CHALMERS

Success Factors in Large Infrastructure Projects: The contractor's perspective

Master of Science Thesis in the Master's Programme Design and Construction Project Management

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Department of Civil and Environmental Engineering
Division of Construction Management
Chalmers University of Technology
SE-412 96 Göteborg
Sweden
Telephone: + 46 (0)31-772 1000

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ABSTRACT

The most appropriate time to evaluate a project is after completion. However, this is seldom done because a completed project is most often seen as the end of an old chapter. Project managers tend to ignore this because new projects are far more interesting and seen as more important than old ones. This does result in a huge loss of receiving knowledge and experience from completed successful projects.

Four case studies were performed in order to highlight factors that contribute to project success, from a contractor's perspective, in large infrastructure projects. In total, fifteen qualitative interviews were performed with the contractor's project management from four completed projects that all was considered successful by the contractor. In addition, a mini-survey was performed with each interviewee in order to map the project management perception of the success in the four projects.

The study come up with success factors that were of a project specific character but also some more of a general character. These factors are important to consider when starting up new projects in order to achieve a successful project. However, it is important to keep in mind that there is not possible to ensure project success by fulfilling the success factors but it will provide a higher tendency to do so if more success factors are being met.

The results from the mini-surveys indicate that project success criteria that require much effort tends to be perceived as more successful when they are achieved and project success criteria that requires less effort are perceived as less successful when they are achieved.

Key words: project success, project success criteria, perceived success, construction industry, Sweden

Framgångsfaktorer inom stora infrastrukturprojekt: Byggentreprenörens perspektiv

Examensarbete inom Design and Construction Project Management

TEDH ADELBÄCK & NICLAS JOHANSSON

Institutionen för Bygg- och Miljöteknik
Avdelningen för Construction Management
Chalmers Tekniska Högskola

SAMMANFATTNING

Den lämpligaste tidpunkten för att utvärdera ett projekt är efter att det är avslutat. Detta sker dock sällan eftersom ett avslutat projekt ofta ses som slutet på ett kapitel. Projektledare tenderar att ignorera detta eftersom nya projekt är mycket mer intressanta och ses som viktigare än gamla projekt. Detta resulterar i en stor förlust av kunskap och erfarenheter från avslutade framgångsprojekt.

Fyra fallstudier har genomförts i syfte att belysa faktorer som utifrån byggentreprenörens perspektiv bidrar till framgång i stora infrastrukturprojekt. Totalt har femton kvalitativa intervjuer genomförts med byggentreprenörens projektledning från fyra avslutade projekt som alla anses vara framgångsrika enligt byggentreprenören. Dessutom har en mini-enkätsundersökning utförts med intervjupersonerna i syfte att kartlägga projektledningens upplevda framgång i de fyra projekten.

Studien kommer fram till framgångsfaktorer som är av en projektspecifik karaktär men även generell karaktär. Dessa faktorer är viktiga att beakta när man startar upp ett nytt projekt i syfte att uppnå ett framgångsrikt projekt. Det är dock viktigt att tänka på att vi inte kan garantera ett framgångsrikt projekt genom att uppfylla framgångskriterierna utan att de endast ger en tendens till att göra de desto fler framgångskriterier som uppfylls.

Resultaten från mini-enkäterna visar att projektets framgångskriterier som kräver stort ansträngning tenderar att uppfatts som mer framgångsrikt när de uppnås jämfört med framgångskriterier som kräver mindre ansträngning som tenderar att uppfattas som mindre framgångsrikt när de uppnås.

Nyckelord: projektets framgång, projektets framgångskriterier, upplevd framgång, byggindustrin, Sverige

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Tedh Adelbäck & Niclas Johansson

1 Introduction

1.1 Background

When a project goes wrong and fails to achieve its purpose, it is common to review the project to find out what made it fail in order to not repeat the mistake. Many times it can be quite easy to pin point reasons why a particular objective could not be accomplished. However, while answering the question why a project went wrong is relatively easy, answering the question why a project was successful is more complicated. There is never one single simple answer to this question. Still, the question is important and needs to be asked in order to continuously discuss what drives projects towards success.

To manage a construction project successfully is a big challenge and has attracted significant amount of literature the past couple of decades. Project success factors was first introduced by Rubin and Seeling [1967, cited in Belassi and Tukel (1996)] and have since then been used frequently within project management literature (Nguyen et al., 2004). Studies of project success factors are seen as one way to improve the effectiveness in projects (Chan et al., 2004). But different perceptions of project success complicate this process. When defining project success, researchers have considered different project boundaries from the perspective of different stakeholders. The client is seen as the main person in construction projects and has attracted most attention regarding project success, but little research has been done from the contractor's perspective. Still, the relationship between the client and the contractor is seen as one of the most important necessities for successful projects (Bryde and Robinson, 2005, Toor and Ogunlana, 2008). With this in mind, it would be interesting to view what factors a contractor consider as important for a successful project.

According to Stuckenbruck (1986) is the most appropriate time to evaluate a project after completion. However, this is seldom done because completed projects are considered by contractors as end of history. The project managers tend to ignore this because new projects are far more interesting and important than the old ones. This does result in a huge loss of receiving knowledge and experience from earlier project that ended up with a success or a failure (Stuckenbruck, 1986). A study of success factors in completed successful projects would hinder this and provide information about useful factors that could help project managers in their future projects.

1.2 Aim and research questions

The overall aim of this study is to investigate factors that contribute to project success and to get a better understanding of what drives success in large infrastructure projects.

The method chosen form the limitations for this study. A qualitative approach was chosen in order to investigate what drives success in large infrastructure projects from

a contractor's point of view. This was done by performing four case studies of projects considered as successful by the two departments within Skanska Sweden: Skanska Infrastructure and Skanska Major Projects. The case studies were performed through semi-structured interviews with the project management and Skanska's criteria for project success formed the basis for the interview questions. Considering this research approach, the study takes the perspective of the contractor's view of project success.

In order to fulfil the aim, two research questions were formed:

1. What factors, from a contractor's view of project success, are contributing to a successful project?
2. How are a contractor's criteria for project success perceived by the management in successful projects?

2 Project Success

There has not been a distinct answer how to manage large construction projects which are both complex and dynamic (Nguyen et al., 2004). A constantly changing environment with a lot of activities, planned and unplanned, during the life-cycle are the underlying for this (Sanvido et al., 1992). Participants in projects strive to minimize these uncertainties in order to reach project success (de Wit, 1988, Josephson and Björkman, 2011). There have over the decades been discussions of what is defined as project success and authors as Stuckenbruck (1986), Nguyen et al. (2004) and Sanvido et al. (1992) argue that a project that achieves it goals and objectives is defined as successful. This is a definition several project managers would agree upon but far away from being the only one (Sanvido et al., 1992). An explanation of why the definition of project success differs is that the view of success are dependent on which kind of perspective the evaluator chose to observe the project (Nguyen et al., 2004). Further follows various definitions from the literature of what defines as project success;

> "results much better than expected or normally observed in terms of cost, schedule, quality, safety, and participant satisfaction" (Ashley et al., 1987)
>
> "having everything turn out as hoped . . . anticipating all project requirements and have sufficient resources to meet needs in a timely manner" [Tuman (1986), cited in Sanvido et al. (1992)]
>
> "the project is considered an overall success if the project meets the technical performance specifications and/or mission to be performed, and if there is a high level of satisfaction concerning the project outcome among: key people in the parent organization, key people in the project team, and key users or clientele of the project effort" (de Wit, 1988)

Project success is defined differently and Ashley et al. (1987) state that it means to have results "much better than expected". While Tuman (1986) and de Wit (1988) limit their expectations to more meet the technical solutions and objectives. To evaluate whether a project is successful or not is something project managers have to struggle with every day. Project managers are frequently experiencing that a successful completed project is not received with expected enthusiasm from the top management. This despite the fact that the project is finished within time, below budget, and according to the technical specification (Stuckenbruck, 1986). An explanation to this could be that project managers have to put more emphasises on additional criteria when judging if a project is to be successful or not (Stuckenbruck, 1986, de Wit, 1988). This puts the project manager in a position with insufficient information. The project manager have to get all stakeholders to share the project goals and further strive to fulfil the success criteria to reach project success (de Wit, 1988).

In order to understand project success it is important to distinguish the difference between project success and project management success. Project success is

something that can be measured only after the project completion and refer to the overall objective of the project (Cooke-Davies, 2002). Baccarini (1999) would like to add product success as a component to project success. Product success is defined as the effects of the projects final product. However, project management success is something that could be measured over the project life-cycle and relates to performance of the conventional criteria; cost, time, and quality (Cooke-Davies, 2002, Han et al., 2012). With this in mind, de Wit (1988) states that project management success is not required in order to achieve project success and the other way around. A contradiction to this is an argument made by (Shenhar and Levy, 1997, Ika, 2009). They claim that project management success relates to internal actions and the fact that project success is more about the holistic view of a project. This implies that project management success is a necessary element in order to achieve project success, which means that the latter could not be accomplished without the former.

It becomes clear that there is no pronounced definition for project success. People choose to define project success depending on various preferences. A project manager has to understand that his evaluation of project success not necessary needs to be as important as other stakeholders'. Stuckenbruck (1986) states that the top management and client is the most important stakeholders and that this is something that the project manager have to adapt to. A common sense within the industry is that the relationship between all participants, especially the relationship between clients and contractors, is necessary to reach success (Bryde and Robinson, 2005, Toor and Ogunlana, 2008). A project where the stakeholders are well informed tends to become more successful because there is a greater probability to avoid non successful projects, recognise potential successful projects worth putting an effort on, and recognise problems and applicable actions on current projects (Sanvido et al., 1992).

In order to evaluate if a project is judged to be a success or a failure requires a measurement tool which according to de Wit (1988) should be evaluating performance in relation to the projects objective. Authors as de Wit (1988), Pinto and Slevin (1989) and Nguyen et al. (2004) agree upon that measuring success or failure is difficult due to the reason that there is barely never a failure for all involved stakeholders in the project life-cycle process. There is also an argument made by de Wit (1988) that the perceived success is more important than the real success.

When evaluating if a project is successful or not, it is important to take both objective and subjective measurements into consideration, otherwise it could be misleading. An evaluation process is individual for each project due to the fact that; projects operate in different environments, size of project, procurement strategies, and different cultures and norms (Hughes et al., 2004, Toor and Ogunlana, 2009). The first reason for doing a project specific evaluation is because each project has its own unique characteristics and researchers have considered different boundary conditions for each project studied (Toor and Ogunlana, 2009). Common project conditions could be operational environment, size of project, procurement strategies, and diverse cultures and norms. Secondly, there are different perceptions of project success. Researchers often hesitate between two different perceptions, the macro perspective described as

the overall objectives of the project and the micro perspective that concerns project success from the viewpoint of the individual stakeholder (Toor and Ogunlana, 2009).

2.1 Project success criteria

Lim and Mohamed (1999) define project success criteria as the set of principles or standards by which project success can be judged. Similarly, Atkinson (1999) describes project success criteria as something that projects can be measured against. In other words, criteria are somewhat used in order to compare goal level against performance level. If project success is the goal, then the accepted objectives of the project are the criteria to achieve the goal (Chan et al., 2002). Sanvido et al. (1992) speak of success criteria as the expectations of the project and further add that expectations are dependent on participants, scope of services, project size, technological implications and other factors.

Historically, the so called "Iron Triangle" including time, cost and quality (Figure 1) has been frequently used as project success criteria (Atkinson, 1999) and many authors are still referring to these criteria as a basic foundation for assessing project success (Han et al., 2012). However, the literature seems to agree on the limits of only referring to these criteria and consequently new criteria and models for deciding criteria have emerged (de Wit, 1988, Atkinson, 1999).

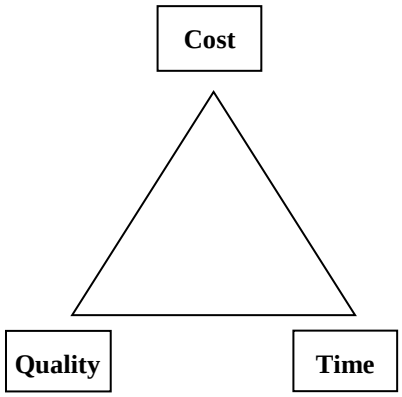

Figure 1: The Iron Triangle (after Atkinson, 1999)

Atkinson (1999) states that incomplete definitions of project management has steered managers to only use the Iron Triangle as criteria. This view of success criteria might result in biased measurement of project success, either for better or for worse. Atkinson further argues that many times a project can be perceived as unsuccessful even though the known success criteria were reached. Thus, the Iron Triangle does not consider how well the project is used by the client, whether it was liked by sponsors or if it improved effectiveness or efficiency for the organization. Consequently, continuing using an incomplete set of success criteria will result in repeated reported failures (Atkinson, 1999). With this in mind, Atkinson suggests the technical strength of the resultant system, the benefits to the organization and the benefits to wider stakeholder community as three additional success criteria categories. This framework

of considering success metric will, according to Atkinson, provide a more realistic and balanced indication of success.

Other authors base success criteria on the fact that success is something perceived individually by different stakeholders. The relevant success criteria must represent different views, since construction projects involve many different stakeholders as clients, managers, contractors, workers, and end-users (Stuckenbruck, 1986). Bryde and Robinson (2005) state that different views of success criteria between contractors and clients are hindering an effective working relationship. In their research, conducted by questionnaires, Bryde and Robinson concluded that contractors put more effort into reducing cost and time, while clients put more effort into satisfying the needs of other stakeholders. The view of the client has attracted more attention than other stakeholders, due to that the client is often considered as the main person in a construction project. Frödell et al. (2008) go further into the client's perspective on success criteria and notice that different clients have different interests. Consequently, they suggest that measurement of project success should be based on different groupings of client types. Sanvido et al. (1992) reviewed previous literature and grouped success criteria into the different perspectives of owner, designer and contractor. From these groupings Sanvido et al. were able to identify certain common criteria as well as unique criteria for all perspectives. All three viewpoints consider the financial aspects and schedule as important criteria as well as absence of legal claims or proceedings on the project. The designer's desire to improve professional development and professional satisfaction, the contractor's concern for safety and the owner's interest in knowing that the building project will function as intended are all examples of unique criteria (Sanvido et al., 1992).

In a similar vein, Stuckenbruck (1986) states that there are common success criteria that are generally applicable for the evaluation of any project regardless of project type. These are:

- Be profitable
- Be accomplishable
- Not have unacceptable risk
- Produce useful end products
- Be within the organization's capability
- Efficiently utilize available resources
- Be environmentally acceptable
- Be socially acceptable
- Be politically acceptable
- Not be a dead end

Stuckenbruck further adds that every project has special criteria for success. These could be dependent on the client, but are most usually characteristics of the specific industry. E.g. success criteria in the construction industry are characterized by certain

standards and codes. Likewise, commercial and public projects have criteria to be acceptable to the public (Stuckenbruck, 1986).

Lim and Mohamed (1999) classify the perspectives of project success into two categories: the macro and micro viewpoints. The macro viewpoint of project success reflects the question: Is the requested project concept achieved? If so, the project can be considered as successful. If not, the project can be considered as less successful or even a failure. The question can only be answered in the operational phase after the construction of the project and generally it is the owner, users, stakeholders and general public that look at project success from this point of view. In the micro viewpoint smaller components of the project achievement are addressed. Most often the micro viewpoint considers the conclusion of the construction phase and typically concerns the construction parties. Lim and Mohamed suggest completion as criteria for micro viewpoint and both completion and satisfaction as criteria for macro viewpoint. Together, completion and satisfaction represents two sets of criteria for determining project success. The completion set of criteria could differ dependent on which viewpoint one look at. From the micro point of view completion typically involves the contractor's concern of achieving their own project objectives, such as time, cost, quality, performance and safety. The satisfaction set of criteria involves the users' perceived success of the project and could be utility and operation (Lim and Mohamed, 1999). The frameworks of macro and micro viewpoints of success are illustrated in Figure 2 and Figure 3 respectively.

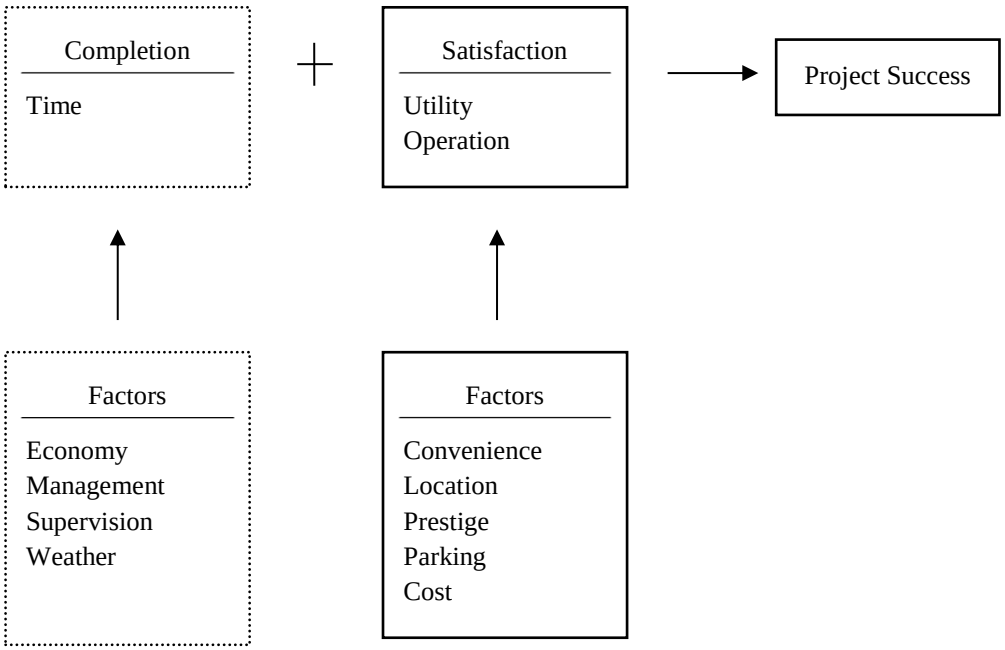

Figure 2: The macro perspective of project success (after Lim and Mohamed, 1999)

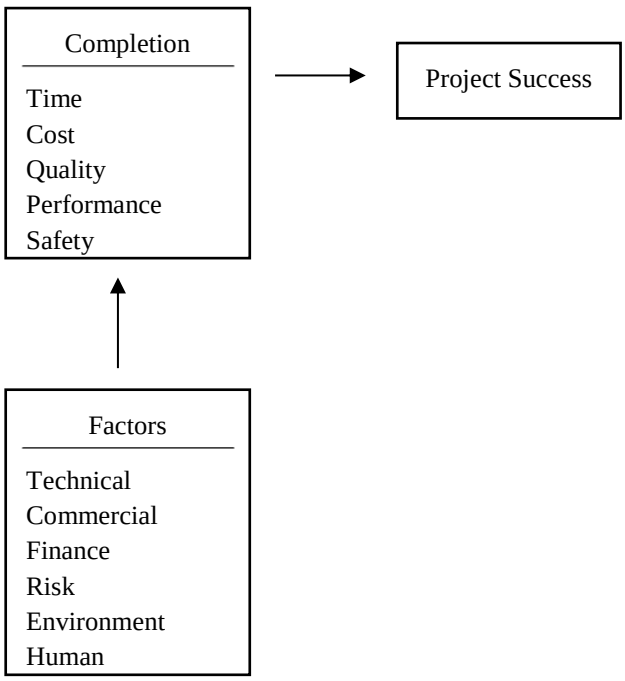

Figure 3: The micro viewpoint of project success (after Lim and Mohamed, 1999)

2.2 Project success factors

The literature state that factors, both success and failure, first was introduced by Rubin and Seeling [1967, cited in Belassi and Tukel (1996)]. However, since then there has not been an evident definition of success factors. A general description of success factors is defined as personal characteristics that is necessary to perform the job, such as knowledge, skills and attitude (Nguyen et al., 2004). Lim and Mohamed (1999) define a factor as "any circumstance, fact, or influence which contribute to a result" and further describe factors for project success as "influential forces which either facilitate or impede project success". While success criteria is the set of conditions necessary to make a judgment of project success, success factors are something that contribute to the project success (Lim and Mohamed, 1999). The relation between success factors, success criteria and project success described by Lim and Mohamed are described graphically in Figure 2. In a like manner as Pinto and Prescott (1988), Lim and Mohamed suggest that there are sets of factors relevant for each phase of the project life cycle. From the macro viewpoint of success, the conceptual and operational phases form the basis for success factors. Since, it is in these phases that the project gets conceptualized and tested. From the micro point of view, it is the construction phase and the contractual parties' goals as time, cost, quality and safety that form the basis (Lim and Mohamed, 1999).

Efforts have been made to clarifying the concept of project success factors by categorizing them. Chan et al. (2004) reviewed previous work on project success within construction in order to develop a framework on CFSs by grouping factors affecting project success into five different categories (Figure 4).

Project-related factors are factors that describe the projects characteristics, such as type of project, nature of project, complexity of project and size of project.

Project procedures consist of two attributes; procurement method and tendering method. Procurement method is described by Chan et al. (2004) as "the selection of the organization for the design and construction of the project" and tendering method as "procedures adopted for the selection of the project team and in particular the main contractor".

Project management factors are characterized by the actions of the project management. Those actions are a key to achieve project success. Project management attributes that affect the project success are adequate communication, control mechanisms, feedback capabilities, troubleshooting, coordination effectiveness, decision making effectiveness, monitoring, project organization structure, plan and schedule, related previous management experience etcetera.

Human-related factors represent factors concerned with characteristics of all key players such as project manager, client, designer, contractor, consultants, subcontractor, suppliers and manufacturers. For instance, examples of variables concerning the client are client experience, knowledge of construction project organization, project financing, client confidence in the construction team etc. The factors of the participants can be divided into categories related to client and related to the project team. Further on Chan et al. (2004) suggests that team spirit is crucial for project success and underlines the important of team building among the different participants.

External factors consist of the external influences affecting the project, such as economic environment, social environment, political environment, physical environment, industrial relation environment and level of technology advanced.

Chan et al. (2004) state that the variables within each category are interrelated and intrarelated. This means that a variable in one group can affect a variable in another group and vice versa.

Figure 4: Factors affecting the success of a construction project, divided into five categories (after Chan et al., 2004).

3 Method

3.1 Case studies

A qualitative research method with a case-oriented approach has been chosen for this study. Qualitative research is often chosen when there is a lack of objectivity (Kvale, 2009). It also gives insight to what the interviewee sees as relevant and important and emphasizes words rather than quantification in the collection and analyzes of data (Bryman, 2004). The choice of a qualitative research method is further justified by the fact that project success differs dependent on from whose view you look at it and in what context it operates in. It also offers the opportunity to get a deeper understanding of what the project management of a contractor perceives as project success and what factors they experience are contributing to achieve it. Most qualitative studies use a case-oriented approach, according to Neuman (2011). The reason for this is that complex cases with many different specific factors and events in one place and at one time, requires in-depth knowledge and an insight in a small number of cases (Neuman, 2011). For this reason, four case studies were chosen for this study. The cases were chosen by the regional manager of Skanska Infrastructure and the head of Skanska Major Projects. These two managers did, by our request, form criteria for success in their projects. The managers came up with ten criteria that formed a basis for the selection of cases. All four cases are considered fulfilling these criteria and thus are considered as successful by Skanska.

3.2 Data collection

Both primary and secondary data have been used in this thesis. Primary data were collected from the interviews in the case study, from a mini-survey and from conversations with supervisors at Skanska. In addition, documents from the four projects were used as primary data in order to describe the characteristics of the cases studied. The secondary data was collected mainly from scientific reports, resulting in the literature study. The literature study was made before and during the interviews. The purpose of the literature review was to get an understanding of project success, success criteria, and success factors and how they are related in order to form appropriate interview questions. The results from the interviews brought up new subjects that were necessary to be included in the thesis. This is the reason why the literature study was conducted throughout the interviews as well.

The interviews conducted were semi-structured. According to Bryman (2004) the interviewer, in semi-structured interviews, have a series of questions that are generally formed and are free to vary the sequence of questions. Also, the interviewer has the opportunity to ask further questions in response to the managers' replies. In contrary, structured interviews are typically following a schedule and are characterized by more closed questions, offering the interviewee a more fixed set of answers (Bryman, 2004).

The choice of semi-structured interviews made it possible to have discussion-oriented interviews. By having the possibility to ask follow-up questions we were able to get more in-depth information about important success factors and the interviewee's reasoning behind them. This would not have been possible with structured interviews, where the opportunities for follow up reasoning are much more limited. The interview method does also provide the opportunity to distinguish a common thread among the managers reasoning about success factors.

Key personal from the project management were chosen as managers in order to get as good overall picture of the investigated projects as possible. The managers from the projects included personal with roles as: project manager, assistant project manager, design manager, production manager, site manager and section manager. Whether to include other roles such as supervisors and craftsmen were considered but where excluded due to the limited period of time. Thus, the data from the interviews conducted are limited to the project management of the four projects.

When deciding which persons to interview, the regional manager of Skanska Infrastructure and the head of Skanska Major Projects where asked to choose appropriate representatives from each project, illustrated in Table 1. The managers were informed in advance about the general purpose of the interviews and that their respective project is seen as successful from the view of Skanska's management. The intention was to make the interviewee start to think in terms of success factors in their specific project and not in projects in general.

Table 1: Number of managers and their roles

Roles	*Case 1*	*Case 2*	*Case 3*	*Case 4*
Project manager	-	1	1	1
Assistant project manager	1	-	1	-
Production manager	-	1	1	1
Design manager	1	-	-	1
Section manager	2	2	-	1

A mini-survey was conducted together with each interview. The mini-survey considered Skanska's ten criteria for success. Each interviewee got to rank, on a sliding scale later transferred to index 0-100, how well he/she experience that they have achieved each criterion. The purpose of the mini-survey was to see if there are some patterns or differences of perceived success, internally or between the projects investigated. This information was considered as interesting when analysing the cases.

3.3 Data analysis

All interviews were conducted face-to-face with the managers and recorded. Notes were also made during the interviews. The recordings were transcribed and acted as support when analyzing the information gained from the interviews. The results from the interviews were used in order to analyze what the managers experienced as contributing factors for the success in their respectively project. Also, what the managers thought were the reasons why their projects are considered as successful were investigated. The results from the mini-survey were analyzed in relation to the findings from the cases in order to see any relations between perceived success and success factors.

4 Four Case Studies of Infrastructure Projects

This study is conducted in collaboration with Skanska and its two departments, region Infrastructure and region Major Projects. The two regions are mainly working with large and complex infrastructure projects such as bridges, roads, tunnels, railways, harbour and all with a contract sum exceeding 100 million Swedish crowns. These extensive projects do often require a lot of labour, which usually means that the two regions chose to collaborate in order to carry out the projects. In the following chapter, four projects will be analysed, that has been carried out by the two regions. Each project based on their individual situations to achieve a successful project.

Through an interview with the regional manager of Skanska Infrastructure and the head of Skanska Major Projects that together came up with the ten criteria for success, it was made clear that the criteria budget, safety, ethics, environment and quality are based on Skanska's core values. The remaining criteria schedule, employees, client, objectives and media were considered by the two managers to be included as the most prominent ones when judging the success of a project. Success in this case is seen to be judged on a sliding scale. As one of the managers put it "project success cannot simply be judged in ones and zeros". Every criterion has a part of subjectivity. However, the managers further ensured that this set of criteria can be used as a frame of reference when judging the successfulness in their projects. If these criteria are met or exceeded, the project will be judged as successful. Further on, the set of criteria formed a base for the selection of interview questions.

The success criteria and the two manager's explanations were listed as follows, without any particular ranking.

Budget – This criterion is fulfilled if project ends up meeting or falling below its budget. A project that is making losses cannot possibly be seen as a successful project.

Schedule - The project gets finished on time or before the scheduled completion.

Safety - No serious accidents during the project. This criterion is measured by LTAR (Lost Time Accident Rate) and should not exceed the goals set for the particular business category.

Employees - The proportion of satisfied employees is measured by a total index from an employee survey and should meet or exceed the regional average value.

Client - Client satisfaction is measured by a client satisfaction index that is generated from a client survey. The client satisfaction index should indicate that the client is satisfied with the project.

Objectives – Most often each project has 3-5 specific objectives that should be reached in order to perceive the project as successful. Example of these can be that certain prefabrication elements or BIM (Building Information Modelling) should be used through the project.

Quality – The quality should be aligned with the purpose of the product. Minor errors in e.g. the final inspection are not considered to jeopardize the success of the project. However, if the fault is major it might have a negative impact on other success criteria. A major fault in the quality might for instance result in a cost increase and time loss, affecting the budget and the time criteria and consequently also the client satisfaction.

Ethics - The project should have no ethical transgressions. This event occurs very seldom, but if does, it can have serious negative impact on the notion of project success.

Environment - The project is not allowed to have any serious environmental accidents. Whether an environmental accident is considered as serious or not is very much considered as a subjective feeling of its consequences. Minor accidents could occur during the project without affecting the perception of the project as successful.

Media - This criterion is met if the project is considered having an externally positive media image. To decide whether the media image is considered as positive enough to call a project successful is difficult. The media image is somewhat seen as a subjective feeling that is not measured.

4.1 Case 1: Large bridge in an inner city environment

Case 1 is a complex inner city project that connects two European highways. The project comprised one long overpass and some additional small bridges.

The project offered several challenges. The geotechnical conditions required extensive foundation work, including support piling, cohesion piling, embankment piling, lime-cement piles, shite-piles, foams and expanded aggregate fillings. The traffic offered another challenge, the daily traffic of the two routes was estimated to 80,000 and 45,000 vehicles respectively. In addition, eight train and tram tracks passed under the overpass during the construction.

The project has been awarded several awards both internally and externally to Skanska. Internally it was rewarded both nationally and internationally "Project of the Year". Externally it was rewarded "This Year's Work environment price" and "This Year's FIA-Price" (FIA – Innovation in Civil Engineering), both issued by The Swedish Transport Administration.

Table 2: Additional information about case 1: Large bridge in an inner city environment

Client	The Swedish Transport Administration
Contract form	Design-build contract
Contract sum	SEK 1,200 millions
Traffic flow	180,000 vehicles / annual mean day

All participants in the interviews felt that this project was judged as a successful project. Depending on the managers' roles in the project they had different perspectives of why it was judged as a success. In the following section there will be a brief description of what is assumed to be success factors and success criteria of this project.

The managers highlighted, from their own perspective, certain explanations why the project is judged as a success. The criteria mention was;

- Schedule – Completed the project on time
- Budget – A constantly focus on economy and measure all goals in money
- Satisfied clients – Was aware of the client's needs
- Satisfied employers – Informed and invited the employers into meetings
- Safety – Always a safety conscious mindset

The tendering process

The interviews revealed that it is important to have a well prepared and thorough tendering document despite the awareness of the risk of not getting the tender. This is conscious thoughts within Skanska even though there is a constantly awareness of knowing that the lowest price gets the bid. However, a thorough tender process provides the organization with a good basis for further decisions, but especially a secure and calm climate. If it turns out to be errors in the tender document it does not matter how hard you work or technically advantageous solutions you come up with because the project would most likely end up with an economically negative result.

> *"A thoroughly tender does not give any greater chance to get the tender, but it gives you a greater possibility to carry out a successful project. Because of this reason, we invest a lot of resources and preparations in the tendering process"* (Design manager)

In order to achieve a thorough tender document, the managers revealed that it is important to involve persons with experience from the production phase. This mainly due to the reason of having a broad basis for future decision making and also being able to analyse the tender in order to highlight difficulties and possible benefits. This early stage sets up the basis for future negotiations that could be valuable in the future. The production manager became a key person early in this tendering process on the basis of his experience. During this process there were a conclusion made by the production manager that there was a need of an extra period of six month to be able to finish the project in a cost efficient way. It initially seemed to be additional costs of doing like this, but on the other hand there was an option to run the production in a more logical way which would save money but especially trust towards the client.

> *"If we halfway into the project had requested for an extra period of sex month, the client would probably shake his head and ask himself what we were doing. With a trustworthy time schedule you give rise to trust."* (Section manager #2)

In the initial phase there was a major focus on the budget, especially in the design phase, which has a tendency to be underestimated in the tendering process. In order to minimize the usual stress there were a decision made to include an additional cost of 20 percent into the detailed design. This is not entirely risk free but considered positive in order to avoid stress.

Satisfying detailed design

The interviews revealed that the design team decided in a greater extent to focus on finding as good solutions as possible in the initial phase and further ensure to follow this. In ordinary projects, it is common to do changes along the way, which was not the case in this project. Doing changes late in the detailed design meanwhile the production is running do often results in favorable cases but with the same cost as the original design. Additional costs due to production interruption, meanwhile producing calculations and drawings once again are often higher than initially estimated. To make changes along the way do also cause concerns among the employees which is not good for the productivity. Therefore, there was a distinct view in not doing any changes along the way. In order to achieve this there was a need to govern the communication between foremen and structural engineers. All questions raised during the project should go through the detailed design manager, who only considered the relevant issues, this to create a sense of calmness in the project.

Among the managers, there is a general interest of calmness, which was created by sufficient resources in the early stage of the production. It was in the early stage important to convince all participants that this was necessary even if it initially seemed to be associated with additional costs. This was done and with sufficient labor, there was enough time to pick the right solutions which further give rise to success.

> *"Success breeds success, when you get a little self-esteem and things are moving on, you have sufficient with time in order to pick secure solutions rather than doubtful solutions."* (Design manager)

A clear focus on finding the most technical advantages in the beginning is considered as being a cost saving process. Besides this, the design team focused on getting a mutual understanding of the production through continuous communication with production-oriented employees. A more causal communication led to a more detailed secure work about temporary constructions.

Trust-based relationship with the client

The managers reveal that there has been a major focus on the client because there are many benefits of having a close relationship. Earlier deterrent projects with failures within the relationship made this project to establish a close relationship with mutual agreements of not doing the same mistake again, nobody wanted to be the one who made it failed.

The top management level managed to keep up a good dialogue with the client and then solve problems together with the client. A good relationship is when we constantly talk to each other, give and take in various situations, show respect for each other and understand the clients' situation. Furthermore, if an organization is structured as a reflection of the client side it is probably a lot easier to collaborate. When setting up the organization, it is important to pick out the appropriate person with right knowledge. If this is done there is a tendency that problems are addressed and solved at the right level, before it has time to become deeply rooted in the organization. According to the managers this creates a positive spiral.

> *"Experienced and professional people see problems as they approach, less professional people see problems when they already have occurred".* (Design manager)

A close relationship creates knowledge of the client, which in itself enables a better understand what they are looking for. In the initial phase of the project there was a collaboration meeting together with the client in order to increase the understanding and respect of each other's work. Participants during the collaboration meeting had the opportunity to speak on the same level during more relaxed circumstances. The general feeling among the managers was that this facilitates future contacts during the production phase.

During discussions and meetings with the client regarding the budget there were always a consciously thoughts about how to act and behave, who gives notice, who speaks with whom and when to inform them about the costs. This working procedure had to be consistently because there was not enough time for a document to be sent back and forth.

> *"We deliver right documentation and they pay for it"* (Section manager #1)

Prepared time schedule

Many of the managers agree upon the importance of a worked through time schedule with ability to build cost effective. This has been achieved in this project and mainly due to an engaged production manager that has been taking part in the tendering process. The time schedule was established by Skanska even before the client notified any contractor, which is highly unusual. It is also necessary to have a time schedule that is suitable for the design phase, otherwise it might create uncertainty and concerns in the project. Typically things that cause these concerns are when changes are done in the structure of when things should be done. Since the time schedule was well worked through and the fact that the production manager was involved in the tender process made the time schedule possible to use as a governing tool.

The experienced production manager realized in the early stage that there was a need of allocating more time to the production phase. Skanska was granted with an extra period of six month, which led to an increase in their work environment. This meant that they now had the opportunity to work in a calmer way according to a work force diagram. This resulted in that there was no need for temporary labor.

"If we had asked for more time in the middle of the project, instead of the beginning, there would not have been a successful project." (Section manager #2)

With a worked through time schedule there was further a focus on having everything planned from the beginning which should create trust both internally and externally. The internal trust was created throughout the production with a knowledgeable production manager and the fact that it turned out that the time schedule fulfills during the process. A step to achieve this is to break down the time schedule into milestones and then do following ups to ensure they are met, which creates trust in itself.

Furthermore, external trust was created during the early stage of a project. In order to achieve this there is a need to provide sufficient resources from the beginning. However, the general sense among the participants was that the project had sufficient labor with low stress and time to think through their decision-making. There was also a feeling among the managers that there was enough time to take care of the client in a greater extent than normally.

The project managements' perception of achieved success

In the end of the interview there was a mini survey conducted to analyze the participants' perception of how well they felt that the project met the criteria expressed by the two top managers in the regions in order to meet a successful project. The main criteria that the managers expressed in the mini survey, illustrated in Figure 5, was budget, time schedule, safety, client, employees, quality and ethics. Regarding these criteria, the managers were relatively consistent as was evidenced in the conducted survey. One of the interviews had a slightly less positive view of the quality and this was because he did not feel that they had put any greater effort than assigned in the contract.

Criteria that were considered to be least successful were environment, objectives and media. The interviews reveal that the perception of the criteria, among the managers, differs more regarding less successful criteria. The objectives are the exception because the managers shared the same view that they had not achieved the requirements, which some considered as vague.

Environment and media was considered by three out of four managers to be less successful. They did not make any additional effort besides what was assigned in the contract, considered by most of the managers to be the cause of the low value. At the same time all managers made clear that these criteria are as important as all the others, otherwise the project would not be successful.

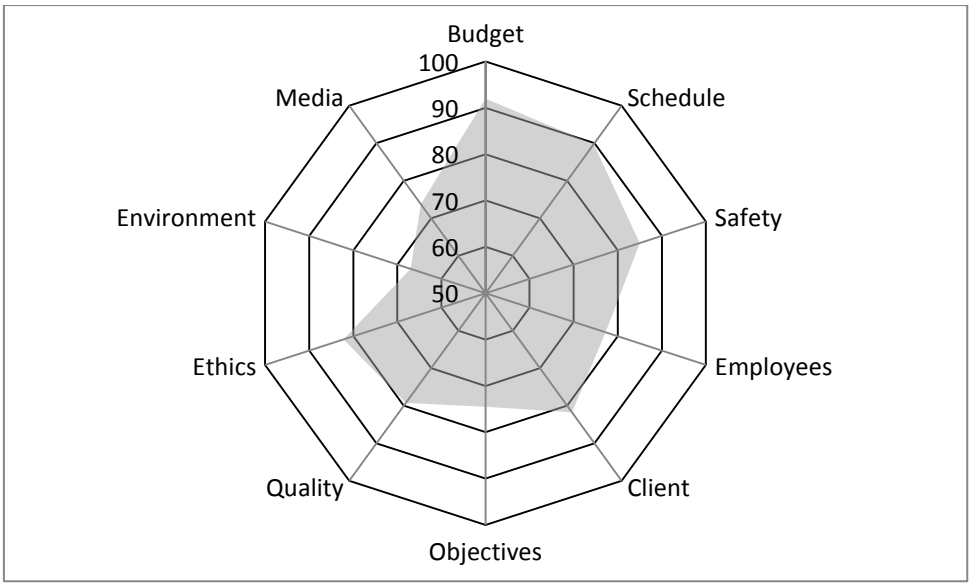

Figure 5: Mean value from the mini-survey in case 2. The scale is cut from 50.0 in order to make it easier to discern differences in the results.

4.2 Case 2: Road project with a large traffic junction

Case 2 is a 3.6 km long route of road and railway. Along the distance there are both residential areas and industrial activities, which mean that the work environment can be considered as urban.

The road and rail works have, in some part of the route, been conducted in narrow corridors and in areas of contaminated ground. Other challenging problems to solve have been the difficult geotechnical conditions and the different kinds of traffic that has been passing through the site during the construction.

The project has comprised the extension of the railroad track to double tracks, four-lane high-way, local road with pedestrian and bicycle path and rebuilding and expansion of a bridge to a traffic junction. Moreover, the project was awarded a work environment price issued by the Swedish Road Administration.

Table 3: Additional information about case 2: Road project with large traffic junction.

Client	The Swedish Transport Administration
Contract form	DBB contract with construction responsibility for the traffic junction
Contract sum	SEK 700 millions
Traffic flow	25,000 vehicles / annual mean day

On the question whether they perceive the project as successful, the managers answered that they perceive it successful considering the challenges that arouse during the project. There were major faults in the design and the project turned out to be 34% more extensive than predicted. Hard work was put into making the client understand

these faults and that changes had to be done. Nevertheless, the project was finished in time and made a profit.

The following reasons were also mentioned as reasons why the project is perceived as successful.

- Budget – They made a profit
- Time – The project was finished in time
- Work environment - They achieved a good work environment
- Environment - They achieved the environmental requirements
- Client - They had a good relation with the client
- Client - They had a satisfied client
- Third parties - Third parties were satisfied
- Safety – They had few accidents and mishaps

Share a common view of the project with the client

The interviews revealed that there has been a certain focus on developing and sharing a common foundation of goals and values together with the client. The client did early state that they wanted to make this project the best stage on this route and wanted the project to be carried out with increased collaboration. In order to achieve this Skanska and the client developed what was, during the interview referred to as, "the pyramid". The pyramid was a pyramid-shaped illustration of how the parties should act together in the project in order to meet this ambitious target. The pyramid comprised of four layers with key-words that both parties had chosen during collaboration meetings and as the foundation of the pyramid were unpretentiousness, proficiency, commitment and openness.

> *"That we really committed to the pyramid was a really good thing. It has contributed to success in that we have had outspoken values that we constantly have fallen back to. It has always been in our minds"* (Production manager #1)

All of the managers mentioned that the pyramid had a major positive impact on the project and that no one wanted to break it. The collaboration meetings together with the client played an important role in the adoption of the pyramid. By constantly having it on the agenda, it was always in their minds and if someone acted in a way which they thought was not in accordance with the values of the pyramid they could always refer to it and correct their behaviour.

The collaboration between the project leader from Skanska and the project leader from the client was mentioned by two managers as one factor that has influenced the project in a positive way. At the beginning of the project, the collaboration did not go that well but the project manager from the client got replaced with another, in the view from Skanska, more competent project manager. One of the managers claimed that the former project manager did not have the leadership in order to get things together and that this outcome was crucial for the project success. The new project manager from the client and Skanska's project manager developed a close dialogue

and put up a structure for good forward planning in the project. Further on they did not intrude in details but delegated responsibility, which was appreciated by many.

Skanska's project manager himself did, during the interview, highlight the importance of having a project leader from the client that is competent in the sense that he understands how the product is constructed and that he is capable of seeing the project from the contractor's point of view.

> *"What I think is important is that the client has a competent project manager. He should be familiar with how to practically build things and might as well be the manager of the contractor and build it."* (Project manager #1)

Organization, internal routines and communication

The organization together with the working structure was mentioned as contributing factors in the success of this project. During the interviews, it was made clear that Skanska's project organization in Case 2 had been working together for a couple of years before this project. Being that, individuals within the project organization had the opportunity to develop together. Individuals have been able to identify areas of improvement together such as internal routines and communication and grow into certain roles with specific areas of responsibility that complete each other in the sense that there are no gaps in responsibility allocation. One of the interviewee described this process as a puzzle. Each piece of the puzzle representing one individual, some pieces has to expand and other needs to shrink in order to achieve a puzzle with no gaps.

> *In order to be skilled, you have to be allowed to stay long enough in your role so that you can master it and even develop it. Then if everyone has stayed long enough in their roles and are good people from the beginning and are able to master and develop their roles, then you'll get a good organization.* (Production manager #1)

The work structure has been characterized by clearly defined responsibilities. Special recourses were allocated into planning, cost controlling etc., with one person responsible for each category. Especially the recourse allocation for planning was mentioned as an important aspect of this project. One specific person was responsible for all planning and internal coordination, which was seen as important for an effective/efficient production with better propulsion and less redoing. All but the person responsible for the planning himself had an exclusively positive approach towards this responsibility allocation. He thought that more people needs to be involved in the planning and express their opinions in order for them to feel a belonging to the schedule.

One precondition for this kind of work structure was that they had a sufficient number of people in the project organization. Some of the managers had, in previous projects, experienced that they were understaffed and too many tasks were allocated on each individual. But in this project, the workload was more reasonable, which meant that

problems could be dealt with more thoroughly compared with other cases were one had to handle too many problems at the same time.

There was a high focus on internal routines, especially routines regarding correctional and additional work was considered as particularly important. There was an uncertainty among the employees about how these should be handled and which account that should be used for each recourse, a knowledge that could offer tremendous incomes according to one of the managers. Dialogue was conducted with the one person responsible for the handling of correctional and additional works, which resulted in the establishment of keeping diaries as a basis for the correctional and additional work. If the adjustment concerned was estimated to be a cost exceeding a certain sum than the client was informed at once by sending a notice. If the adjustment was estimated to be less than that sum than the adjustment was saved to the end of the month and implemented in a simple manner. The thorough work with routines together with knowing the contractual agreements enabled them to justify many adjustments towards the client and to get paid for them.

During the last year of the project they constructed what they called "the goal arrow". The goal arrow was basically an arrow that visualized near-term production goals. More specifically, the arrow consisted of dates of when different critical tasks should be completed and a drawing of the activity was linked to it. When an activity was completed, a dot that initially was red turned green. The goal arrow was displayed for all in the production and became an important tool for motivation and for them to strive towards common goals.

> *"Some thought that it was too simple, of course. But I thought that it contributed by visually showing what should be done. It ignites something in everyone involved. You get an understanding of when things need to be done and you can avoid emergency call-outs."* (Production manager #2)

The goal arrow benefited not only the white-collar workers but also the craftsmen. The schedule got more graspable and so increased the involvement of the craftsmen.

> *"A regular schedule might be readable for a white-collar worker but for a craftsman that doesn't have the time to put in the same effort, it becomes quite meaningless."* (Section manager)

The project managements' perception of achieved success

All of the four managers performed the mini-survey. The results are displayed in Figure 6. The participants seem to be most satisfied with their performance regarding budget, time, employees, client, objectives, ethics and environment. Especially time, client and ethics was ranked high with a score above 90. All of these but ethics were mentioned in the beginning of the interviews by the managers as reasons why this project is successful.

The criteria safety and quality was ranked relatively low compared to the other criteria. Safety was especially ranked low by one of the participants who motivated this with that there was a couple of accidents during the last half year. He could not

see what they could have done differently to avoid them but nonetheless they were not expected. Quality was ranked relatively high by two of the managers and low by the other two. One of these who ranked quality low explained that they had to, due to special preconditions, produce the road in different stages instead of producing it from start to end without any interruptions. This had some minor effects on the quality but he still thought that the quality was good considering the preconditions that was given.

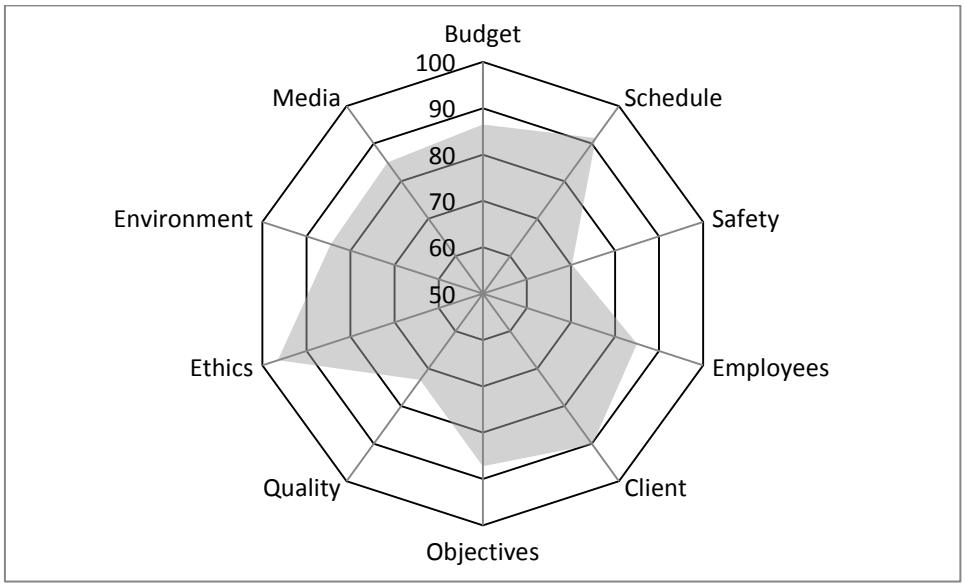

Figure 6: Mean value from the mini-survey in case 2. The scale is cut from 50.0 in order to make it easier to discern differences in the results.

4.3 Case 3: Large rural road project

The project comprised one 20 km long road with 2 + 1 and 1 + 1 lanes and a mid-rail. In addition, 11 bridges were built, including one relatively large bridge.

Environmental questions have been a focus during the project. There has been continuous work with reducing emissions from the vehicles in the project. A total reduction of 1,100 ton carbon dioxide equivalents was accomplished, which was equal to a reduction of seven percentages.

The project has been characterized by the collaboration between Skanska and The Swedish Transport Administration. The collaboration has intended the whole project process, from the design of working documents to the handover of the completed construction.

The collaboration between Skanska and The Swedish Road Administration has concerned the following procedures:

- The design, in order to achieve optimal constructions and production methods
- Cost control, in order to decide what the cost framework should consist of
- Production control, in order to decide what should be included in the schedule

- Procurement/purchasing, in order to jointly decide upon subcontractors and suppliers
- Risk management, in order to jointly work towards avoiding conflicts, mishaps, accidents, environmental impact etcetera.
- Planning and implementation of activities regarding information to third parties and external stakeholders.

Table 4: Additional information about case 3: Large rural road project

Client	The Swedish Transport Administration
Contract form	DBB contract
Contract sum	SEK 400 millions
Traffic flow	700 vehicles / annual mean day

The managers agreed on that the project is a success, despite not reaching all the project goals. However, not reaching the project specific goals is not necessary the same as a failure which was communicated within the project. The general sense was however that this was a successful project and the most distinct criteria mention by the managers was;

- Schedule – The project was completed faster than estimated
- Safety – No serious accidents at the construction site
- Budget – The project was constructed cheaper than the contract sum
- Quality – Zero errors in the final inspection

Close collaboration with the client

The interviews reveal that this project had a closer collaboration with the client than usually. A reason to this was the early effort in establishing a common target plan. This included among other things a well functioned communication between entrepreneur, client and consultants. The consultants had, highly unusual, the opportunity to discuss technical solutions with the contractor which increased the ability to develop more functional ways of producing the end product. The communication even speeded up the process of setting up the time schedule, technical solutions, and milestones, which resulted in a good and secure start.

Other circumstances that gave rise to a close collaboration were that the client was doing their work on the construction site, sometimes even the consultant. They were sitting under the same roof and shared common administrative section, which reduced the fear of asking questions. The consultant was during the production phase present half of the time, which facilitated the collaboration and issues related to the production.

"Everything will be a lot easier. You are suddenly able to communicate by sitting down with a pencil and sketch and illustrate. Furthermore, easy to take the car and go out and take a look." (Production manager)

With a good collaboration to the client offers the opportunity to build up a well functioned organization. Within this project there was an agreement of having sufficient with resources during all stages of the project, includes the contractor as well as the client. It appeared early in the project that the client and contractor was good at different things and more evident was the client´s experience within negotiation. The project manager from Skanska reveals that the client which was a government agency is better at negotiation and therefore took responsible for all major purchases. This was a beneficial decision for the project because the profit was divided equally with the client. Furthermore, the client and contractor met early in the project in order to set up common project rules, both objective and subjective ones. This meant that they got an early understanding of each other, which further encourage everyone in the organization to avoid duplication.

With a relationship where the contractor knows the client is beneficial because it gives the contractor a greater ability to meet and handle the client when problems are arising. One of the interviewee highlights the issue that there is never a good idea to put the client in a bad position, regardless if they caused the problem or not. If there is a problem then it is a good idea to present the problem together with a complete solution that we can think of building them, to an additional cost. Furthermore, there was a focus on finding technically smart solutions that will make the project cheaper. In order to motivate the contractor and client to comply with this there was a need of an incentive contract where the profit was shared.

Collaboration meetings generates trust

Within this project there were regularly collaboration meetings where the client and contractor were able to discuss issues and even evaluate each other's performance. The meetings were held outside the construction site and follow-ups from the initial meeting were discussed but even questions regarding the common goals. These meetings were of some participants associated with additional costs which the managers were convinced that they were worth the additional cost, according to them increased the interrelation in the project.

By carry out the collaboration meetings there was a mutual trust created to each other. This was according to two of the managers created by the transparency, which existed in the project. This transparency is created in the beginning of the project and therefore important for all participants to have no hidden activities, which can create mistrust to each other. The basis for creating a trust-based organization is according to the managers due to the start-up meeting in the initial phase of the project.

To be able to manage this collaboration contract there was a need for a person who could take the role as collaboration manager. A project manager is often, as in this project, busy with their regular tasks and therefore was a consultant needed to deal

with this issues. The consultant was independent and mainly focused on the collaboration meetings and joint goals. Because the consultant was independent this made the project as a whole could achieve their joint goals.

Joint goals for client and contractor

The managers reveal that there was a conscious mind-set in developing project specific goals. After having determined this there was follow-up questions about how they would develop these goals. It is difficult to know how to set up goals but it is clear that all participants need to be involved in the process to get a sense of belonging to the project. When everyone agrees upon the goals it will be a lot easier to implement them. This was the case in this project and none of the managers had ever been in a project with joint goals with the client, highly unusual. Establishing joint goals creates an understanding of what the client is really looking for. The managers mention that they are generally bad at doing this but the joint goals helped them to manage both subjective and objective goals.

The joint goals were created together with the client in the beginning of the project. Representatives from the client and the contractor gathered to develop values and what was thought to be important in the project. Furthermore, they created an action plan, which was intended to achieve the goals. This later turned out to be good basis for the further.

The project managements' perception of achieved success

The mini survey, illustrated in Figure 7, was conducted with all three participants of the interviews. Most prominence criteria revealed by the managers were time, safety, employee, quality and ethics. The result from all managers were consistent and partly the same as mention by the managers themselves, besides budget and ethics, as being the criteria to achieve a successful project.

Other criteria that are not being put that much emphasizing on are client, objectives, environment, media and budget. A common thing between these criteria is that the managers had a widely varying outcome among the participants. The most noticeable criteria are media and environment, which is by the managers considered to be the least important criteria. The interviewees reveal that the criteria are unimportant until the day when an accident occurs, and then it is considered extremely important.

One of the interviewed managers state that they did not put any extra effort on the client because they worked exactly the way they were used to do, nothing extra ordinary. This is considered to be one reason why the interviews indicate a good relationship with the client, while the survey claims the opposite.

Regarding the project specific objectives, the project had set up extremely tough goals with some not even achieved. According to the project manager this would not mean anything negative, only encourage people to achieve the set goals. Economy was a goal that the project was far away to achieve, this mainly due to a too high goal. This

seems to be the explanation for a low satisfaction related to economy even though the project itself was profitable.

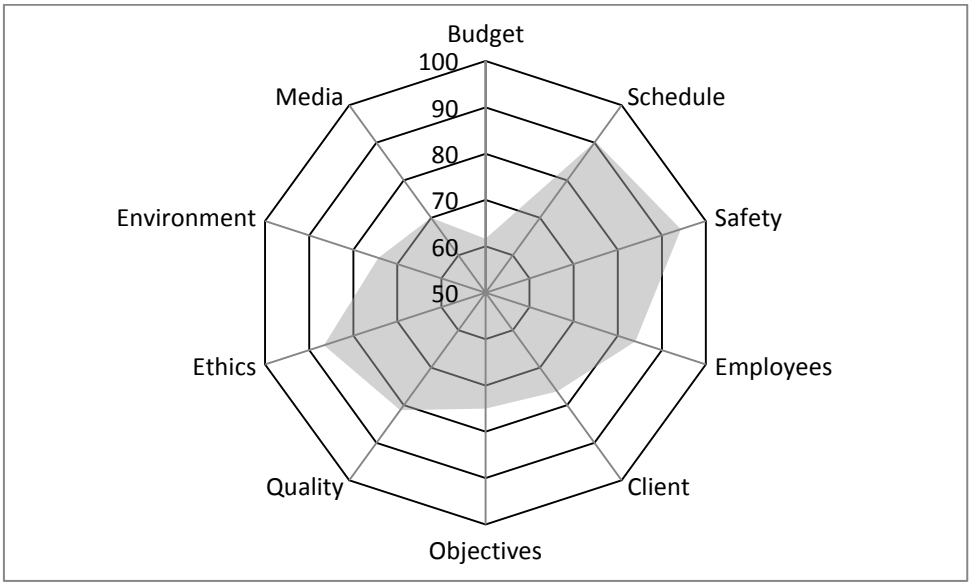

Figure 7: Mean value from the mini-survey in Case 3. The scale is cut from 50.0 in order to make it easier to discern differences in the results.

4.4 Case 4: Complex tunnel project

Case 4 consisted of an 830 meter long road section with two tunnels that connects two European highways. More detailed, the project comprised one rock tunnel that demanded careful blasting and one concrete tunnel with associated road- and earthwork. The project was characterized by deference and caution due to the near situation of a hospital, a traffic junction and a European highway.

Table 5: Additional information about case 4: Complex tunnel project

Client	The Swedish Transport Administration
Contract form	DBB contract with construction responsibility for concrete constructions
Contract sum	SEK 400 millions
Traffic flow	-

All four managers agreed upon that NL11 is a successful project. On the question why they thought the project was successful, without us mentioning the criteria, the managers mentioned the following reasons:

- Budget – They made profit
- Time – They completed the project before estimated time
- Safety – The project was awarded a couple of prizes and there was no absence because of accidents
- Satisfaction – The project was harmonious and pleasant to work in
- Quality – The project had an outstanding quality

Understand the tender

The project manager claimed that the first thing they did in order to achieve success was to make sure that they really understood the tender, which brought reasonable schedule, reasonable risk assessment and a reasonable budget into the project.

> *"It gets really tough if you end up with errors in the tender and realize it later. But here it was tough terms by more than 10% to the runner-up."* (Project manager)

The importance of doing a thorough tender work and having a reasonable budget into the project was further highlighted by the production manager and one of the section managers as a fundamental precondition in order to reach project success.

> *"Sufficient amount of money into the project removes the economic stress. Employees can focus more on production and we get a positive spiral if we have a good economy, in the same way, we will get a downward spiral if it is the reverse case."* (Section manager)

Thorough planning

The interviews revealed that there has been a major recourse focus on the planning of the project design, which made the project design more complete and detailed than what is common in projects like these. The project team knew by experience that it is common that there are shortcomings in the project design and deliberately wanted to avoid this. Coincidentally, the start of production was postponed. The project team took advantage of this and prolonged the design phase, resulting in that they were able to be more completed with the project design before the production start and well-thought out concepts that made the production more efficient. For instance, they were able to develop pre-fabricated concrete and reinforcement components that simplified and speeded up the production.

> *"The concrete tunnel was originally designed for a construction period of 15-18 months, which we did in 9 months. This is because we had an outstanding design and I mean down to every single rebar."* (Design manager)

One thing that frequently was brought up during the interviews was contractor's way of working with the project design and the organization of the design team with more involvement from the production team. The interviewed managers revealed that, usually in projects like this, it is common that the design team takes the role as an unofficial subcontractor and does not send the production team the project design for feedback until the production has already started. At this stage, the production team is fully focused on the production and their response is often lacking. This was prevented by appointing two production managers in the early stage of the project. The concrete section manager was temporary appointed the role as production manager while the ordinary production manager was involved in the design team, focusing on the project design. The ordinary production manager that focused on the project design did later replace the temporary production manager who withdrew to

his ordinary role as concrete section manager. This approach generated some advantages. Firstly, they were able to keep the planning well ahead the production. Secondly, it made it possible to take advantage of the expertise of the production team and increase their impact on the design. Thirdly, it brought personnel closer together, making it easier to make adjustment in the design. Fourthly, the concrete section did not have any specific tasks in the beginning of the production, but due to the early involvement of the concrete section manager as a production manager did the concrete section get insight in the production in an earlier stage. Lastly, the production team got a better understanding of the product they were producing.

> "*A job like this had not been possible to perform if we did not have an organization like this. What I mean by this is that the project design requires production personnel who can provide experience and expertise."* (Design manager)

The design team consisted of 15 people, including six designers from Sweden and nine designers from India. The foreign labor brought engineering competence and resources that could not be found on the Swedish labour market. The Indian designers were able to bring up extra manpower in a really short notice, making it possible to create a more detailed design.

> *"These extra resources meant that we were able to plan the design down to the individual rebar. This had never been possible in Sweden, the shortage of engineers is way too great."* (Design manager)

The Indian designers did also possess great expertise in 3D-design. After making a 3D-design for the concrete tunnel, the Indian team was asked if they could do the same thing with the rock tunnel, which was not a problem. The 3D-designs made it possible to see how everything was connected and the question was further raised whether the 3D-design, together with the detailed design data, could be used in order to control machines. After some inconsistencies but hard work, it turned out that it was possible to control machines with the design data. For instance, 8,000 holes were drilled and several machines were running based on this data.

Innovative solutions and thinking ahead

One thing that permeated the whole project was that there was a high focus on new technology and other innovative production related solutions. For instance, a tunnel membrane was installed as a cloth that was attached with rock bolts. This was a totally new product that never has been used in Sweden before. The new product was on the critical path and was supposed to be mounted in the third year of the project, but due to the importance of getting it right at the first try, thorough preparations began as early as in year one. Study visits were made, suppliers were contacted in an early stage, a 3D-design was developed and all outcomes were thought through in order to get the product right. This new venture resulted in a product that was easy to mount and had an incredible quality.

"The client said that this is an amazing tunnel. It was certainly over quality but it was a cheap way and we had a really happy client and no guarantee remarks." (Project manager)

"It's about turning a risk to success. To frequently take the time and then build in a short time when it's started" (Project manager)

Another challenge which required some thinking ahead was the tunnel blasting under critical points as a European highway and a hospital that are very sensitive for vibrations and disturbances. These points required tremendous caution in order not to disturb the public, which would have resulted in crucial consequences for the project. By preparing themselves through testing different blasting methods, before reaching these critical points, they managed to gather information for developing the most optimal method to get past the critical points. Consequently, they were able to lower the vibrations, stay closer to maximum levels and get past the obstacles much faster than planned, saving them a lot of money.

"Much of the success came from that we were well-informed and was thinking ahead. We were not waiting, instead we were looking ahead at all times. What's the situation now? And then we gathered new information, which you don't do in all projects. If you have designed it once than you stick to that. But the design might be based on a few test drillings. Then you don't know on which level the rock is on, you don't really know how the rock looks like. In this case we had a finished design that was continuously updated."(Project manager)

From experience, craftsmen working close to each other were identified as one of the most time-wasting causes in production. Since the project is a tunnel, the work was carried out on a single front, limiting paths of movement and making it difficult to take shortcuts. Due to these limitations, the project gets very sensitive to disturbances. That is to say, if one activity gets disturbed you get stuck because you cannot start on another. To avoid this sensitive work approach, a new concept was developed. Instead of letting all different functional sections work in the tunnel at the same time, they divided them so that only one section at the time had access to the tunnel. Meaning that the rock section finished their job in the tunnel from the beginning to the end, before next functional category as the concrete section went in and did their job.

"This concept went really well. The rock tunnel was completed in 9.5 months instead of 17 months and we got a really good economy, no conflicts, there was no coordination needed, they just went into the tunnel and did their thing. In the normal case the rock craftsmen would have to talk to the concrete craftsmen and tell them to leave the tunnel before they start with the blasting "we can't get through because we have cut the road" and so it goes. We got nothing of that, only flow, flow, flow." (Project manager)

The interview with the production manager further revealed that this concept also contributed to a safer work place and more motivated and satisfied employees. By minimizing the amount of people working on the same spot, the risk of accidents gets

reduced as well. The motivation and satisfaction increases among employees when they can see that there are no obstacles in front of them and when there is a flow in their work.

The establishment of a trust based relationship with the client

The trust of the client seems to have been particularly important in this project in order to enforce those kinds of solutions necessary for conducting a successful project. With the trust of the client it gets easier to implement ideas that would benefit the production and perhaps even the project in itself.

All managers seem to agree upon that they have had a well function relationship with the client, especially the project manager from Skanska and the project manager from the client seem to have had a close relationship in the project. This was a conscious tactic from both parties.

> *"Another thing was that the client's project manager and I worked from day one on that we would get to know each other and be able to handle any question. I think this was a successful concept."* (Project manager)

The contractor's project managers and the client's project manager met outside the project every second week just the two of them. At these informal meetings they were able to meet without any certain agenda, socialize and reason about each other's situations, both professional and personal. This resulted in a close dialogue between them that strengthened their cooperation and encouraged other employees to socialize across corporate boundaries.

> *"If we felt that there was a little tension arising between us and the client, then we were able to talk about what we should do about it. We had some sort of authority in the project that made it possible to avoid conflicts before they occurred in some situations. You can nurture the relation with the client by having a close dialogue. It was unique and is seldom that one has."* (Project manager)

> *"The top managers strike the tone for the project. So if we hang out, it strikes the tone that the others should hang out as well."* (Project manager)

This dialog between the contractor's project manager and the client's project manager was further noticed and appreciated by employees within the project.

> *"There was one thing that our project manager had. He continuously met with the client's project manager one-on-one and talked through things that could appear to be problems or things that were helpful and solved many concerns. I think that was pretty good. It is not usual to meet this way."* (Section manager)

> *"If the project screws up at the top level then it will be no good down either. It strikes through everything."* (Section manager)

Another success factor identified in the interviews was the client's trust in the contractor. With the trust of the client it becomes easier to implement ideas and technical solutions that would benefit the production and even the project as a whole.

The project managements' perception of achieved success

The participants were especially satisfied with the project's results in budget, time, safety, employees, client, quality and ethics, see Figure 8. All of these but client and ethics were mentioned in the beginning of the interview as reasons of why this is a successful project. Ethics was by two of the three managers ranked with the highest score. The third manager ranked ethics with 6.8. This participant thought that ethics was not something that they have had any problems with but motivated the relatively row rank with that ethics have not been anything that they have worked actively with.

Objectives, environment and media were ranked relatively low. The interviews revealed that there was no higher focus on these three criteria. The managers did not have any specific milestones. Instead their goals consisted, according to one of the managers, of working with new technical solutions and doing things right at the first try. The environment was ranked relatively low by one of the managers. This manager motivated this with that the environment criterion was not very prioritized. The other two managers had a similar view and explained that environment is not something that they have put any extra effort in to achieve, but nonetheless ranked this criterion much higher. As with objectives and environment, was media nothing that demanded any extraordinary work. This responsibility lay mainly with the client and Skanska's part of it was to not disturb external stakeholders and their activities.

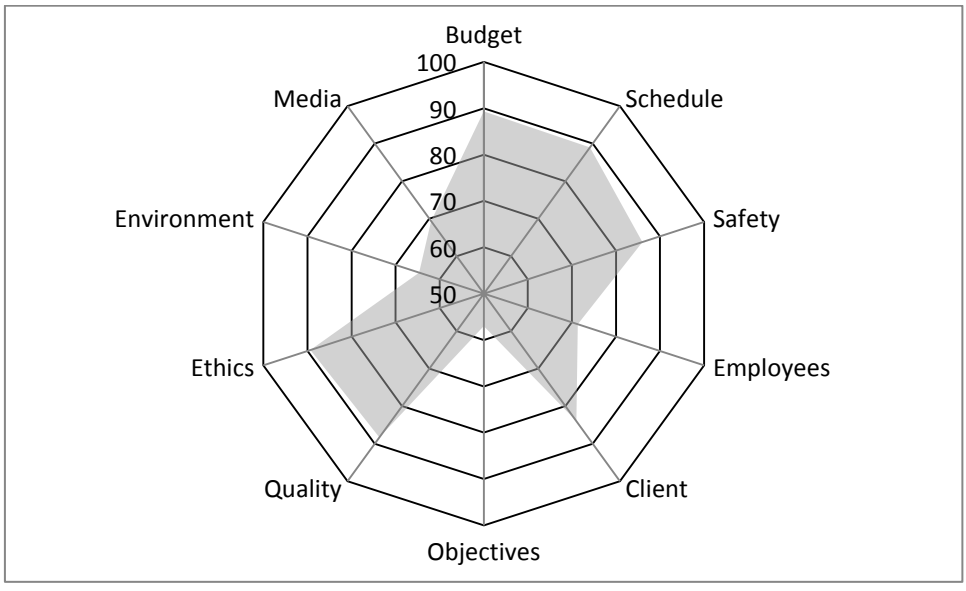

Figure 8: Mean value from the mini-survey in Case 4. The scale is cut from 50.0 in order to make it easier to discern differences in the results.

5 Discussion

In order to get a better picture of the success factors indicated in the four cases, a model similar to the framework introduced by Chan et al. (2004) have been developed. The framework has been modified due to the differences in the scope of study. This study is limited to project success of the contractor's project management perspective while the framework created by Chan et al. (2004) treats project success in a much broader sense, including all project participants and factors outside the influence of Skanska's project management. The reason to why this model was selected is because there are no applicable models in the theory that are based on entirely a contractor's perspective. The theories normally refer back to the project as its whole or alternatively project success from a client's perspective.

5.1 What factors from a contractor's view of project success, are contributing to a successful project?

The purpose of this study is to identify factors that are giving rise to project success. In order to accomplish this, we have been doing case studies on four completed infrastructure projects. The studied success factors are suitable within respectively project but they are not necessary general factors that are suitable into the entire industry due to the fact that each project has its own unique conditions. Furthermore, it is not possible to ensure project success by fulfilling the success factors but they will provide a higher tendency to do so if more success factors are being met.

All success factors that were revealed during the interviews are illustrated in Table 6, modified after Chan et al. (2004). Some success factors are mentioned in its original design meanwhile some additional factors has been added, based on the findings from the interviews. All success factors were further graded into three categories based on how often they were mentioned in each specific case; black circle indicates that the success factor were mentioned by the majority of the managers, half circle indicates that the success factor were mentioned by a few of the managers and a white circle indicate that the success factor were mentioned by none of the managers.

It is important to keep in mind that all factors are success factors even though some were mentioned more than others. Some factors are for instance not mentioned in all four cases but that does not necessarily mean that they are less important than the factors mentioned in all of the cases. They are only considered as more project-specific factors. The success factors mentioned in all four cases are considered as more general success factors that are suitable in different types of projects. However, it is important to keep in mind that the interview questions were not based upon any success factors. The interviews were instead conducted with questions that were of an open character in order to not restrict our study to some specific success factors.

The study concludes that the success factors are something the project management has to consider in order to have a greater chance of being successful. A clear project-specific factor mentioned during the interviews was the tendering process. This factor

was particular important in Case 1 and 4, but not especially important in the other cases. One reasons for this is thought to be the type of procurement contract, if it is a Design-Bid-Build contract, a Design-Build contract or even a combination of them both. Case 1 was a pure Design-Build contract and Case 4 was a combination of both contract forms. This indicates that when a contractor has a design responsibility, there is a commitment to make a thorough tender in order to carry out the project with the right conditions. This is one reason why it is difficult to exclude any particular factor because they are all, to some extent, a success factor.

The study determined factors and most of them were more of a subjective nature, which are difficult to measure whether they are fulfilled or not. The managers in the projects were aware of this and emphasized the importance of having a discussion about them, despite the difficulties in establishing objectives. One of the success factors that were mentioned in all four cases was to establish a trust-based relationship with the client. To the importance of fulfilling this was especially evident in Case 4 where the two project leaders decided quite early to get to know each other better than they were used to do. This was carried out with informal meetings outside the construction site ones every two week. The two project leaders discussed issues from the project but also issues of a more personal character, all in order to get to know each other. If they knew each other the belief was that they should be able to handle any question at all, which was done in this specific case.

All project leaders agreed upon the important of having a trust-based relationship with the client which was not possible in the start-up phase of Case 2. According to the project managers there is important that the client's project managers is experienced and committed to the extent that they should be able to be the contractor's project manager. This was considered as a serious shortage in Case 2 where the client's project manager was replaced due to Skanska's loss of confidence for him. This indicates an awareness of the benefits to adjust the factors when it is possible. Factors that preliminary are the contractors concern are easier to adjust compared to the factors that are highly dependent on the client. However, both parties understood the importance of this and therefore were the client's project manager replaced.

Another general success factor that was revealed during the interviews was that everyone should have responsibility areas. Responsibility areas should be clearly defined by assigning people responsibility descriptions but also giving them the mandate to take decisions on their own. This in combination with a well-functioned communication allows each participant to know what to do and why their colleagues sometimes are prioritized in front of them.

There were also some project-specific factors that were mentioned as particular important and one was to have a constant focus on technical solutions in the early stage in order to produce an appropriate product and avoid potential delays. It was stated by the managers that this was time consuming but worth the doing. Technical advantageous solutions enabled the projects to save time, become safer during production and improve the quality.

Two other projects highlight the need of extra resources in the early stage of the project, although it is associated with an additional cost. Adequate resources make it possible to do things right from the beginning and avoid choosing doubtful solutions. Resources in the beginning of the project reduce the risk of falling behind and everyone have time to do what they are supposed to do. This allows the project to start well and have a tendency to get into a positive spiral where success breeds success.

By having a consciously mindset of these success factors would create calmness in the project which hopefully give rise to successful projects.

Table 6: Project success factors that were brought up during the interviews. Black circle – success factor mentioned by the majority of the managers, half circle – success factor mentioned by a few managers, white circle – success factors not mentioned by the managers.

Success factors	*Case 1*	*Case 2*	*Case 3*	*Case 4*
Factors mentioned by Chan et al (2004)				
Implementing an effective quality assurance program	◒	●	●	●
Develop an appropriate organization structure	●	●	◒	●
Client's contribution to construction	●	◒	●	●
Control mechanism	◒	●	●	◒
Feedback capabilities	◒	◒	●	●
Project team leaders experience	●	◒	○	◒
Implementing an effective safety program	●	◒	◒	◒
Project team leaders' early and continued involvement in the project	●	○	◒	●
Additional factors mentioned by the managers				
Establish a trust-based relationship with the client	●	●	●	●
Clear defined roles within the organization to make sure everyone knows what to do	●	●	●	●
Develop a detailed schedule that is reliable and suitable for the production phase	●	●	●	●
Project leaders ability to put together a well functioned team	●	●	●	●
Establish clear and consequent communication paths and routines with the client	●	●	◒	●
Sufficient with resources in the beginning of the production phase	●	●	○	◒
Focusing on technically advantageous solutions	●	◒	○	●
In depth understanding of the tender document	●	○	○	●
High effort on the planning in order to have a schedule that takes the relation of the design and production into account	●	○	○	◒
Client's knowledge of production	○	●	○	○
Project managers sets a good example of how to act towards each other, internally and externally	◒	●	○	●
Utilize the knowledge in the project	◒	◒	●	●
Get the employed involved in order to make them feel a belonging to the project	◒	◒	●	●
Make the everyday tasks more efficient	◒	◒	●	◒
Sufficient with resources in the design phase	◒	○	○	●
Involve production oriented people in the design phase	●	○	○	●
Innovative solutions and thinking ahead	◒	◒	○	●

5.2 How are a contractor's criteria for project success perceived by the managers in successful projects?

The results from all four cases are displayed graphically in Figure 9. Within the projects the managers agreed on many criteria. While at other criteria, it was common that one participant's perception differed significantly from the others. This had a major impact on the mean value of some criteria since there were only 3-4 mini-survey participants in each case.

It can be seen, when comparing the four cases, that there are many differences in perceived success between the four cases. Those criteria that stand out the most have been circled with solid lines in Figure 9. In Case 2, safety and quality got a relatively low score compared to the other three cases. During the interviews it was made clear that there actually was one accident that were considered as quite nasty by many of the managers and this would explain this lower score. Regarding the quality in Case 2, there was especially one of the managers that ranked this criterion lower than his colleagues. He argued that the preconditions made that they could not build the road from start to finish in one stage. Instead they had to divide the road into many stages and build the road in a different order, which had a negative effect on the quality.

In Case 3, the budget got a much lower score than the other three cases, even though they made a profit. This we think was due to that the management had put up really high goals regarding the budget internally in the project which they could not achieve. In other words, the management did not feel that they had lived up to their own expectations of the budget.

In case 4 the objectives got a really low score. The interviews revealed that several of the managers experienced that they did not work with objectives in this case. Instead they had one major objective which was to work with new technical solutions and doing things right at the first try. The minor focus on objectives might be the explanation to this low score.

Even though there were many differences in the results between the four cases, some similar patterns were also identified. Through listening to the managers reasoning while performing the mini-survey it was made clear that, besides the manager's expectations and interpretation of the criteria, did the effort made to achieve the criteria have an effect on the managers' perception of achieved success. This meant that criteria that did not require any extra efforts or was achieved through common routines tended to be assessed as less successful, even though the criterion was considered as fully achieved by top management. Such criteria were environment and media, circled with dotted lines in Figure 9. Several managers did during the interviews indicate that the environment and media criteria are primarily the client's concern. They argued that they did nothing extraordinary for achieving the environment criteria but following the requirements of the client. Similarly, argued most of the managers that they usually do not put in any extra effort in the media criterion. They did more act as a support to the client during meetings with media and

other external stakeholders. But even though environment and media got a generally low score, were most of the managers careful to point out that they are still important criteria for project success. They further argued that if they would have failed completely in one of these criteria, than that would have jeopardized the success of the whole project.

In a similar vein it can be argued that criteria that required much attention and effort to achieve were judged as more successful. This does to some extent explain why some criteria are generally assessed as more successful in the four cases. Contractors do, according to the literature reviewed, put more emphasis on the safety and reducing time and cost than other project participants. This is somewhat reflected in the success assessment of the criteria budget, time and safety which were all perceived as very successful in most cases. These criteria have been circled with dashed lines in Figure 9. The fulfilment of budget, time and safety were mentioned by all of the managers interviewed as reasons why their projects were considered as successful and they were on the daily agenda in all of the cases. This indicates that a lot of effort has been put into achieving these criteria.

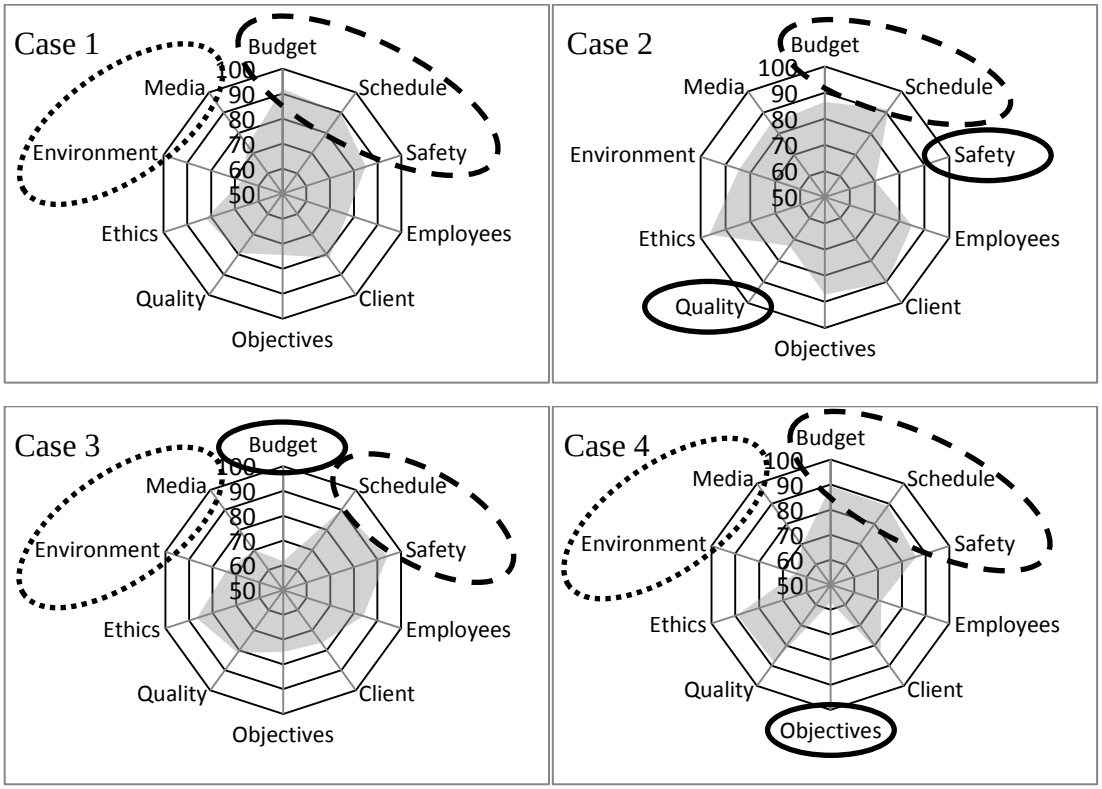

Figure 9: A comparison study between the four different cases. Criteria that are circled with solid lines are considered to stand out the most. Criteria that are circled with dots are generally considered as less successful. Criteria that are circled with dashed lines are generally considered as more successful.

6 Conclusion

The interviews conclude that success factors in infrastructure projects consist of a large number of factors which are important to consider in order to achieve a successful project. However, it is difficult to highlight only a few success factors that are applicable in the entire industry because each project has their own circumstances.

It is also important to keep in mind that all factors, in some extent, are success factors even though some mentioned more than others. Certain factors were especially prominent in one case which means that the factors are more of a project specific character. On the other hand, the study reveals success factors that are mention in all four cases which means that the factors are more of a general character. Some of the more prominent but also general success factors that were mentioned during the interviewees were;

- Establish a trust-based relationship with the client and ensure to solve issues as a joint team.
- Clear defined roles within the organization to make sure everyone know what to do.
- Sufficient with resources in the beginning of the project in order to make the right decisions.
- Focusing on technically advantageous solutions in order to build faster, safer and with improved quality.
- In depth understanding of the tender document.

It is important to keep in mind that there is not possible to ensure project success by fulfilling the success factors but it will provide a higher tendency to do so if more success factors are being met.

Expectations, interpretations of the criteria and effort made to achieve the criteria have a major impact on project participants' view of achieved success. The effort made to achieve the success criteria meaning for project success is something that have not been discussed within previous literature. The criteria that require much effort tends to be perceived as more successful when they are achieved and the criteria that requires less effort are perceived as less successful when they are achieved. This implies that different project participants will have different perceptions of achieved success dependent on what criteria they have focused most on. It does also further imply that there could be a gap between project managers' and external top managers' view of achieved project success since top managers do not work with the project criteria in the same extent as the project managers.

Further research could examine the importance of the factors and when they might occur. Knowledge about when each factor is most appropriate could offer the opportunity to emphasis on the right thing at the right time. This combined with examining how to implement the success factors is needed in order to increase the

chance to carry out a successful project. Future research could also go deeper into the relation between project success and the effort made to achieve it. This relation could have a significant importance when setting the objectives for each success criteria. If the objectives are set low and are too easy to achieve, the project might be considered as successful from an external viewpoint but less successful by the internal project participants. The project participants' perception of achieved success could be used in the project evaluation as an indicator of whether objectives were set on an appropriate level.

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