. From the time the owner first conceived the idea for a construction project until the point when the contractor vacated the site for the final time. The PLC also provides an understanding of the saliency of risks in the different PLC stages of construction projects where some risks are more salient during a specific stage of the PLC while other risks are more salient during another stage of the PLC.

Bennett (2003, p. 7) developed a PLC approach that was especially suited for the construction industry and construction projects since it consists of all the important stages that construction projects are likely to go through from the beginning to the end of the construction projects. This model is particularly suited for construction projects as it consists of two contractors related phases, something that is not often included in other life cycle models. The different phases that are part of the Bennett model (2003, p. 7) are the pre-project phase, the planning, and design phase, the contractor selection phase, the contractor mobilization phase, the project operation phase, and finally the project closeout and termination phase.

According to the author, the stages here above are very likely to be the stages that construction projects go through until their completion, yet in practice, this does not mean that all construction projects need to pass through exactly these stages.

Nevertheless, Bennett's PLC model was used for this study, as the model is especially appropriate to use for construction projects. Hence, in the next section of this study, Bennett´s PLC approach will be presented in detail along with the activities associated with the respective phases of his PLC model, structured in this way, the results should be an understanding not only of the importance of each phase individually, but also provide a better overview of the construction risks that are predominant within each PLC phase. The different stages of the construction life cycle developed by Bennett (2003, p. 7), are shown in the table 1 shown below, and focus particularly on what stakeholders are doing in the respective stages of a construction life cycle.

Table 1: Stages of the construction life cycle according to Bennett (2003).

Pre-project phase & Conceptualization	Decision makers of the construction project will identify different business opportunities, choose the delivery system and decide which type of contracting to use.
Planning and design phase	Decision makers will establish the project objectives, make an actual design and prepare the contract documents. There should also be a detailed project plan, financial plan, quality plan, and risk plan.
Contractor selection phase	Decision makers will look at different tendering conditions such as a bid or not to bid and submit offers.
Contractor mobilization phase	Decision makers and the contractor will make the preparation for the operational phase of the project.
Project operation phase	This phase of the PLC is also the stage when the actual construction begins. Decision makers and the contractor will monitor and control resources, manage documents, and control the overall project in relation to time, cost, and quality of work.
Project closeout and termination phase.	Decision makers will make the final inspection of the project. In addition, the finishing of the interior and exterior of the construction should be made.

2.4 The different stages of Bennet´s PLC and some of the identified risks

Westland (2007, p. 59), explains that during the pre-project phase, which is the first stage of the construction PLC, project owners start to define if and where there is a need for a construction project and how to meet that need, which will then, in turn, become an opportunity. At this stage, whether an idea will be conceptualized into an actual construction project will be decided upon in the planning and design stage of the construction life cycle (Bennett, 2003, p. 8). During the pre-project phase, the owners of a future project start forming an idea of the different stakeholders that could eventually be part of the construction project where such stakeholders could be everything from contractors, banks, and consultants, to architects and designers. At this stage of the PLC, owners of the potential project would also start to think about how the many future tasks of the project would come to be distributed among all the chosen stockholders (Westland, 2007, p. 59). In addition, during the pre-project stage and conceptualization phase, the owners of the construction project would start to initiate the idea of whether they will use both an architect and a contractor holding the architect responsible for the design while the contractor would be responsible for the construction or alternatively let a single entity be responsible for both the architectural designs and the construction of the project (Bennett, 2003, p. 8).

During the planning and design phase, which is the second stage of the construction PLC, project owners will first start analyzing how they can start to materialize and implement their entrepreneurial idea that was first conceived in the pre-project and conceptual stage of the PLC given a set of criteria. Such criteria could, for example, be regulatory circumstances that would prohibit a certain construction idea to be realized and it is not uncommon that a project is not granted construction authorization by governmental bodies. Once owners have a fair and a good estimate that the project could be realized, the project owners will start to look at where and how they could obtain sources of funding for the project (Bennett, 2003, p. 9). Secondly, the owner will analyze the different engineering criteria needed for the project where these engineering criteria could be the materials that would be used for the project and these materials could range from wood to cement or other. Owners would also together with architects and engineers start to look at the structural design for the projects, meaning the aesthetic of the construction or building. The choice for the structural designs is first carried out by an architect and/or building engineer who is aware of all the engineering requirements and the engineer, or the architect would then propose a structural design mock-up to the owner. It is important to mention that the architect or engineer being responsible for the structural design, must ensure that this design favours both the public and any political bodies. This is because the latter will ultimately and indirectly become stakeholders of the project once the project would be materialized and, in some cases, geographically affected by the construction project.

Therefore, especially for bigger construction projects there is a political risk in this stage of the PLC, and where the root cause of these political risks entails both public and regulatory acceptance or public and regulatory rejection of the construction project (Zou et al., 2008, p. 123). Hence, it is consequently important from a political standpoint to make sure that the construction project is accepted both in the eyes of the public and by different governmental bodies that have any decision-making authority over the project. Polat et al. (2014, p. 435) further made a study where they found that one of the most important and existing risks of the planning and design stage of the PLC relates to design risks. The authors explain that design-related risks often start in this stage of the PLC and these design risks could also unwillingly be transferred or passed onto the other stages as the project passes through the different stages of the PLC. According to the same author, the reasons for these design risks occurring during the design and planning stage of the PLC and passed onto other stages of the PLC are due to mocks up changes, design changes, and that there are too many contradictions of the design documents as well as constructability problems. These contradictions often occur because there is a mismatch between the design and what could be physically achieved (Polat et al., 2014, p. 435). Hence the authors above suggest, to avoid any risks during the planning and design stage, the design documents and the technical information of the project must be well considered and documented in advance and before the project starts. Renuka et al. (2014, p. 33) explain that other risks exist in the planning and design phase of the PLC which are related to both the site for which the construction project will take place but also other unknown geological conditions. The authors argue that, if a construction project starts on a site where the geological conditions are not well known in advance nor have these conditions been well documented before the project starts, there is a great risk that the project will run into difficulties in the operation phase of the construction project.

The contractor selection phase is the third phase of the Bennet PLC model, and this phase is one that is the most overlooked risk in construction projects nor is this stage often included in different PLC models as well as being a stage that is not very well documented in the literature. However, there is some research that suggests that the bidding and the contractor selection processes are an important phase of the construction PLC for the project owner and the contractors as there are many risks involved in this process (Arslan et al. 2006, p. 1406; Karim et al. 2012, pp. 340-344; Schieg 2006, p. 79).
During the contractor selection phase of the construction PLC, the project owners will select a contractor where this contractor will, if awarded the contract, have the responsibility to realize the project. The owner of the project can decide to start a bidding round where all the potential contractors will be invited to make an offer for the construction project. However, the owner can also invite only a few handfuls of contractors to bid for the contract, if the owner believes that these few handfuls of contractors are the most suited to perform the construction of the project. The contractors would first give each an offer including the estimated price that the owner must pay for the project, the engineering criteria, and the amount of time that the project will take to its completion. Once the owner has received all the bids, the owner will have to decide which one of the bidders will receive the construction contract.

The choice of a contractor during the selection phase of the construction PLC is an important part of the construction process. For the owner of the construction project, it is important to choose the correct contractor since several studies have shown that there are a great number of risks in relation to the selection of a contractor. Once a contractor has been given the construction contract, hence being responsible for the project completion, it may turn out at a later stage of the PLC that the contractor may not have the necessary technical skills and experiences to attain the construction objectives. It is further possible that the contractor may not be able to fulfil all the requirements as set in the contract between the owner and the contractor (Karim et al., 2012, p. 348; Schieg 2006, p. 79; Ehsan et al., 2010, p. 19). During the contractor selection phase of the PLC, a real risk exists for the owner to choose the wrong contractor and there are many reasons why this could happen. The contractor often gives very low prices in the bidding stage, and they do so to increase their chance of getting a construction contract due to competitive pressures or scarce start-up funds (Flyvbjerg, 2006, p. 7). Sometimes, contractors in the construction industry deliberately and strategically tend to overestimate benefits and underestimate costs. There is often a fine line between the contractor receiving or not receiving the construction project contract at the bidding stage because if the contractor overestimates the cost of the construction project, the client might not accept the offer but if they underestimate the cost of the project, the contractor might lose a great amount of money in performing the task (Potts, 2008, p. 75).

In turn, contractors may compensate for any loss by reducing their own operational costs during the project, hence jeopardizing other criteria such as predefined quality and scope. These actions could lead to a loss of reputation for both the contractor and the owner of the project, as well as lead to conflicts between these two parties. Overestimates by contractors could also occur because of the psychological effect of optimism bias and overconfidence, meaning that the contractors may judge future outcomes in a more optimistic light than is warranted by actual experience. Malmendier and Tate (2005) wrote in their research paper that "overconfidence is especially strong among highly skilled individuals, possibly due to insufficient weighting of the comparison group (`base rate neglect´)" (p. 651). As explained here above, the contractor selection phase is not without its risks and as such, it is important for both contractors and owners to realize the risks that are associated with this stage of the PLC. Nevertheless, once the contractor has been chosen to perform the construction of the project, the project moves into the next stage of the PLC, namely the contractor mobilization phase.

The contractor mobilization phase is a small phase between the contractor selection phase and the project operation phase. During the contractor mobilization phase, some small activities are completed before the project operation can start. Such activities include establishing insurance and licenses for the construction project. The contractor mobilization phase also includes the organization of the different workplaces and the construction site. Such workplaces include the provision of temporary building services, access and delivery of materials, and security criteria (Bennett, 2003, p. 9). As far as the literature is concerned there are very few and almost non-existing risks during the contractor mobilization phase. There could be many reasons for this but one hypothesis or the absence of risks could be that this stage consists of very few activities and that the few activities that do occur in this stage of the PLC are mainly administrative. Nevertheless, once the contractor mobilization phase has been completed the PLC passes through the next stage of the construction life cycle which is the project operational phase.

The operational phase is the phase of the PLC where the actual construction of the building begins. During the operational phase of the project, the contractor and the owner monitor and the operation control manages the resources and makes sure that communication on the construction site runs smoothly (Bennett, 2003, p. 10). During the project operation phase, the owner and the contractor need to make sure that the project runs on time and on schedule. Monitoring the construction schedule is important since there are many unexpected planning changes that occur in the operation phase of the construction project (Schieg, 2006, p. 79). The owner and the contractor also need to closely monitor the costs of the project and make sure that all the technical requirements are met (Bennett, 2003, p. 10). During the project operation phase, a lot of time is spent making sure that the resources are allocated correctly to the construction operations. It is also the job of the contractor to coordinate the different communication activities within the teams on the construction site and with the different stakeholders (Bennett, 2003, p. 205). It is also the contractor's responsibility to make sure that the personnel are performing their tasks in the right way, and that there are no disagreements between the different teams of the construction project (Schieg, 2006, p. 79). Communication in construction projects is especially important since improper coordination between teams could affect how well the construction project will progress and meet the project objectives (Renuka et al., 2014, p. 33).

The last stage of the PLC is the project close-out and termination phase. This phase is the end phase of the construction project life cycle, and this is the phase where the final product is delivered and handed over to the owner if a contractor was used for the project. In theory, the project close-out and termination phase consist of two different stages. The first stage consists of the completion of all the physical and operational activities on the construction site. The second stage consists of the closure of the project, which involves the preparation and signing of an array of documentation. Such documentation often consists of financial statements, certificates, and project records of the operations and the inventory of spare parts that have not been used. After the preparation of these documents, they are handed over to the owner of the construction project (Bennett, 2003, p. 289).

It is not uncommon for the contractor to review the whole project and make assessments for potential improvements for the next construction project (Westland, 2007, p. 59). However, many problems ensue during the project closeout and termination phase. Bennett (2003) explains that the contractor of a construction project often does not finish the project at one hundred percent (p. 289), which results in quality concerns for the owner of the project. Bennett (2003) further states: "Construction projects proceed smoothly until they are 95 percent completed, and then they remain at 95 percent forever" (p. 289).

According to the same author, the main reason for this incompleteness is due to an early disengagement from the construction company because the contractor needs to make sure to secure the next project and this disengagement especially arises when there is no future project that has been secured by the contractor. Another reason for this disengagement is the contractor wanting to make sure that not too much time passes and is lost between the finalization of one construction project and the start of another which will result in higher costs at the expense of the constructor because of an idle workforce. In other words, the contractor is transferring time and resources to secure the next job away from the ninety-five percent finished project. Another reason why a project is most often not completed fully is that the contractor has grown comfortable and has become less motivated to complete the construction project (Bennett, 2003, p. 289). An added common risk factor at this termination phase of the construction project is that the project end is delayed. The delays are not only caused by delays in the project closeout and termination phase of the construction project but are most likely to be the sum of the added delays that occurred during all the previous stages in the construction life cycle (Schieg, 2006, p. 79).

2.5 Risk management

In the previous sections, we explored the topic of risks that exist in construction projects as well as the different stages of Bennet's PLC. Previously, it became clear that many very different types of risks exist in construction projects. From the previous chapter, this study identified many risks where the risks identified showed to occur in one or more stages of the stage of PLC and in some cases, the same risks occur not only in one stage of the PLC but in all the stages of the PLC. Because of the number of risks that exist in construction projects, it becomes important to explore the topic of risk management both from a practical and theoretical perspective.

Hence, in this last part, the study will present the notion of risk management in more detail. Uher (2003, p. 253) defines risk management as "a systematic way of looking at areas of risks and consciously determining how each of these risks should be treated". Risk management can also be viewed as a management tool that aims at identifying sources of risks and uncertainties, determining their impact, and developing appropriate management responses (Uher, 2003, p. 253). According to Aven (2009, p. 176), risk management is used to "ensure that the adequate measures are taken to protect the people, the environment, and assets from possible harmful consequences for the activities being undertaken". But according to Baloi and Price (2003) "the main objective of risk management is to reduce uncertainties and thus improve decision making" (p. 265).

As mentioned previously by Beckers et al. (2013, p. 2), one cause for the failure of meeting the construction project's objectives is due to a lack of professional and forward-looking risk management. The same authors explain that managers and project owners often fail to estimate the outcome of risks occurring in various stages of construction projects which in turn could have negative consequences for the outcomes of the construction projects. As such there are benefits for construction stakeholders to correctly manage risks in construction projects. The benefits of risk management in construction projects are especially accentuated by Banaitiene and Banaitis (2012) as they state:

> "*Risk management helps the key project participants, client, contractor or developer, consultant, and supplier to meet their commitments and minimize negative impacts on construction project performance in relation to cost, time and quality. Risk management is an iterative process meaning the process is beneficial when it is implemented in a systematic manner throughout the lifecycle of a construction project, from the planning stage to completion*" (p. 430).

The later describing the benefit of risk management is also shown by Shibani et al. (2021, p. 8) as their results indicates that Risk management implementation play a significant role in the project success. The use of proper risk management also gives some advantages when it is used correctly and such advantages could be the achievement of previously set objectives, shareholder reliability, reduction of the cost of capital, and fewer uncertainties regarding potential risks that could occur during the project as well as creating value for the project (Ehsan et al., 2010, p. 5). Serpella et al. (2014, p. 654) explain that there are many deficiencies in the management of risks in construction projects and there are indications that not all countries use the same techniques for risk management and the consistency in which risk management is used also varies depending on the geography of the construction project, hence there is not a clear standard for its use in practice. The same authors clarify that project owners that use risk management in construction projects often do so with a reductionist approach that produces poor results and limits the quality of project management within construction projects. In addition, many companies and project owners that hire construction services and contractors on a recurring basis do not apply systematic risk management for their construction projects which often affects the construction project negatively (Serpella et al., 2014, p. 654). In addition, the measures put in place for risk management in both small and bigger construction projects are not always respected or used as efficiently as possible.

The deficiency of implemented risk management in construction projects and the reasons for its poor use are further accentuated by Akintoye and Macleod (1997) as the authors explain that "formal risk analysis and management techniques are rarely used due to a lack of knowledge and doubts on the suitability of these techniques for various construction industry activities" (p. 31). Other literature shows that medium-sized construction projects with a revenue of between 60 and 120 million euros have, according to Hwang et al. (2014, p. 116) a relatively small level of risk management implementation. The authors argue that the lack of risk management processes implementation for smaller construction firms is due to a lack of time for its implementation from the decision makers, a lack of budget where the low-profit margins of smaller construction companies make decision-makers believe that risk management is deemed unnecessary. In addition, small construction projects in comparison to bigger projects, do not often implement risk management because the process is tedious, costly, and understood as involving too much information gathering and analysis, which is deemed too time consuming.

2.6 Risk management cycle

Smith et al.´s model (2009, p. 40) here below was chosen to show the different steps often taken for risk management and to identify how the different risks that were found from the primary and construction projects were managed. There are many different approaches for managing risks in construction projects, but this study chose the risk model below that uses the four steps of the risk management model as suggested by the authors in the figure 1 shown below:

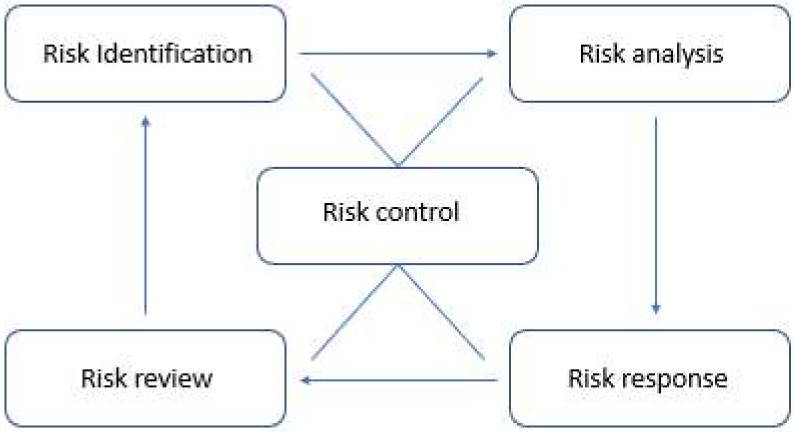

Figure 1: Risk management cycle, presented by Smith, Merna, and Jobling (2009, p. 40).

Risk identification is the first part of the risk management cycle. During the risk identification stage of the risk management cycle, stakeholders of construction projects try to identify which risks are salient during their construction project as well as identify risks that are likely to occur during the project. According to Heldman (2010, p. 13), risk identification involves identifying and documenting all the risks that could affect the project, and ultimately as such the end goal of the risk identification process is to be able to produce a list of documented project risks.
As stated in the previous section, it is not uncommon in the planning and design stage of the construction project PLC to start the project by first making risk plans with the process of identifying any possible upcoming project risks. According to Smith et al. (2009, p. 44), common techniques that are used to identify risks at the risk identification stage are brainstorming sessions with key project stockholders and conducting interviews with project personnel from different disciplines and staff within the project. Other risk identification techniques involve the examination of historic data from the same type of construction projects as well as reviewing risk registers from previous similar projects to tap into already known information about potential risks, hence facilitating risk identification by utilizing corporate knowledge. (Smith et al., 2009, p. 44).

Other risk identification techniques found in the literature are workshops, questionnaires, benchmarking activities such as reference class forecasting, and documenting the experience of stockholders and consulting experts in the risk field. There are some issues when stockholders use risk identification for finding upcoming risks in projects as deduced from the literature (Smith et al., 2009, p. 33). The risk identification process is often heavily decentralized meaning that each stakeholder in the project will list only the risks from their respective part. This process can produce a long list of uncorrelated risks, from which project owners are forced to select and monitor a few among many and to abandon others that could have an impact on the project.

Risk analysis is the second step of the risk management cycle from the framework presented by (Smith et al., 2009, p. 40). The risk analysis part of the framework consists of systematically using all available information to be able to describe and calculate the risks associated with a given phase (Holmgren & Thedéen, 2009, p. 199). Risk analysis can be further defined as "the systematic assessment of decision variables which are subject to risk and uncertainty." (Edwards & Bowen, 1998, p. 1). Risk analyses often contain questions such as: *What can go wrong? How likely is it for different risks to happen and what could be the consequences if any risk does occur?* These questions are asked to find, organize and categorize the set of risk scenarios. Therefore, the process of analysing risks is important because it gives an understanding and awareness of the impact and consequence of a risk for the project (Smith et al., 2009, p. 46). The risk management literature shows that there is a wide range of risk analysis techniques and tools that could be used to analyse risks, but only a handful of these tools are used in practice (Forbes et al., 2008, p. 1242). As stated above there is a wide range of risk analysis techniques available and some technologies may be too detailed and complex to fit all construction projects, while other techniques may be too superficial or simplistic for other construction projects. Therefore, the different techniques that will be used for risk analysis will to some degree depend on the type and the size as well as the tools available for any given construction project (Smith et al., 2009, p. 44).

Nevertheless, it is worth mentioning that the most common techniques used for risk analysis are sensitivity analysis, scenario analysis, probability analysis, probability impact, and priority analysis (Smith et al., 2009, p. 51). According to Akintoye and Macleod (1997, p. 35), other tools and techniques used for risk analysis consist of risk premium, risk-adjusted discount rate, subjective probability, decision analysis, sensitivity analysis, Monte Carlo Simulation[1], and Delphi techniques[2]. Forbes et al. (2008, p. 1244) explain that there are approximately 36 different techniques available to analyse risks, but that only a handful of these techniques are used in practice where those are subjective probability, Monte Carlo simulation, and sensitivity analysis. According to Forbes et al. (2008, p. 1244), other techniques existing for risk analysis are not as widely adopted nor used because there is a lack of confidence in the techniques, or these techniques are perceived to have a lack of applicability to a certain type of construction project. Flanagan et al. (1987, p. 56) give more clarity for the vast number of existing

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[1] Monte Carlo simulation is a probabilistic risk analysis technique that provides information such as estimates of the likelihood of achieving certain project targets and the likely range of outcome of the project in terms of its duration economic parameters where computers programs are used together with model simulations.

[2] The Delphi technique attempts to produce objective results from subjective discussions it is an interactive forecasting method, which relied on a panel of independent experts. This method is often used to understand the likelihood of occurrence and potential impacts of identified risks (Kamane & Mahadik, 2013, p. 59).

techniques for risk analysis when they explain that three dominant approaches are used for risk analysis consisting of sensitivity analysis, probability analysis, and Monte Carlo simulation.

Risk response is the third step of risk management from the framework presented by Smith et al. (2009, p. 40). In the risk response stage of the risk management lifecycle, the response to a risk can be fourfold, and such a stakeholder can approach a certain risk in four different ways. One can either avoid the risks, reduce the risk, transfer the risks, or retain the risks (Smith et al., 2009, p. 192). According to these authors (2009, p. 46) risk avoidance and risk reduction is an obvious first steps in the risk response stage of the risk management lifecycle. Once the risks, particularly the sources of risks, have been identified and analysed, it may be possible to formulate methods of avoiding certain risks, while making only minor changes to the project. Risk avoidance means that by looking at alternative solutions to the construction project, the risks can be eliminated. In extreme cases, projects may be abandoned due to an inability to avoid or reduce some of the risks (Smith et al., 2009, p. 46). However, by changing certain features of the project, it may be possible to avoid the number of risks in the project, rather than trying to avoid the risks totally. Risk avoidance and risk reduction can further be achieved by minimizing the potential risks by decreasing their likelihood of occurrence. Hence, it becomes important for the process of risk mitigation and for stakeholders to be aware of the probability of occurrence and the impact that these risks would have if they occurred.

It is also possible to transfer different risks, where the responsibilities for any risk consequences and outcomes are transferred to an outside party or to any of the project's stakeholders. According to Smith et al. (2009, p. 92), risk transfer involves transferring risks from one party to another, without changing the total amount of risk in the project. Risk transfers can occur between the parties involved in the project or one party and the insurer. The authors agree that the decision to transfer any risks to another party is implemented through an insurance policy or under certain conditions of the contract, but there some conditions that are needed to be taken into consideration when transferring risks to another party (Smith et al., 2009, p. 192).
First, it is important to distinguish, if the party that is absorbing the risk, i.e., the party where the risk is being transferred, can manage or control that risk, and whether they would accept the consequences should the risk be realized (Smith et al., 2009, p. 192). It is generally agreed upon that risks should be accepted by the party that is best able to manage or control them, or the party that is best able to accept the consequences should they occur. In addition, according to the same authors, there is little point in transferring any risk to a party that cannot manage the risk or cannot accept the consequences should the risk come to be realized.

The last stage of the risk management cycle is called risk retention and review and is the fourth step of the risk management process as per the framework presented by Smith et al. (2009, p. 40). The risk retention and review process are the last possible strategy for risk response, which is when a risk cannot be transferred or avoided, and where the only best solution is to retain the risk (Smith et al., 2009, p. 193). If risks are retained, these risks may either be controllable or uncontrollable. If the risks are controllable, then control may be exerted by the stakeholders of the project to reduce the likelihood of occurrence or the amount of impact of that risk (Smith et al., 2009, p. 93). The timing of an action taken to mitigate the effects of risk may dictate the action that is chosen. The first possible action is one that reduces the chance of the risk occurring. Then there are after-the-fact actions (Smith et al., 2009, p. 393). This refers to actions that are taken once the risk comes to occur; using the resources that are available at the time the action is taken, a purely after-the-fact action requiring essential prior actions. These actions require the use of contingency measures that are planned prior to the start of the project (Smith et al., 2009, p. 93), which is why proper risk identification and risk analysis are crucial to reducing actual risk occurrences and their impact.

To conclude, how well stakeholders in construction projects handle different risks that are likely to occur in construction projects will ultimately depend upon the thoroughness and clarity of the two first steps of the risk management process, risks identification and risk analysis (Smith et al., 2009, p. 193).

3 Method & data collection

This chapter describes the method of data collection. Saunders et al. (2009) describe the method section of a study to be an explanation of the "techniques and procedures used to gather, analyze and present data" (p. 43). Secondary data refers to the published articles and summaries, which provide information to answer the study question at hand, but this data also gives support for the final findings, discussion, and conclusion of the study. Primary data, on the other hand, is all the new information gathered to address the study research question where this primary data refers to the raw data collected through interviews or other means (Saunders et al., 2009, p. 261).

3.1 Secondary data

In this study, secondary data was used for the background and literature review section. Cooper and Schindler (2014, p. 118) explain that secondary data has the main advantage of saving time and money since data is already available for a specific subject which can later be used to support the primary data obtained during the study. To be able to use secondary data in an efficient manner there are some rules that need to be taken into consideration. First, secondary data should have all the information needed to cover and address the specified study question (Cooper & Schindler, 2014, p. 94). Secondly, the detail of the secondary data should be precise and accurate enough to be able to align with the definition of the problem that the study question is trying to address (Cooper & Schindler, 2014, p. 94). Therefore, following the authors′ theory, there should be guidelines to ensure that the secondary data is relevant to the study question and of high quality (2014, p. 95).

In this study, the secondary data was collected from peer-reviewed scientific journals that were found in two different universities e-libraries, namely the e-library of University of Gävle and Copenhagen Business School. The secondary data in this study was used to understand the risks that exist in construction projects and how they could be classified in a PLC setting. The secondary data was also used to find a risk management framework that could be used as the framework of choice for this study. As such, the risk management framework presented by Smith et al. (2009, p. 40) was used to understand the concept of risk management and used later to answer the second part of the research question that aims to identify any process or techniques that were used by the participants of the interviews. to identify, analyze or mitigate any risks that existed in their construction projects.

3.2 Primary data

The primary data was used for two reasons. First, to answer the first part of the research question that aims for the classification of risks in a PLC setting. The primary data were used as a complement to the secondary data in table 3 shown in the next chapter and as such, if there were risks that were not found in the literature but of relevance to the purpose of this study, then primary data were used to fill this knowledge gap and how this was done will be covered further in later chapters.

The second aim of the primary data was to collect data and find evidence to be able to answer the second part of the research topic which covers risk management and how different processes and techniques were used for risk management in relation to the different construction projects that the participants of the primary data took part in. The details of the participants that were included in this study can be revisited in the table 2. This table contains the anonymized participants, the associated company they represent, their respective roles in the project, the construction projects that they have been part of the cost of the project they were involved in, and finally the duration and date of the interview. It may be important to notice that Respondent D represents two different projects. Hence, when speaking about Hotel Charleroi this is represented by the D1 code, and project Mons is the D2 code. When the project coordinator (respondent C) talks about the project Mons (D2), it is the same project as described by respondent D. The (D2) and (C2) are therefore the same project. The data from the interviews were collected on five different occasions where the interviews were all face-to-face encounters. The advantages of face-to-face interviews are the depth and the detail of the data that is collected. This method for data collection was used because of its high quality, in comparison to other data collection methods since the interviewer can improve the quality by observing and probing with additional questions (Cooper & Schindler, 2014, p. 148).

However, there may also be disadvantages of face-to-face interviews in comparison to other data collection methods because face-to-face interviews are time-consuming, could deliver biased responses, and require a lot of time for data processing.

Before the interviews took place, I composed interview questions that can be found in the appendix section of this study. Nevertheless, the interviews were conducted and recorded in the mother tongue language of the participants which is French. Once the interviews were recorded, the interviews were then transcribed in their original language.

Table 2: Interview participants and their construction projects

Name of participants	Company	Project Roles	Construction Project	Construction Reference symbol	Project Cost	Time	Interview date
Respondent A	Abgren Construction	Expert	Various construction type	-	-	40 min	01/02/201 6
Respondent B	Wan der Valk	Project owner / Client	Hotel Verviers	3	12 million euro	30 min	16/01/201 6
Respondent C	Wan der Valk	Project coordin ator	Hotel Mons	2	17 million euro	28 min	15/01/201 6
Respondent D	Wan der Valk	Project Coordin ator	Hotel Charleroi	1	15 million euro	25 min	20/08/201 6
Respondent D	Wan der Valk	Project owner	Hotel Mons	2	17 million euro	25 min	20/08/201 6
Respondent E	Confederation de construction	Risk Expert	Various construction type	-	-	15 min	26/01/201 6

Qualitative interviews can be categorized in three different ways, namely standardized (formal or structured) interviews, unstandardized (informal or non-directive) interviews, and semi-standardized (guided semi structured or focused) interviews (Berg, 2000, p. 68). In this study, I used the semi-standardized interview method to collect my primary data and this method involves the use of many predetermined questions on a special topic, where these predetermined questions are asked in a systematic and consistent order. However, the interviewees were allowed some degree of freedom to elaborate on the pre-prepared questions during the interview, meaning that the interviewees were permitted and expected to give any additional information to the questions asked (Berg, 2000, p. 70). If the subjects did not automatically give additional information to the questions provided, then I probed with follow-up questions if I deemed that more information was needed on a specific topic. These follow-up questions were mainly asked as they provide benefits to the study as probing questions give "interviewers a way to draw out more complete stories from subjects" (Berg, 2000, p. 76).

From the interview questions that can be found in the appendix, the first part of the questions related to the role that the respondent played in their construction projects and what construction projects the respondents took part in. The second section of the interview questions related to whether any of the objectives of cost, time, and quality were met, and if any of these objectives were not met, I proved to understand why this was the case. The first three open questions of this second part of the interview questions were asked to understand if any risks in the construction projects the underlying causes were for one or more of the objectives not being met from the various construction projects of the participants. The third part of the interview questions in the appendix is related to the PLC and the risks that exist in each stage of the PLC of construction projects. For the questions in the third part of the appendix, I let the interviewees themselves explain how they perceived the project life cycle of construction projects, and if the respondents did not understand what the construction project life cycle was, Bennett´s PLC was explained to them.

During this part of the interview, I used open questions to let the interviewees identify which risks they believed to be the most prominent risks during each stage of the construction life cycle developed by Bennet (2003, p. 7). I also probed this by asking the participants if they believed that other risks were of importance to include in the different stages of the PLC that did not particularly relate to the risk experience of their construction projects but rather any risks found in the construction industry in general. The aim of the fourth part of the interview questions was to understand how the interviewees dealt with different risks that exist in construction projects and if any risk management tools or processes were used to identify, analyze or mitigate for these different risks in their own construction projects or to their knowledge, in the construction industry in general. The last open questions were asked to give the interviewees the possibility to further give additional information on the topics covered by the interview and to provide any new information that may not have been covered from previous interview questions and topics.

4 Empirical Findings

In previous chapters of this study, the risk literature was reviewed to give an overview of three main but distinct parts of interest for this study that is: the construction project lifecycle (PLC), the risk management framework presented by Smith et al. (2009, p. 40) and find risks that exist in construction projects as well as how these risks are classified. From the previous chapter, risks that exist in construction projects were collected from the risk literature together with the author's different risk classifications.

Therefore, this section will aim to combine the risks existing in a construction project that were found from the primary data and add these risks into a new table called table 3 shown below to have a complete list of risks summarised in one same table. In this table will also be summarized the risks that are mentioned by the interviewees of the primary data and if that happens, the risks from table 3 will be further classified into Bennet's PLC framework and table 4. Hence, risk table 4 shown further down, will aim to classify the risks that were either found from the secondary data given that these risks were also found to be risks by the interviewees of the primary data, or the risks found from the primary data but not found to be risks from the secondary data into to the different stages of the construction project life cycle developed by Bennet (2003, p.7).

The last part of this chapter will examine how risk management was used against the different risks that have been identified to exist in various construction projects by the respondents of the primary data, thus including the risk found from the secondary data given that they were also found from the primary data and the risks found solely from the primary data. The figure 2 shown below shows the risk elimination steps taken to classify risks into Bennet's PLC model (2003):

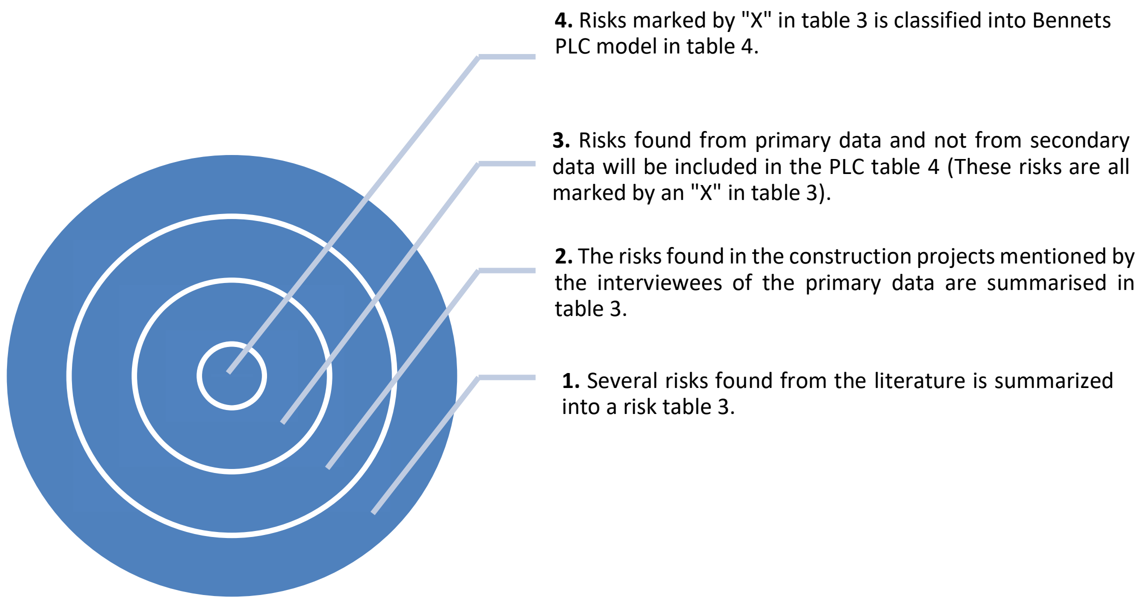

Figure 2: Data collection methodology in this study.

As stated previously, the first subcategories of the research question of this study are "What are the risks in the different phases of construction projects PLC?"
Combining both the risks found in the primary data and the risks found from the secondary data in the same table (table 3) gives a complete overview of all the risks that could later come to be categorized in table 4 which is the PLC model developed by Bennet (2003, p. 7).
When a risk originated from the risk literature and that same risk was also mentioned to be a risk for the construction projects of the participants of the primary data, then this risk is marked in the column with an "X". If a risk was a risk that only originated from the secondary data but not mentioned by the participant of the primary data, then this risk is not marked with an "X" and not included in table 4. Therefore, only the risks that either originated from the primary data solely or the risks found from the secondary data but given to also exist in the construction projects of this study as mentioned by the interview participants, are marked with an "X" and included in the PLC model of table 4.

At the end of this chapter and in table 4, all risks marked with an "X" in table 3 were classified into the PLC table developed by Bennet (2003, p. 220), thus being certain that only the risks that are seen to be actual risks for the type of construction project of this study remain in scope for further discussion. It is important to mention that the risk classification and risk group found in table 3 in column "risk category" were created by using many of the same risk classification groups used by the many authors found in the literature review of this study. This risk category classification was made to differentiate the diverse risks and to make it easier to read and understand the different risks in the table 3 shown below. It is fully possible that if the same study were to be made by other authors, these authors could have classified the same risks in a different manner.

Table 3: Risks identified from secondary and primary data where the risks marked by an "x" will be classified in table 4 (PLC model)

Risk number	Risk category	Primary or Secondary data	Risk factors	Risk mentioned to exist by Primary Data
1	Financial risks	Karim et al. (2012)	Delays in payment for claim	
2	Financial risks	Karim et al. (2012)	Cash flow difficulties	
3	Financial risks	Karim et al. (2012)	Insolvency of subcontractors	x
4	Financial risks	Karim et al. (2012)	Insolvency of suppliers	
5	Financial risks	Karim et al. (2012)	Lack of Financial resources	
6	Financial risks	Ehsan et al. (2010)	Financial risks	x
7	Financial risks	European commission (2005)	Budget based on incomplete data	
8	Financial risks	European commission (2005)	Cost related risks	x
9	Financial risks	Ismail et al. (2014)	Cash flow and financial difficulties faced by contractors	
10	Financial risks	Baloi & Price (2003)	Economical (Price fluctuation, exchange rate & markets)	x
11	Financial risks	Karim et al. (2012)	Poor estimation of resources risks (forecasting)	x
12	Financial risks	Karim et al. (2012)	Budgeting risks	x
13	Financial risks	Polat et al (2014)	Poor estimation of cost and the time required to complete the project	x
14	Financial risks	Ismail et al. (2014)	Subcontractors' bankruptcy	x
15	Financial risks	Renuka et al. (2014)	Risk of unavailability of funds and financial failure from banking institutions	x
16	Natural environment risks	Renuka et al. (2014)	Environment and geological risks	x
17	Natural environment risks	Baloi & Price (2003)	Construction risks (Geology site condition)	x
18	Natural environment risks	Renuka et al. (2014)	Natural Hazards	
19	Natural environment risks	Renuka et al. (2014)	Risks of underlying pipeline and rock structure	x
20	Natural environment risks	Baloi & Price (2003)	Site conditions and unknown geological condition risks	x
21	Natural environment risks	Baloi & Price (2003)	Weather and seasonal implications risks	x
22	Socio Political risks	Renuka et al. (2014)	Political risks	x
23	Socio Political risks	Karim et al. (2012)	Change in law and regulations	
24	Socio Political risks	Baloi & Price (2003)	Political (political system, labour & government relations)	x
25	Socio Political risks	Ehsan et al. (2010)	Socio Political risks	
26	Socio Political risks	Banaitiene & Banaitis (2012)	Public objections of project	x
27	Socio Political risks	Banaitiene & Banaitis (2012)	Expired temporary construction permits	
28	Socio Political risks	Banaitiene & Banaitis (2012)	Laws and local standards change	

Risk number	Risk category	Primary or Secondary data	Risk factors	Risk mentioned to exist by Primary Data
29	Socio Political risks	Banaitiene & Banaitis (2012)	Tax change	
30	Socio Political risks	Baloi & Price (2003)	Fraud and corruption	
31	Socio Political risks	Banaitiene & Banaitis (2012)	Expired temporary construction permits	
32	Socio Political risks	Banaitiene & Banaitis (2012)	Project desirability and public rejection	x
34	Socio Political risks	Karim et al. (2012)	Government relation risks	x
35	Team and management risks	Karim et al. (2012)	Poor quality of workmanship	x
36	Team and management risks	Karim et al. (2012	Poor supervision	
37	Team and management risks	Ismail et al. (2014)	Poor site management	
38	Team and management risks	Banaitiene & Banaitis (2012)	Inexperienced workforce and staff turnover	x
39	Team and management risks	Ehsan et al. (2010)	Management related risks	
40	Team and management risks	Banaitiene & Banaitis (2012)	Project team conflicts	x
41	Team and management risks	Renuka et al. (2014)	Poor Communication between teams	x
42	Team and management risks	Renuka et al. (2014)	Risk of improper coordination between teams	x
43	Team and management risks	Banaitiene & Banaitis (2012)	Risk of inadequate managerial or project leader skills	x
44	Team and management risks	Banaitiene & Banaitis (2012)	Poor communication of risks between teams	x
45	Team and management risks	Banaitiene & Banaitis (2012)	Risk of disagreements in the teams	x
46	Logistics risks	Karim et al. (2012)	Risk of shortage of materials	x
47	Logistics risks	Karim et al. (2012)	Late delivery of materials	x
48	Logistics risks	Karim et al. (2012)	Shortage of equipment	
49	Logistics risks	Polat et al. (2014)	Theft on construction site	x
50	Safety risks	Karim et al. (2012)	Site safety	x
51	Safety risks	Primary data	Personnel risks on site	x
52	Safety risks	Banaitiene & Banaitis (2012)	Lack of protection on a construction site	
53	Safety risks	Renuka, et al. (2014)	Risks of workers falling from high	x
54	Safety risks	Renuka et al. (2014)	Risk of workers being by falling materials	x
55	Contractors and tender risks	Ismail et al. (2014)	Incompetent subcontractors	x
56	Contractors and tender risks	Renuka et al. (2014)	Contractual risks	
57	Contractors and tender risks	Banaitiene & Banaitis (2012)	Failure to comply with contractual quality	x
58	Contractors and tender risks	Banaitiene & Banaitis (2012)	Scheduling errors, contractor delays	

Risk number	Risk category	Primary or Secondary data	Risk factors	Risk mentioned to exist by Primary Data
59	Contractors and tender risks	Secondary data	Failure to carry out the works in accordance with the contract	
60	Contractors and tender risks	European commission (2005)	Insurance Risks	
61	Contractors and tender risks	Schieg (2006)	Scheduling error and delays created by contractor	x
62	Contractors and tender risks	Schieg (2006)	Choosing the wrong contractor	x
63	Contractors and tender risks	Schieg (2006)	Risk of insufficiently skilled staff or subcontractors	
64	Contractors and tender risks	Schieg (2006)	Quality risks caused by contractor	x
65	Project management risks	Karim et al. (2012)	Change of scope of work	
66	Project management risks	Karim et al. (2012)	Inadequate planning	
67	Project management risks	Ismail et al. (2014)	Poor project management	
68	Project management risks	Ismail et al. (2014)	Schedule delays	x
69	Project management risks	Ismail et al. (2014)	Inadequate planning and scheduling	x
70	Project management risks	Renuka et al. (2014)	Lack of resources risks	
71	Project management risks	Renuka et al. (2014)	Project execution risk	
72	Project management risks	Baloi & Price (2003)	Estimator risks (cognitive and Bias)	
73	Project management risks	Primary data	Meeting deadline risk, the project end is delayed and schedule delays	x
74	Project management risks	Schieg (2006)	Cost risks	
75	Project management risks	European Commission (2005)	Poor estimation of time	
76	Project management risks	European Commission (2005)	Poor scoping	
77	Project management risks	European Commission (2005)	Unclear or unattainable project objectives	
78	Project management risks	Banaitiene & Banaitis (2012)	Stakeholders request late changes	
79	Project management risks	Zou et al. (2006)	Time related risks	x
80	Project management risks	Banaitiene & Banaitis (2012)	New stakeholders emerge and request changes	
81	Project management risks	Banaitiene & Banaitis (2012)	Construction cost overruns	
82	Project management risks	Bennet (2003)	Risk of having to make trade-off between quality and cost	x
83	Project management risks	Polat et al. (2014)	Inability to forecast risks and its effect on the objectives of the projects	x
84	Quality and compliance risks	Renuka et al. (2014)	Compliance risks	

Risk number	Risk category	Primary or Secondary data	Risk factors	Risk mentioned to exist by Primary Data
85	Quality and compliance risks	Banaitiene & Banaitis (2012)	Contradictions in the construction documents	
86	Quality and compliance risks	Schieg (2006)	Risk related to the quality of the project	
87	Design risks	Banaitiene & Banaitis (2012)	Design process takes longer than anticipated	
88	Design risks	Banaitiene & Banaitis (2012)	Design errors and omissions	
89	Design risks	Banaitiene & Banaitis (2012)	Incomplete architectural designs	x
90	Design risks	Banaitiene & Banaitis (2012)	Risk for change in scope of design	x
91	Technology risks	Banaitiene & Banaitis (2012)	Technology changes	

Table 3 provided this study with a list of risks existing is construction projects where these risks originated from both the primary and the secondary data. Table 4 below only includes the risks that were marked with an "X" symbol in table 3, meaning that these risks were either identified to exist in construction projects by one or more participants of the primary data or the risks were found in the literature review, but these same risks were also identified to exist in the construction projects of this study as mentioned by the interviewees of the primary data. This means that only the risks that were solely found from the secondary data but not identified as potential risks in the construction project by the interviewees will not be included in the PLC table 4.

The PLC table (table 4) shows at which stage of the PLC the participants of the interviews believed the risks found in table 3 and marked with an "X" are existent. It is important to notice that some risks do not only occur during one phase of the PLC life cycle but during several phases of the construction project life cycle and as such, these risks have been duplicated across the PLC phases. The interviewees were asked to communicate in which of the phase of Bennet's PLC model, each risk found were existing. If the participants of the interviews did not understand the different phases of Bennet's PLC, then the different stages of the PLC were explained to them. It is worth mentioning that no risks were found for the "contractor mobilization phase" and the reason for this will be further discussed in upcoming chapters.

Table 4: Risks identified as being existent in the different stages of the PLC.

Risk classification	Risk number	Risk factors	Pre-project phase	Planning and design phase	Contractor selection phase	Contractor mobilization phase	Operational phase	Project closeout phase
Financial risks & cost related risks	11	Poor estimation of resources risks (forecasting)		B, D1, C2, D2				
	13	Poor estimation of cost and the time required to complete the project		B, D2, C2				
	12	Budgeting risks		B, D2, C2, D1				
	14	Subcontractors' bankruptcy					D2	
	3	Insolvency of subcontractors					B	
	15	Risk of unavailability of funds and financial failure from banking institutions					B	
	10	Economical (Price, exchange rate & markets)	B, D2	B, D2				
Natural environment risks	20	Site conditions and unknown geological condition risks	E, B, D2				B	
	19	Risks for underlying pipeline and rock structured	E, B, D2					
	16	Environment and geological risks	E, B, D2					
	21	Weather and seasonal implications risks					B	

Risk classification	Risk number	Risk factors	Pre-project phase	Planning and design phase	Contractor selection phase	Contractor mobilization phase	Operational phase	Project closeout phase
Socio political risks	33	Project desirability and public rejection		B, C2, D1, D2				
	26	Public objection of project		B, C2, D1, D2				
	24	Political risk (political systems, labour & governmental relations		B, C2, D1, D2				
	34	Government relation risks		B, C2, D1, D2				
Design risks	95	Incomplete architectural designs		E				
	96	Risk of scope and design changes						D2, C2
Safety risks	54	Personnel risks on site					D2	
	56	Risks of workers falling from high					D2	
	57	Risk of workers being struck by falling materials					D2	
	53	Site safety risks					D2	
Project management risks	82	Time related risks		B, D1	B, D1			
	70	Schedule delays		B, D1	B, D1			
	71	Inadequate planning and scheduling		B, D1				
	75	Meeting deadline risks that the project end is delayed and schedule delays						B, D1

Risk classification	Risk number	Risk factors	Pre-project phase	Planning and design phase	Contractor selection phase	Contractor mobilization phase	Operational phase	Project closeout phase
Project management risks	85	Risk of having to make trade-off between quality and cost						D2, C2
	86	Inability to forecast risks and its effect on the objectives of the projects		B, D1, C2				
Logistics risks	52	Construction site, theft risks					C2	
	48	Risk of late delivery of materials					C2	
	48	Risk for shortage of materials					C2	
Contractor and tender risks	66	Risk of insufficiently skilled staff or subcontractors			C2, B, D1			
	65	Choosing the wrong contractor			B, C2, D1, D2			
	58	Incompetent contractor			B, C2, D1, D2			
	67	Quality risks caused by contractor						B, C2, D1, D2
	60	Failure to comply with contractual quality						B, C2, D1, D3
	64	Scheduling errors and delays made by contractor						B, C2, D1, D2

Risk classification	Risk number	Risk factors	Pre-project phase	Planning and design phase	Contractor selection phase	Contractor mobilization phase	Operational phase	Project closeout phase
Team and management risks	35	Poor quality of workmanship					D2, C2, B	
	43	Poor Communication between teams					D2; B	
	46	Poor Communication of risks between teams					D2, C2, B	
	47	Risk of disagreements in the teams					B	
	45	Risk of inadequate managerial or project leader skills.					D2, C2, B	
	44	Risk of improper coordination between teams					D2, B	
	39	Inexperience workforce and staff turnover					D2, C2, B	
	41	Project team conflicts					D2, C2, B	

The sub-chapters below explain more in detail the risks that were found in each of the different phases of the PLC and from table 4. These sub-chapters, then, are divided into the different PLC stages where the risks found from each stage are presented more in detail, and as such, the risks found in the different stages of the PLC here above with the interviewees represented by their symbols will be further discussed in text format.

In comparison to previous chapters of this study, this chapter contributes with the additional context in the form of statements and extra information provided by the interviewees of this study. In addition, the secondary data that were found from the literature review is also used in this chapter to support or contradict the information found from the primary data and the information provided by the interviewees. Interestingly, no risks were found in the contractor mobilization phase and a limited number of risks was found for the pre-project phase of the

PLC, hence a sub-chapter for “the contractor mobilization phase” will not be presented here and this stage of the PLC will be further debated in the discussion chapter of this study.

4.1 Pre-project phase

The primary data shows that few risks exist in the pre-project phase of construction projects and little evidence for existing risks was found in this stage of the PLC from the literature review. Some of the participants in the interviews mentioned that economics (price, exchange rate, and markets*)* could be a potential risk at this stage (B and D2), together with the risks of site conditions and unknown geological conditions, (E, B, and D2), risks for underlying pipeline and rock structured (E, B and D2) and environment and geological risks (E, B and D2). The risks mentioned above are all risks that could occur at this stage because these risks could happen not only in the pre-project phase but also in other stages of the PLC if these are not considered or accounted for in this early stage of the PLC.

4.2 The planning and design phase

The primary data shows that many risks occur in the planning and design phase of construction projects and evidence from the risk literature shows that risks do occur during the design phase of the PCL. The primary data indicate that risks exist in the planning and design stage due to the inability of project owners themselves to correctly forecast different risks and what uncertain effects and impact these risks could have on the objectives of the projects (B), (D1) and (C2). As such these forecasting risks do not only exist during the planning and design phase as the outcome and impact of these risks would only become eminent in the later stages of the construction project life cycle.

According to the respondents of the interviews, there are financial risks in the planning and design phase of construction projects because project owners in the beginning underestimate the cost required to complete construction projects (B), (D2) and (C2). Exchange rates and market fluctuation also play a role in the pricing of goods and services and because many of the construction projects of the interviewees were built around the financial crisis, the price of goods and services was cheaper according to two of the participants.
On the other hand, because of the financial crisis, there were also more risks for subcontractors to become insolvent or even bankrupt. As mentioned before, three respondents explain that there are financial risks during the planning and design stage and these risks existed because it was difficult to correctly assess the amount of money that was required for the construction of a project (B), (D2 and (C2).
The same participants explained that there are risks during the planning and design phase because of the negotiations that often take part with financial institutions. Once the first lending was approved by financial institutions, it could become difficult to receive more funding once

the project had received the initial funding, hence the importance of good financial forecasting in the planning and design stage of the project.

In addition, two participants from the interviews (D2) and (B3) explain that their construction projects went two and four million euro over budget respectively because of financial forecasting uncertainties that occurred in the design and planning phase of both projects. The existence of financial risks during the planning and design phase in construction projects are also mentioned by Renuka et al. (2014, p. 33), where the authors explain that the unavailability of funds and financial failure is an occurring risk factor in the construction industry. The European Commission (2005, p. 25) also shared the same notion of financial risks in construction projects as the study shows that poor estimates for funding as well as having a budget based on incomplete data are risks that are likely to occur in the design and planning phase of various construction projects. Another respondent of the primary data state that "financial risks are important risk that project owners need to take into consideration during the planning phase because of the number of subcontractors that works on the project" (D1).

According to the same respondent, there are sometimes trade-offs that need to be made between, letting the contractor choose all the subcontractors but often at a higher cost and with fewer risks or letting the owners work with the subcontractor directly without the contractor as an intermediary with higher risks but at a lower price. In addition, the secondary data shows that some risks occur because of overconfidence and biases in the forecasting of time and cost required to complete a project, especially in the study made by Flyvbjerg (2006, p. 8).

The primary data of the study further shows that it is important for decision-makers to understand the site geological conditions in the design and planning phase of construction projects since geological conditions could affect the stability of the building and affect the project later as further assessment is needed to correct for the unknown geological conditions. Three respondents explain that geological risks are important risks in the design and planning stage of construction projects because of unknown underlying pipeline and rock structures (E), (B) and (D2). One interviewee from the primary data states "If there are any miscalculations or uncertainties regarding the site condition or any geological dilemmas for which the construction has to be built upon, it can have negative consequences for the construction project" (B). However, the same respondent estimates that these geological and site condition risks have a low probability of occurrence but that these types of risks still need to be accounted for and taken into consideration as the impact of these risks may be high.

Baloi and Price (2003, p. 264) further show that socio-political risks exist in the design and planning phase of construction projects. These socio-political risks are also mentioned by the respondents of the data where three respondents agree that political factors play an important role in the planning and design stage of a construction project, especially for bigger projects (B), (C2), (D1) and (D2). The respondents explain that a good relationship with governmental bodies facilitates for the acceptance or rejection of the construction project. One respondent further explains that having a good relationship with the political bodies involved in the construction project decreases certain financial risks and risks that are related to the desirability of the construction project regarding the eyes of the public (D2). And respondent (B) states that "if you don't have political bodies beyond you for these kind of construction projects there is a chance you would never be able to get your project accepted".

4.3 The contractor selection phase

The primary data shows that some risks exist in the contractor selection phase of the construction life cycle. In agreement with several of the respondents of the data, there is a risk of choosing the wrong contractor, where the choice of giving the construction contract to the wrong contractor could have a negative effect on construction projects (B), (C2), (D1) and (D2). According to the data, choosing the right contractor is important because an inexperienced contractor could decrease the quality of the project as well as create delays in the project's completion. Similar findings are found in the risk literature for employing the wrong contractor as not all contractors have the necessary technical skills and experiences to attain the construction project objectives (Karim et al., 2012, p. 349; Schieg, 2006, p. 40; Ehsan et al., 2010, p. 20).

One respondent from the interviews (D1) further explains that giving the construction project contract to a contractor with a good past reputation may be better as the product will be of higher quality than choosing another cheaper contractor but with less reputation.

4.4 The operational phase

Based on the primary data, there are some risks that seem to be predominant in the operational phase of the construction project life cycle, and evidence from the risk literature shows that most risks do occur during the operational phase of the PCL. One explains that contractors and subcontractors start to fail to meet their objectives which become apparent in the operational phase of construction projects (D2). The primary data also indicates that the people working on the construction project may not always have the required expertise to meet all objectives required for the operational phase of the project life cycle (C2), (B), and (D1).

One respondent explains that workers don't always have the right expertise to conduct their specific tasks that are required during the operational phase of the construction project life cycle which in turn could delay the project (B). The risk literature indicates that during the operation phase of construction projects, the owner of the project and the contractor must make sure that the construction project runs on time and on schedule (Schieg, 2006, p. 79). As such, the owner and the contractor need to closely monitor the costs of the project, respect all the technical requirements and allocate resources correctly to the construction operation (Bennett, 2003, p. 10). The construction literature explains that it is the contractor's responsibility to make sure that the personnel is performing their tasks in the right way and that there are no disagreements within the team (Schieg, 2006, p. 79). The risk literature further shows that inefficient communication between participants could result in communication-related risks hindering the project to meet the different objectives of the construction project (Karim et al., 2012, p. 340).

In addition, Baloi and Price (2003, p. 264), Ehsan et al. (2010, p. 3), and Schieg (2006, p. 79) argue that there are existing relationship risks during the operational phase of the project as the stakeholders of the construction projects do not fully understand the relationships that are needed between the different people within the project. The risk literature shows that poor communication between team members and the lack of an experienced project leader seems to be two important risk factors for the construction industry, as both risks may delay the important parts that need completion during the operational phases of the project life cycle (Karim et al., 2012, p. 340). Two respondents explain that it is not uncommon for a lack of expertise from stakeholders working on the construction where the project leader, workers, or the contractor on the construction site does not possess the required skill set to manage tasks and different teams (C2) and (D2). One respondent (B) states: "During my construction project there was some disagreement between different teams which resulted in some of the people from these teams leaving the project because the people within these teams could simply not work effectively together". A third respondent (D1) explained that they used two contractors to finish the project as fast as possible but because of communication problems occurring between these two contractors, management hurdles ensue. The risk literature indicates that during the operation phase of construction projects, there are environmental and geological risks that the owner and the contractor of the construction project must account for Baloi and Price (2003, p. 262). Three respondents of the interviews confirm the existence of such natural and geological risks where they explain that some of these geological and natural risks could be unknown underlying pipeline and rock structures (E), (B), and (D2). One of them clarifies that there are chances that the rock materials that created the basis for the building are not suited for a certain type of construction (B).

Geological risks were experienced by two respondents of the interviews where geological problems occurred during the operation phase of the construction project because these geological risks were not accounted for prior to the operation phase of the construction project which resulted in having to make extra unaccounted work on the foundation for the building (B). In addition, because of drilling, there are existing risks due to water leakage which are risks that are very common in the operational phase and especially for smaller construction projects. These water leakage risks can either be the cause of poor workmanship or lack of complete architectural designs created in the design and planning phase of the construction project life cycle (E). The risk literature shows that external weather and force *majeure* risks are common risks that are prominent in construction projects and these risks need to be properly accounted for (Baloi & Price, 2003, p. 264). The unknown weather condition of a longer period of rain was a risk that was identified by analyzing the primary data and one respondent explains that such factors could delays the project as the bad weather conditions for one construction project resulted in three weeks delay (B). In addition to the external risk factor of force *majeure* and weather conditions, logistical risks seem to be existing in construction projects as deducted both from the primary and secondary data. The risk literature indicates evidence of risks exiting due to a shortage and late delivery of materials and that some of the materials, once delivered do not always meet their mandatory requirement (Karim et al., 2012, p. 340).

One respondent explains that theft at the construction site occurred during the construction of their project, which resulted in logistical complications and resource management dilemmas (C2). Even though theft have a financial impact on the project, theft could also result in logistical problems and delays for the project and one respondent further agreed to this clarification as "thefts do not only increase the costs of the projects but it does also result in material shortage where new materials have to be bought and brought to the construction site and this process could increase the lead time of the operational phase as some material take time to reorder" (C2).

Safety risks also need to be considered, especially in the operational phase of a construction project as these safety risks are more likely to occur during the operational phase in comparison to other phases of the PLC (D2). The primary data shows that the most common safety risks are workers falling from height and workers being struck by falling materials. Safety risks are also commonly referred to in the construction risk literature where various studies in this field suggesting that most accidents in the construction industry occurs because of workers falling from elevated places, they are struck by falling or moving object, they are being hurt by moving vehicles or they are being trapped by something collapsing (Bennett, 2003, p. 223).

4.5 Project closeout and termination phase

The termination phase of the construction life cycle is a stage that is difficult to manage from a risk perspective as deducted from the primary data of this study. The primary data shows that there are trade-offs that must be made between the risk of occurring higher costs versus the quality needed for the construction project (D2) and (C2). For example, one respondent (B) explains that it is not uncommon for the stakeholders of projects to change design criteria regarding interior designs, at the termination phase of construction projects, which often results in higher costs and delays for the overall project. In addition, many respondents explain that contractors and construction companies fail to finish the job with the pre-decided quality criteria that were previously negotiated upon when the contractor was given the construction contract (B), (C2), (D1) and (D2). These design quality criterias were mostly related to the interior of the building and the participants explained that these design faults could be everything from electrical wiring to bathroom instalment and carpeting. On this topic, Bennett (2003, p. 289) confirms that contractors of construction projects often do not finish the projects at one hundred percent at the expectations that the owner had for the project. The European Commission

(2005, p. 17) also concurred with the evidence that not all projects are fully completed at the last stage of the construction PLC explaining that there are results in quality concerns for construction projects. Bennett (2003) further states that "projects proceed smoothly until the 95 percent completion mark, and they remain at this 95 percent completion mark forever" (p. 289).

Based on the primary data, one very common risk factor at the termination phase of any construction project are the risks for construction delays which may not be linked to the termination phase per se but the sum of all added delays occurring before the termination phase of the PLC as each previous phase accumulate delays making it difficult to finish the project in time. (B), (C2), (D1) and (D2). Respondents′ data explained that delays are not only caused by delays in the construction project termination phase, but these delays are most likely to be the sum of all added delays that occurred during the previous stage in the construction life cycle up to the termination phase of the life cycle. Delays in construction projects seem to be a common risk and, evidence supporting this, was found both from the literature review and from the primary data of this study where two respondents explained that they experienced large delays in their construction projects where these delays caused the decreased quality of the projects and a loss in income since they could not start profiting from their construction projects (B and D1).

4.6 Risk management

As mentioned in the previous chapter and in the purpose section of this paper, the second aim of this study is to find out how different risks are identified analyzed, and managed, as well as understand if there are any risk management processes or techniques that are used by decisions makers for different construction projects.

In this section, I will therefore present the results obtained regarding risk management processes for the different construction projects of the primary data. It is important to mention that the interviewees of this study mainly consist of project owners and as such the representations of the risk management techniques found from this study are based upon this narrow group only except for one risk expert and one contractor that was also part of this study. As such it is possible that other risk management techniques exist for construction projects or in the construction industry in general and if this study had more construction stockholders represented as part of the primary data, especially for contractors and construction companies' other risks technique could have been found. Nevertheless, the primary data shows that only a few risks management techniques were used where the interviewees relied solely upon the "divide and conquer" principle, the project owner's own judgment, the experience of past projects, best and worst-case scenarios, brainstorming, risk matrix questionnaires, past record, literature survey and interviews with risk experts.

One respondent explains that during the planning and design stage of a construction project, it was useful to divide the project into different phases to better identify risks for each of the

different phases of construction projects (D1) (D2). The process of dividing a project into different phases to better understand them is often referred to as the "divide and conquer" principle (Clemen & Reilly, 2005, p. 8). The authors (2005) explain that "Divide and conquer" is to decompose a problem into chunks that can be more readily analyzed and understood (p. 8). The same authors further expose that the decomposition of the problem is vital for a decision-making process since it will be easier to understand the different subjective and quantitative uncertainties and values that exist within a problem.
According to one respondent of the primary data (D2), during the planning and design phase of the construction project, it is common for owners to try to identify risks by using past historical records and by asking risks experts who specialize in various types of construction projects and use their judgment from past construction projects to identify risks.

From the literature, common risk management techniques used for risk management is statistical modelling technique such as the weighted Delphi method, multi-criteria analysis, event tree analysis, hazard analysis, or other statistical simulations (Heldman, 2010, p. 142). The primary data of this study shows that not many of these risk management techniques have been used during the risk analysis phase that aims to analyze various probabilities of occurrence for various risks of the risk management framework presented by Smith et al. (2009, p. 40). For example, one construction company and two project owners (B), and (D2) explain that they mainly use tools such as risk matrix, brainstorming, and relying on their past construction experiences to identify risks and solely rely on adding upper margins[3] to reduce the risk impact of identified risks. Another respondent (E) believes that mitigating the risks of increased cost and delays could be done by adding a 20% upper margin prior to the commencement of the construction or by creating a best and worst-case scenario.
One more respondent (C2) said that the reason for not using any quantitative risks management tools is because such tools are deemed too time-consuming and too difficult to use, and they lack people with enough expertise to use the required software. Not using risk tools for risk management in construction projects is also explained by Baloi and Price (2003, p. 265) as these authors clarify that time and assets can be wasted if owners of projects put too much emphasis on risk management for risks that are deemed unlikely to occur.

However, if potentially wasted resources are the cause for the respondent of the data not using quantitative risks management tools are unknown from the data of this study. Three respondents (B), (D2), and (D1) explain that they did not use any risk management tools or techniques but relied entirely on the contractors or construction companies to perform all the proper steps of risk management in their construction project. These findings suggest that these three respondents mitigate for risks that could occur during the construction project by transferring these potential risks to an outside party. In this case, the transfer is made from the owner to the

[3] Upper margins mean that if there is for example a risk of delays, a margin is added to the cost and time it will take to complete the project.

contractor or the construction company. According to all the respondents, they have a contract with the contractors, which stipulates that the project must be delivered on time. If the project is not delivered on time, then the contractor will accumulate late fees.
However, what is interesting is that for all respondents there have been a lack of the quality at the end of the phase of the projects. A very likely reason for the lack of quality could be that contractor does not deliver the right quality due to not meeting the deadline, hence not having to pay any fees on behalf for a lack of quality. In the words of Smith et al. (2009, p. 92), risk transfer involves transferring risk management from one party to another, without changing the total amount of risk in the project.

Risk transfer can occur between the parties involved in the project or one party and an insurer. The decision to transfer or allocate risk to another party is implemented through an insurance policy or in the conditions of the contract. It is usually up to the owner to initiate the transfer of risk, although there are several factors that need to be considered before any risk is transferred. First of all, consideration should be given as if the party that the risk is being transferred could do anything to manage or control the risk, and whether they could accept the consequences should the risk be occurring. It is generally agreed upon that risks should be accepted by the party that is best able to manage or control them, or the party that is best able to accept the consequences should they be released.
This does not necessarily mitigate any risks and can potentially open new risks. The same two respondents (B) and (D) earlier identified a risk of choosing the wrong contractor, which might increase risks of bad communication between stakeholders, especially when as identified by the two respondents that the contractors are not making the risk identification, but the risk management is still transferred. These findings are like the risks management literature (Serpella et al., 2014, p. 654) which explains that many of the owners that hire construction services or contractors on a recurring basis do not apply systematic risk management techniques for their construction projects.
This is quite interesting since the different risk management techniques should be used not only by the contractor but also by all the different parties that have a role in the construction project for construction projects to be successful. In addition, Hwang et al. (2014, p. 116) argue that risk management should be implemented regardless of the size of construction projects.

5 Discussion

In the following section, I aim to discuss and interpret the results found in previous chapters. First, a general discussion on the main findings of the classification of risks in the scope of a PLC of this study will be made. And then, the results of the PLC method will be highlighted to suggest that there is reason to further explore risks existing in construction projects within the scope of a PLC approach as the model offers the possibility to understand risks that exist in each of the different stages of a construction project.
This study found that there are existing risks during the planning and design phase. For example, the results of this study show that one occurring risk during the planning and design stage is related to financial risks due to bad forecasting. However, it is important to notice that even though the data shows that errors in forecasting have in fact occurred during most of the construction projects by the respondents of the data, the real underlying cause for these forecasting errors is still unknown.

Other risks that were identified during the planning and design stage were related to governmental and project desirability risks, which shows that outside actors play a role in construction projects. The risks that were also found as being of importance during the planning and design stage relate to communication risks, site conditions, and unknown geological condition risks. That is interesting since these two risks were also identified during the operational phase of the PLC, suggesting that project owners see early identification of risks during the planning and design stage of the PLC as a valuable step towards mitigating risks in later stages.

Furthermore, during the planning phase, most risks were linked to some degrees of uncertainty prior to the construction of the building and some incapability for stakeholders of the construction projects to assess, forecast and measure valuable project inputs such as cost, time, and risks. There are some pieces of evidence of a lack of stakeholders being able to properly estimate the amount of time required, and the estimated costs for construction projects as well as making the proper budget estimates. The planning and design phase seems to pose many estimated risks because decision-makers should identify and plan for different risks that might occur throughout the whole construction project, which according to my primary data was challenging.

Secondly, the results of the primary data show that logistical risks do exist and are salient risks during the execution and project operation phase of construction projects. That is because potential logistical risks include late delivery of materials and shortage of materials. In addition, this study shows that there are several risks in construction projects that are related to various skill sets of stakeholders within the construction projects, more precisely poor quality of workmanship, inadequate managerial skills, improper coordination between teams, and insufficiently skilled subcontractors. These risks need to be taken into consideration already in the first phase, because most of the respondents of the data have experienced risks that are

related to improper skillsets, and they further believe these risks are an occurring phenomenon in the construction industry. Owners of construction projects should choose contractors wisely, especially since both the primary data and risk management literature shows that disagreements between teams during construction projects are very common, which could lead to both high direct and indirect costs for the owner and the contractor of construction projects.
In relation to and during the operational phase, most risks are linked to communication, logistical risks, skills & workmanship, experience, geology, site uncertainty, weather condition, and theft. During the termination phase, I have found that there is a risk that the quality of the project is not being met, something that has also been argued for in the risk management literature (Schieg 2006, p. 80). During the termination phase, there is also the risk of design change by the client.

Thirdly, the results of this study show that there are some risks identified in the project closeout and termination phase of construction projects. The result shows that most risks at this stage are related to increased cost, end delay, quality concerns, and risk for scope and design change. One of the most important risk factors during the project and closeout stage is quality concerns at the end of the project because the predefined quality standards were not met. These quality standards are often set in the planning and design stage and contractor selection stage. As shown by this study these standards are not always fully met, which are findings that correspond with the risk literature. Many risks lifted in this study were not identified by the respondents as occurring during their project or they did not see these risks as more salient than other risks. Even though they may exist, their probability of occurrence is not high enough for the respondents to see them as risks.
The other reasons why the respondents may not consider different risks found could be that they do not have the same risk aptitudes, as would other stakeholders, such as a contractor for example. This has also been mentioned in the literature (Baloi & Price, 2003, p. 262) where the concept of *risk* in construction projects might have a different meaning depending on whom you are asking.
Examples of some risks that were found in this study but not brought up during the interviews were insurance problems, law and local standard changes, tax changes or contradiction in the legal documents. The reason for these risks not to include in the PLC could be that Belgium has a stable legal environment. Hence, the reason “insurance” is not seen as a risk, is because the respondents believe that they are legally covered by the contract they have with various subcontractors or insurers. The results from the interviews also show that the understanding of what a construction project life cycle consists of differs somewhat from the one developed by Bennett (2003).

From my results, I was not able to identify too many risks to be existing during the “Pre-project phase” and the “Contractor mobilization phase”. I could argue that these phases do not have as many risks as other phases in construction projects because these phases are rather small in comparison to the other phases of a construction project.

The reason for these phases not having many risks could also be that not much activity occurs during these phases but there is not enough evidence from the data to back up these claims and are therefore subject to further research. One interviewee (C) explains that the construction life cycle is an interlinked process rather than the different stages following each other one after the other. According to another respondent (D), it is possible for the “Contractor selection phase” to occur already within the “Pre-project phase” of the construction life cycle. In addition, the “contractor mobilization phase” of the construction life cycle has been non-existent during their construction project (B) and (D), which points to the fact that whole phases are overlooked when identifying risks.
It could be argued that either the “Contractor mobilization phase” was not present in the construction life cycle of the construction projects of the respondents of the data, or the “Contractor mobilization phase” did not include as many risks in the eyes of the interviewees. Therefore, the respondents did not see this stage as being as important as other stages, hence not as widely mentioned during the interviews.

With this study, I also aimed to understand how risks are managed in construction projects and in the PLC. The primary data shows that only a few risk management techniques were used where these risk tools were non-computerized. The reasons for not using computerized tools were a lack of knowledge, and the tools being deemed too time consuming, unnecessary, or inappropriate. The same reasons for not using such tools can be found in the literature where Akintoye and Macleod (1997, p. 31) already have stated that formal risk analysis and management techniques are rarely used due to a lack of knowledge and doubts about the suitability of these techniques for various construction project activities. In addition, from my primary data, the qualitative tools that were used were limited to past historical data, expert opinion, best- and worst-case scenarios and risk matrixes.

Not saying the PLC method for the identification of risks could be a substitution for the risk management process, but the PLC could be an important interlinked part of the risk management cycle where there could be an incentive to promote the PLC framework as a risk identification process. This results in a more comprehensive risk management cycle, as it is very unlikely that any stakeholder, when first having identified risks in each part of the PLC, will ignore these without initiating further analysis and mitigation measures for the risks identified during each stage of the construction project life cycle.

5.1 Limitations and future research

The first limitation of this study is the number of respondents from which the data was collected. In this study, five interviews were held with five different individuals representing different stakeholders in construction projects. If more respondents were added to the sample groups, the results would be more conclusive.

Moreover, most of the respondents are owners of construction projects and some are biased which can therefore occur that more data from contractors and risk experts are needed when making further research on this topic.

The second limitation of this study is that all the projects and the participants of this study originate from the country of Belgium and are within the hotel construction business. Therefore, the risks that have been identified from this study and the risks management tools that are used might be the results of cultural, economic, or political condition that solely exists in Belgium and in the hotel construction business as well as risks being identified solely by the owners of the construction project as this stakeholder's group is the most represented group in this study.

Since this study focuses on construction projects that are the construction of hotels with between 100 to 200 rooms, and with restaurants, further studies need to be made regarding how smaller or bigger construction projects are handled and what the different risks are, and how these risks would be managed for these types of construction projects. As stated previously, since the construction projects are all located in Belgium it would be interesting to make the same study in another country for the same type of construction project and determine if the same conclusions can be made. Furthermore, it is important to state that no measurement was made in this study for the likelihood of risks occurring or the impact (financial, reputation, or other) of these risks if these risks would occur.

This study shows what kind of risks exists but not the measurement of these risks and as such more research needs to be done to understand the importance of each risk and if more resources should be put into place to mitigate certain risks in comparison to other as the impact and likelihood may be greater. It is also important to explain that this study made use of its own risk classification to classify the different risks found in the primary and secondary data. It is probable that if this study were to be done by other authors, it would be possible that these authors would use other risk classifications to present the risks found in this study.

6 Conclusions

The aim of this study was to answer the question “What are the risks and how is risk management used in construction projects in a PLC approach?”. This research question was divided into two distinct parts and each of these parts were answered separately.
The study first aimed at understanding the risks that exist in a construction project following an plc approach by collecting both primary and secondary data.
The second part of this study aimed at answering how risks are managed in construction projects. Even if the primary data is limited to make the proper conclusion for what the risks are in each stage of the PCL, there are still some interesting findings that can be discussed throughout this study. According to the literature collected, the planning and design phase is an important phase where risks should be identified and planned for as they might occur throughout the whole construction project.

However, this step is deemed difficult to quantity using analytical methods and softer techniques are often used instead, such as brainstorming and past knowledge and experiences. Another finding of this study is the importance of socio-political risks in construction projects since outside stockholders can affect if a construction project would come to fruition because of governmental or public opinions. Socio-political risk was a greater risk than I myself thought prior to start writing this thesis. In addition, results from the study indicate that choosing the wrong contractor for the project was of importance as different contractors may have different skills for the project. Choosing one with inadequate skills could in the end have an impact for the outcome of the project. The latter results did not come to much as a surprise since contractor risks is well documented in the risk literature. This study also found that team management risks are important existing risks, especially during the operational phase of the construction projects, meaning that the softer skills are also important in constructions. Upper management or project managers need to be able to resolve disputes and communicate effectively between different teams. These softer skills are something that stakeholders need to make into construction when managing complex projects. Some other risks existing in the operational phase are, logistical risks, workers skills and workmanship, stakeholders' experience, the geology of the sites, weather conditions, and theft. All these risks were also found in the literature, and this just accentuate their importance, however it is worth mentioning that geological impact was seems to have a low probability of impact based on this study,

When it comes to the termination phase, this study also shows that there is likelihood that contractors do not fulfil all the predefined quality criterias at the end of a construction project. I have found that there is a risk that the quality of the project is not being met based on the primary data of this study. This is interesting since I myself did not think that this would be such a predominant risk. However, it is possible that this risk was only predominant in my respondents and that other owner of other construction project may not have experienced the same thing.

Furthermore, risk management is a process that all the stakeholders in this study are aware of and doing but the findings suggest that more simplistic non-computerized risk management tools and techniques are used. The findings show the “divide and conquer” principle, owner's own judgment, the experience of past projects, best and worst-case scenarios, brainstorming, risk matrix questionnaires, past records, literature surveys, and interviews with risk experts. I believe that this are important findings because it may indicate that computerized risk tools are rarely used in construction project. However more studies need to be done in order to further investigate this theory. This study further shows evidence that stakeholders have a tendency of transferring risks to an outside party, especially for the quality and financial risks.

Based on this, it would be interesting to study further the relationship between a risk management framework such as the one presented by Smith et al. (2009, p. 40) together with a construction PLC. I believe that there is a further need to understand, if the risk management process is the same in all the different stages of the PLC or if the risk management process is different depending on the stage of the PLC.
In conclusion, combining risk classification in a PLC with a risk management cycle framework could show itself to be an effective method to manage risks. This combination could potentially give an understanding of the existing risks in construction projects and provide the necessary tool to analyze the impact and likelihood of these risks and develop the proper response to mitigate them. This study's results in terms of applying the PLC approach to risks in construction projects gives insights of three main component, namely existing risks in construction projects and where these risks can occur in the PLC and how risk management can be practiced in each different stage of the PLC.

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Appendix

Interview questions

Introduction questions (related to the construction project)

1) What construction project did you take part in?

2) Can you tell me about the role you had in this Construction Project?

3) Did you have that role during the entire project and what phases of the project did you take part in?

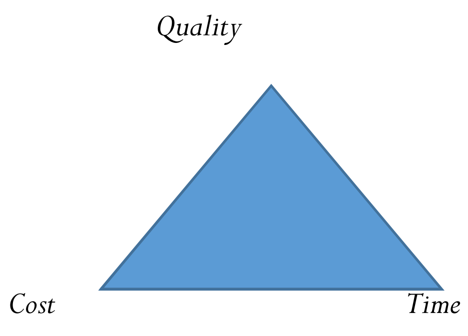
4) Can you tell me the size of the construction project, how long it took to build the Hotel and how many people worked on the project?

Questions related to risk factor in relation to Cost. Quality and Time,

1) According to you, what were your priorities for the construction project (according to the model below?)

2) In your project, what were the end result when it comes to time, cost and quality?

3) Why do you think that your construction project ended up to these end results?



Questions related to Risk in the project life cycle (General question)

1) According to you, what are the different project phases in a construction project?

2) What do you think are the distinct risks for each of these project phases?

3) What effects can those identified risks have in a construction project? (Time, cost and quality, other etc.), in the project?

Questions related to Risk Management (related to the construction project)

1) Who dealt with risk management in your construction project?

2) How were the risks managed within the project (procedures, etc.)?

3) Did you quantify risks in the project somehow? For example, using probabilities.

4) Were you or someone else (Risk responsible, contractor) using any risks tools in order to deal with different risks? What are these tools? *If no tools are used, why is this the case and which tools are you familiar with?*

5) Were there any situation that you found difficult to solve from a risk point of view and what where the reasons?

End question (General question)

1) What are the main challenges in a construction project and what are the best ways way to deal with these challenges?

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