

Norges miljø- og
biovitenskapelige
universitet

Master thesis 2018 30 stp

Business school
Bernt Aarset

Development of Key Performance Indicators for measuring performance at Bispevika construction site

Eirik Fonnum

Innovation and entrepreneurship
Business school

Table of content

List of figures	4
List of tables	5
Preface.....	6
Summary	7
Norwegian summary	9
Introduction.....	11
Theoretical approach	15
KPOs and the link to KPIs.....	15
Criteria of project success	15
Benchmarking.....	16
Changing measures of project performance over the last decades	16
KPI guidelines	21
Challenges using KPIs in construction industry	25
The case.....	29
OSU new thinking	30
AF use Virtual Design and Construction	31
AF Gruppen.....	31
Designing	32
Method.....	35
Information collection.....	35
Semi structured interview	35
Design of interview guide.....	36
Execution of the interviews.....	36
Organizational documents	37
Naturally occurring talk	38
Observations	39
Method triangulation	40
Informants	41
Reliability	42
Validity.....	44
External validity (transferability).....	44
Ethical judgements	45
Results	46
How project objectives, KPOs and KPIs are linked together and used at the Bispevika project	46
Findings from interviews	52

Project objectives	52
Findings about KPOs	54
Findings KPIs	56
Discussion	62
In which way will the four main project objectives help to achieve project success?.....	62
How can the defined KPOs help improving the design process to meet the project objectives, and can improvements be suggested?.....	63
How can the proposed KPIs help to measure the KPOs and can improvements be suggested?.....	65
Conclusion	70
References	72

List of figures

Figure 1: The four dimensions of project success 18

Figure 2: Micro and macro viewpoints of project success 19

Figure 3: Consolidated framework for measuring project success 21

Figure 4: KPIs for project success 23

Figure 5: The two cycles of performance measurement system 26

Figure 6: Alignment of KPIs.....27

Figure 7: The EFQM Model.....28

Figure 8: Dronninglunden.....29

Figure 9: Vannkunsten.....30

Figure 10: Project objectives linked with KPOs/KPIs.....46

Figure 11: Project objectives linked with KPOs and KPIs.....48

List of tables

Table 1: Success dimension and measures 20

Table 2: Summary of available previous studies on performance indicators at project level 24

Table 3: KPOs and KPIs from the measurement system 49

Table 4: KPIs and how AF Gruppen is measuring them..... 52

Table 5: Adjusted KPOs and KPIs within function designing 69

Preface

This thesis is written in collaboration with the business school at Norwegian University of Life Science (NMBU) and the contractor and industrial group AF Gruppen department Byggfornyelse.

I have a background as a civil engineer from Western Norway University of Applied Sciences (HVL). In addition, I worked eight weeks at a building site at a residential and commercial buildings project. This helped me understand a lot of the processes and what was happening at the building site and made the work much easier. Now I am studying innovation and entrepreneurship. The combination of construction and business school is a good background for solving the challenge of establishing a set of Key Performance Indicators (KPIs) for a construction site.

I am grateful for working with AF Gruppen and I would like to give a special thanks to my advisers Sebastiano Lombardo from AF Gruppen, Anders Lillelien adviser from AF Gruppen and my adviser from Norwegian University of Life Science (NMBU) business school Bernt Aarset.

Summary

One technique many companies successfully use to improve their business is to measure performance in their organization. Performance measurement and benchmarking is a commonly used method of defining KPIs to measure the most critical factors for overall success for the company. KPIs are gatherings of data measures used to assess the performance of a construction operation. KPIs play a key role in providing information about the execution of construction work, projects and businesses.

The Bispevika project is considered a large priority construction project with a contract budget of 1109 MNOK. The area for the 355 apartments is 48000 sqm with an addition area of 8,000 sqm allocated to industry buildings. AF Gruppen focus on innovation in all the stages of the project. It's innovation in design, procurement, execution and sales. The advantages are smarter solutions and reduced construction cost.

At Bispevika there are four specific project objectives. They are:

1. Bispevika will be the most attractive district in Oslo
2. Bispevika will create 40% more value than traditional construction projects
3. Bispevika will have the most satisfied residential customers
4. Bispevika will change the interaction pattern in the construction industry

The project objectives are closely linked to the project KPOs and KPIs and the leadership need to secure that these objectives are accepted and understood throughout the organization.

At Bispevika, a comprehensive measurement system has been created to help the organization achieve the main project objectives. This study will investigate the KPOs and KPIs that were defined within the important function designing to evaluate if the measurement system could be improved. The study also focused on the link to the four main objectives used at Bispevika to see if the KPOs and KPIs help to achieve these objectives.

Chan & Chan (2004) presents some frameworks for measuring project success of construction projects. Some common factors in the models are: cost, quality, time,

health & safety, participants satisfaction, user expectations, environmental performance, commercial profitable/value.

Collin (2002) claims that a successful KPI is characterized by focusing on critical aspects, must be used systematically, easy to gather data from, understood and owned by the organization and simple in design.

More advanced models emphasize the importance of linking the KPOs and KPIs to business objectives and use the measurements as data-based decisions to identify bottlenecks and implement a change in how the work is organized.

In the study qualitative methods have been used. Interviews and conversations indicate that the defined KPIs in a good way measure the critical aspects of designing and that there was a good connection between project objectives and KPOs and KPIs. The study further suggests some improvements of the KPIs and discuss if the KPIs could be used more efficient to implement changes in how the work is organized.

Norwegian summary

En teknikk som mange bedrifter har brukt til å forbedre virksomheten, er å måle ytelsen i organisasjonen. Prestasjonsmåling og referansemåling er vanlige metoder for å definere KPIer for å måle de mest kritiske faktorene for suksess for selskapet. KPIer er kompileringer av data som brukes til å vurdere ytelsen til en byggeoperasjon. KPIer spiller en nøkkelrolle for å gi informasjon om gjennomføring av byggearbeid, prosjekter og virksomheter.

Bispevikaprojektet regnes som et stort prioriteringsbyggingsprosjekt med et kontraktsbudsjett på 1109 millioner kroner. Området for 355 leiligheter er 48000 kvm med et tilleggsareal på 8.000 kvm tildelt til næringsbygg. I AF Gruppen er det fokus på innovasjon i alle stadier av prosjektet. Det er innovasjon innen design, innkjøp, gjennomføring og salg. Fordelene er smartere løsninger og reduserte byggekostnader.

På Bispevika er det fire spesifikke prosjektmål. De er:

1. Bispevika vil være det mest attraktive distriktet i Oslo
2. Bispevika vil skape 40% mer verdi enn tradisjonelle byggeprosjekter
3. Bispevika vil ha de mest fornøyde boligkundene
4. Bispevika vil endre samhandlingsmønsteret i byggebransjen

Prosjektmålene er tilknyttet prosjektets KPOer og KPIer, og ledelsen må sikre at disse målene blir akseptert og forstått i hele organisasjonen.

På Bispevika er et omfattende målesystem opprettet for å hjelpe organisasjonen å nå de viktigste prosjektmålene. Denne studien vil undersøke KPOer og KPIer som ble definert i det viktige fagområdet «prosjektering» for å vurdere om fagområdet kunne forbedres. Studien fokuserte også på koblingen til de fire hovedmålene som ble brukt på Bispevika for å se om KPOer og KPIer bidrar til å nå disse målene.

Chan & Chan (2004) presenterer noen rammer for måling av prosjektsuksess av byggeprosjekter. Noen vanlige faktorer i modellene er: kostnad, kvalitet, tid, helse og sikkerhet, kundetilfredshet, brukerens forventninger, miljøprestasjon, fortjeneste.

Collin (2002) hevder at en vellykket KPI fokuserer på kritiske aspekter, må brukes systematisk, er lett å samle data fra, blir forstått og eid av organisasjonen og enkel i design.

Mer avanserte modeller legger vekt på viktigheten av å knytte KPOer og KPIer til forretningsmål og å bruke målingene som databaserte beslutninger for å identifisere flaskehalsen og gjennomføre en endring i hvordan arbeidet er organisert.

I studien har kvalitative metoder blitt brukt. Intervjuer og samtaler indikerer at de definerte KPIene på en god måte måler de kritiske aspektene ved utformingen, og at det var en god sammenheng mellom prosjektmålene, KPOene og KPIene. Studien foreslår videre noen forbedringer av KPIer og diskuterer om KPIene kan brukes mer effektivt til å gjennomføre endringer i hvordan arbeidet er organisert.

Introduction

Bispevika is a 48000 sqm project with a contract sum of 1109 MNOK (AF Gruppen, 2018). This is considered a very large project. The project also has a huge commitment to find innovative solutions, save costs and increase efficiency and quality. To achieve their objectives, AF Gruppen and their collaborators use management tools and objectives to manage the project in a systematic way. Especially the managers have a very high workload and a lot of responsibility, and they need benchmarks and management tools to be able to decide on both short and long-time plans. One of these management tools is KPIs. KPIs help managers and employees measure the effectiveness of various functions and processes that are important to achieving organizational objectives. In many companies KPIs are linked to a firm's strategic objectives and are used to help managers assess whether they are on target as they work towards those objectives (Reh, 2017. p. 1).

The goal of the thesis is to propose a recommendation of different Key Performance Outcomes (KPOs) and KPIs that can be used in Bispevika, to manage the innovation work there. Based on the needs at the project we will find measures that will be prioritized. It is not easy to find good KPIs. They need to be simple to collect and measure, but complex enough to measure the effect so they can be used to improve the work processes. It is hard to know if the right KPIs have been chosen since there often is many measurements to choose from. In this work the KPIs will be chosen by using company documents, observing and interviewing key employees at AF Gruppen within the function "planning and designing". Here designing is used to describe the tasks in the planning of the work. This would include Architects drawing the building and making 3D-models, engineers performing strength calculations, groundwork and electrical design. In addition, comes time planning and cost calculation.

The purpose of the assignment is to investigate the relationship between project objectives, KPOs and KPIs in the field of designing. The project objectives are defined to help the company achieve success at the Bispevika construction project. For the company to succeed in following up its four project objectives, the objectives are split up in KPOs for the information to be more manageable and consistent with how the company works. Project objectives should also be easier to deal with in

everyday life. Furthermore, to achieve the KPOs AF Gruppen have proposed KPIs that will be used to measure the project objectives and the KPOs. Working with KPIs is new to AF Gruppen and they have only been measuring the KPIs for a couple of months. It will be investigated to what extent the KPIs are good indicators to achieve KPOs, which are linked to the project objectives. For example, the results may show that the KPIs does not help to achieve the project objectives in the company and other KPIs may be suggested.

Since many KPIs and a similar large number of measurements had been proposed by AF Gruppen, a narrowing and reduction of measurements was necessary, which also became one objective of this thesis. AF Gruppen requested focusing on design during the work on the thesis.

By choosing the right KPIs, AF Gruppen hope to better measure and understand bottlenecks and non-efficient work processes and thereby identify improvements in quality, cost, efficiency, safety and other key data.

Based on this I have chosen the following approach to the problem.

Which Key Performance Indicators and Key Performance Outcomes within the function “design” should be used at Bispesvika to achieve the main project objectives?

To help answer the issue approach, these research questions are chosen:

In which way will the four main project objectives help to achieve project success?

How can the defined KPOs help improving the design process to meet the project goals, and can improvements be suggested?

How can the proposed KPIs help to measure the KPOs and can improvements be suggested?

Traditionally, companies that succeed in having all the functions work efficiently together often achieve long-term success. One technique many companies successfully have used to improve their business is to measure performance in their organization. The measures can typically be financial numbers, production efficiency or customer satisfaction. These measurements can then be used to understand

bottlenecks or unnecessary cost and are then used as a basis for improving the business.

Over the last 70 years there has been a development both in what people measure and in the degree of detail of the measurement. Traditionally, entrepreneurs in the construction industry succeeded in doing business simply by measuring economic norms. A management that concentrates on this measure (profit maximization) may ignore investing time and money in the improvement of key success factors. To match the market, contractors must continually improve the construction project management, the project quality and their own operation. Performance management aims to offer managers and employees the ability to develop direction, traction and speed in the organization (Luu, Kim & huynh, 2008, p 758).

According to Luu, Kim & Huynh (2008) “performance measurement is the heart of ceaseless improvement. Benchmarking is the next step to improve contractors’ efficiency of products and processes”. Benchmarking can be used by an organization to measure and compare performance with other industries or competitors. The purpose is to identify strengths and weaknesses in performance. Then, use lessons learned from the best ones to determine the best practices that can lead to improving your own company (Elshakour, Al-sulaihi & Al-Gahtani, 2013, p 125).

To measure the company's performance and to use benchmarking approach, it is necessary to create appropriate KPIs that are most critical to determining the overall success of the company. KPIs is collections of data measures used to assess the performance of a construction operation. KPIs play an important role in providing information on the completion of construction work, projects and businesses.

A building project is a result of a combination of many events and interactions with changing participants and processes in a constantly changing environment. The high complexity is a challenge for the effectiveness of project teams, and especially the project managers. To help managing projects the concept of project success is developed to set criteria and standards of how project managers can complete projects with the best outcomes. Still many managers carry out their work by improvised allocation of resources across various project areas (Chan & Chan, 2004, p 203).

Project success is difficult and project success means different things to different people. As a help, both for project management and to measure construction success, a set of KPIs can be defined. This set can then be used to measure overall construction performance. To demonstrate the usefulness of KPIs. Case studies could be a good way to evaluate the KPI set (Chan & Chan, 2004, p 203).

In this thesis, my goal is to evaluate different KPOs and KPIs for the Bispevika project within the function designing. In the theory part of this thesis I will discuss how KPIs have been used in the last decades, how a good KPI should be defined and different ways to categorize KPIs using different models. After that, I will give a summary of the interviews with employees that are responsible for the design and planning at Bispevika. This interview summary together with the research questions are both important input in the results and discussion chapter for evaluating the KPOs and KPIs. Finally, I will conclude with which KPOs and KPIs that should be used at Bispevika to achieve the project objectives.

Theoretical approach

To be able to find the right KPOs and KPIs within design, it is important to understand what a good KPI is and how it should be used. The theory part will help to understand how to link KPOs and KPIs to the project goals and define and understand how to measure sub-goals (KPOs). A focus in the theory chapter is to get an overview of the field and learn from earlier work. If you know what to look for in a KPI it is much easier to find the right measurements at Bispevika.

KPOs and the link to KPIs

KPOs are results of completed actions or processes and can be interpreted as sub-goals or small steps that need to be achieved to reach the main objectives. The KPOs could be a result of multiple factors (KPIs) that should be measured and may be improved during the project time. The measured KPIs can be used to make decisions on how to change and optimize work processes. In the literature, there are many KPIs that are outcomes and not indicators (Beatham, Anumba & Thorpe, 2004, p 107). Scientific articles often focus more on KPIs than KPOs. The focus in this theory section will mainly be on KPIs.

Criteria of project success

To be able to understand how to choose good KPIs, it's important to understand criteria of project success at a construction site. Traditionally project success has been measured using the three criteria: time, cost and quality. These criteria are still very important, and it is difficult to believe that a successful set of KPIs can be established without these three. Munns and Bjeirmi (1996) consider a project as the achievement of a specified objective, which involves a variety of activities and tasks that use resources.

Each industry, project group or individual has its own definition of success. Pariff and Sanvido (1993) consider success as an intangible perceptive feeling, which varies with different expectations from management, among individuals and phases of the project. Owners, designers, consultants, contractors, and sub-contractors all have their own project objectives and criteria for measuring success. For example, architects often consider aesthetics rather than construction cost as the most important criteria for success. However, clients may appreciate other dimensions more. The same person's understanding on success can change from project to

project. Project success definitions depend on project type, size and complexity, project participants and experience with owners, etc.

Benchmarking

Performance benchmarking is the comparison of performance data between organizations to improve the organization's own performance. The comparison of methods and practices for carrying out business processes is based on process benchmarking. In this work, people learn from the best to improve their own processes by strategic choices and dispositions from other organizations. By gathering this information, they would be able to improve their own strategic planning and efficiency. Benchmarking approach has also proven to be useful in measuring project management performance based on KPIs or success criteria. Modern benchmarking framework have been claimed to improve construction productivity and identify critical success factors for building projects in construction. A set of KPIs can be used to create a framework for measuring and benchmarking the success of selected construction projects. (Luu et al, 2008, p 760). Benchmarking is the key to adding value to performance measurement. The results are compared to benchmarked data and decisions are made based on this comparison. (Beatham, et al, 2004, p 98)

A challenge in the construction industry is the huge variation in projects. As an example, direct comparison of building homes and a hospital will in most cases not make any sense. Direct benchmark therefore requires comparing projects of similar complexity and size. On the other hand, a KPI describing the relationship with suppliers may be comparable between a much larger group of projects. There are specific challenges for the use of benchmarking and I will discuss this later.

Changing measures of project performance over the last decades

The definition and understanding of what is considered project success have changed over the last 50 years. In this chapter, some different ways of defining and measuring project success is described and discussed.

Previously, construction companies used mainly economic measures to measure and evaluate their results. The questioning of using only financial performance began in the 1950s and has built momentum since the late 1970s. The main problem lies in that financial indicators are lagging indicators. In this context “Lagging” means that

they are often results of decisions that are taken too long ago to correct. Managers need current, updated and additional non-financial information to take better decisions. After a long reliance on financial measures, many studies have been conducted to develop performance measurement frameworks that add non-financial indicators (Elshakour et al, 2013, p 126).

In the early 1990s project success was tied to performance measures, which were tied to project objectives. Success was measured by the project duration, cost and project performance, at the project level. The basic criteria to project success were time, cost and quality and they are called the “iron triangle”.

- Pinto and Pinto (1991) claimed that measures on project performance also should include soft measures such as participant satisfaction level.
- Pocock, Hyun, Liu & Kim, (1996) further propose to include “safety” as a success indicator, as it is reasonable to expect that in case of accidents, both contractors and clients may be subject to legal requirements, as well as financial loss and contract delay in the construction project.
- Kometa, Olomolaiye & Harris (1995) wanted to use a comprehensive approach to assessing project success. Their criteria include: safety, financial cost (construction cost), running/maintenance cost, time and flexibility to users.
- Songer & Molenaar (1997) considered a project as successful if it is completed on budget, according to plan, according to the user's expectations, meets specifications, achieves quality work and minimizes construction defects.
- Thorpe & Kumaraswamy, (1996) included several criteria in their study of project evaluation. These include meeting budget, schedule, quality of crafts, client and project manager satisfaction, technology transfer, friendliness of environment, health and safety.

Shenhar, Levy & Dvir (1997) suggested that project success should be divided into four dimensions. As we can see in figure 1, these four dimensions are time-dependent. The first dimension is the period throughout project execution and afterwards project completion. The second dimension can be considered shortly thereafter, when the project has been delivered to the customer. The third dimension can be considered after a significant level of sales has been achieved (1-2 years). 3-5 years after completion of the project, the fourth dimension can be used.

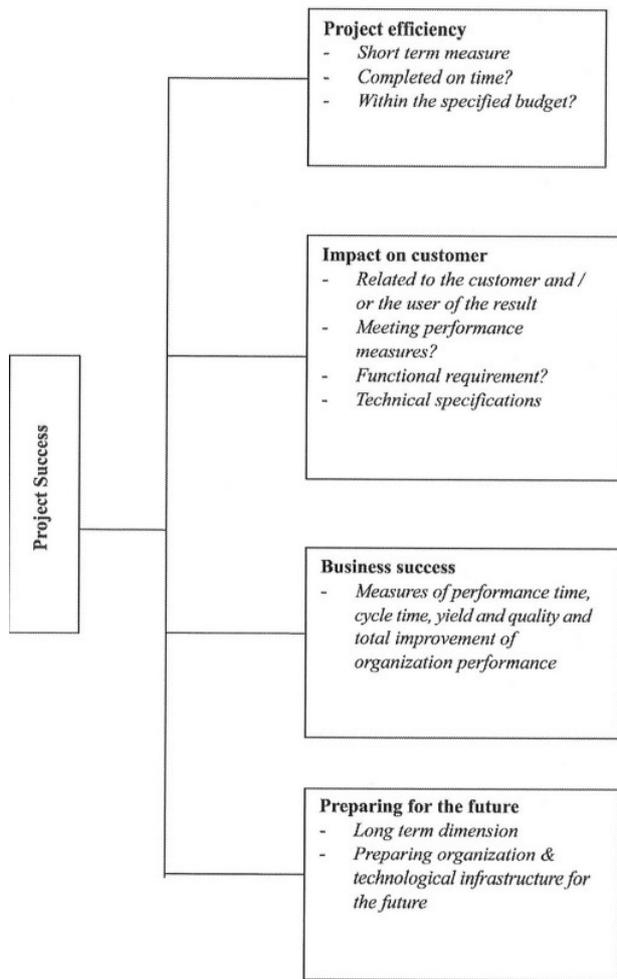


Figure 1: The four dimensions of project success

Source: (Shenhar et al, 1997)

Lim and Mohamed (1999) claimed that project success should be seen from different perspectives of the individual owner, developer, contractor, user, the public and so on. As we can see from figure 2 the authors suggested evaluating project success from both macro and micro viewpoints. The micro viewpoint can be understood as being related only to the construction company and the macro viewpoint the company together with customer, suppliers and owners.

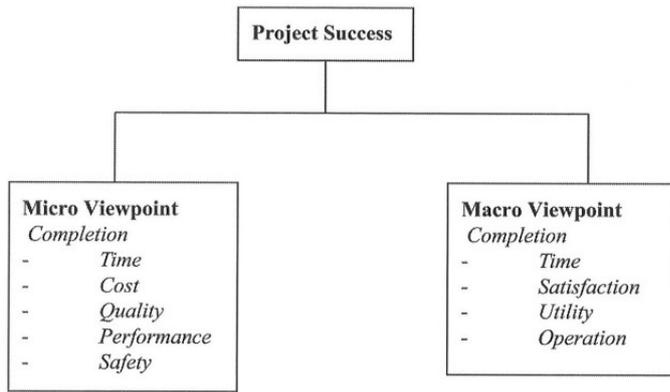


Figure 2: Micro and macro viewpoints of project success

Source: (Lim & Mohamed, 1999)

Sadeh, Dvir & Shenhar (2000) has divided project success into four dimensions. The first dimension was to meet design goals, which apply to the contract signed by the customer. The second dimension is the benefit to the end user, which refers to the benefit to the customer from the end product. The third dimension is beneficial to the developing organization, which refers to the benefit that the developing organization has gained because of the execution of the project. The final dimension is the benefit to the technological infrastructure of the country and of organizations involved in the development process. The combination of all these dimensions gives an overall assessment of the project success. From table 1 we can see the success dimensions and measures. The thesis later describe how AF Gruppen's main goals fit with the success dimensions and how the KPOs and KPIs for the design group fits with the success measures.

Table 1: Success dimension and measures

Source: (Sadeh et al, 2000)

Success dimension	Success measures
Meeting design goals	Functional specifications Technical specifications Schedule goals Budget goals
Benefit to the end user	Meeting acquisition goals Answering the operational need Product entered service Reached the end user on time Product has a substantial time for use Meaningful improvement of user operational level User is satisfied with product
Benefit to the developing organization	Had relatively high profit Opened a new market Created a new product line Developed a new technological capability Increased positive reputation
Benefit to the defence and national infrastructure	Contributed to critical subjects Maintained a flow of updated generations Decreased dependence on outside sources Contributed to other projects
Overall success	A combined measure for project success

In recent decades, researchers have suggested different criteria for measuring project success. Figure 3 presents different acknowledged framework put together for measuring project success of construction projects.

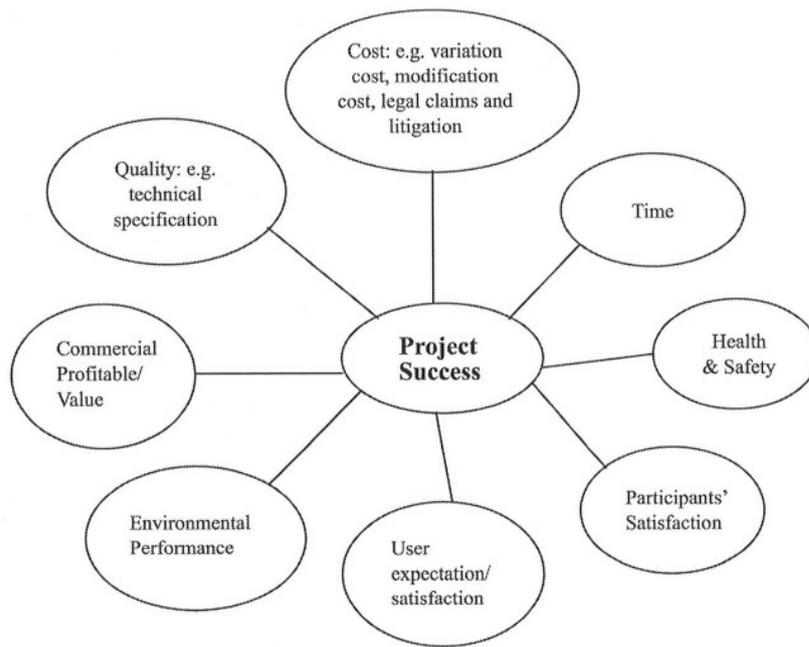


Figure 3: Consolidated framework for measuring project success

Source: (Chan & Chan, 2004)

The models shown and discussed above contain important points to take into consideration in the work to find good KPIs for the Bispevika project. By summing up the models above the following may be concluded: All models describe more elements than the iron triangle and all of them bring in safety and customer satisfaction. Figure 1 emphasize on learnings from the project and focus on improving the company to prepare for the next project. Improvements could be new technology, improving the organization, benefits to stakeholders and participant satisfaction.

KPI guidelines

The purpose of the KPIs is to enable measurement of project and organizational performance in the construction industry. The measurements would be a basis for improvements to secure project success.

Collin (2002) has given some very good guidelines on what factors should be considered for establishing KPIs and will be considered in the evaluation of the KPIs proposed by the AF Gruppen's leadership shown in table 3:

- *KPIs are indicators of performance that focus on critical aspects of outputs or outcomes.*

- *Only a limited, manageable number of KPIs is maintainable for regular use. Having (measuring) too many (and too complex) KPIs can be time- and resource-consuming.*
- *KPIs must be used systematically in many projects as the value result from comparing projects over several years.*
- *Collecting data must be as simple as possible.*
- *A large sample size is required to reduce the impact of project specific variables. Therefore, KPIs should be designed to be used on every building project.*
- *For performance measurement to be effective, the measures or indicators must be accepted, understood and owned across the organization.*
- *KPIs will need to evolve and it is likely that a set of KPIs will be subject to change and refinement*
- *KPIs need to be simple in design, easy to update and accessible*

Taking these KPI factors in consideration, a set of KPIs including objective and subjective indicators can be developed to measure the performance of a construction project. As we can see from figure 4, the calculated methods of the suggested KPIs are divided into two groups. In the first group mathematical formulae is used to calculate the values. The other group uses subjective opinions and personal assessment of the stakeholders. This group includes the quality, functionality of building and the satisfaction level for different stakeholders. To measure these KPIs a seven-point scale scoring system is used. In total, there are nine KPI categories, each may include one or more measuring methods. From figure 4 we can see a graphical representation of the KPIs (Chan & Chan, 2004, p 209).

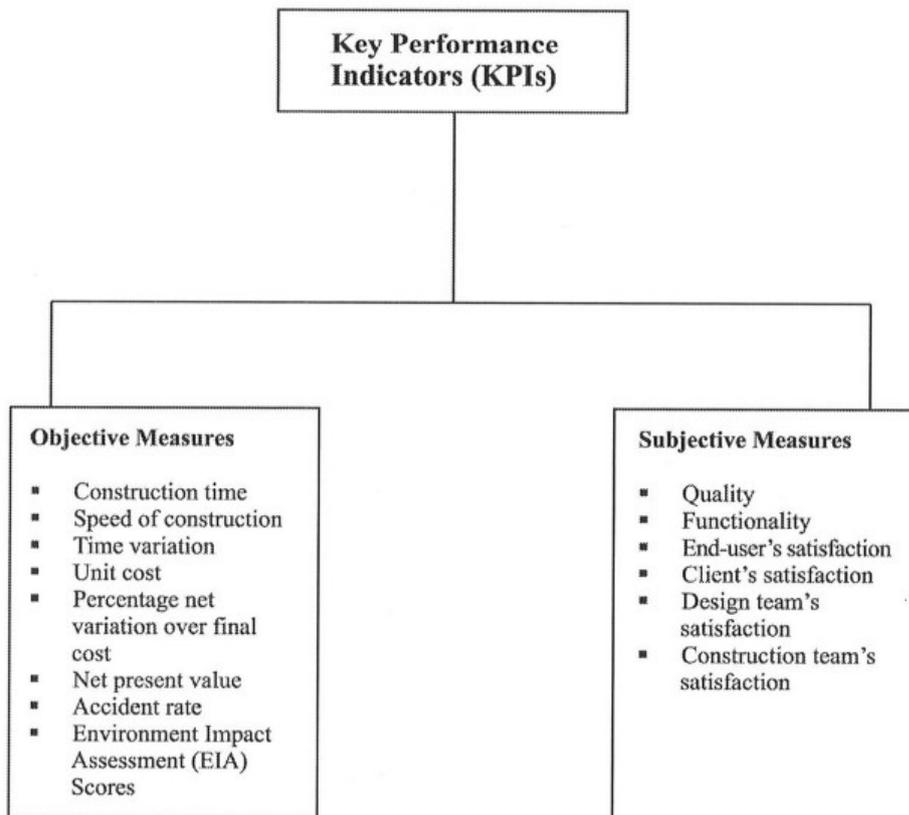


Figure 4: KPIs for project success

Source: (Chan & Chan, 2004)

By comparing figure 4 with the models shown in the chapter describing project success many similar factors are found, linking project success to KPIs.

One of the challenges in defining a KPI set is the balance between the resources you use to get the data and information you can extract afterwards. This can be looked at from what level you choose to gather the measured data. It is hard to find the crossing point between a manageable number of KPIs and the amount of data needed to extract relevant information from the KPIs. The more measuring points you have and the lower level you can measure performance, the more information you can extract, but at some point, the measurement will be too time- and resource-consuming. A challenge with having too detailed level is the difficulty of getting the whole organization to spend time on documenting and if it is not fulfilled, the data may be inconclusive and unusable. The resources used for measuring the KPIs for the design group at Bispevika is an important factor in the evaluation of the measurement system from AF Gruppen.

To many KPIs can be unmanageable. Management must choose appropriate KPIs for each project management objective. The suitable number of KPIs has been suggested to be 8-12 (Elshakour et al, 2013, p 126).

Table 2: Summary of available previous studies on performance indicators at project level Source: (Elshakour, 2012)

No.	Author and year	Country	Performance indicators
1	Jastaniah (1997)	Saudi Arabia	1. Client satisfaction 2. Planning period 3. Staff experience 4. Communication 5. Safety 6. Closeness to budget 7. Profitability 8. Payment 9. Claims
2	Egan (1998)	UK	1. Predictability – time, cost 2. Construction cost 3. Construction time 4. Productivity 5. Profitability 6. Safety 7. Defects 8. Client satisfaction
3	Department of the Environment, Transport, and the Regions (DETR), 2000 Department of the Environment, Transport, and the Regions (DETR) (2000)	UK	1. Time 2. Cost 3. Quality 4. Client satisfaction 5. Client changes 6. Business performance 7. Health and safety
4	Pillai et al. (2002)	India	1. Benefit 2. Risk 3. Project status 4. Decision effectiveness 5. Production 6. Cost effectiveness 7. Customer commitment 8. Stakeholders 9. Project management
5	Cheung et al. (2004)	China	1. People 2. Cost 3. Time 4. Quality 5. Safety 6. Client satisfaction 7. Communication 8. Environment
6	Wong (2004)	UK	1. Staff experience 2. Resources 3. Site management 4. Safety 5. Contractor experience 6. Time 7. Cost 8. Quality
7	Constructing Excellence (2005, 2006, 2009) and Roberts and Latorre (2009)	UK	1. Client Satisfaction 2. Defects 3. Predictability cost, time 4. Construction cost, time 5. Variance cost, time 6. Contractor satisfaction 7. Profitability 8. Productivity 9. Safety 10. Social indicators 11. Environment
8	Rankin et al. (2008) and Canadian Construction Innovation Council (CCIC) (2007)	Canada	1. Cost 2. Time 3. Quality 4. Safety 5. Scope 6. Innovation 7. Sustainability 8. Client Satisfaction
9	Luu et al. (2008)	Vietnam	1. Construction cost 2. Construction time 3. Customer satisfaction 4. Quality management 5. Team performance 6. Change management 7. Material management 8. Safety
10	Skibniewski and Ghosh (2009)	USA	1. Construction cost 2. Construction time 3. Predictability cost and time 4. Defects 5. Client satisfaction product
11	Toor and Ogunlana (2010)	Thailand	1. On time 2. Under budget 3. Specifications 4. Efficiently 5. Effectiveness 6. Safety 7. Defects 8. Stakeholders 9. Disputes
12	Construction Industry Institute (CII) (2011)	USA	1. Cost 2. Schedule 3. Changes 4. Accident 5. Rework 6. Productivity

Different researches are summarized in table 2. Table 2 show that KPIs differ from country to country. Various market situations, policies and strategies, cultures and competitive environments demand different measures. Therefore, there is a need to develop a set of KPIs that suits the environment in Norway (Elshakour et al, 2013, p 126).

As we can see from the literature, tables and models shown above, there are many different parameters that can be used as KPIs. This gives us the opportunity to choose parameters that suits the project at Bispevika and a Nordic leadership style.

Challenges using KPIs in construction industry

The use of KPIs is not as simple as it may sound and over the years many articles has focused on how to overcome the challenges with KPIs. Some challenges have been mentioned in the chapters above, but here I would like to focus on some specific ones:

- 1) Too much focus has been put on post-event KPOs. Such outcomes offered little opportunity to change and were not used by businesses to influence decisions. Many measures do not offer the opportunity for change during the period for which the measure has been taken. An exception is safety because this is a legal requirement and is measured continuously throughout all projects. Measures should be used on a regular basis throughout the life of a project. The measures provide trend information and offer the opportunity to change (Beatham et al, 2004, p 93).

Companies can now design measures that attempt to give early warning of problems that may occur later in the process. One example of this: If the KPI that measures supplier satisfaction is low, then the company can change the way the logistics will work with the supplier. You do not wait with the action until the project is finished.

The KPIs must be involved in a performance measurement system that includes review and action. Figure 5 shows the two cycles which must be entered if performance measurement is to be successfully implemented. There are two cycles in a performance measurement system. These are:

Cycle 1 - Implementation of measures

Cycle 2 - Change action driven by results

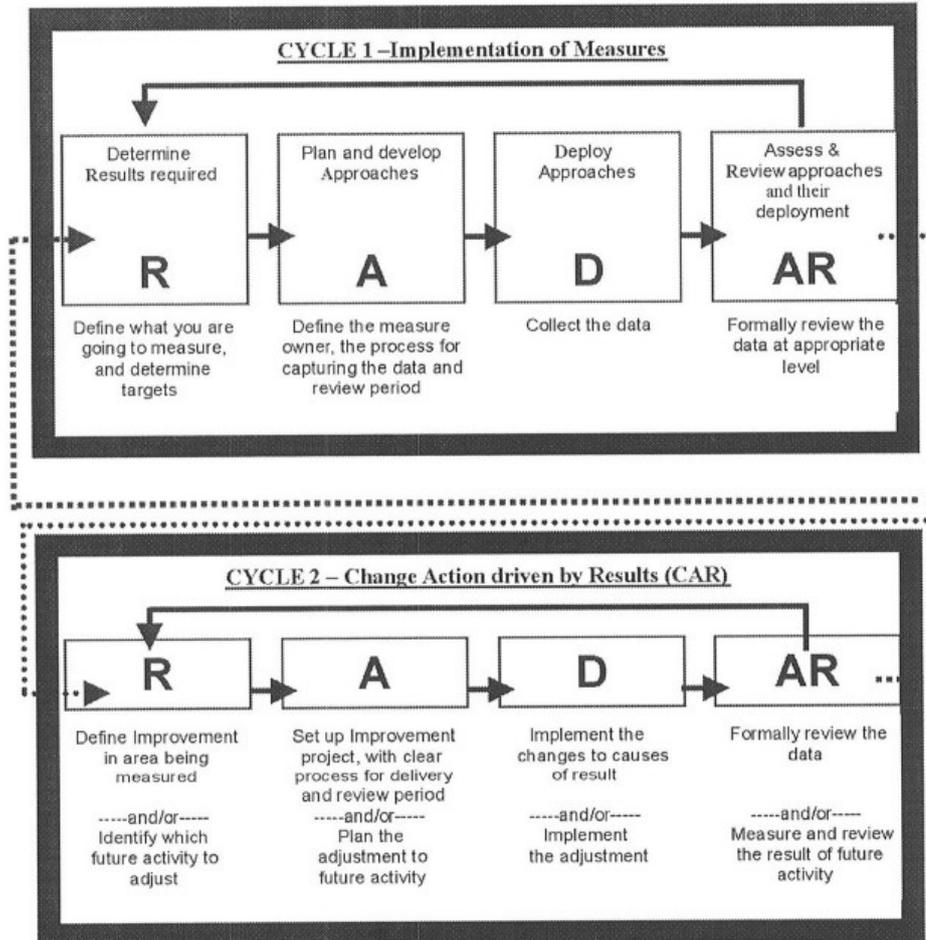


Figure 5: The two cycles of performance measurement system

source: (Beatham et al, 2004)

Figure 5 is based on the RADAR logic. In Cycle 1 you define goals, measure, collect and analyze data. Cycle 2, as shown, shows the process necessary to implement change. If the measure outcome fails to accomplish the desired goal, then change is required. The reason for the outcome must be reviewed and changed with an intention to improve the results in the future. Measures used in this context could be lagging. The same measure could also be looked at as leading measure for future activity. The result is then used to implement change in future activity with the purpose of improving the desired result. For the use of any performance measurement system to reach sustainability, Cycle 2 must be entered. Failure to initiate change is an important reason why performance measurement fails (Beatham et al, 2004, p 113). This could be an important aspect for AF Gruppen to apply in their KPI work.

2) KPIs are often not aligned to the strategy or business objectives of construction companies. They can tend to be a complete suite of KPIs, which may not be aligned to an organization's business needs. Although they are generic, and it can be claimed that they are relevant to almost all companies, but they may be beyond to the business goals of an organization. Much literature concludes that measures should be developed based on the business goals of an organization.

Figure 6 shows how the measures should be aligned with the company's vision, mission and strategies, and how different levels of measures need to be used to handle different aspects (Beatham et al, 2004, p 93).

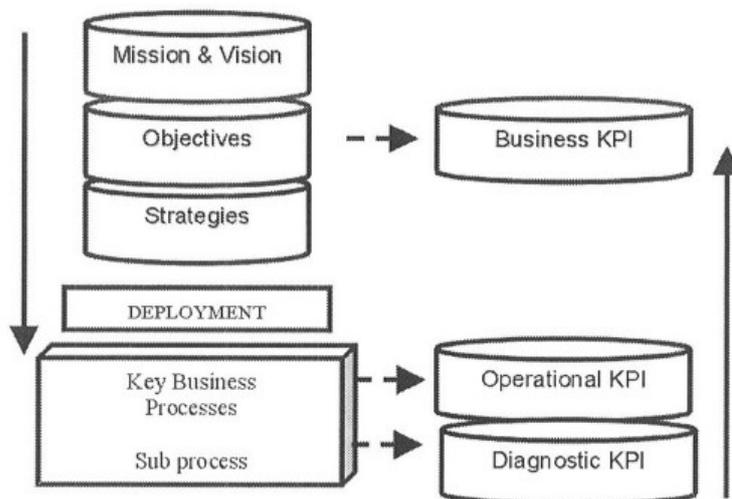


Figure 6: Alignment of KPIs

Source: (Beatham et al, 2002)

3) KPIs can be designed for benchmarking purposes, but because of lack of certainty in the data, problems with various procurement routes and lack of validation of results, this type of benchmarking is not thought to be viable. Benchmarking KPIs could be used more as a marketing tool than an improvement tool. The main use may be the need to provide comparative data for customers across the industry. One of the problems lie in too many procurement and contractual arrangements that exist in the industry (Beatham et al, 2004, p 112).

Companies develop their own set of KPIs. They have therefor the opportunity to benchmark themselves internally. But, the only data that is successfully used for benchmarking across the industry requires a third party independent

authority. Only KPIs relating to people's performance, safety and customer satisfaction can be used to benchmark with other industries. KPIs can be designed for cross-industry benchmark, which is only acceptable if the information is delivered based on improvement and not competition (Beatham et al, 2004, p 112).

One challenge in comparing different projects over a long-time period is the project specific variables. An example could be the special difficulties you have with the challenging ground conditions (building below sea level) at Bispevika, which will increase cost and time compared to most projects. AF Gruppen could use the outcomes of the KPIs to benchmark their results against others. Benchmarking is therefore a factor to have in mind when you define a set of KPIs. On the other hand, benchmarking seems to be so problematic that this will not be a priority for the KPIs chosen in this work.

- 4) The KPIs cannot provide a complete representation of the whole business. The European Foundation of Quality Management (EFQM) excellence model describes the key areas that are required for business excellence and is shown in figure 7. From this model, it can be observed that criteria 1 (Leadership) and criterion 2 (Policy and Strategy) not are covered by any of the industry KPIs. Further, there are quite a few process or sub-process measures. The focus is on business, people and customer results (Beatham et al, 2004, p 113).

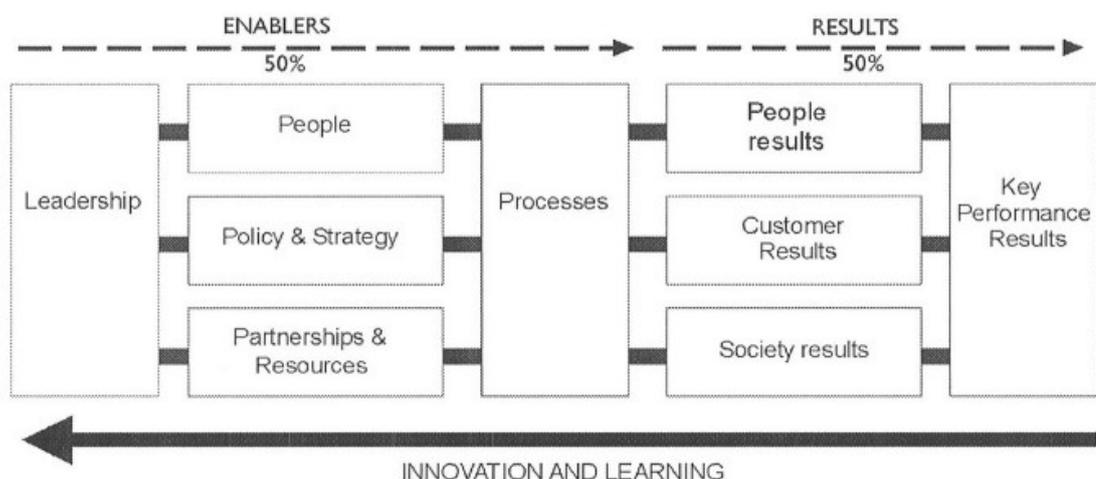


Figure 7: The EFQM Model

Source: (Beatham et al, 2002)

The case

After building the barcode, Bispevika is now the next part of Bjørvika that Oslo S Utvikling (OSU) will change to a modern urban area with apartments and restaurants. AF Gruppen was chosen as contractor for the 2 projects initiated so far; Dronninglunden, field B2, 140 apartments, and the project Vannkunsten, field B6a with 240 apartments divided into nine buildings. The contract budget for the projects Vannkunsten and Dronninglunden is 1109 MNOK. The total building area for the 355 apartments is 48000 sqm with an addition area of 8,000 sqm allocated to businesses. The contract form is interaction enterprise between AF Gruppen and Oslo S Utvikling. When AF builds 355 apartments, they focus on innovation in all the stages of the project. It's innovation in design, procurement, execution and sales. The advantages are smarter solutions and reduced construction cost (AF Gruppen, 2018).

“OSUs vision is to develop Bjørvika to become Norway’s most attractive industrial and department area. We hope a collaboration with AF shall contribute significantly to this and is willing to think new and unconventional to get this done”. Rolf Thorsen
CEO at Oslo S Utvikling

«Our team inn Bjørvika builds stone by stone on a project management model we believe will create basis for lasting increased competitiveness for both AF Gruppen, our customers and our subcontractors”. Lars Petter fritzsønn, Project director at AF Gruppen.



Figure 8: Dronninglunden

AF gruppen's building Dronninglunden, field B2 at Queen Eufemia Street. The building is shaped like a horseshoe and embraces a thriving garden. Also, the roof terrace on the 9th floor becomes a lush area where residents can enjoy the view.



Figure 9: Vannkunsten

Vannkunsten consists of 9 houses with a selection of unique 2- to 4-bedroom apartments with usable area from 40 to 140 sqm.

OSU new thinking

When OSU started planning the development at Bispevika in Bjørvika, the biggest and most acknowledged contractors in the industry was invited to come up with suggestions to how the area could be realized through industrialization, digitalization, interaction, planning processes and contract structures that can provide good solutions and major reductions in construction cost.

AF Gruppen was selected as a contractor for the two projects that have been initiated so far with a total of 355 new apartments. Reduction of project costs, reduction of building and contractor risk, development of smart and optimal technical solutions, ensuring predictable and rational production and commitment to motivate all partners in the project to think innovative are the main goals of AF Gruppen's novel work in Bjørvika. (AF Gruppen, 2018)

AF use Virtual Design and Construction

Virtual Design and Construction (VDC) is a way to streamline the construction process through technical and managerial innovation and has really gained a foothold in the Norwegian construction market. The method has already been applied to the Bispevika project, both by AF employees and by their partner Norconsult.

VDC structures promotes the interaction between different players in a project. Better exploitation of our partners' competencies to achieve competitive advantages is an important part of AF Gruppen's strategy to become a preferred partner for both customers and suppliers (AF Gruppen, 2018).

VDC is based on four foundations:

- Defined goals: VDC is based on both the end user's and the project's goals
- Building information modeling (BIM): Through close collaboration between consulting engineers and contractors around BIM, one can ensure that it is being designed for construction and that this is the construction that is being built.
- ICE (integrated concurrent engineering/simultaneous engineering): A goal-based meeting methodology that measure and focus on the progress of the project
- Project production management: This is a collection of techniques for planning and managing the processes in the project. The techniques are based on lean principles.

AF Gruppen

AF Gruppen is a leading construction and industrial group. The purpose with the business is to create value for customers, owners, employees and the society. They have division within construction, building, property, energy, environment and offshore. AF Gruppen are in total 4200 employees.

They are proud of their good financial results, but equally important are the non-financial values that are created every day; a safe working environment for the employees and the employees of subcontractors, new services that help solve society's environmental challenges and ethical business that create security for the

customers. This gives AF Gruppen the opportunity to create additional values for their owners.

AF Gruppen has a revenue goal of 20 billion kroner in 2020. Their strategy is to invest in large cities in Norway and Sweden, nation-wide mobile operations and offshore. Ambitious goals for profitable growth provide opportunities for their partners and not least their employees.

Their main strategy focuses on innovation, customers and suppliers, to become the preferred employer and organizational and structured growth (AF Gruppen, 2018).

Designing

Over the years, the perception of what is under the concept of designing has changed and the legal basis for what is within the concept of designing is today plan and bygningsloven, teknisk forskrift and byggesaksforskriften.

During the design phase you lay the foundation for the construction of the building. One way to think about it is that designing is another word of planning, and all construction work must be planned to be carried out rationally, properly and in such a way that all requirements for the construction process and the desired result are achieved. The plan shall state what is to be done, what legal, regulatory and contractual requirements are imposed on the work processes and the results and the methods and materials that the executor should use (Codex Advokat and entrepriserettadvokater.no, 2018).

Today we can identify five clear tasks that fall within the scope of designing:

- 1) Describe the work. All the work must be described, and it is a requirement that the design must be documented. The description must therefore be in writing, preferably in combination with images. It is a question of the constructor's wishes and requirements being communicated to the parties involved so that misunderstandings do not arise, and the contractors get a clear description of what to do (Codex Advokat and entrepriserettadvokater.no, 2018).

- 2) Make drawings. The designers are also responsible for making necessary work drawings. This is done to clearly communicate to contractors what is planned.

- 3) Calculations. Designing is responsible for describing the dimensions of the structure through calculations of statics, strength calculations and construction safety. A more appropriate term of the task today is checking against authority requirements. That means, designers must satisfy legal requirements for the construction and satisfy law, regulation and contract. This includes, among other things, determining which strength requirements apply, but also what fire requirements, sound requirements, energy requirements, etc. which applies to the specific project (Codex Advokat and entrepriserettadvokater.no, 2018).

Today, it is especially TEK10 that sets requirements for construction. The designers must map out all these requirements and describe them so that it is possible to choose design methods and materials that ensure that the requirements are met.

- 4) Select methods that ensure that the functional requirements are met. Designers must choose which methods to use. The methods shall ensure that the requirements are fulfilled.

Method selection often impacts later method and material choices, investment cost and operating costs, and designers must balance all considerations within the law and regulations.

- 5) Select materials that ensure that the functional requirements are met. The last task involved in the design is to select materials that ensure that the functional requirements are met. For example, there are various materials for insulation and wind proofing of a building, but not all will cause the performance requirements of TEK10 or the contract to be met. Then it is the responsibility of the designer to decide which materials to use (Codex Advokat and entrepriserettadvokater.no, 2018).

In summary, we can say that it is the designer that will make all choices in terms of method and materials.

The contract form at the Bispevika project is a collaboration contract. In the Collaboration contract all parties have shared responsibility and risk allocation in project. Construction projects with collaboration contract, a collaboration group consisting of the most important designers and constructors is appointed. The members of this group are jointly responsible for designing towards an agreed target price (Anskaffelser.no, 2017).

During the design phase, the following documents are normally prepared and completed:

- Ground and condition investigations and evaluation.
- Plans (Situation, Outdoor, Floor plans with main features, roof plans)
- Ceiling Plans
- Section drawings (space treatment, door and window sketch, staircase, floor coverings and solid decor)
- Signs and markings
- Lighting plans, signal systems
- Plans for safety, health and work environment.
- Descriptions (architectural design, overall material usage, design principle, fire concept, sound / acoustics, energy and environmental solutions)
- Universal Design
- Areas, costs
- Progress and assembly plan
- Descriptions with amount lists based on NS 3420
(Anskaffelser.no, 2017)

Method

Information collection

After getting in touch with AF Gruppen and Sebastiano Lombardo, we decided to study their KPIs and key measurements. Different approaches were used for the work. The most important results came from interviewing key employees. The informants were recruited through my advisor Anders Lillelien who worked as controller at AF Gruppen. In addition, company documents such as strategy, project objectives and so on were studied. The case was also discussed with the employees at AF Gruppen at various occasions during my visits. Getting to know the company also gives a certain idea off which KPIs are important. The analyze unit in the case study was the residential development project in Bispevika and both secondary and primary data were used.

Semi structured interview

What information you can extract from an interview depend on the form of the interview. Interviews with individuals are the most common approach (Thagaard, 2009, p. 99), and it also became the chosen method for the study.

In qualitative interviews, semi-structured interviews are most common. The topics the researcher will ask about is essentially determined in advance. In this way, the researcher can follow the story of the informant, but still provide information about the topics identified in the first place. Flexibility is important in linking the questions to the informant's assumptions. It is also important that the interviewer is open for the informant to address topics that were not planned (Thagaard, 2009, p 89). Semi-structured interview was used because of the need to have a certain structure at the same time as to get the opportunity to take care of flexibility and openness in the interview situation. A guide with topics was prepared. The goal of the guide that was both to find answers to important questions and at the same time gave the opportunity to follow up on what might arise from topics that were not part of the interview session.

The semi structured interview and the guide help to prevent the informant from reflecting freely. The interview form is suitable for comparing and processing the various informants' answers. The interview is characterized by little structure in the form of a casual approach, as in an open conversation. Such an approach seeks to

facilitate an open relationship in a friendly atmosphere (Thagaard, 2009). The Bispevika case has an exploratory element in the research. There are aspects of the case that are new and unclear and therefore little information is available for a survey. For example, working with KPIs is new to AF Gruppen. Because of this, semi-structured interviews are a good solution for this case.

Design of interview guide

Thagaard (2009) says it is important that the researcher has worked well in advance with the informant's situation and context to ask questions that are relevant to the situation. The questions were asked in a way that encouraged reflection and openness. The main questions are the basis of the interview guide, and follow-up questions will give me more detailed and nuanced information (Thagaard, 2009, p.101).

The interview guide was designed with the background in the framework, which was based on the problem, my research questions and the theoretical basis prepared for the assignment.

The interview guide was made by following Johannessen interview guide (see attachments). The guide contains eight parts: introduction, factual questions, introductory questions, transition questions, key questions, complicated and sensitive questions and closing questions (Johannessen, Christoffersen & Tufte, 2014, p 149). The guide was followed to ensure a good structure on the interview guide.

Execution of the interviews

First contact with the informants was over mail with a description of the task. Then approximate meeting times were agreed. Full days at the office were spent so it was possible to conduct the interviews as it suited the informants. The six interviews that took place took from 50 to 70 minutes and were kept in their own group rooms at the office, which made it quiet and easy to conduct a conversation. The conversations were recorded on audio recordings, so there was no need to take notes along the way. This also made it easier to get involved in the information and ask follow-up questions. The informants agreed on the sound recordings.

During the interviews, it was important to answer the questions in the interview session. At the same time, attempts were made to be open and attentive to topics that had not been thought of but suited the theme. In the interviews, there was a

natural dialogue where eager informants willingly shared their experiences and knowledge relevant to the assignment. The interviews were ended by thanking for the participation and that they had to contact me if there was anything they were wondering about during the interview.

Organizational documents

Document analysis has a long tradition in qualitative research. Analysis of documents differs from data the researcher has collected in the field, because the documents are written for a different purpose than the researcher will use it for. Published documents are available to everyone, but closed documents require special access to anyone else from whom they are written for. One aspect that is important in document analysis is that the sources must be considered in relation to the context in which they are designed (Thagaard, 2009, p 62).

Professionals who study documents are more concerned with the processes through which texts describe reality instead of whether such texts contain true or false statements (Silverman, 2014, p 285).

As Atkinson and Coffey (2004) put it: One must be clear about what documents cannot and can be used for. Documents are “social facts” and they are produced, shared and used in socially organized ways. However, they are normally not representations of organizational routines, decision-making processes or descriptions of the information flow in the company. We should approach documents for what they are and for what reason they are written. To be able to study organization documents for “what they are”, these questions have some answer to this question:

- 1) How are documents written?
- 2) How are they read?
- 3) Who writes them?
- 4) Who reads them?
- 5) For what purpose?
- 6) On what occasions?
- 7) With what outcomes?
- 8) What is recorded?
- 9) What is omitted?
- 10) What is taken for granted?

11) What does the writer seem to take for granted about the readers?

12) What do readers need to know to make sense of them?

(Hammersley & Atkinson, 1995, p 142)

These questions can be interesting to ask about the organizational documents.

Anders Lillelien and Lars Kristan Hunn from AF Gruppen and Petter Bråten from OSU did some early work to define indicators in the beginning of the project with specific measurements to cover the most important functions at the construction site. The measurement system is divided into the following categories: designing, operation, procurement, development, health, environment and safety, quality assurance and economy. The measurement system involves thoughts on how to define measures and how to measure them. They also discussed using measurements for both customer and supplier satisfaction.

Later, I received an updated version of the measurement system. This measurement system contained KPOs, KPIs and how they are to be measured. The measurement system was divided into the following functions: design, operations, procurement, buyer/user, but also by field: digitalization, interaction, financial management and risk management. This document became the basis for studying which KPOs and KPIs that should be used to achieve the project objectives within the process of designing and planning the construction work.

Naturally occurring talk

When social interaction takes place, conversation is the primary medium. At work, we talk to each other and the outcomes of this talk (as in meetings or job selection interviews) is often placed in dossiers and files. We call such data “naturally occurring” because they arise from situations that exist irrespective of the researcher’s intention. However, it is not a large difference between naturally occurring and research-induced data. Usually, naturally occurring data do not speak for themselves but must be recorded and converted into field notes (Silverman, 2014, p 316).

Naturally occurring talk was a part of the everyday life at Bispevika. The staff were curious about what my task was at Bispevika and it was no problem to discuss KPIs

with the employees. The answers were used to find solutions and get to know the KPIs better.

Observations

Data from observations is usually detailed descriptions of human activities, behavior, or actions and interpersonal interaction and organizational processes. What a person tells us is an important qualitative data source, but it is limited how much we can learn about what the person says. To understand the complexity in many situations one must observe the phenomenon directly. We use the term observation about observe, see, discover or pay attention. We experience, smell, taste, listen and see. To sense, is about register impressions. With observation in research we want to acquire new knowledge. We then put observation in system (Johannessen, Christoffersen & Tufte, 2014, p 121).

Observation is often time- and resource consuming, so the researcher should be sure about using this method to gather data before he starts. Observation as a method is suitable when the researcher wants direct access to what he investigates. For example, interaction between humans. In many occasions, the only way to gather valid knowledge is to be present at a setting. For example, when the researcher tries to understand what is really happening when decisions are made in a company. Sometimes knowledge cannot be generated without observation in a natural setting because knowledge is not always possible to formulate, possible to remember or construct in an interview. It is not always what we say we do, it is what we end up doing. A setting, a situation or interaction gives information on many levels. Both if it is direct observation or the researcher's interpretation to be in the setting. When the researcher is placed in the natural setting, he can do his reflections through to whole process. The researcher uses himself as a filter with interpretation of the data (Johannessen, Christoffersen & Tufte, 2014, p 123).

In the setting at Bispevika, present observer will be the observation method. That means that the observation in a small degree will participate in the interactions between the participants in the field. The researcher engages through conversations and interviews but not as a participant. Here the researchers' status as researchers is clearer than when he is observing participant. He is an interested and engaged third

party. Many, maybe most of observational studies is by this type (Johannessen, Christoffersen & Tufte, 2014, p 128).

In one way, it was a challenge to use observation as data collection method in this task. The reason is that the KPIs as described in the assignment is based mainly on measurements and not on human behavior or actions. There were cases where observation would be very important such as observing customer satisfaction through sales meetings or vendor satisfaction, but because of the extra organizing effort, I was not allowed to participate in such meetings. A more involved observer would have gained access to more information.

Method triangulation

One of the goals of triangulation is to make sure you have valid data. Several methods are used at the same time, so that bias within one method is compensated by another. Combining multiple methods shows data from different angles.

Triangulation therefore focus on integrating different methods. In addition to verifying data, triangulation is also used to elaborate understanding for different aspects related to the same thing. That means, to make the research more complete. You can also use triangulation by using only qualitative methods to gain greater insight or wider understanding (Ryen, 2002, p 194).

Benefits of triangulation are summarized here:

- Increase trust in data
- Make the study more complete
- You can ask different, but complementary questions in the same study
- The research can reveal new relationships or processes that may result in the development of new theories or modifying existing
- The researcher will come closer to the research situation, thus contributing to a more complete understanding of the study's focus (Arksey & Kneight, 1999, p 25)

By triangulation, you can get different answers to the same question. Explanation of differences may be in error, which can lead to work with procedures that are more careful.

Disadvantages of triangulation are summarized here:

- Triangulation takes time and costs money
- It can be difficult to repeat or make comparable studies
- Not all researchers master special methods
- To produce a more comprehensive report, the researcher may be tempted to make datasets comparable which are not (Arksey & Knight, 1999, p 25).

Using more than one qualitative method was a great asset to the study. Triangulation was used between documents, interviews, naturally occurring talk and observations. Even though I only spent two weeks at the construction site it was a great asset to be there, not only for the interviews. Being able to speak to the employees and observe at the office helped to reduce misinterpretations. Questions could also be asked about the data set (documents) provided by Anders Lillelien. On top off this, interviews were used to gather more data and make the study more complete.

Informants

Informant 1: Is educated as civil engineer from Norwegian University of Science and Technology (NTNU). Worked 10 years with energy efficiency, 5-6 years in the construction industry and 2 years for AF Gruppen. Main responsibilities have been Project Management in energy and savings projects. Has responsibility for technical facilities today, especially within ventilation systems. Now has a role as ITB (integreerte tekniske bygnings installasjoner) where there is a coordination responsibility between all the technical subjects in the project.

Informant 2: Is educated as civil engineer from Norwegian University of Science and Technology (NTNU) within energy environment. Started working as a consultant in Multiconsult in 2012. Has worked for seven years in the construction industry and half a year in the AF Gruppen. Has previously worked with engineering of VVS (Plumbing) in Multiconsult. In AF Gruppen, the position is project manager. Must provide all references for VVS and that it is delivered on time with the right quality.

Informant 3: has a degree as Master of Architecture and Master of Management. Has been working for thirteen years as an architect. After that, the position has been project manager, and construction manager in two different companies. Has worked 25 years in the industry and one year in AF Gruppen. Started working as a

consultant. Has been building manager and supervising design and worked with many different types of buildings. The responsibility in the Bispevika project is project group leader.

Informant 4: Master's in both Industrial economics and in Energy and Energy Economics from the Norwegian University of Life Sciences (NMBU). Has worked three and a half years as vendor in Elkraft, which is a power supply company. Employed in AF Gruppen since March, as an energy engineer. Is responsible for environmental certification (BREEAM AP).

Informant 5: Holds a degree as a civil engineer from the Norwegian University of Science and Technology (NTNU) in mechanical engineering. Started working in the oil service and moved to the construction industry. Has worked 2 years in AF Gruppen. Is now a project group leader with overall responsibility for all the different subjects. Also, VDC responsible at Bispevika.

Informant 6: Is a civil engineer with master's degree in engineering from the University of Edinburgh from 2010. Worked as construction industry consultant for Norconsult from 2011 to 2017. Worked as an entrepreneur for AF Gruppen since 2017. Has been the project leader for the design subjects from the summer of last year. Is now working as a development manager for construction and foundation at Bispevika.

Reliability

Reliability relates to the research data: what data is used, how they are collected and how they are processed (Johannes, Christoffersen & Tufte, p 243).

The data that is being used in this thesis is coming from observations from visiting the construction site (observation and naturally occurring talk), reviewing project documents and interviewing people within the function design. The research was conducted by staying at the office at the construction site for approximately two weeks. The main information was gathered during six interviews but also by talking with people during lunch, café breaks, when people naturally were walking by etc. It seemed like everybody knew each other well, so it was easy to be recognized as a new person at the office. People were interested in the study and it was easy to talk

about KPIs and related subjects. If useful information was received, the information was documented right after the conversations. The observations were also valuable. Observing people while they were talking with each other and me (to see reactions) and watching schedules and meeting plans hanging around in the office helped to understand the setting at the office.

Sound recording was used during all interviews and transcribed later. The recordings made sure that valuable information was not lost during the interview. In the data collection process, measures were taken to specifically strengthen the reliability of the findings. During the interviews, the informants were asked if the perception of the point was correct, so my understanding was consistent with what the informant meant. During the interviews, small summaries were made to ensure that the main points of the informant had been perceived and to ensure that information the informant emphasized was not omitted. This also gave the informants an opportunity to come up with additional information before the transition to the next topic. Following the interviews, a check was also made by sending the transcript to the informants by email.

One factor in the question of reliability can deal with the researcher's role in the interview situation. Thagaard (2014, p 115) claims that "the personal contact that occurs between interviews and informants through the interview is a methodical point in itself." A poorly conducted interview can result in different sources of error and may be the result of poor interaction in the interview situation, social distance between interviews and informant. Other sources of error may be that the informant is able to influence the interviewer's values, wants to produce himself in good light to give a good impression, or highlight negative pages to enhance challenges. Both through the preparation of the interview and through the interview itself, I was attempted to reflect on the role, be aware of good organization and to put the informant in the center.

A weakness of how the interview data was processed was the translation from Norwegian to English. By direct translation, nuances can get lost, and the sentences can be interpreted differently. The direct translation also applies to data from the company documents. The KPI list from Table 3 has been translated from Norwegian to English.

Validity

A common definition of validity within qualitative surveys is the question "do we measure what we think we measure?". Is there a connection between the phenomenon investigated and the data collected? (Johannes et al, p 244).

To ensure that there was a connection between the phenomenon investigated and the data collected relevant theory from previous research about KPIs were used.

Lincoln and Guba (1985) refer to two techniques that increase the likelihood that the research produces credible results: persistent observation and triangulation. Since only two weeks was spent at the office, it was hard to understand the complexity of all the processes that happened during the stay. If my understanding of design was better, the opportunity to dig deeper into understanding the processes involving the KPIs would also have been better.

The method made it possible to investigate the phenomenon of KPIs from several sides. Triangulation was used between documents, observations, naturally occurring talk and interviews and helped to get more credible results.

Credibility has also been enhanced by the results being disseminated through the thesis so that others can analyze the same data.

The selection of six informants leading the design work was done by strategic selection made based on those who best could evaluate the KPIs within design. That is, those who work in design. Nevertheless, choosing only informants from those responsible for design could also be a potential problem since the design work was not evaluated by the people ordering or receiving the work, such as the assemblers or the contractors. It would not be surprising if the project leader group or the assembler would see other perspectives than the employees responsible for design.

External validity (transferability)

Can results from the research project be transferred to similar phenomena?

(Johannes et al, p 247). This study is closely linked to a construction project. There is no doubt that other construction projects could use a similar KPI set as a help to focus on the project objectives and investigate bottlenecks.

The results from this research project help to create a measurement system where quantitative data was used to a large extent. It was a goal that the measurement data from the measurement system would be transferred to other construction projects.

Therefore, my recommendations are useful for creating the right measurements which can be used at several construction projects.

It is more difficult to see that the specific findings can be directly transferred to other industries, but general results like using KPIs as a tool in the planning and execution process is an example of a general result could have widespread use.

Ethical judgements

Before the interviews were completed, all informants were sent an e-mail to inform about the project's content and objectives. This included a brief description of the task, information on how I have kept anonymization, how the data we collected was processed and contact information. I repeated this when I conducted the interviews. The transcription in the assignment were sent to the informants for a review and approval.

Results

How project objectives, KPOs and KPIs are linked together and used at the Bispevika project

At Bispevika there are four specific project objectives. They are:

1. Bispevika will be the most attractive district in Oslo
2. Bispevika will create 40% more value than traditional construction projects
3. Bispevika will have the most satisfied residential customers
4. Bispevika will change the interaction pattern in the construction industry

The four main objectives are crucial for project success and the leadership need to secure that these objectives are accepted and understood throughout the organization.

In figure 10, we can see how the project objectives are linked to the project KPOs/KPIs. This link is also very similar to the alignment of KPIs with business vision and objectives shown in figure 6 by Beatham (2002).

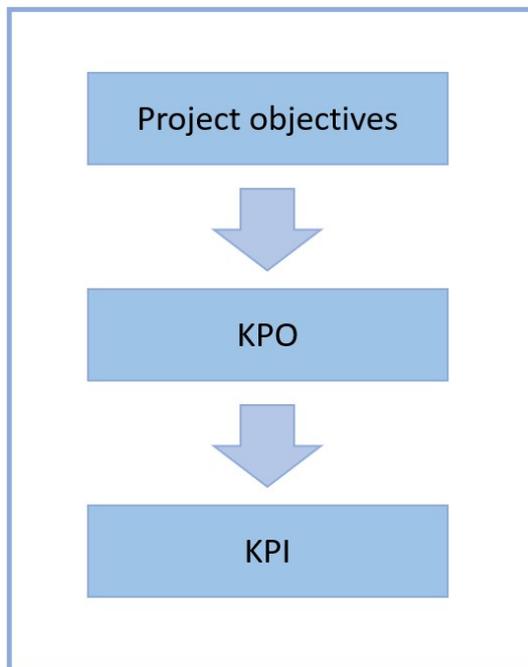


Figure 10: Project objectives linked with KPOs/KPIs

If we look at project objective 3, one KPO could be “customer satisfaction”. The associated KPIs could be “to periodically measure customer satisfaction using surveys”. This could be done by measuring:

- a) Information

- b) Site visits
- c) Number of contacts between customer and sales organization

One way, leadership can influence the employees to work towards the four project objectives is to have the project objectives transformed into KPOs and then to KPIs. By measuring the KPIs and follow up on the KPIs, the project objectives will get more attention in the organization. This should lead to more focus on the project objectives. Since the KPIs are linked to the main project objectives, they can be looked at as small steps to achieve the main objectives.

In figure 12, we can see examples of some KPOs and KPIs that can be derived from the project objectives. We can see that AF Gruppen has defined different functions to categorize the KPIs. A clear connection between the project objective, the KPOs, the KPIs and what is being measured. Ability to make decisions at the right time, effective ICE-meetings and measuring number of decisions in ICE meetings divided by planned decisions will all help to create more value at Bispevika. The figure only shows a few of the KPIs that are linked to project objective 3 and plenty more off KPOs and KPIs could have been picked from AF Gruppen's measuring system. Figure 11 shows how AF Gruppen follow Beatham's (2004) theory about the challenges with aligning the project objectives with KPIs.

Economically, project objective 2 is the most important. Four examples of KPOs and KPIs are shown in figure 11 as examples of how the project objective is linked to the KPOs and KPIs. Taking decisions, is important because if you want to get things done you have to decide on a solution. Without an answer, people will have to wait for the decision. Waiting leads to project delay and money is lost. That is why the ICE (integrated concurrent engineering)-meetings is of such importance for the progress and cost. Example number two on designing cannot be used as a project management tool as it is written now because measuring end cost designing budget is most probably only measured once. This measurement can still be used for learning, since improvements can be implemented in later projects, and help AF Gruppen create benchmark data as described as business success dimension by Shenhar et al (1997) and figure 1.

The third row is in within the function of interaction and could therefore also be linked to project objective 4. However, effective change management is also linked to

efficiency and construction cost. Interaction is therefore an example of a KPI that is linked to two project objectives. The last example is within the function operation and may be the most important cost driver, keeping the progress of the construction plan and measuring progress against plan.

Project objective	Subject area	KPO	KPI	Measurement
Bispevika will create 40% more value than traditional construction projects	Designing	Ability to make decisions at the right time	<u>Effective ICE-meetings</u>	Number of decisions in ICE meetings divided by planned decisions
	Designing	Minimize resource usage on projecting	Resource use	End cost projection against budget
	<u>Interaction</u>	Effective change management	<u>Number of change request</u>	How many change request are received
	Operations	Complete scheduled activities at scheduled time	How many activities are completed according to plan?	When the activities are completed

Figure 11: Project objective linked with KPOs and KPIs

The focus area of this thesis was the function designing. Table 3 show all the KPOs and KPIs that are proposed to achieve the four project objectives within designing. In most cases there are more than one KPI measuring each KPO. Table 3 only show a part of the measurement system made by AF Gruppen. The KPIs that are marked with green are the ones that is being measured. The other KPIs are suggestions to which KPIs that should be measured. The entire measurement system is shown in attachments.

Table 3: KPOs and KPIs from the measurement system

Designing	
KPO	KPI
Create repeatability and similarity from project to project	Number of solutions reused
Minimize resource usage on designing	Continuity personnel advisory group Use of resource
Ability to make decisions at the right time	ICE meetings
Clear goals for the project that provide good guiding and focus on the priorities in the design	Optimization Hand-over from calculation conducted
Deliver designing materials with the right quality to the right time, including planned work according to plan structure	Project plan performed (PPU) Lookout plan Phase plan Obstacle analysis Health, environment and safety by designing Collision test Quality deviation Third party control Number of revisions Delivery to procurement/operation according to plan
Achieve BREEAM classification very good	Estimated score against requirements Score achieved as-built
Target Value Design	Completed Target Value Design processes

To be able to understand the KPIs an explanation of the construction design terminology used in table 3 is given below.

ICE (integrated concurrent engineering/simultaneous engineering) meetings: A goal-based meeting methodology that measure and focus on the progress of the project. People from different disciplines and with interdisciplinary backgrounds join the meeting to decide on solutions for the design process.

Hand-over from calculation conducted: In the AF Gruppen there are employees that specialize in calculating the basis for the tender. During this phase, only a few people are involved, and not always those who are going to build the project. It is therefore important that the principles and basic design assumptions for solutions and costs are transferred from the calculator to the group that design, procure and manufacture.

Project Plan Completed (PPU): Which activities that will be performed each week is defined. Towards the end of the week, it is being reported whether the activity was completed and built with correct quality. A percentage showing the completed work is then calculated.

Phase plan: To achieve the best possible planning, the production of a project has been divided into different phases, this will primarily be; foundation work, concrete work underground, concrete work over the ground (rough structure), dense construction (exterior wall, ceiling and facade), interior design and adjustment. This is often linked to milestones in the contract between the contractor and entrepreneur. In a good time before the phase starts at the construction site, there is a review with the subcontractors who are involved in the phase to detail the planning of this phase, i.e. phase plan. The phase plan does not consider dates (such as holidays, weekends, etc.), it is focusing at activities and duration as well as the necessary resources on these.

Lookout plan: is a level in AF Gruppen's plan structure under the phase plan. The time horizon in the lookout plan is 6-9 weeks. They set specific dates and identify obstacles that need to be removed to start "healthy" activities in accordance with Lean principles.

Obstacle analysis: It is an important principle to identify and remove obstacles for the activities that start to be "healthy." Examples of obstacles can be; enough space, enough / proper personnel, equipment etc. AF Gruppen wants to analyze both how good they are to identify current obstacles in planning and how good they are to remove them.

Collision test: Collision tests are performed at specified intervals during the design process to ensure that the design can be used in actual production. An example of a collision could be that a water pipe is built through a door opening. It is investigated whether there are collisions with what is being planned.

Third party control: Is when an outside person checks that projected solutions are in accordance with laws and regulations, such as that escape routes meet requirements. This is a control from a person that doesn't have a role in the project from before (impartiality).

Score achieved as-build: When a score is given after the building is done. The BREEAM score achieved is independently checked and recalculated after the building is finished

Target Value Design: Target Value Design (TVD) is an approach to Toyota's Target Costing (TC), introduced in Japan in the 1970s. Target Costing is aimed at reducing the total price of a product, using the company's department and an active contribution from the supply chain.

Target Value Design is an adaptation to Target Costing for the construction industry. In production, the product is produced several times while construction projects are often unique since a new product is produced for each customer. Target Value Design contains three main elements: 1) The customer's values and limitations are ideally determined by key project participants. 2) Set target costs to the amount the customer can pay. 3) Design a construction for target costs. This technique will help the construction industry to increase the number of successful results by allowing the project team to effectively control project costs (TVD Research group, 2013).

Table 4 show the different KPIs and how they are being measured:

Table 4: KPIs and how AF Gruppen is measuring them

KPI	What AF Gruppen is measuring
Number of solutions reused	Number of solutions that will be reused on multiple projects
Continuity personnel advisory group	How long each person in the advisory group is affiliated with the project, in over 60% position
Use of resource	End cost designing against budget
ICE meetings	How many of the proposed decisions are made in the ICE meetings in relation to planned decisions
Optimization	Has a strategy been developed for optimization work per subject
Hand-over from calculation conducted	Has a review been completed with the calculation and current project manager (s)?
Project plan performed (PPU)	Delivery of design material with the right quality. Projecting materials must be approved by AF Gruppen before proceeding to purchase/production
Lookout plan	Has there been a lookout plan according to time interval defined in the plan structure
Phase plan	Has a phase plan been completed according to the time interval defined in the plan structure
Obstacle analysis	Are all identified obstacles that should be solved? solved? In the long run, you should look at the possibility of measuring how many days you are running overtime or before the deadlines to see trends.
Health, environment and safety by designing	Must be defined by interval for such reviews and measure whether they are performed or not
Collision test	How many identified collisions remain
Quality deviation	How many quality deviations have been discovered in the design. How many quality deviations are solved
Third party control	Number of third party checks performed against planned third-party controls
Number of revisions	Number of revisions
Delivery to procurement/operation according to plan	In the purchase plan, necessary deliveries are defined from the design to make purchases, is this delivered at the agreed time?
Estimated score against requirements	Score design stage versus BREEAM requirements. What score the AP associated with the project estimates that the project achieves along the way in the project
Score achieved as-built	Achieved score after feedback from BREEAM
Completed Target value Design processes	Completed Target value Design processes

Findings from interviews

Project objectives

To be able to better understand the link between the project objectives, KPOs and KPIs it was important to gather information about the project objectives. To better

understand how KPOs and KPIs are to be designed, information about the project objectives has been collected. Beatham (2004) describes in his article some important challenges with KPOs and KPIs. He observes that when the KPOs and KPIs are not linked to the company's major business objectives, they may lack relevance or related to lower priority objectives. This would reduce the value of using KPIs. Below are therefore listed some findings on the design group's opinions and thoughts around the project objectives.

Bispevika is a high priority project with high ambitions. Such a project should also have ambitious project objectives. Most of the informants stated they the project objectives was exiting but it would be a challenge to achieve them. One of the informants said that *"I think they were very exciting. One of the reasons I would work on the project"*. This shows how meaningful the project objectives can be for the employees. Most of the informants mentioned that the objectives covered broad and complex work streams *"very different objectives"*, It is good because the four main objectives should cover all the different aspects in the construction project, not only the iron triangle. One of the informants stated one of the reasons why this project is of such importance: *"They are ambitious. It belongs in a project that should be as central as it is here. In fact, we will have an influence on how the center of Oslo will look like for a long time"*.

It was clearly stated that the most ambitious objectives were to create 40% more value *"40% value creation is a world record in itself"*. Having such ambitious objectives can affect the employees to think differently, which may be good for the project. *"Achieving 40% more value is entirely dependent on thinking differently than previously"*. The informants seemed satisfied with being a part of and working on this project.

There were also a few concerns about the project objectives. One point that appeared several times was that the project objectives was not precise *"What is needed to meet the objectives is not precise"*. One example of this is *"I think value creation is not handled properly. We have no zero point. We do not know if saving 100 million will be enough to reach the objective"*. That is actually a very good point. Another concern was about the most attractive district in Oslo. How is it possible to evaluate what the most attractive district is? It was stated that *"best district is very subjective"*. People's perceptions are very different, so it will be very difficult to

conclude that Bispevika is the most attractive district in Oslo. One exception to the unprecise objectives was the objective about most satisfied residential customers. It was stated that, at Bispevika they use surveys to quantify customer satisfaction.

One of the informants said that *“The other objectives are very tied to the 40%. You cannot sell the apartment at the price we need if it is not the best housing in the city. Then you will automatically get the most satisfied residential customers and the most attractive area I think”*. It is clearly that 40% more value is a very important project objective.

The informants also came up with statements or requirements needed to achieve the four project objectives: *“We rely on good logistics on the construction site”*, *“The fact that the organization is co-located helps very much”* and *“That we manage to keep on the expertise that we acquire along the way”*. One of the informants pointed out exactly what I am looking at in this thesis. *“The most important thing to reach the objectives is to break them into logical sub objectives, which are measurable and manageable”*. It did not seem that the informants knew that this had already been done.

We also discussed how the field of designing helps to achieve the four main objectives. It was clearly very important. *“Designing is key in achieving the four main objectives”*. The designing phase is very important in a construction project and is essential in making sure the project reach the objectives. Some important points that was said about designing helping to achieve the four main objectives was *“Designing is the time to come up with innovative solutions”*, *“It’s about creating the absolute best solutions. So, it can be built very cost effective and without errors”* and *“We must deliver a designing work that is feasible and establishing good connections to those who will build it”*.

Findings about KPOs

Here we will look at findings from the KPOs. The suggested KPOs from before the interviews is shown in table 3 with the corresponding KPI or KPIs.

Due to lack of knowledge about KPOs, the acronym KPOs were defined and explained for most of the informants. They were first asked to come up with their own KPOs. Some of the suggestions the informants came up with were: *“Get the design perfect right from the start”*, *“more co-location. Solve issues while the designers are*

present”, “*Good planning, the more optimization, you'll get out of it*”, “*Important to allow us to spend time looking at more than one solution*”. One of the things that came up several times was spending more time and resources on planning the design work.

Afterwards I asked the informants to comment on the KPOs in Table 3. At this point, the informants did not know which KPIs that were linked to each KPO. They had the following to say about the KPOs: “*Many of the KPOs are very similar*”, but “*Every one of them are essential*”, “*All of these create a good project*”, “*Most of the KPOs target increasing of the value of the project*”. In general, they seemed satisfied with the KPOs.

Then they commented on each KPO. With the KPO **Create repeatability and similarity from project to project** they said: “*Very valuable. This will reduce the time for designing*”. If you can copy I solution from one apartment to another it can reduce the time for designing a lot. It was also said that “*requires that there is a transfer of knowledge between the projects*” and “*The fact that we can learn from mistakes and improve is directly related to 40% more value I think*”. Everybody was very satisfied about this KPO and the fact that it is aligned with the most important project objective about creating 40% more value is good.

About **Minimize resource usage on designing** the informant was a bit more skeptical. One of the Informants commented that “*working with the efficiency of the design is better. The less time you spend on the design the worse the result will be*”. This has to do with the resources you put into the designing. All the informants were very clear about using a lot of time on the design phase is an efficient way of reducing building cost.

The informants had the following comments on **Ability to make decisions at the right time**: “*Important to make the right decisions at the right time, so you do not make a decision too early that affects how the building should be*”, “*Very important*”. They agreed on this as an important KPO.

The informants had this to say to **Clear goals for the project that provide good guiding and focus on the priorities in the design**: “*It is a bit unclear, did not understand what it meant specifically*”, “*If we can see that there is a focus area where there is great potential. Then it must be clarified for the design*”. Some of the

informants were struggling with understanding what this KPO meant. Both statements can be seen in relation with Collin (2002) who says that *for the performance measurement to be effective, the measures or indicators must be accepted, understood and owned across the organization*. It is important that everyone in design understand and know what is being measured.

Deliver designing materials with the right quality to the right time, including planned work according to plan structure. The interview objectives did not have much to say about this KPO. Some said “Good” and another one stated that “*It is about delivering at the right time and making decisions at the right time*”. They all seem to agree this was a good KPO within designing. The informants had the following to say about **Achieve BREEAM classification Very good**: “Good”, “*Will be a value for the customer and resale of apartments*”, “*Directly linked to satisfied residential customers*”, “*The least ambition is to achieve the rating “very good” for BREEAM*”. Overall the informants seemed satisfied with the KPO, though one interview informant stated that it was the least ambitious. They agreed on that it was easy to deal with, which is important.

About the last KPO **Target Value Design** just one or two out of six informants knew what Target Value Design was. They stated that “*Do not know what this is*” and “*not heard of*”. The one that had heard of Target Value Design said, “*Target Value Design, to the extent that you can use it in the BIM model, it is terrific*”. This means that this KPO might have potential, but it is a problem that most of the interview objectives had not heard of it.

Findings KPIs

The third part of the interviews was targeted at getting a better understanding of the KPIs, the current use of KPIs and thoughts and suggestions around KPIs. Like the main project objectives and KPOs, several KPIs had already been suggested by the Bispevika project leaders. The suggested KPIs are shown in table 3.

The informants were first asked to come up with their own KPIs before they were shown the list of suggested KPIs from table 3. It could seem from how the questions was organized in the interview that the informants did not think freely but rather suggested KPIs linked to the KPOs they just had read. The answers below were stated before the list of KPIs from table 3 were shown.

One suggestion to a new KPI was to *“Have a decision plan. Make decisions internally and externally with a planning tool, you can track if decisions are taken. At the right time”*. To be able to track when the decisions are taken is important. This KPI should be a bit more specific, but it is a good fit with the KPO **Ability to make decisions at the right time**. A decision plan could be a good idea for improving the ICE meetings.

To measure **Create repeatability and similarity from project to project** one of the informants suggested that *“The only measurable quantity is the number of hours per apartment”*. I would say that there are more possibilities here, but if you are able to track hours per apartment, you can look at the apartments that took the longest or slowest time and try to find out what the time was spent on. Then you can learn from it.

Another KPI that was suggested was *“manage to have enough info to make the right decisions when required”*. It is often very difficult to take the best decision when you do not have all the information to fully understand the situation. This is even more true when it is required to take the decision within limited time. Having enough information available is therefore very important and crucial in the ICE meetings.

“Minimize resource usage on designing. I would rather say how to measure productivity with hours spent on designing. You can measure hours spent per predefined activity. Report on it”. Instead of **use of resources**, he said that the focus should be on productivity. Hours spent per predefined activity is quite similar as number of hours per apartment. This type of measuring clearly has potential as a KPI.

“Clear goals for the project are still unclear. Hard to find KPI to take care of it”. Here the interview informant is talking about **clear goals for the project that are guiding and focusing on prioritization in designing**. The problem here is that the KPO is unclear. To be able to measure the KPO, the KPO needs to be clear or else it is a problem.

“Deliver designing materials with the right quality at the right time, including planned work according to plan structure. “Back to whether things are done or not. Register it and run a non-conformance procedure if things are not done within

plan meetings". Here the interview object suggests using **Quality deviation** which is one of the KPIs from the document. This is considered a good thing because this shows that the informant is familiar with the method.

None of the informants came up with ideas to measure **Target value design**. Probably because almost none of them had heard the process and they asked me what it was.

After the interview, when the informants came up with their own KPIs they were shown the list of the suggested KPIs from table 3 made by the project leaders. Here we can look at what is being said about each KPI. Not every KPI were mentioned.

Number of solutions reused: *"important", "easy to measure"*. According to Collin (2002) it is a benefit that the KPIs are easy to measure. Collin (2002) says *Collecting data must be as simple as possible*. The informants were asked specifically to specify which KPIs that are easy to measure.

Continuity personnel advisory group: *"Is easy to measure", "It's a weakness to be very person-dependent", "important factor. Have history in the group. If someone is exchanged, it is important to have an experience transfer overlap"*. Some of the informants said it was a bad thing that this was an important KPI. They wished that it was not important.

Use of resources: This KPI resulted in some different opinions. The answers varied from *"Should be a priority"* and *"easy to measure"*, to suggesting alternative KPIs *"Perhaps even easier to measure resource usage per square meter or per apartment"* A solution here could be to add another KPI and keep this one. The KPI could be to measure resource usage per square meter, apartment or predefined activity. It was also pointed out that the linked KPO rather should be measuring effectiveness or productivity. Changes in the KPO should probably also cause a change in the linked KPI or KPIs.

ICE meeting: *"Is important", "easy to measure", "Have a person who can decide things in the ICE meetings, so we do not design a solution nobody wants to have"*. It was the person that was running the ICE meeting that came up with the last statement. The informant had experienced that there was a need for somebody to

decide which solution should be chosen. The informant said it should be the contractor, and that the contractor need to be very clear about his decisions.

Optimization: *“One way to get the entire organization to achieve 40% savings”, “In order to reach the main objectives of the project, you are dependent on thinking differently”*. These statements show that there is a connection with the project objective and the KPIs, which is a good thing. Even though they said the linked KPO was unclear, they all seemed to agree this was an important KPI.

Hand-over from calculation conducted: *“Very important”, “have a relation to what is calculated”*. Many informants agreed on this as an important KPI.

Project plan performed (PPU): *“Is the most important”*. PPU might be the most important indicator telling if the activities are delivered according to plan. *“good for revealing strengths and weaknesses in the design”*. Revealing strengths and weaknesses is an important benefit with a KPI according to Elshakour et al (2013). *“The purpose is to identify the strengths and weaknesses in performance. Then using lessons learned from the best ones to determine the best practices that can lead to improving their own company”*.

Lookout plan: *“Important”, “Perform it in proper time periods to have a relation with which deliveries will come in the long run”*. Checking supplies is particularly important in a project like Bisepevika because there is not much place to put the deliveries on in the project.

Phase plan: *“Is the most important”, “absolutely favorable”, “important but difficult to implement”*. The fact that it is hard to implement is a big disadvantage with the KPI.

Health, environment and safety by designing: *“There is zero tolerance with health, environment and safety deviation in the AF Gruppen”*. Pocock et al (1996) pointed at safety as an important success indicator. In addition, in general health, safety and the environment are extremely important at the construction site.

Collision test: *“I think I would reformulate this one a little. Not only a collision but also visual inspection, because you cannot exchange visual inspection with a collision test”, “Critical to this one”, “Important”, “Cheaper to remove errors in our 3D-models than removing errors at construction site”*. During the interviews, it seemed

like this program was a bit hard to use. It seemed difficult to conclude if there really was a collision or not by using the software.

Quality deviation: *“Important”, “quality deviations must be prioritized and that is already being done”, “quality deviation is important for revealing strengths and weaknesses in designing”*. The interview objectives agreed on this as a very important KPI.

Third party control: Not mentioned

Number of revisions: *“Deliver good quality from the starting point”*. Deliver good quality from the start to avoid revisions was stated many times in different settings. Obviously, an important point.

Delivery to procurement/operation according to plan: *“Certainly, an important point”*, Important to see if project material is delivered for procurement/operation according to plan. *“Avoid re-design when purchase is done”*. This is important because a redesign may result in a financial loss if materials you do not need are ordered or purchased.

BREEAM - Estimated score against requirements: *“Designing in an extra buffer for energy requirements significantly increases the chances to achieve the objectives”*, *“easy to measure”*. Both KPIs regarding the program BREEAM seemed easy to deal with and easy to measure, which is good.

BREEAM - Score achieved as-built: *“good follow-up along the way in the development of the project”*. It is important to check the score along the way to make sure the score is on track.

Completed Target Value Design processes: *“I am not familiar with the expression Target Value Design”*. Since most of the people was unfamiliar with target value design, the informants were also unknown to the KPI regarding Target Value Design.

In general, the informants were very satisfied with the KPIs. Among other things they said, *“Nothing of this is not interesting”* and *“a lot is covered”*. They did not have much negative to say about the different KPIs.

The informants also came up with thoughts about the use of the KPIs. One of the questions was to have them come up with critical comments about the use of the KPIs. One of the concerns that came up was regarding the work related to using KPIs. The informants said, *“I am afraid, that there will be a lot of reporting”, “someone has to report and gather the results”* and *“Comprehensive KPO/KPI work cause the workers in the project to spend a lot of time on gathering and analyzing this data”*. KPI work can truly be very time consuming and the employees in the construction industry have a very high workload, which make this an important point.

Another point that came up was *“define objectives and specify them for all the people in the project. The objectives have to be precise, so it is easier to relate to”, “I think it is important that it is well-informed to everyone”*. KPI-work require a certain commitment from the organization. First, the objectives need to be defined and then it is important that everyone in the business is well informed about the KPI.

Even though the informants had little experience with KPIs *“I have little knowledge about what KPI is”*. They pointed out a few important points about KPI work that is important. That was *“Two key elements learning and improvement”, “Use the numbers we get from the KPIs to make sure we get better”, “I think everyone should do measuring”*. The first statement is closely related to the RADAR logic from Beatham’s (2004) theory from figure 5. First, you have the implementation of measures and then you change action driven by results.

One of the interview object stated *“Indoor climate and well-being depend on how well you perform. The KPIs does not take such requirements into account”*. This was something that the interview object meant was not covered by the KPIs. It is very hard to make sure that the KPIs cover everything. It will be an assessment case to consider whether this is important enough the make another KPI.

Discussion

In which way will the four main project objectives help to achieve project success?

It is no doubt that the project objectives are ambitious. Having ambitious objectives can improve the organization at many levels and make it easier to prioritize. A major requirement is that all employees through the organization are well informed about the objectives. The interviews showed that all designers I interviewed were very well informed. Almost everyone knew all the four project objectives and had thoughts about them. Especially the objective about reaching 40% more value is forcing the employees to think differently, which is one of the essences in a priority project like Bispevika.

The expressed concerns were that they had no zero point to measure against and that the objective stating the most attractive district in Oslo is too subjective makes it very difficult to conclude if the objectives are reached. Even if the four project objectives are hard to evaluate quantitatively, a very important company motivator is that the full organization work towards reaching this objective. If the organization work very hard to become the most attractive district in Oslo, this vision obtains high visibility and priority that makes it much easier to get a good result. A very good result can be achieved even if, in the end, many people may prefer for example Aker Brygge instead. All though the design group does not have a KPO linked to this objective, other functions have the KPO "Completion of expectations for the area's attractiveness over time".

The informants seemed to agree on the idea of breaking the project objectives into sub objectives or KPOs and measure them through KPIs as a good idea. The main reason to do so is to define smaller more specific objectives to help a smaller part of the organization to achieve the main objectives. This showed that the project objectives were being transferred down through the organization in a good way, even though they pointed out that some objectives were not precise enough.

One of the four main project objectives are: Bispevika will change the interaction pattern in the construction industry. Usually in construction projects the designers are in different offices, but in the Bispevika project they are all co-located in one office. All the informants pointed out how important the co-location was. One stated that "*the*

fact that we are co-located here as much as we can, is important, I think” and it was also stated that *“If we manage to collaborate across all subjects, then there is a good chance that we will get it done”*. One way that the project can learn from the co-location is by using a survey, to gather the different opinions on what is working or not. It is important to document the learnings for the future to transfer the knowledge to a next project.

It was also a good decision to concentrate on a subset of KPIs for the function design as the function play a critical role in achieving the four main objectives.

To answer the researching question, the four project objectives seemed to be well understood and specific sub-objectives (KPOs and KPIs) for different functions are clearly defined and help the organization to reach project success. The four main objectives also fit well with Sadeh, Dvir & Shenhar (2000) theory in table 1 since the four objectives cover the main success dimensions. The four main objectives fits with the requirements on succeeding on design criteria “meeting design goals” (40% more value and design group KPOs and KPIs) “benefit to the end user” (the most satisfied customers), “benefit to the developing organization” (changing the interaction pattern) and “overall success” (create 40% more value). The objectives help the organization at a high level to focus on the most prioritized success factors. Having said this, there are also some obvious improvements that could be made, the project objectives may be difficult to quantify, and it is difficult to understand if you reached the objectives. The project objectives therefore may be understood as visions that describes priority’s in the project. It may be important to consider that the four objectives must be a goal for all the functions that work at Bispevika and it may therefore be difficult to have them to specific. In most cases, the KPOs will define more specific objectives for the different functions in the project.

[How can the defined KPOs help improving the design process to meet the project objectives, and can improvements be suggested?](#)

Collin’s (2002) guidelines on what factors should be considered for establishing KPIs was very central in the interview guide and is therefore also central in the discussion part. The guidelines will be used to understand which KPOs and KPIs that should be used in the Bispevika project.

The interview objectives were satisfied with **Create repeatability and similarity from project to project**. This KPO should be kept as it is.

When we look at **Minimize resource usage on designing** it's more difficult to conclude. By taking the following statement into consideration "*working with the efficiency of the design is better. The less time you spend on the design the worse the result will be*". The interview object seemed to be clear on the fact that a small investment could result in significant reduction in building cost. A too high focus on reducing design cost could therefor result in a bad design and thereby increased building cost. The KPO could be changed into **Increase the effectiveness of the design process**. Information from the interviews further indicated that minimizing resources on designing may not be the right thing to do at all. When asking the informants to come up with new KPOs that could help achieve the four main objectives, the following statements appeared "*Get the design perfect right from the start*" and "*Important to allow us to spend time looking at more than one solution*". These suggestions indicated that the overall cost could be reduced by spending more time on design phase. It may be understood that the more work that was spent on designing the better the solution would be, but at some point, you will reach the breaking point when you do not get enough profit from the work you put into planning the designing. It is favorable to try to reach this breaking point to get the best result out of the time you spend on planning the designing work. Still, it will be hard to find a corresponding KPI that could measure this, but if that is possible, it could be considered a KPO.

The informants were all positive to **Ability to make decisions at the right time**, so the KPO will stay as it is.

Clear goals for the project that provide good guiding and focus on the priorities in the design. Answers from interview indicate that this KPO was unclear. The KPO may not fulfill the requirements stated by Collin (2002), *for the performance measurement to be effective the measures or indicators must be accepted, understood and owned across the organization*. It seems like this KPO should be rephrased, so it is clear what the KPO really means. The reason for uncertainty could also be that the informants were asked for their opinion about the KPO alone. If the KPO had been shown together with the KPI and combined with information on what was measured, they may have been easier to understand. The KPI linked to this

KPO are **Optimization** and the KPI is measured by: preparation of an optimization strategy and **Hand-over from calculation** is measured by: has a review with the project leadership been implemented. A suggestion for an improved KPO could be a KPO with the same meaning just a rephrase of the sentence, that makes it easier to understand it.

Deliver designing materials with the right quality to the right time, including planned work according to plan structure and **Achieve BREEAM classification very good**. Based on what was said in the interview, the informants were satisfied with both KPOs. Therefore a good conclusion will be to keep them as they are today.

Target Value Design seemed to be unfamiliar to most of the people that was interviewed. The phrase from Collin (2002): *for the performance measurement to be effective the measures or indicators must be accepted, understood and owned across the organization*. Since only one or two informants who work with design had heard of the Target Value Design it should be removed. An alternative for the organization is to make sure that everyone has heard of it. If the informants from design were familiar with the Target Value Design, they might have agreed on it as important. Collin (2002) also said that *Only a limited, manageable number of KPIs is maintainable for regular use. Having (measuring) too many (and too complex) KPIs can be time- and resource-consuming*. That is why I chose to leave it of the list, even though it might have potential.

The fact that the interview objectives were satisfied with the KPO-list showed that it is proper work put into the KPO list. The defined KPOs will probably help improving the design process to meet the project objectives and improvements have been suggested.

[How can the proposed KPIs help to measure the KPOs and can improvements be suggested?](#)

For the KPO **Create repeatability and similarity, from project to project**, alternative KPIs were proposed. One of the informants suggested, *“The only measurable quantity is the number of hours per apartment”*. The square meter price can be compared between different projects and could be used for benchmarking. Square meter price is already used a lot both in construction. Average value square

meter price is also used in sales of apartments and houses are published for market understanding. Square meter price for designing of the apartments alone could be used for benchmarking since many of the variable costs for different projects can be omitted for this calculation. It has also been suggested that “*You can measure hours spent per predefined activity*”. By considering these two suggestions, I would like to add a KPI to the list. The KPI could be either **number of hours per apartment or number of hours spent per predefined activity**. The KPI **use of resource** would still be kept because it was also stated that it was important and easy to measure, which Collin (2002) believe is a good thing.

There were different opinions about the **collision test** KPI. One person stated: “*I think I would reformulate this one a little. Not only a collision but also visual inspection, because you cannot exchange visual inspection with a collision test*”. Collin (2002) says that *Having (measuring) too many (and too complex) KPIs can be time- and resource-consuming*. If we also add visual inspection to the KPI it will probably be too complex. It already seemed hard to understand if there really was a collision using the program.

Since almost nobody had heard of the Target Value Design a KPO was taken of the list. Because of this, the linked KPI **Completed Target Value Design processes** should also be removed from the list of KPIs.

During the interview, the interview objectives were asked specifically to specify which KPIs that should not be a priority. That means that the KPIs that were not mentioned, still could be important. It was probably a coincidence that some were not mentioned. Even though they were not mentioned they were read and understood, which is important. The informants were in general satisfied with the KPIs. I would therefore keep the KPIs that were not mentioned on the KPI list from table 3.

The KPOs and KPIs in design focus on the iron triangle: time, cost and quality, which is important as stated by Songer & Molenaar (1997), but as we can see from the figure 3 and 4 it is also important to add more factors then the iron triangle. In figure 3 and 4 Chan & Chan’s (2004) factors for project success very clearly show that participant satisfaction, in this case construction team’s satisfaction, is one of their main factors to reach project success. This statement is also supported by Thorpe & Kumaraswamy, (1996) and Shenhar, Levy & Dvir (1997). During the interview one

informant stated, *“I find that management has insufficient understanding of what the design makes and the importance of the BIM model”*. This shows that it is important to measure and document how well the design work is organized and executed. A different aspect of team satisfaction is the working environment both physically and mentally. One of the informants stated *“the work environment depends on how well you perform. The KPIs does not take such requirements into account”*. To better understand the challenges and priorities of the design team and learn from the current process a KPO that aims to improve feedback from the design team and a KPI that measure how the design team think the design process can be improved should be used. The KPO could be **improve feedback** and the corresponding KPI could be **employee satisfaction survey**. One possibility could be to use a survey to listen to the whole design group. Taking this one step further the survey could also include both contractor/Bispevika project leaders and the receivers of the design could also participate. By conducting a survey and get feedback on people and leadership AF Gruppen would get closer to the EFQM model shown in figure 7.

The measurement system at Bispevika contains a total of 19 KPIs within the function designing. From the informants it can be concluded that 18 out of 19 are valuable KPIs and that all 18 helps in measuring performance of the design group. On the other hand, Collin (2002) claimed that *Only a limited, manageable number of KPIs is maintainable for regular use. Having (measuring) too many (and too complex) KPIs can be time- and resource-consuming*. The different KPIs should therefore go through an evaluation with the aim of reducing the number of KPIs within this function.

A suggestion for AF Gruppen is related to the RADAR logic from Beatham's (2004) theory from figure 5. First, you implement the measures, and then you improve the work processes driven by the measured data. This means that the KPIs should be used to improve the design work by analyzing the data from the different KPIs while the design work is still ongoing. The improvements should be implemented during the project time. Per time, AF Gruppen is in the initial phase of using the KPIs to make changes in the sense that the amount of KPI data is so small sample that it is difficult to see trends. Right now, the KPIs are mostly used to give focus/prioritization in the daily work, not to change the actual processes. One of the informants also stated that this is important *“Two key elements learning and improvement”*. By using the KPIs by

the RADAR logic it will be easier for AF Gruppen to learn from their deficiencies and make improvement in the work processes.

The informants seemed satisfied with the KPIs and they cover a wide range of factors. By comparing the KPIs from table 3 with success measures from table 1 the KPIs in general cover the aspects off “meeting design goals”. This means that the proposed KPIs are good indicators to measure the KPOs and some adjustments have been suggested, where improvement potential was noticed.

To conclude on which KPOs and KPIs within the function designing should be used at Bispevika to achieve the main project objectives table 5 show the different adjustments from the measurement system. The KPOs and KPIs that are written in blue are the suggested additions based on the research and theory part. The KPOs and KPIs that are removed are colored in red.

Table 5: Adjusted KPOs and KPIs within function designing

Designing	
KPO	KPI
Create repeatability and similarity from project to project	Number of solutions reused
Increase the effectiveness in designing	Continuity personnel advisory group
Minimize resource usage on designing	Use of resource
	Number of hours per apartment
Ability to make decisions at the right time	ICE meetings
Clear goals for the project that are guiding and focusing on prioritization in designing	Optimalization
	Hand-over from calculation conducted
Deliver designing materials with the right quality to the right time, including planned work according to plan structure	Project plan performed (PPU)
	Lookout plan
	Phase plan
	Obstacle analysis
	Health, environment and safety in designing
	Collision test
	Quality deviation
	Third party control
	Number of revisions
	Delivery to procurement/operation according to plan
Achieve BREEAM classification very good	Estimated score against requirements
	Score achieved as-built
Improve feedback	Employee satisfaction survey
Target Value Design	Completed Target Value Design processes

Conclusion

Feedback from employees in the design group at AF Gruppen show that the ambitious four project objectives help the organization to think differently and is crucial for achieving project success. The project objectives lay the foundation for what the company will focus on. Having the project objectives linked to KPOs and KPOs linked to measurable KPIs is a good way to handle the project objectives.

Overall, the informants seemed satisfied with the KPOs and the KPOs will probably help improving the design process to meet the project objectives, but I also suggested some improvements. Suggestions for improved KPOs was to change: **Minimize resource usage on designing to Increase the effectiveness of the design process**. The goal of this change was to make sure more resources and time was put into the design process. The KPO **Clear goals for the project that provide good guiding and focus on the priorities in the design** needs a rephrase. In addition, **Target Value Design** was removed from list because it was unfamiliar to the design group. **Improve feedback** was added to the list to ensure learning from the work processes in the organization. Especially co-location of the design group and their work environment at Bispevika are important factors for including the KPO **improve feedback**.

The informants seemed satisfied with the KPIs and stated that the proposed KPIs were good indicators to measure the KPOs. A few small improvements were made. **Number of hours per apartment** was added to the list. This KPI is easy to measure and help AF Gruppen benchmark their data. **Completed Target Value Design processes** was removed from the list because almost nobody had heard of the process. To better understand the priorities and challenges in the design group the KPI **employee satisfaction survey** was added to the list. All the suggestions to improvements is listed in table 5.

I would recommend AF Gruppen to focus on the most important measures and remove some of the KPIs from the list. Another recommendation is to involve the employees in the KPI work. That fact that none of the informants had seen the KPIs before the interview suggests that there is a huge improvement potential for reaching a level where these measures are in active use and improve the work processes at Bispevika.

This thesis has given me a very good insight into the complexity of a large construction site and have given me an overview of all the activities that need to be conducted and at the same time to get a great result. The KPOs and KPIs focus on measuring key accomplishments and therefore some main challenges at a large construction site. The measures therefore also point specifically to what is needed to solve some of the main challenges and at the same time suggest solutions on how to control the work. This knowledge is of very high value and is a very valuable experience to bring with me when I start working in the construction industry.

I believe that the qualitative interview method that was used worked well. I could recommend using the method to interview other function groups. This is an efficient technique for improving the measurement system and to make sure the system focuses on the most important factors.

References

- AF Gruppen. (2018). *Boligutvikling I Bjørvika*. Gathered from <https://afgruppen.no/prosjekter/bygg/bispevika/>
- AF Gruppen. (2018). *Strategi 2020*. Gathered from <https://afgruppen.no/om-oss/strategi-2020/>
- Albert, P. C., Chan, Ada, P.L. Chan., (2004). Benchmarking: An International Journal. *Key performance indicators for measuring construction success*. Volume 11, Issue 2. Pages 203-221. Doi: 20.1108/14635770410532624
- Anskaffelser.no, (2017, 09.11), Prosjektering i byggeprosjekter, Gathered from: <https://www.anskaffelser.no/prosess/gjore-anskaffelser/hva-skal-du-kjope/bygg-anlegg-og-eiendom-bae/byggeprosess/prosjektering>
- Arksey, H & Knight, P. (1999), *Interviewing for Social Sciences*, London: Sage.
- Atkinson, P & Coffey, A. (2004), *Analysing documentary realities*, in d. Silverman., qualitative research, second edition. London: sage. P 77-92
- Atkinson, R. (1999), International Journal of Project Management, *Project management: cost, time and quality, two best guesses and a phenomenon, it's time to accept other success criteria*, Volume 17. NO 6. Pages 337-342. Doi: 10.1016/S0263-7863(98)00069-6
- Bassioni, H. A. Corresponding author., Price, A. D. F & Hassan, T. M., (2005). Construction management and economics. *Building a conceptual framework for measuring business performance in construction: an empirical evaluation*. 23:5. Pages 495-507. Doi: 10.1080/0144619042000301401
- Beatham, S., Anumba, C., Thorpe, T., (2004). Department of Civil and Building Engineering. *KPIs: a critical appraisal of their use in construction*. Volume 11, NO 1. Pages 93-117. Doi: 10.1108/14635770410520320
- Blayse, Aletha, M & Manley, K. (2004), *Key influences on construction innovation*, Construction innovation, Volume 4. No 3. P 143-154. Gathered from: <https://eprints.qut.edu.au/7301/1/27507.pdf>
- Chan A. P. C (1996), *Determinants of project success in construction industry of Hong Kong*, University of South Australia, Adelaide.
- Codex Advokat and entrepriserettadvokater.no, (2018, 03.09), Hva må prosjekterende gjøre før arbeidene er ferdig prosjektert? Gathered from: <https://www.entrepriserettsadvokater.no/konsulentavtaler/hva-ma-prosjekterende-gjore-for-arbeidene-er-ferdig-prosjektert/>
- Collin, J. (2002), *Measuring the success of building projects – improved project delivery initiatives*, July 2002

Cowie, A. P., (1990), *Oxford Advanced Learner's Dictionary of Current English, 4th ed.*, Oxford University Press, Oxford

Elshakour, H. A., Al-Sulaihi, I. A., Al-Gahtani, K. S., (2013). *Journal of King Saud University – Engineering Sciences. Indicators for measuring performance of building construction companies in kingdom of Saudi Arabia*. Volume 25, Issue 2. Pages 125-134. Doi: 10.1016/j.jksues.2012.03.002

Haddadi, F., Yaghoobi., (2014). *Management Science Letters. Key indicators for organizational performance measurement*. Volume 4, issue 9. Pages 2021-2030. Gathered from <http://growingscience.com/beta/msl/1701-key-indicators-for-organizational-performance-measurement.html>

Hammersly, M & Atkinson, P. (1995), *Ethnography, Principles in practice*, second edition, London: Tavistock

Johannessen, A, Christoffersen, L & Tufte, P. A (2011), *Forskningsmetode for økonomisk-administrative fag*, abstrakt forlag

Johannessen, A., Christoffersen, L. & Tufte. P. A. (2011), *Forskningsmetode for økonomisk-administrative fag*, abstrakt forlag

Kaplan, R. S & Norton D.P, (2000), *Harvard business review on point, Using the balanced scorecard as a strategic management system*, Product 4126. Pages 1-14. Gathered from http://jackson.com.np/home/documents/MBA4/Management_accounting/BSCHarvardBusinessReview.pdf

Kaplan, R. S & Norton, D. P (1996). *The Balanced Scorecard*, Harvard Business School Press, Cambridge, MA

Kometa, S. T., Olomolaye, P. O & Harris. F. C, (1995), *Construction and Architectural Management, An evaluation of clients' needs and responsibilities in the construction process*, Engineering, Volume 2, Issue 1. Pages 57-76. Doi: 10.1108/eb021003

Lim, C. S & Mohamed M.Z. (1999), *International Journal of Project Management, Criteria of project success: an exploratory re-examination*, Volume 17. NO 4 pages 243-248. Doi: 10.1016/S0263-7863(98)0040-4

Lincoln, Yvonna, S & Guba, E. G (1985), *Naturalistic inquiry*. Beverly hills: Sage

Luu, V. T., Kim, S & Huynh, T., (2008), *International Journal of Project Management, Improving project management performance of large contractors using benchmark approach*, Volume 26. Issue 7. Pages 758-769. Doi: 10.1016/J.ijproman.2007.10.002

- Luu, V. T., Kim, S. Y., Huynh, T.A., (2008). *International Journal of Project Management. Improving project management performance of large contractors using benchmarking approach*. Volume 26, issue 7. Pages 758-769. Doi: 10.1016/j.ijproman.2007.10.002
- Munns, A. K & Bjeirmi, B. F., (1996), *International Journal of Project Management. The role of project management in achieving project success*. Volume 14, NO 2. Pages 81-87 Doi: 0263-7863(95)00057-7
- Naoum, S. G (1994), *Journal of Construction Engineering and Management, Critical analysis of time and cost of management and traditional contracts*, Volume 120. NO 3. Pages 687-705)
- Parfitt, M.K & Sanvido, V.E (1993), *Checklist of critical success factors for building projects*, *Journal of Management in Engineering*, Vol 9. No 3. P 243-249. Doi: 10.1061/(ASCE)9742-597x(1993)9:3(243)
- Pinto, M. B. & Pinto, J. K. (1991). *Project Management Journal, Determinants of cross-functional cooperation in the project implementation process*, Volume 22. NO 2. Pages 13-20. Gathered from <https://www.pmi.org/learning/library/determinants-cross-functional-cooperation-team-performance-2076>
- Pocock, J. B., Hyun, C. T., Liu, L.Y & Kim, M. K., (1996), *Journal of Construction Engineering and Management, Relationship between project interaction and performance indicator* , Volume 122. NO 2. Pages 165-176. Doi: 10.1061/(ASCE)0733-9364(1996)122:2(165)
- Reh, F. J., (2017). *The Basic of Key Performance Indicators (KPI)*. Gathered from <https://www.thebalancecareers.com/key-performance-indicators-2275156>
- Ryen, A. (2002), *Det kvalitative intervjuet: Fra vitenskap til feltarbeid*, Fagbokforlaget.
- Sadeh, A., Dvir, D & Shenhar, A. (2000), *Project Management Journal, The role of contract type in the success of R&D defence projects under increasing uncertainty*, Volume 31. NO 3. Pages 14-21. Doi: 10.1177/875697280003100303
- Shenhar, A. J., Levy, O & Dvir, D, (1997), *Project Management journal, Mapping the dimensions for project success*, Volume 28. NO 2. Pages 5-13- Gathered from <http://www.reinventingprojectmanagement.com/material/other/7.%20Mapping%20dimension%20of%20projects%20success%20PMJ%201997.pdf>
- Silverman, D, (2014), *Interpreting qualitative data*, Sage
- Slaughter, E. S (1998), *Models of construction innovation*, *Journal of Construction Engineering and Management*, volume 143. No 3. P 226-232. Doi: 10.1061/(ASCE)0733.9364(1998)124:3(226)

Songer, A. D & Molenaar, K. R, (1997), Journal of Construction Engineering and Management, *Selection factors and success criteria for design-build in the US and UK*, Volume 123. NO 1. Pages 34-40. Gathered from

<https://www.colorado.edu/engineering/civil/db/papers/usuk/>

Thagaard, T, (1998), *Systematikk og innlevelse: en innføring i kvalitativ metode*, Fagbokforlaget

Thorpe, A & Kumaraswamy, M. M, (1996), Journal of Management in Engineering, *Systematizing construction project evaluation*, Volume 12. NO 1. Pages 34-39 Doi: 10.1061/(ASCE)0742-597X(1996)12:1(34)

TVD Research Group (2013), What is Target Value Design, Gathered from <http://targetvaluedesign.org/about.html>