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Identify and Develop Key Performance Indicators for High-Technological Engineering and Construction Projects

A Case Study of Kockums AB

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Abstract

Background: There is an ongoing trend amongst management within engineering and construction business to adopt Key Performance Indicators (KPI). Since this line of business requires timely information in order to take the adequate decisions and actions to ensure that no delays occur. Kockums AB operates within the defence industry with development, design and production of naval vessels. This company is currently developing KPIs in order to enhance the control over its projects.

Purpose: The purpose of this paper is to identify critical activities and develop situational key performance indicators in the design phase for advanced high-technological engineering and construction projects.

Method: The selected research approach is a qualitative approach, since the complexity of Kockums AB's productions and processes requires a deeper understanding to identify and develop KPI's. In this report the collection of information has been obtained by interviews with employees and by accessing internal documents at Kockums AB.

Conclusions: Kockums AB is currently developing five KPIs for its operations within the design phase, but there are several critical success factors, which Kockums AB must address before introducing the KPIs to its operations. Furthermore, there is a need to include a base of standard KPIs and complement within situational KPIs. It is also decided that the traditional targets of project quality, budget and time must be extended to include employee satisfaction in order to ensure the sustainability of the competence of the company.

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Abbreviations

ACWP	Actual Cost for Work Performed
BAC	Budget At Completion
BSC	Balanced Scorecard
BCWP	Budgeted Cost for Work Performed
BCWS	Budgeted Cost for Work Scheduled
CEO	Chief Executive Officer
CFO	Chief Finance Officer
COO	Chief Operative Officer
C/SCSC	Cost/Schedule Control Systems Criteria
CSF	Critical Success Factors
DG	Decision Gates
EAC	Estimate At Completion
EC	Executive Committee
ERP	Enterprise Resource Planning System
ETC	Estimate To Completion
EVM	Earned Value Management
FMV	Swedish Defence Materiel Administration
ICO	Installation Check-Out
KAB	Kockums AB
KPD	Key Performance Drivers
KPI	Key Performance Indicators
KPO	Key Performance Outcomes
KSF	Key Success Factors
PMBoK	Project Management Body of Knowledge
PMS	Performance Measurement System
PoC	Percentage of Completion
R&D	Research & Development
RFI	Request for Information
RFQ	Request for Quotations
TLS	Through Life Support
ToR	Terms of Reference
VBM	Visual Boards Meetings
WBS	Work Breakdown Structure

1. Introduction

This section presents the problems regarding the performance measurement system and project management, subsequently followed by background information regarding the case study of Kockums AB. The section continues by an argumentation that will constitute the basis for this paper's purpose. Furthermore, it will present a description of the papers further disposition.

1.1 Problem Discussion

Today's modern business climate is rapidly changing due to the expansive globalization which results in growing competition that increases the pressure on companies within all sectors to make their operations and organisations more efficient in order to ensure a high profitability and thus a long-term survivability. The Performance Measurement System (PMS) constitutes a critical part within the business management toolbox, in terms of supporting, clarification, controlling and achievements of the organisation's objectives. It is also expected to provide a balance between short and long-term performance of the organisation (Simons, 2000).

An ongoing trend amongst management that has grown in popularity is to adopt a PMS such as Key Performance Indicators (KPI), Performance Prism and Balanced Scorecard (BSC) in order to improve the efficiency within the company and the linkage of the company's strategy throughout the organisation (Neely et al., 2002; Davis & Albright, 2004; Kaplan & Norton, 2001, Cheng et al., 2007; Hall, 2008; Franco-Santos et al., 2012). However, the definition of PMS is highly debated among scholars. According to Neely et al. (2005) efficiency and effectiveness are vital parts within the PMS, on the contrary Franco-Santos et al. (2007) chooses to combine different definitions in order to obtain a sustainable PMS definition. Furthermore, Franco-Santos et al. (2007) classifies the PMS into three perspectives, namely the operations, strategic and accounting. The intentions of the combined perspectives are to present valuable information, consequences and function. This is in line with Shank (1989) and Nanni et al. (1992) perception that states, PMS may be included with policies and actions to facilitate communications between activities and the strategic goals. In addition, the key task of the PMS can be divided into five parts; measuring the business performance; communication; align the strategic targets; affect the behavioural status of the organisations; and to learn and improve the ongoing business (Franco-Santo et al. 2007).

In conclusion, the PMS consists of two critical functions, which is to align the strategic targets to measurement and subsequently supervise the ongoing performance. However, there are two reasons why it is especially challenging to develop measurements for organisations. The first reason is to define the performance, effectiveness and efficiencies. The second reason is to achieve adequate measurements and metrics, due to the lack of definitions (Philips et al., 1999).

The technology-based and service-providing companies of today are using projects more extensively in order to increase the effectiveness of their operations, change and development (Flyvbjerg et al. 2003; Artto & Wikström, 2005; Davies, 2004). In addition, many companies will also choose to operate their business solely as projects (Macheridies, 2005). The main issue is to break down the scope of work into packages, which requires interaction and integration together with planning in order to meet the contracted deliveries. The integrated solution between work and material constitutes a fundamental part within projects and this in turn increases the demands of integrated organisational solutions. Consequently, the project management's central task is to manage the project within this complex environment. Thus, the control of both the project and the project oriented activity is critical to achieve long-term profitability and resource selection for a company's business (Söderlund, 2008). According to Söderlund (2008) there is an absence of literature within the field of project management control. Furthermore, the practitioners are currently applying inadequate project models and there is a confusion regarding the progress and resource consumption.

Adams & Neely (2000) presented the performance prism as a result of an extensive research (Marr & Schiuma, 2003; Najmi et al. 2012) in the recent years in the area of framework and models of performance measurement. This model seeks to explain five inter-related aspects: (1) stakeholder satisfaction, (2) stakeholder contribution, (3) strategies, (4) process and (5) capabilities. According to Neely et al. (2002) one of the most common misunderstandings regarding the design of performance measurements is the requirement of derived strategy to the measurements. Instead, the most important task is to judge the stakeholders needs before formulating the strategy, hence this framework suits companies that prioritise the creation of value for the stakeholders. A main advantage in applying such a model is that it challenges the current strategy previous to the design of the measurements. Consequently, the newly formulated strategy will have a strong link to the organisations. According to Tagen (2004) the performance prism will contemplate new stakeholders, which are regularly ignored in the design of the measurements. The main critic towards the performance prism is the lack of

review procedures (Najmi et al. 2012). However, it is suggested by Najmi et al. (2012) and Kaplan & Norton (2004) that BSC can offer a review as the primary process, which is performed by recurrent workshops and meetings.

Historically, project managers within the construction business are usually focused on the idea of developing performance measurement system in order to facilitate the status determination of the project in terms of activities and targets (Haponava & Al-Jibouri, 2009). Traditionally the main purpose can be derived from the theory of benchmarking applied within many organisations in order to enhance the product or processes and increasing the comparability (Hapovana & Al-Jiborui, 2009). However, the PMS are mainly applied for review reason, consequently making them unsuitable for status reporting, more commonly known as the lagging problem i.e. drivers vs. outcomes (Haponava & Al-Jibouri, 2009; Walsh, 1996). In construction projects it is extremely important to gain control and recognize the potential critical phases, in order to ensure the success of the project. The main limitation for these types of projects are constituted by the iron-triangle, which consists of three aspects time, cost and quality (Walker, 1995; Belassi & Tukel, 1996; Lendyuk & Rippa, 2009; Lauras, et al., 2010)., Recently, an increasing popularity have occurred to extend these indicators to include more aspects as e.g. productivity and risk (Cha & O'Connor, 2006; Cha & Kim, 2011).

As stated above, traditionally the limitations of the project measurements are based upon the iron-triangle. Prior researchers Ward et al. (1991), Moshini & Davidson (1992), Gahalyini & Nobel (1996) and Cha & Kim (2011) stipulate the need to extend the base in order to guarantee success of the projects within the construction business. Several researchers are also discussing the importance of processes in order to facilitate the development of measurements. According to Feurer & Chaharbaghi (1995) the recommendations are to prioritise process measurements over function within the projects. Measuring the outcomes in construction projects is secondary to the process (Pillai, 2002). The findings of Naik et al. (2004) enhances previous theory that it is essential to identify the process goals, which act as the foundation of the measurements to predict and facilitate the control of the continuous progress of a project. The construction business has been criticised regarding the KPI for only applying end-product measurements, consequently negatively affecting the ongoing progress control (Beatham et al., 2004).

The above project organisation and performance measurement theory is supposed to be evaluated in conjunction with a project-oriented company's operations within the engineering

and construction business. The selected company is Kockums AB (KAB), which is one of the world leading designer and constructor of conventional submarines.

1.2 Background Kockums AB

Kockums Workshop was first founded in 1840 and its business field has included general mechanical production such as commercial shipbuilding, railroad wagons and naval vessels. During the aftermath of World War 2 KAB focused on ship construction and in the 1950s-60s was awarded the world's most productive shipyard in the world with a yearly delivery of 12 oil tanker ships. Regarding the submarine business, KAB received a licence from an Italian shipyard in 1914 to construct submarines, which was the beginning of the designing and construction of submarines. Since then there has been continuous design and production of submarines within the company. In 1962, KAB was awarded a contract from the Swedish naval forces through *Swedish Defence Materiel Administration* (FMV) regarding the design and production of six new conventional submarines. This contract made it possible for the company to develop the air independent propulsion and formed the basis for KAB to become a world leading designer and constructor of conventional submarines. In 1986, KAB announced the new contract for the design of a new submarine class to the Royal Australian Navy. The six submarines were primarily produced in Australia within a company mainly owned by KAB. This contract had a value of $ 3900 ABN at the time and was considered the largest in the history of Swedish defence business. (Pålsson et al., 2008)

KAB, is today solely concentrating the business on maritime and naval solutions. Furthermore, since the early 21st century KAB is a subsidiary to the ThyssenKrupp AG group, which is located in Germany. The company's operations is located in three places in Sweden; their headquarters is in Malmö with the task of design and developing the submarine; the production is located in Karlskrona, where also the design and construction of surface vessels is made; Karlskrona and Muskö is accountable for the maintenance of submarines and naval vessels. According to the fiscal year of 2011, the inflow of orders amounted to 1, 3 BNSEK and turnover was 1, 86 BNSEK. There are currently 949 employees distributed among the three geographical locations of the company (Kockums AB, 2011).

The company makes a significant difference in the definition of projects. There are currently two project classifications: customer- or internal-oriented. The customer-oriented classification means that the project is divided into six phases: (1) marketing, (2) tendering, (3) design, (4) production, (5) verification and (6) maintenance. Furthermore, these projects

are often strategically important for the company, linked to a contract, runs during a longer period of time and include a greater collaboration between different departments and the supply chain. The characteristics of the internal projects are small in scale, life time and are commonly limited to one department; with the exception of KAB financed Research & Development (R&D) projects (Bergman, 2013). The defence industry has a long tradition of working in projects on the international arena and KAB is no exception, for instance the Australian Project. (Westergård, 2013)

The overall responsibilities of the project are divided among the steering committee and the project management. The steering committee is the projects decision-making body and the tasks include scrutinizing, approving and monitoring the project specification. Furthermore, the committee establish the projects necessary strategies and goals, in order to ensure the progress of the project. Consequently the project management's responsibility is to achieve the project goals and the contract, whereas the steering committee is accountable for the strategic decision. (KAB, 2013)

Recently, the KAB business for submarines and naval vessels has further developed its project control system and subsequently developing and implementing a new PMS, more precisely the KPI, but, this survey will only include the submarine business. In the early 2011, the company has launched a business development program "*Kraft 2.0*" in order to improve the overall efficiency and outcomes of the entire organisation. Previously, the company has applied project management in conjunction with its steering committee to control the projects. Consequently, the company is only in the beginning of the identification and development phase with KPI, which is emphasized in this paper. Further, the company has numerous factors that might complicate this process such as the production of very complex products, high demands from the customers together with special laws to obey regarding the safety and security associated with the product. The ongoing projects within the company's project portfolio are competing regarding the different types of resources such as different competences within the company staff. From a project management perspective is it necessary to ensure that the progress of each project is following its time schedule and stays within budget, thus, it is crucial for the project management to obtain project control. These combined factors offer a highly interesting opportunity to acquire a deeper understanding and knowledge of both the KPI and project management. (Westergård, 2013)

1.3 Purpose

The purpose of this paper is to identify critical activities and develop situational key performance indicators in the design phase for advanced high-technological engineering and construction projects.

1.4 Delimitations

The scope of this paper will mainly focus on the project organisation KPI, but it will also include the line organisation for explaining purposes. It is also stressed that this paper includes only one company in order to receive a better understanding of this case. Therefore, the analysis will primarily constitute of theoretical generalisation characteristics.

1.5 Disposition

Section 2 – Method

In this section are the scientific approach described and a motivation of the case. The interview approach is also explained and the source criticism. The section ends with the validity and reliability

Section 3 – Theoretical Framework

The section starts with an introduction to the overall project management, thereafter follows a general presentation of the key performance indicator's and critical success factors. The section also includes theorisation regarding the performance prism and balanced scorecard.

Section 4 – Presentation of the Case

Here is the case presented and its organisational responsibility, the section continuous with describing the processes. The section ends with a presentation of the company's key performance indicators.

Section 5 – Analysis

The section concerns the analysis of the empirical material and starts with the organisations. Subsequently, the company's critical activities are analysed in conjunction with the key performance indicators.

Section 6 – Conclusion

This section will discuss the general conclusions of the case and whether the applicable towards similar companies. The section ends with recommendations of further research.

2. Methodology

This section addresses the methodology of this paper. Initially the chosen research approach is presented and a motivation of the case is given. A brief explanation of the papers continuously approach is described. The section ends with an appreciation of the validity and reliability.

2.1 Research Approach

The purpose of this paper is to study how KAB can identify critical activities and develops situational KPIs in the design phase for advanced high-technological engineering and construction projects, and to motivate why these particular KPI has been selected. It is important to gain a deeper understanding while designing situational KPIs for these complex projects, and therefore a case study is suitable to perform. According to Yin (2007) when the researcher desires to answer how or why a certain action succeeded or failed, the case study is the best way to answer it. Furthermore, it is important to stress that no general conclusions regarding the population can be learned from only one case study (Yin, 2007).

The selected research approach for this paper is a qualitative approach, mainly, because the selected company produces a highly complex product, which requires specialist know-how. With this in mind, interviews will be prioritised over surveys in order to provide a deeper comprehensibility, which is required to develop satisfactory conclusion for the selected case. The interviews are equally designed to counteract that the respondents may perceive the questions differently. According to Bryman & Bell (2003) it is suggested that the quantitative research approach is suitable to utilise for measurements, but is not in line with the purpose of this paper. This requires a profound methodology to account for the complexity that this entails. This paper will apply a combination of inductive and deductive method, mainly since the company has begun to develop a certain KPI and these areas will be subject for assessment. Furthermore, recommended Bryman & Bell (2003) to apply an inductive approach together with a qualitative research. The inductive approach aims to study the research object without the base of theory for the survey, thus the researcher creates a theory solely based on theory from the research object. The critics argue that the inductive approach often lack scope or generality, due to the empirical based foundation for the given situation (Patel & Davidson, 1991).

2.2 Motivation of the Case

The selected company is KAB, mainly because of the author's permanent employment at KAB, which gives full access to the needed data. This constitutes a general advantage when conducting the research on this company. Usually the researcher is limited by the access of the empirical material. However, this company is active within the defence industry, which makes it difficult to publish information, but this mainly concerns technical and commercial vital information. In addition, there is a risk that the author might overlook information, due to the employment. Furthermore, the company has a long and extensive collaboration with Lunds Technical University; hence it has previous experience with master students. This case offers a great attractiveness to be able to study the development of a PMS from step one. According to prior researchers Chan & Chan (2004) and Hapovana & Al-Jibouri (2009) is it highly essential to control the early phase of projects in order to facilitate the control later on. KAB is applying the iron-triangle as the target for control, but it is argued that it might be insufficient (Pillai, 2002; Naik et al., 2004; Cha & Kim, 2011). During the research period the company launched its second efficiency program "Kraft 2.0" for a few selected departments for a testing period. The intention is to implement this program on the entire company.

2.3 Interviews

The company has assigned a supervisor (Johny Westergård) to the author to facilitate the interviews and collection of empirical material. The interviews have mainly been collected from a small group within the company with the mission to develop KPI's to support the project management level. The total performed interviewed at KAB amounted to eight persons (figure 1). The work streamline is formed by employees from process-, project management submarine, quality and process- and process development departments. During the interviews an open environment has been emphasized where the interviewee can feel safe and clam, in order to receive an open interview (Yin, 2007). Furthermore, as an employee the author is familiar with the most of the respondents, this also is a benefit to create an open interview. In certain cases the interviewee has suggested that other employees might have more experience in certain areas. According to Yin (2007) the respondent becomes an informant instead of an interviewee. The average length of the interviews has been around 0, 5 - 1 hour, and the form has been a dialogue. The main reason to why there are several meetings (figure 1) with Johny Westergård is because the author needed guidelines in order to collect information and meetings. To further strengthen the theory chapter an interview has

been performed in conjunction with an internal consultant from Combitech. Björn Enqvist who's daily work includes consulting companies of their implementation of KPI.

Respondent	Position	Place	Characteristics	Length	Occasions
Annika Nilsson	Subproject Manager	Malmö	Person-to-person	30 min	1
Anders Otterlund	Project Manager	Malmö	Person-to-person	30 min	1
Björn Enqvist	Internal Consultant	Malmö	Person-to-person	30 min	1
David Lussi	Process Development Manager	Karlskrona	Telephone	30 min	1
Florina Barbu	Planning Manager	Malmö	Person-to-person	30 min	1
Gunnar Örn	Head of Administration Department	Malmö	Person-to-person	30 min	1
Johny Westergård	Quality Manager	Malmö	Person-to-person	240 min	8
Lars Ekstrand	Head of Submarine Design Department	Malmö	Person-to-person	60 min	1

Figure 1: Interviews

2.4 Primary and secondary data

There are two different kinds of sources, which is primary and secondary data. Primary data means that the researcher gathers information and analyses it directly from the source. Consequently, the data gathering can be tailored for a specific problem. Secondary data refers to when the researcher gathers information that derives from other than primary sources, with the consequence that the concerned information might have other purposes than the research intended (Jacobsen, 2002). The main empirical findings are gathered from interviews, direct observations, archival material and internal documents, which is consistent with the primary data. Yin (2007) highlights the difficulties with the accessing of internal documents and archival material, but the author has full access to these materials, thus facilitated the collection of empiric material. The only used secondary data is the journal article and textbooks.

2.5 Source Criticism

When applying a source critical judgement the practice is to use four different criteria:

- *Authenticity*: This indicates that the researcher can question the control of the source.
- *Time Relationship*: This is only relevant regarding storytelling sources. There is a risk that the collected data from the interviewed become less reliable the longer time has passed.
- *Depending*: The concerned information shall derive from the primary source in order to increase the information value.

- *Tendency*: The source shall constitute impartiality in order to increase the reliability of the information (Thurén, 1996).

The above mentioned criteria will constitute the source selection of this paper, where all sources are carefully and critically examined and the sources which were not considered to fulfil these criteria are not included. Concerning the journal articles, the majority is scrutinised and "peer-reviewed" that refers to an expert, who has determined that the information is reliable. This paper will not use newspaper articles as source due to the low reliability they are considered to possess. Internet sources are used to that extent that the reliability can be assured, e.g. governmental, or company websites. The use of textbooks is minimized, due to the lack of scientific foundation.

2.6 Validity and Reliability

The definition of a valid paper is that the survey measures what the researchers has the intent and desire to measure (Saunders et al, 2007). To further improve and enhance the validity the result should be unaffected by non-desired factors. The author has an employment at the studied company and this might constitute a problem regarding the neutrality of the empirical material. However, the author has taken several precautions to prevent this from occurring. First, the company is in need of a neutral report to assess the development and to judge the validity regarding the KPI. Secondly, the report should be grounded in the academia. Third, the author is not directly working with his own department or manager. According to Yin (2007) there are four types of judgements regarding the quality of a paper: the conceptual, internal, external and reliability. To ensure conceptual validity the clarification progress is emphasized during the report. Since the company design and produces military products, consequently the published information is required to be scrutinised in terms of safety and security. The company supervisor has performed this in order to make sure that no confidential or secret information has been included in this report. This might constitute a problem regarding the internal validity from a case study's perspective, which is to guarantee that the conclusion based on the empirical findings is not influenced or affected by others (Yin, 2007). However, the advantage that the company supervisor will scrutinise is that he can highlight errors within the empirical material, which in other cases had not been discovered. The conclusions of this report cannot be subjected for a statistical generalisation, but rather an analytical generalisation. Yin (2007) provides that it is incorrect to criticise case studies for the lack of generalisations mainly, because survey studies are based on statistical generalisation whereas case studies generates analytical generalisations. The definition of a

high reliability is the possibility to replicate the survey and obtain the same results again (Saunders et al, 2007). However, if an equivalent survey is performed several times with varying results, the original survey will not be considered as a reliable measurement (Bryman, 2008). By applying a critical source selection the reliability of the survey may increase. In this paper a vast majority of the sources originate from journal articles, which in turn increases the reliability of the paper.

3. Theoretical Framework

This section begins with an overall presentation of the theory regarding the project management and performance measurement within industrial construction companies. This includes the operational, strategic control, stage-gates, key performance indicators, critical success factors, key success factor, performance prism and balanced scorecard.

3.1 Project Management

There are two major issues concerning the control of a project: (1) should a project form be chosen? If the company has decided to select the project form, it needs to clarify targeting and the control responsibility of a project manager: (2) the arisen difficulties to judge the projects progression in terms of value creation (Söderlund, 2008). Furthermore, the control within a project oriented environment can be divided into two levels: (1) the *strategic control*, which concerns the choice of project and the balance within the project portfolio. Furthermore, the strategic control should decide that the individual projects strategy is in line with the current company strategy (Lyneis et al. 2001). The strategic control also addresses the issue of how the project shall be managed and by whom either as a line organisation activities or ongoing work. (2) The *operational control* concerns the project levels responsibilities and defines the role of the project manager. Furthermore, the operational control addresses issues affecting the project process, project-planning the evaluation of business potential and feasibility studies etc. (Söderlund, 2008) (Lee et al. 2006).

The project life cycle should be closely linked to the project economy and it consists of four different phases (se figure 2):

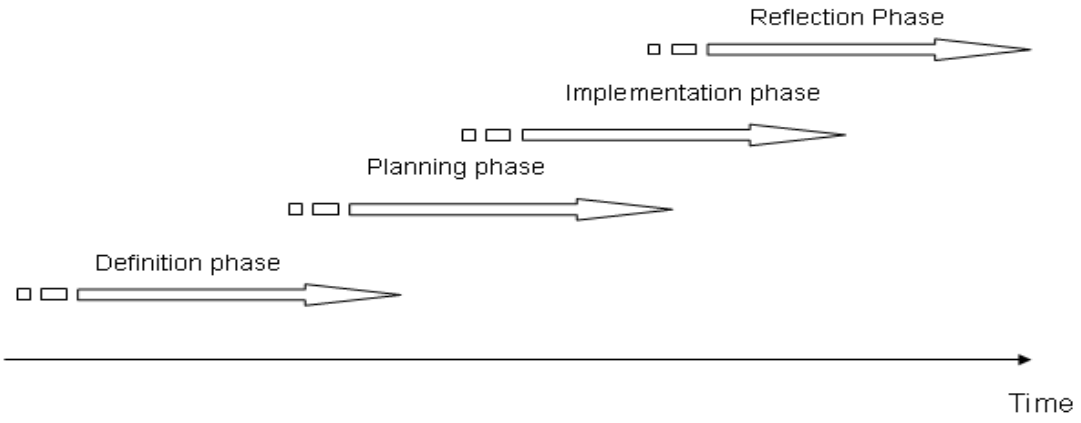

Figure 2: The Project Life Cycle Phases (Macheridis, 2005).

The definition phase regards the start-up process, which includes pre-projects and project definition studies that will act as a foundation for progress decision. The three other phases is continuously ongoing in relation to the project life cycle. The reflection phase refers to the evaluation and termination of the project (Macheridis, 2005).

There are three types of projects: business projects, development projects and modifications projects. However, in practice it is possibly to locate combinations of the different types. For instance, different phases within a business project may present items that require development work. Söderlund's (2008) model "*a typology of project: business-, develop- and modifications projects*" presents a detailed description regarding the different projects forms, which is illustrated in (figure 3).

	Business projects	**Development projects**	**Modification projects**
Description	Deliver and implement complex solutions/ system to customer.	Develop new technology, product or service for productions/sale or usefulness within the companies business projects.	Modification of organization and operations in order to improve the continuously operation, alternatively to implement improvements in the company's business or development projects.
Control principles	The contract control, specifications regarding what to deliver should act as control document If the contractual payment is included than shall the financial control of the projects cash flow and profitability be Measured.	Project targets and specifications is formed as the basis for control. It includes detailed presentation of work e.g. estimation costs and time. The control of the project can vary between time, cost and quality.	Outcomes and project targets applies as control principles, even though focus lies on long-term outcomes. In some modifications projects will the project target constitute as the main focus e.g. implementation of new set to work, date to follow-up cost for implementation.
Control challenges	Customer dialogue, interaction, negotiations and integration of knowledge between customer and supplier.	Definition of target, specification, integration of knowledge in order to solve the technical problems.	Resistance toward change, abutment, intern marketing and management hierarchy.
Critical success factors	Profitability and customer satisfaction.	Project targets: time, cost and quality. client satisfaction (e.g. product management).	Realized improvements company management/client satisfaction.

Figure 3: A Typology of Projects Business-, Develop- and Modifications Project (Söderlund, 2008)

The general definition of control can be summarised into that the management applies individual's behaviour and/or implement strategy to influence the organisation. The tools to achieve the targets are usually budgets, follow-ups, ratios, planning and responsibilities. This can be translated into a project context, where it is important to ensure that resources are adequately distributed in order for the project to be successful. However, it is hard to determine whether a project success is achieved. The practices usually determine project success as when the project has accomplished its targets i.e. the iron-triangle. According to Ward et al. (1991), Moshini & Davidson (1992), Gahalyini & Nobel (1996), Cha et al. (2011) and Söderlund (2008) the iron-triangle is not sufficient to determine whether the use of resources has been effective throughout the project. With this in regard there are five areas that establish the projects targets and follow-ups: (1) projects targets, the iron-triangle, (2) the projects effect in relation to the customer, (3) the project effects on the internal organisation, (4) the projects commercial impact and (5) the projects future effects (Söderlund, 2008). Both the operational control and the strategic control should interact with these five areas to ensure project success.

3.1.1 Operational control

One of the project manager's responsibilities is to manage the projects resources effectively. In specific cases the project manager has an even more extensive authority such as purely controlling the assigned resources. To counter this problem, many companies increasingly apply a project model. For instance, the international project association has developed the Project Management Body of Knowledge (PMBoK), which prescribes project process. The concept of a project model is that it consists of the different project phases e.g. pre-project to finish. Further, it will supply directions to the concerned activities, which will take part in each phase, such as risk assurance and targeting (Magretta, 2002). The project model is also important to establish a joint language within the project, which acts as a foundation for the strategic and operational control, thus it affects the culture and values of the company. Another advantage is that the project-model pinpoints the demand for comprehensive management decisions, which links the project levels together with the strategic control. The project model will set the priorities in an early phase, which influences the produced information. The information is essential for the continuing progress of the projects, in terms of priorities between different projects. The project model will also direct the responsibilities and control the behaviour throughout activities within the projects. This will be performed by setting activities and assign owners to the concerned areas. Furthermore, the project models

will also indicate the project targets such as the iron-triangle, hence, it can be argued that the project has clear targets e.g. cost control or quality control. (Söderlund, 2008)

3.1.2 Strategic control

Companies that hold a large project portfolio may experience difficulties with the value chain coordination. There are three signs that indicates the problem with the coordination: (1) the company has to many ongoing projects in relation to its capacity, which generates that the organisation lacks the proper resources to reach the project goals, (2) the top management has problem to judge the company's capacity and (3) the top management has difficulties to plan the outcomes of the project, which creates problems with the coordination of resource consumptions between projects. The project portfolio management is introduced to manage these problems and consist of three main components: project generation, project selection and project capacity. Project generation concerns the creation of projects i.e. the project ideas. For instance, it may involve the development of a project in collaboration with partners/customers. The main issue regards to deliver a project proposition with competitive edges. However, the project selection is highly dependent on the performance of the project. The main task for the top management of the company is to choose among the results produced by the project generation in order to receive a balanced project portfolio. The project capacity concerns the judgement of the organisations capacity relatively to the uncertainty of the project portfolio. (Söderlund, 2008)

3.1.3 Stage-Gates

According to Cooper (1990, p. 44) a stage-gate system "*is both a conceptual and an operational model for moving a new product from idea to launch*". The essential part is that the stage-gate system identifies the product process and is separated into sub processes. For every new sub processes there is a check-point or a gate, which will control the scope of work by predetermine criteria in order to let it pass or revise it. If there is a requirement for adjustments an action plan should be performed. The work is performed in phases between these gates that will guarantee that the criteria are fulfilled. These gates are usually consistent of several types of quality control such as field test. Every gate has a gatekeeper that will determine if the product should proceed. This group consists of managers with the authority, horizontal and vertical competence to pass or deny the scope of work. The project manager moves the project between the concerned gates towards the end gate (Cooper, 1990). According to Söderlund (2008) a project model also consists of gates, which determines if the project should proceed, come to a halt or close. The gates main purpose is to govern the

behavioural, to ensure the connection between the operational and strategic control and for the management to recognize the progress and risks within the project.

3.2 Performance Measurement System in Construction Organisations

As previously stated, the definition of PMS is disputed, which in turn has led to difficulties for the scholars to conclude in a united opinion. According to Neely et al. (2005) their definition is fundamental constituted on efficiency and effectiveness. However, this might be to generalizing and simplifying of the complex reality with regards to different e.g. organisational strategy and business operations (Zeglat et al. 2012). On the contrary, Franco-Santo et al. (2007) interpret PMS as a combination of many different definitions within the field of business researching, thus, bypassing the arisen uncertainty and simplifying the definition. Furthermore, Franco-Santo et al. (2012) has extended the definition by introducing the contemporary performance measurement system, which for instance include BSC and KPI.

In the modern enlighten business there are two reasons for the use of PMS. Firstly the demand of non-financial measurement has increased, mainly due to facilitate the achievement of an adequate decision for the management. Secondly, the field of use has both historically and current been to benchmark the organisation's operations in order to improve and enhance the competitiveness. For these reasons the construction industry has emphasized the usage of PMS such as BSC or KPI (Beatham et al., 2004; Hegazy & Hegazy, 2012; Radujkovic et al., 2010; Hapovana & Al-Jibouri, 2009). However, the construction industry is mainly operating through projects, which consequently requires more flexible indicators that can deliver status updates continuously and precise, thus facilitating the control and the possibility for the organisation to act proactively (Walsh, 1996; Radujkovic et al., 2010).

3.2.1 Key Performance Indicators

The perception of the scholars is that there is no current unified definition of KPI. According to Walsh (1996), Radjukovic (2010), Enqvist (2013) and Hapovana & Al-Jibouri (2009; 2012) there is a difference between outcome measurements and leading measurements. However, Parmenenter (2010) claims there is no lagging or leading KPI's, instead there are different targets settings. Furthermore, prior researchers Hegazy & Hegazy (2012), Elshakour et al. (2012) and Chan & Chan (2004) emphasize that KPI's best use is benchmarking the organisation in relation to its competitors. Nevertheless, the researcher appears to be united regarding the purpose of KPI's, which is to improve the organisations overall performance. Enqvist (2013) defines KPI as ratio tools that facilitate the controlling of an organisation and

according to him the description could resemble a compass that should guide the company. It is emphasized that KPI's will only facilitate the control by pinpointing the concerned areas, the success is dependent on how the project management will react.

Project oriented construction companies are experienced with the use of KPI (Cha & Kim, 2011; Radujkovic et al., 2010; Hegazy & Hegazy, 2012; Tuner & Zolin; 2012). According to Cha & Kim (2011) the construction companies PMS may be separated into two different levels. The first level is macro, which represent the company level where the existing strategies are required to be measured with scrutiny and analysing with the intention of developing the future business strategy. The second level is micro, which includes the project levels. The main desirable scope of the KPI on this level is to measure the progression, consequently, project planning is required to be measured. It is also emphasized by Hapovana & Al-Jibouri (2012) that the construction process needs to be divided into three phases: pre-project, design and construction phases. There are five different classifications of the KPI in project, namely project-, procurement-, participants-, project management-related and external factors (Chan et al. 2004). According to Cha & Kim (2012) the KPI shall be linked to quantitative form such as time, cost, quality etc. Furthermore, should the design be standardized in order to promote benchmarking, but it may be difficult to realize within the construction sector, due to the heavily unique projects. Radujokvic et al. (2010) argues that the construction industry has not applied the qualitative since it is managed by the "engineering" approach. Cha & Kim (2012) recommends that the company should use PMS databases for benchmark purpose in order to improve the efficiency and continuously improvements within the projects as well as the company.

3.2.2 Key Performance Drivers

According to Walsh (1996), Radujkovic et al. (2010), Hapovana & Al-Jbouri (2012) and Enqvist (2013) there exists two different classifications of KPI, namely the Key Performance Outcomes (KPO) and Key Performance Drivers (KPD). However, there is a slight difference regarding the terminology between the researchers. The KPO is focus heavily on the measurements, which show the process in relations to the organisational goals, whereas the KPD is concentrating on the measurements that are directly affecting the outcomes. The essential difference between the two classifications is that KPO is lag indicators, thus presenting only the implications of performed actions e.g. reactive. The lag indicator forms the greatest shortcomings of KPI. However, the KPD represent the lead indicators, which supplies alternative for the management to take the adequate adjustments before presenting

undesirable consequences e.g. proactive. Regarding project management it's of highly importance to control the early phases, if not, it may results in serious delays or increased cost and ultimately project failure (Gibson & Hamilton, 1994). As a project manager there exists a comprehensive requirement to obtain information regarding direct occurred problems. The KPD may be a good indicator for the projects status and to supply the opportunities to react instantly to problem. Enqvist (2013) illustrates the existence of KPD with an example, *"A journey has a target, if one will travel by car the distance of one mile and it will take one hour to accomplish is the KPO easy to measure, it is either a success or failure. However, if the journey was measured ongoing (KPD), variables such as time could constitute a direct controlling measure in order to supply the possibility to adjust and thereby ensure the achievement of the target."*

According to Radujkovic et al. (2010) the four most common mistakes in the execution of the practitioners are: (1) the problem to distinguishing between lagging and leading KPI's, (2) the company strategy and vision isn't connected to the indicators, this is in line with findings of Kaplan & Norton (2004; 2006), (3) the companies have developed their own KPI's that are incapable of benchmarking and (4) no model includes factors as different project stage or procurements, this is supported by (Beatham et al. 2005). According to Enqvist (2013) it is important for the company to apply a terminology, which the employees are familiar with, thus minimizing the confusion and to align the employees with the new system. There is also a requirement to describe and to thoroughly contemplate the relationships before defining the measurements. Enqvist (2013) emphasizes the need for soft targets such as professional development, employee health in order to ensure healthy co-workers who can perform their task.

Parmenter (2010) argues, on contrary, to previous researcher the very existence of the lead and lag performance indicators. He continues with an example to further strengthen the argumentation: *"Is the late-planes-in-the-air KPI, a lead indicator, or a lag indicator?"* the answer to this question is that it can be both, depending on the user. For instance, to the airport, which the plane departed from the KPI is a lag, but for the end-airport it will create a future problem. Further, the plane might catch up the time, due to favourable winds etc. He continues with to define the characteristics of KPI, which are to measure a deeper consensus than ordinary measurement e.g. the KPI should concern to measure key customer instead of customer visits. Further, they shall be frequently checked in order to supply relevance and verification. The KPI should also be enforced by the top management, which possess the

authority to quickly adjust the processes. Another intention of the KPI is to supply information to the employees of the desired action, for instance time reducing. In addition, it shall be possible to connect the KPI to a process owner that is responsible for its progress. The KPI should be accordingly linked to the critical success factors or different perspectives within the BSC in order to improve the organisational direction. There is a necessity to test the selected measurements to ensure that they produce the desired results before approving them as KPI (Parmenter, 2010).

Hapovana & Al-Jibouri (2012) stipulates concerning construction industry that most PMS are designed for the organisational levels and the majority of all KPI are designed as historical measurements for projects, consequently the solution to this problem is to focus on process performance. The process PMS promotes two different process-oriented views, rather prefer the processes over the organisations and units, and to base the PMS on hard and soft process subjects. Likewise other researcher Hapovana & Al-Jibouri (2012) provides that the concept of KPI's derives from the possibility for comparison, which offer the organisation to benchmark indicators in order to adjust the organisational performance to the desired result, and the KPI may also constitute as the base of project control. However, Hapovana & Al-Jibouri (2012) emphasize that the measuring of processes is the best solution to improve and enhance benefits of PMS, thus the management has the possibility to respond proactively. It is further stressed that the iron-triangle might not be sufficient (Hapovana & Al-Jibouri, 2012; Chan & Chan, 2004).

Cha & Kim (2012) made a compilation of KPI based on previous research, which is customized for construction projects. In figure 4, the most suitable KPI's for this case has been selected to reflect the construction branch's practical utilization.

Cost Efficiency	=(Revenue-Expense) / Revenue
Cost Effectiveness	=[(Project Cost - Average Cost of Similar Project) / Average Cost of Similar Project]
Construction Cost Predictability	=(Revenue - Planned Revenue) / Planned Revenue
Design Schedule Predictability	=(Perfromed Design Schedule -Planned Design Schedule) / Planned Design Schedule
Overtime Work Rate	=Overtime Days / Performed Schedule
Defect Frequency	=Number of Registered Non-Conformance/Number of Test
Rework Rate	=Number of rework Items/Number of Registered Non-Conformance
Schedule Reduction Rate	=(Value Engineering Schedule Savings-Value Engineering Schedule / Planned Schedule)

Figure 4: Suggested KPI for Construction Projects (Cha & Kim, 2012)

3.2.3 Critical Success Factors

The definition of Critical Success Factors (CSF) is external factors that can affect the project failure or success (Belassi & Tukel, 1996). There are two main reasons to why it's hard to

establish the end-status of a project. First are the different opinions of the involved parties regarding the definition project success e.g. the project management might experience the project as a failure, but the customer is very satisfied with the outcomes. The second reason concerns that different researcher has different recommendations and definition of CSF. According to Rubin & Seeling (1967) the extent of former projects may affect the manager's performance. However Avots (1969) concludes that top management support, the unplanned project cancelations and the project managers are the main CSF. Belassi & Tukel (1996) stipulate that the organisation should rather measure the perceived performance as an alternative to the iron-triangle. Schultz et al. (1987) argue that it exists two classification of CSF: strategic or tactical. These classifications may affect during the different projects stages. The strategic CSF constitute of top management support, the importance of schedule and the project task. The tactical classification considers factors such as personnel competence and communication with the customer.

3.2.4 Key Success Factors

According to Clarke (1999) the definition of Key Success Factors (KSF) in projects is terminating organisational issues in order to improve the effectiveness of the managements. There are four identified KSF regarding the communication within the project, clear comprehensive objectives, to breakdown the processes, to incorporate the project plans in conjunction with the routines and divide the project into smaller targets. Prior researcher has found that lack of communication is one of the main reasons for project failure (Parda, 1996). Advantages of improving the communication might be to avoid time waste, and reduce the uncertainty (Clarke, 1999). In practice it is often difficult to formulate clear comprehensive objectives (Neal, 1995). There is a need to combine the scope and objectives in order to prevent that the employees perceived the targets as uncertain. It is needed to define clear targets for the management to facilitate the supervision of the project progression, consequently, better target setting results in easier design for the measurements. The long-term advantages of having a well define target and scope is the probability decrease of missing essential parts associated with the project. Regarding the incorporation of the project plan, this requires the management to supply the organisation with the adequate information to change. This is highly relevant in large high technological projects, which may have a lot of alteration. Furthermore, if the project plan is not frequently updated it might result in confusion and delays for the project (Clarke, 1999). It is also stressed that the company breaks down goals into smaller targets, mainly, to facilitate for the process owners in terms of

delegating, communication and identification of problems. However, too detailed planning of the project may result in an uncontrollable situation for the project (Clarke, 1999).

3.2.5 Performance Prism

The performance prism consists of two different aspects. The first business performance review that supervises the organisational performance is in consideration to the five perspectives of the prism. The second is performance measurement system review, which is related to examine the PMS in order to ensure effectiveness and efficiency within the organisation. It also assesses the implementation and design such as measures and relationships in contrast to success maps of the PMS.

The business performance review seeks to explain from the performance prism perspective the review process of the organisations performance. The four phases of business performance review is described below.

(1) Planning for performance, according to prior researchers (Crawford, 1988; Ghalayini & Nobel, 1996; Globerson, 1985) it is important to establish the targets of every measurement. There is a need to carefully consider the targets, thus setting targets too low may result in underperforming employees and by having too high targets the employees might constantly fail (Ghalayini & Nobel, 1996). Najmi et al. (2012) also emphasize that the time-frame design should be realistic in relation to the potential of the organisations in order to facilitate the indication when the targets will be achieved. According to Fisher (1992) the management shall consider to keep the target constant, mainly because employees tends to neglect targets if they are frequently shifting. The examination of the targets can be performed in two different cycles. The first considered as the short-term perspective concerns both earlier and future resources of the organisation. The second constitutes the long-term perspective and contemplate the effects of external factors e.g. industrial standards and benchmarking (Najami et al., 2012). The last step in planning for performance is to establish an operational plan to supply resource for the set targets and to incorporate this into scorecards, which has been subsequently developed throughout the design phase.

(2) Measuring performance, in this phase the departments of the organisation should be ongoing working towards the set targets, thus the follow-up is highly dependent on the measurements. It is recommended by Namji et al. (2005) and Najmi et al. (2012) that the examination process can be divided into three different levels depending on the follow-up frequency. The first is closely connected to the stakeholder satisfaction. There are two reasons

for this: first, it is complicated and time consuming to measure continually and second is that this measurement is associated with time lag, consequently supplying modest value for the management. The second level concerns strategically measurements. The strategies should reflect the stakeholder's requirements (Neely et al., 2002). According to Najmi et al. (2005) the principal information derives from the operational level of the organisation, hence these should be reviewed more frequently than the stakeholder's satisfaction. The third level consists of process- and capabilities measurements. It is fundamental for the organisation to comprehend concerned processes, which generates efficiency and effectively, before implementing the strategies. Further, the process is highly dependent on the organisations capabilities (Neely et al., 2002). The recommendation is that these measurements should be monitored frequently, due to rapid change and demands.

(3) Reporting, it is emphasized by Najmi et al. (2012) that to have reliable measurements is not enough, it should also be reported to relevant persons within the organisation. According to Lynch & Cross (1991a,b) there are some important factors to consider in this matter. It is essential that every employee understands the procedure to take adequate adjustments. The measurements shall be complied in one report to present inter-related connection to the user. It should also present past performance in order for the employees to experience continuously improvements.

(4) Analysing and developing action plans, the published information regarding the measurement is required to include analysing, otherwise it will supply little or no value for the user (Neely et al. 2002). The meetings should result in action plans, which are specific described action for correcting the occurred problems.

The performance measurement reviews aim to manage the examination of the performance of the PMS. There are three stages of development within PMS: design, implementation and use (Bourne et al, 2000). The two first stages consider the reviewing of processes, whereas the use stage is approximately equivalent to the process as a whole, thus the performance measurement reviews processes will be considered only to comprehend the design review and implementation review.

The design review type, consists of two processes: (1) The review of individual measures, there might exists various measurements that concerns phenomena, which is only relevant for a particular time. Therefore, the measurements should consist of approximately 20 % temporary, which then could be terminated after the validity (Neely et al., 2002). It is also

emphasized by the researcher that the characteristics of the measurement reflect the outcomes, variables such as measurement frequency, purpose, owners and source of data (Neely et al., 1997). Many researchers stress the importance to have the support of the top management and/or a performance manager (Neely et al., 2002, Kaplan & Norton, 1996; Chan, 2004). According to Bitici et al. (2006) the PMS may affect employee's behaviour in terms of cultural consequences and this might require monitoring from the management.

(2) Reviewing a set of measures, the definition of this category is a group of measurements that is related to each other and the company's strategy (Najmi et al., 2012). There are six reasons for reviewing this category. According to Neely et al. (2002) relates the reasons one to four, if there is any change in these categories it will indicate that there is an extensive requirement for reviewing the whole measurement as a group. The last two will supply managers with the possibility to control if the current organisational strategy will generate success. (1) New stakeholder requirement: the organisation needs to satisfy the stakeholder in order to ensure long-term survivability, hence the measurement should change if their demands changes; (2) new strategy: due to the high competitiveness of the company's environmental the strategy will change more frequently than before; (3) new process or operational system: the processes constitute the company's way to adjust accordingly to the stakeholders demands, thus if a process change the group of measurement requires to be reviewed as well; (4) new opportunity or capabilities: the organisations capabilities is equivalent with the internal aspects such as resources and employees, and the opportunities is equal to e.g. tax rate and price fluctuation. Consequently, these factors combined will affect the organisation possibility to perform the process and needs to be reviewed if any change has occurred; (5) invalid strategic assumption: the definition of strategic assumption is assumed to be connected with the results of the operational level to the strategic objectives. This implies that a strategic decision, which is implemented in the operational level, may generate a negative strategic level; (6) invalid strategy: it is acknowledged that the definition of stakeholder satisfaction is hard to determine, thus the organisational strategy may not reflect the desirable target.

PMS implementation review: Bourne et al. (2000) argue that implementation can be perceived as processes. Consequently, the status of the company's infrastructure such as people, process, culture and systems will determine the success of the process, thus the control is highly important (Kennerley & Neely, 2003). There exist two different information sources within the examination of the implementation process. The first is linked to the deficiencies

within the process. However, there is an extensive problem as the deficiencies can only be verified in practice, hence there is a need for systematically review. If problem has occurred there are two solutions for this: the first is to adjust the processes and the second is to adjust the PMS design. The second part of the implementation process is improvement opportunities, which aim to highlight required implementations improvements within the organisation. This concerns the company's ability to change the infrastructure in order to affect the implementation of the PMS and to offer the possibility to create new opportunities. For that reason the infrastructures should be closely supervised to supply a direct response to the management.

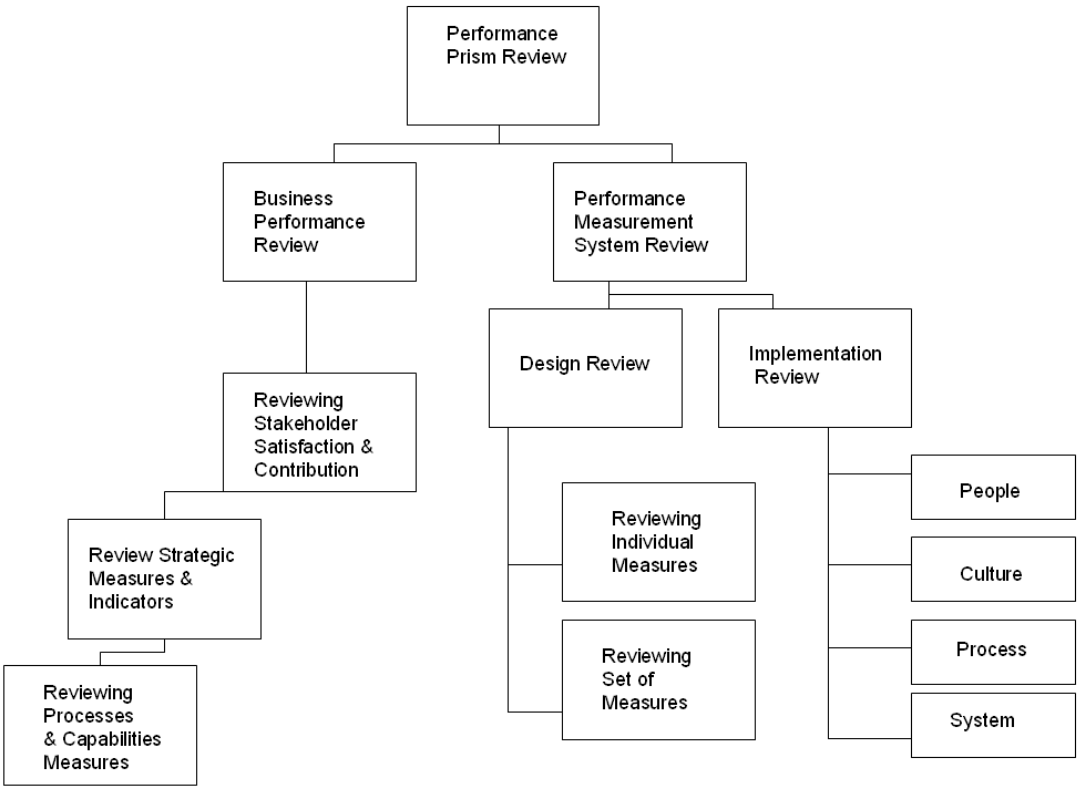

Figure 5: Level of Categorization (Najmi et al. 2012)

3.2.6 Balanced Scorecard

The BSC was first presented by Kaplan & Norton (1992) as a response to the criticism of the traditional financial focus of the management accounting. The fundamental purpose of the BSC is to produce a balance amongst financial and non-financial goals in an organisation. This is performed by translating the company's long-term strategy and vision into measurable organisational goals. The scorecard intention is to function as indicators to provide adequate information to the management in order to facilitate the control of the organisation. The

structure of the scorecard consists of four perspectives: (1) internal, (2) customer, (3) financial and (4) innovation and learning perspective. The purpose of this selection is to supply the management with a few reliable measurements (15-20) to counteract information overload (Olve, 2007). There are two main advantages of the BSC: first, the scorecard collects the information needed into one report and the second is that the scorecard considers the improvement of one area on the expense of another (Kaplan & Norton, 1992).

The project form is suitable for the BSC, mainly because the characteristics of project are for instance the target, temporary, separate organisation. However, there are certain business sectors, which the BSC are more applicable to than others. For instance, the construction industries have specific targets and the use of previous experience, which increases the suitability (Andersson, 2005). The project follow-up is an important part of the project process and should monitor the resource/iron-triangle consumption. The project target can be considered equivalent to iron-triangle, which thereby offers the possibility to evaluate the project progress. Consequently, the iron-triangle can be interpreted as critical success factor. According to Macheridis (2005) the project management can be divided into three aspects: process-, market and performance oriented. These aspects can be linked to the different perspectives within the BSC, such as process to the process perspective, market to customer perspective and performance to financial perspective. Regarding the different phases (see figure 2) within a project, the BSC can offer a good solution for the control. When the project life cycle changes to different phases the measurement within the BSC needs to be updated. For instance, the scorecard can facilitate the connection of strategic goals during the planning phase. It can also, monitor the project progression throughout the implementation phase (Andersson, 2005).

The implementation of the BSC is facilitated by a project manager, which possesses the knowledge within the scorecard methodology and the awareness of the organisations targets. The project manager should also be well supported by the top management in a jointly perception of the project targets. Normally, the role as project manager is given to the controller. However, one might question whether the controller has enough time and resources besides the traditional financial tasks. The next step is to define the work by conducting meetings in conjunction with the top management in order to develop a strategy map. It is important to emphasize that communication and routines is subsequently developed. The recommendation is that each level within the organisation develops their separate

scorecard (Olve, 2007). The last step is to integrate the BSC with the current IT-support system and to follow-up the implementation with continuous modifications.

4. Case Study of Kockums AB Project Management

In this section the case is presented by distinguishing the organisational responsibilities and identifies the procedure to appoint a project manager. Thereafter follows a description of KAB's processes, gate-stages and meeting procedure. The section ends with an explanation of the five key performance indicators within KAB.

4.1 Organisation

KAB has launched its efficiency program and is also developing a new performance measurement system. The company is separately developing KPIs for the project and line organisation. The KAB's mission statement is the same as for each company within ThyssenKrupp AG Group.

- *Competence and diversity, global reach, and tradition form the basis of our worldwide market leadership. We create value for customers, employees and shareholders.*
- *We are customer-focused. We develop innovative products and services that create sustainable infrastructures and promote efficient use of resources.*
- *We engage as entrepreneurs, with confidence, a passion to perform, and courage, aiming to be best in class. This is based on the dedication and performance of every team member. Employee development is especially important. Employee health and workplace safety have top priority.*
- *We serve the interests of the Group. Our interactions are based on transparency and mutual respect. Integrity, credibility, reliability and consistency define everything we do. Compliance is a must. We are a responsible corporate citizen.* (Kockums AB, 2009)

The activities within the tender process for a potential contract are managed by the line organisation. Thus, for larger project there are usually appointed a project organisation, which will operate the contract when awarded in line with already established internal routines within the company. KAB operations are managed in a matrix between the project and line organisation where the responsibilities are distributed between these organisations. The project organisation (figure 8) has the responsibility for the overall activities regarding the finance and project planning. This includes in detail also the controlling and follow-up of the project (*what* and *when*) during the projects life cycle. The project organisation has further responsibility for the contract including the communication and the formal correspondence with the customer and shall ascertain that the contractual obligations are fulfilled. The line organisation (figure 6 & 7) is responsible for the technical solutions and the personnel allocation to the project (*how* and *whom*). The line organisation consists of the company top

management Chief Executive Officer (CEO), Chief Operative Officer (COO) and Chief Finance Officer (CFO). The COO Office, submarine, naval service, surface and production is equivalent to a business unit. Under each business unit there are head departments, which is responsible for the different departments (figure 7). Figure 6, illustrates the different responsibilities between the line and project organisations. (Lindström, 2012; Westergård, 2013; Otterlund, 2013; Nilsson, 2013; Ekstrand, 2013)

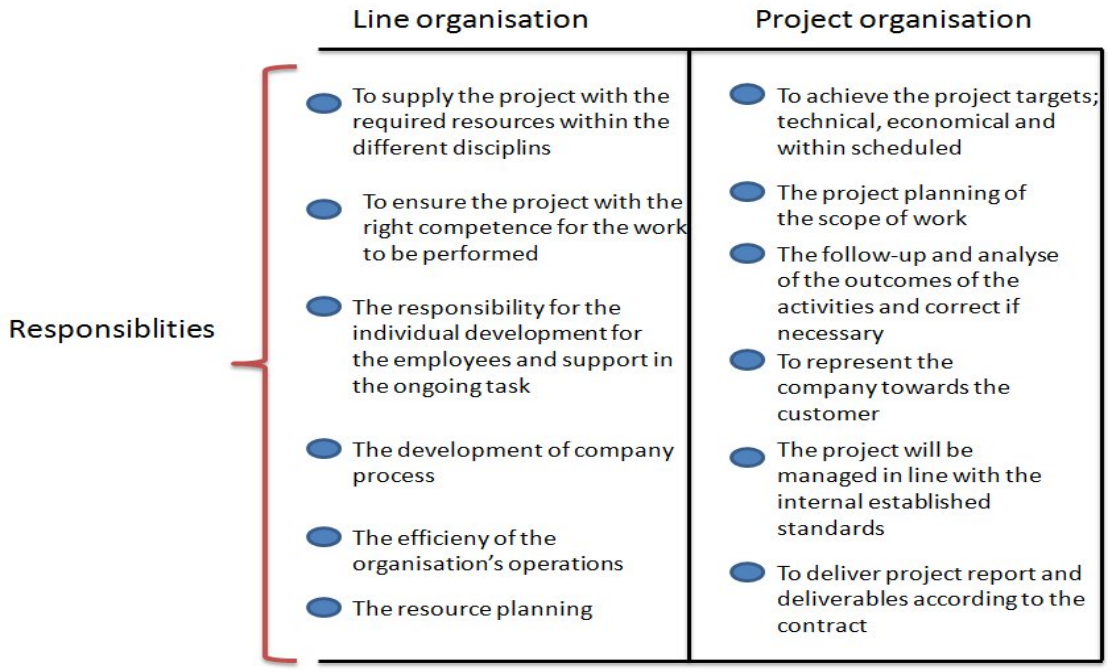

Figure 6: Organisational Responsibility

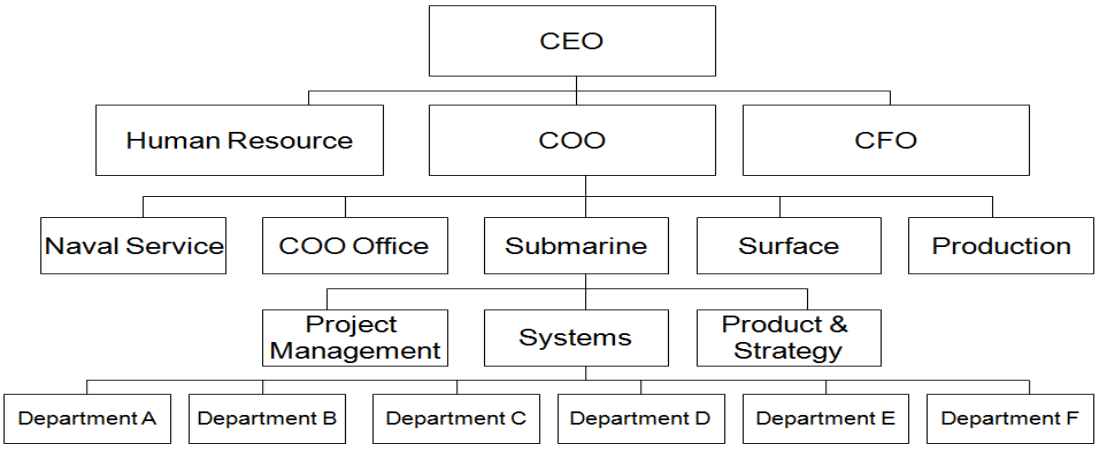

Figure 7: Line Management (KAB, 2013)

4.1.1 Executive Committee (EC)

The EC is responsible for the company's entire business against the company board and EC consists of the CEO, CFO and COO. This group represent the top management of the company. (Bergman, 2013; Westergård, 2013; Otterlund, 2013; Nilsson, 2013)

4.1.2 Project Sponsor

The EC appoints a project sponsor at the start up of every major project and the main task for the sponsor is to nominate a steering committee and appoint a project manager. The sponsor will also fulfil the requirement from the EC to establish a task specification to the project manager. The task specification contains information regarding the expectations in connection with finance, schedule and quality for the project. The task specification is delegated to the project manager with the essential meaning of how the project manager is expected to realize the project. This includes scrutinizing and approving the task specification and through the project manager's project specification the fulfilment of the task specification is described. The specification is approved by the project steering committee. (Nilsson, 2000a;2000b; Westergård, 2013, Nilsson, 2013)

4.1.3 Steering Committee

The steering committee is the internal executive body within the company and for major projects the EC will be a part of the steering committee. The committee has the overall strategic responsibility for the achievement of the project and are responsible that already implemented decisions is not in conflict with the project manager responsibility to achieve the project target and contract. Furthermore, the steering group shall support the project manager by necessary decision, which is required by the project manager. The project managers shall on monthly basis report the project status to the steering committee. (Jansson, 2000a;2000b; Nilsson, 2013)

4.1.4 Project Management

The project manager's response to the task specification is the project specification describing the fulfilment of the project. The project specification is the document that describing the project targets, project organisations responsibilities, planning, quality and risks etc. The purpose of such a document is to establish and define responsibilities, targets, plans and milestones. Further responsibility areas of the project manager are to lead the project organisation and the coordination of the overall project, the contractual requirements and the coordination of the project plan. The total project organisation consists of project manager, support management, subproject managers and the group leaders. This project management

will ensure that the project runs in accordance with the plan, stays within budget and fulfils the contractual obligations. The project management responsibility is also to minimize the project risk, assuring that the time schedule is being followed, assuring the cost are within the budget and performing work in accordance with established procedures. Figure 7 illustrates a project management organisation structure within KAB. (KAB, 2013)

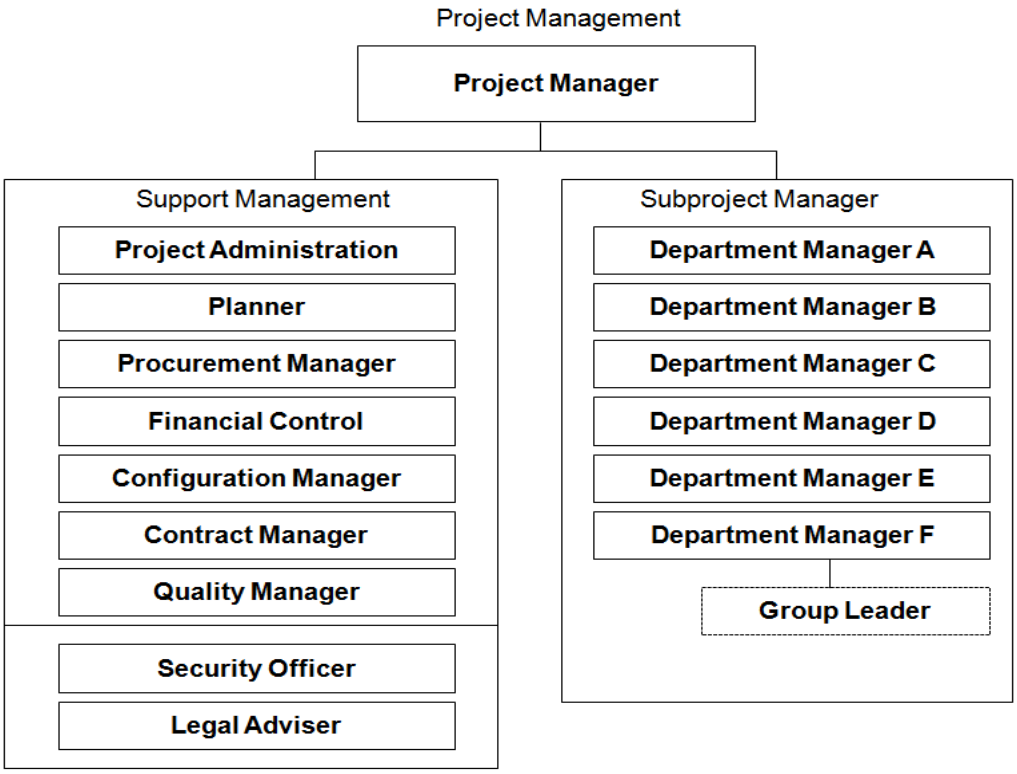

Figure 8: Project Organisation for Design Contract (KAB, 2013)

4.1.5 Work Breakdown Structure

The scope of work is defined by a contract that is broken down within a Work Breakdown Structure (WBS). The WBS is a hierarchical structure of elements covering scope of work within the contract and is based on an international standard. The WBS is normally broken down into five levels, however the figure 9 shows the top three levels of activities or elements; *Submarine*, *Submarine Complete and Submarine Complete Superior*. For each top-level element appearing in the WBS a description of its content is provided. In order to describe the interaction between different elements of the WBS as related to the submarines element of lower levels or activities are identified for calculation and follow-up purposes.

Level 1: Top-level submarine includes the whole product.

Level 2: Interdisciplinary systems together with specific major system A, B, C, D and E.

Level 3: Level 2 system broken down to more detailed level of systems.

Level 4: Level 3 system broken down to more detailed level of systems.

Level 5: Level 4 system broken down to activities.

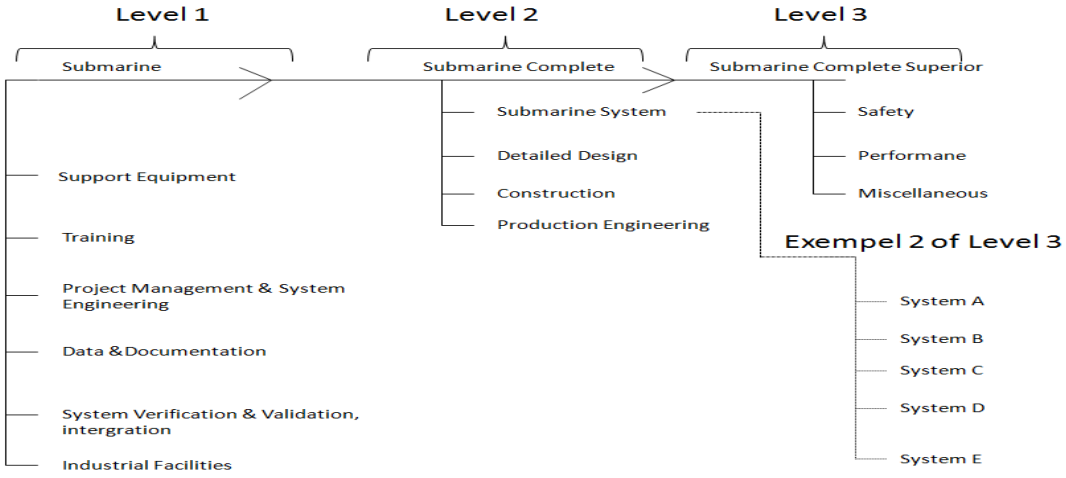

Figure 9: Work Breakdown Structure - Activities/Elements (KAB, 2013)

Each WBS element has a nominated department who is responsible for the estimate within the tendering process. The activities/elements within the WBS (figure 10) are assigned by the different parts of the project organisation for the performance of the project work i.e. both the technical solution and to monitor costs. The WBS is further broken down to at least five levels in conjunction for scheduling and follow-up purposes to create the baseline of the project. (KAB, 2013)

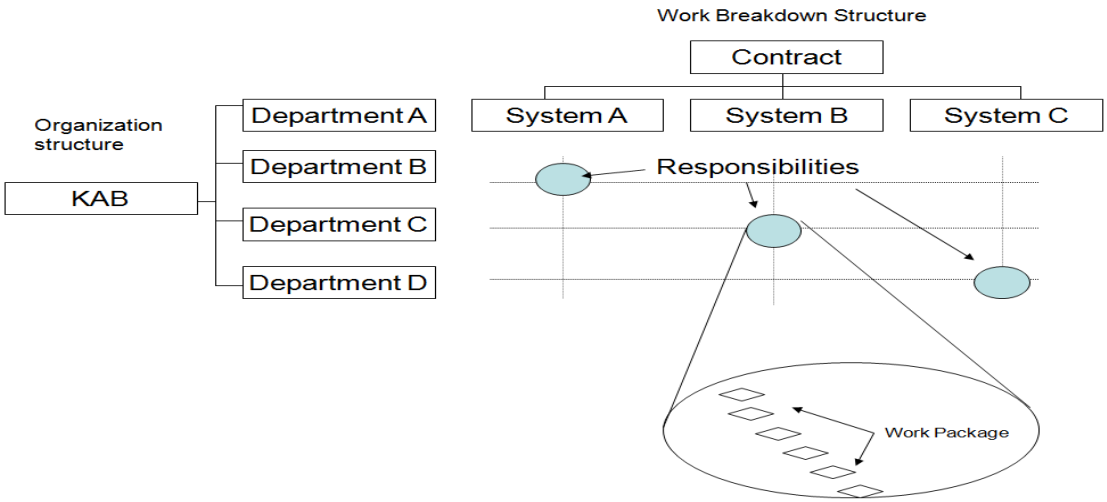

Figure 10: Work Breakdown Structure (KAB, 2013)

4.1.6 Milestones

The customer payment plan is regularly broken down into milestone payments and those are normally connected to essential events of the contract. These milestones will be supported by the company's internal project process below. (KAB, 2013)

4.1.7 The Company's Internal Project Process

The company's internal project process (figure 11) is divided into 13 Tollgates (TG). The first step of the process is related to the "preparation of the projects TG 1". This section includes selection of a "project sponsor", project manager, final negotiations regarding the contract, create a project organisation and project plan. The second step of the process is "TG 2", where the project sponsor considers the result of the preparation and evaluates the task and project specification. The third step of the process involves the TG 3-12, which includes the implementation phase of the project. This phase consists of review meetings, project planning, to control the project, to manage adjustments within the project, report and communicate within the project. It is highly important that the TG3-12 is achieved as scheduled in order to ensure that the project progression to meet the project payment plan. The fourth step is the "finish project process" which includes finalisation of the contract, project evaluation and cost accounting. The DG is presented before the concerned TG in order to function as an internal control for the deliveries. (Bergman, 2013)

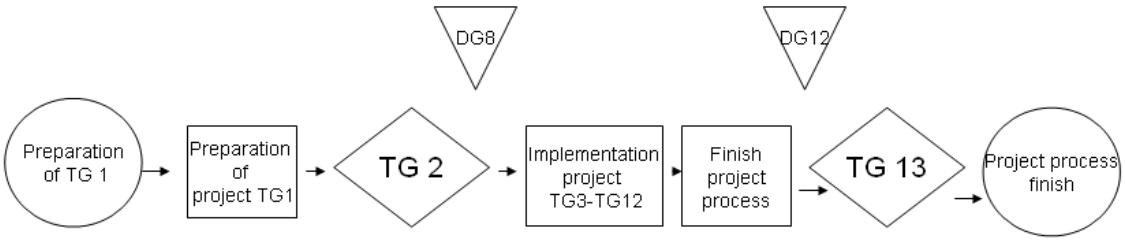

Figure 11: Project Process (KAB, 2013)

4.1.8 Decision Gates (DG)

The DG is a part of the company's operating business and where decision will be made under the conditions the work has been executed and approved as mention under each decision gate (se appendix DG). There are two major steps concerning the DG. The first step includes DG 1-5 and refers to the tendering process for a project and the second step includes the DG 6-12 and refers to the company's internal project process. A DG can be approved with certain remaining not fulfilled items from the previous TG, depending on the characteristics of these

items. The potential remaining items from the concerned TG should be risk assessed within DG. A DG shall be held as soon as possible before a TG. (Bergman, 2013)

4.1.9 Tollgates (TG)

The company's internal project process consists of several internal milestones TG. The intention of these TG is to supply the project organisation with properly control tools in order to facilitate the overall project control during the duration of a project. When the TG is achieved by the project it will be scrutinised and shall be approved by the COO Office and reported to the project steering committee. An approved TG allows the project management to move forward to meet the next TG. The standard procedure starts in accordance with the company's internal project process at TG2 and ends with the TG13. However, due to contractual agreement, certain cases may start with the quotation process instead of the TG2. The number of TG in the implementation stages should be adapted to the projects complexity and scope. The mapping between relevant baselines within the product development process and TG should be defined in the project specification. This includes the requirement to define one or more TG. (Bergman, 2013)

4.2 The Company Business Control Process

The purpose of "*The company business control*"-process (figure 12) is to control and implement profitable business for KAB. The process concerns the whole product life-cycle from a business opportunity to the delivery of the product to the customer and to maintain the product. The process owners are mainly the concerned departments in conjunction with Product Submarine. The target of this process is to establish profitable operations by conducting valid commercial decision, control and follow-up of the result. The start-up begins with the entry criteria of a business opportunity, which is received by the market department or/and R&D departments and there are two exit criteria, namely, the business realized in accordance with the commission and with the customer requirements. Furthermore, the activities in this process should be permeated by concept of "take business decisions". The purpose of this is to evaluate each project from a business perspective, in accordance with pre-defined DG and to review the status to take business decision through the pre-defined mandatory information. Terms of Reference (ToR) for "*business management control meetings*" provides the mandatory framework for reporting and criteria for decisions. Each DG requires that mandatory information must be available in due time before each decision meeting is to be reviewed by EC, or other level of management within the company. (Bergman, 2013;Westergård, 2013)

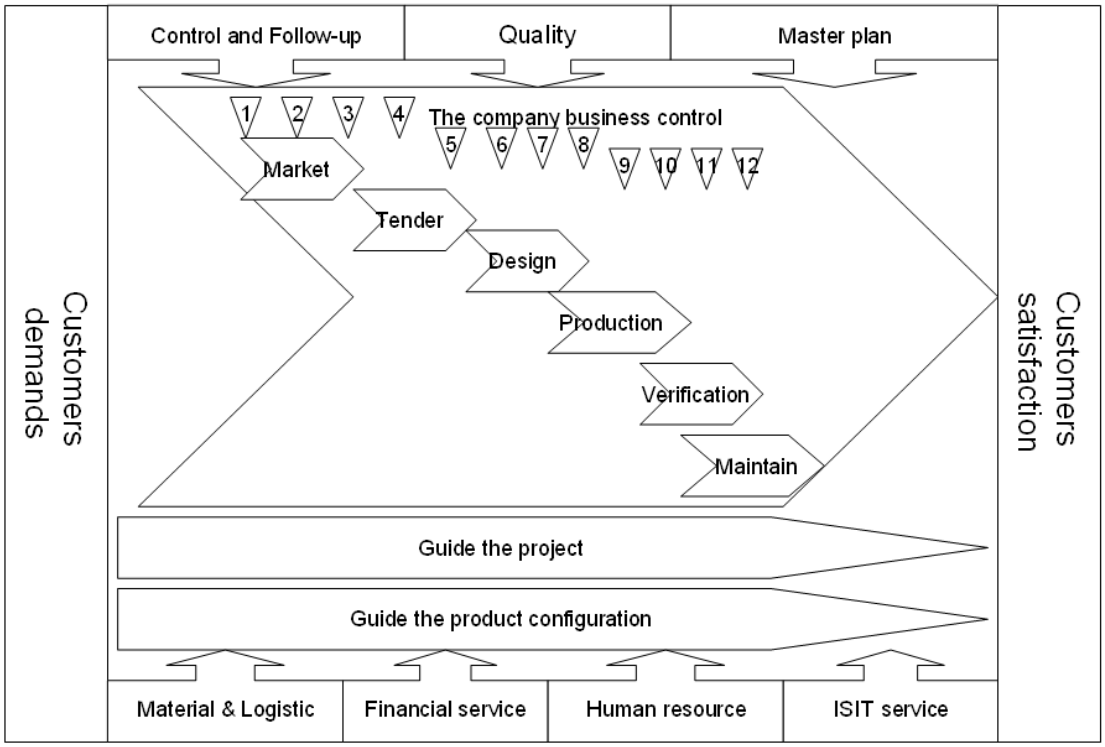

Figure 12: The Company Business Control (KAB, 2013)

4.2.1 Market Process

The Market process shall ensure that the products and services of KAB product portfolio are effectively marketed in order to generate profitable and good prospects caring for the KAB trade mark. This is accomplished through the availability of competent resources, relevant budget and good market knowledge. With the use of relevant market information, the market process will ensure a KAB product portfolio meeting the needs from the market. KAB will receive suitable market prospects and request for tenders through effective market communication and marketing activities. Through good knowledge about the customer, the market, the product(s) and commercial conditions, it is ensured that KAB will sign profitable contracts. (Bergman, 2013)

4.2.2 Tender Process

The purpose of the tender process is to strengthen the KAB ability to submit attractive tenders to customers in order to increase the sales of the company. In addition, the quality in the company tenders is secured and risks are minimized. The process also clarifies how potential orders and contracts shall be managed, to improve the hand over to the future project management, consequently making profitable businesses and projects. (Bergman, 2013)

4.2.3 Design Process

The purpose of the design process (figure 13) is to, through a unified and structured process: transform a product specification into a documented system solution, which fully meets the customer requirements. This, together with the interfacing processes, creates the conditions needed to start detailed design and production work. The design process is divided into 3-5 phases, depending on the scope of work of the contract. Every phase within the design process is initiated through a "gate opening" triggered by a decision from a steering committee or EC. The design process concerns "the implementation project TG3-TG12" within the project process. (Bergman, 2013)

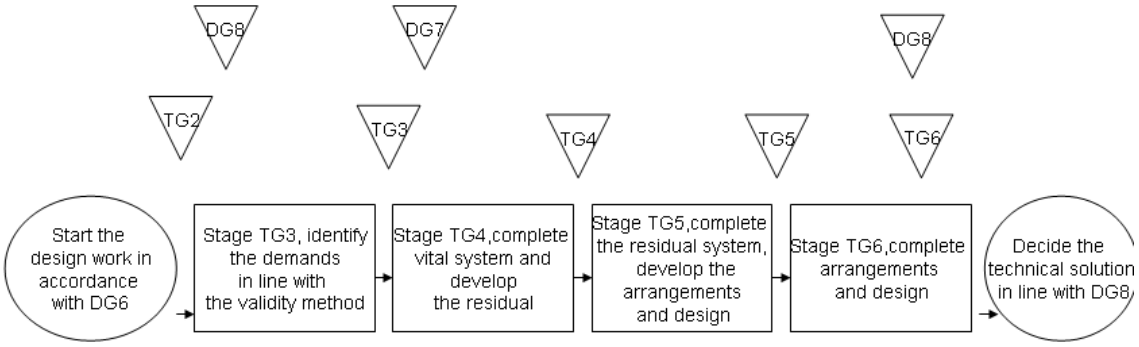

Figure 13: Design Process (KAB, 2013)

4.2.4 Production Process

The production process ensures that all needed preparations are taken before start of production, to obtain an effective production process. Furthermore, to secure the production work during this process and to perform control according to building specifications in order to fulfil the contractual work is required. Final quality control is performed through Installation Check-Out (ICO) per system and ICO per area/room. Subsequently, production is ready for final test and production is finalised. (Bergman, 2013)

4.2.5 Verification Process

The verification process describes the part about verification (final test) from ICO until completion of final control and "Ready for delivery". Roles and responsibilities are described for ICO (and similar control functions) and for completion of final control. Furthermore, the handling of claims, deviations and amendments during the verification phase, are also described. The process also describes how the requirement management, from tender to delivery, is followed and handled and finally, how the planning and document handling are managed during the verification phase. (Bergman, 2013)

4.2.6 Through Life Support process

The KAB ”Through Life Support” (TLS) – process describes the services for products in the operational phase. The process clarifies the content of the “TLS portfolio” and the steps in the maintenance projects from maintenance planning until delivery. The process also describes mission support for military units with the different levels of support that KAB is able to provide. Spare parts supply is an important part in the operational phase and this is part of the process description. The process also covers the handling of material phase out, training and documentation. (Bergman, 2013)

4.3 Visual Boards Meetings (VBM)

The company applies visual boards for the project and line management for the VBM. The project management VBM’s are also divided into project manager and subproject managers. The line management VBM’s are divided in departments and sections. The VBM’s are hosted by the managers and concerns personnel from KAB’s organisation. The purpose of the VBM’s is to inform the participants regarding the status of the projects and the management, to follow-up the KPI’s and activities, made decision with high quality, a structured discussion, planning and create a combined corporate value. It is important to emphasize that there is a difference between organisational and project KPI’s. There are prescribed rules (ToR) of the meeting in order to ensure that the participants are well-prepared and understands the meeting. It is followed by the action log, which ensures that the decision of the meetings will be executed. The action log will be controlled on the next meeting. The ToR includes list of participants, keep focus on the content of the meeting and that it will start in time. There are a general agenda, which is followed strictly and it starts with, information regarding decisions and projects, various and action log. If the participants of the meeting conclude that something needs to be adjusted, the rules require that an action log is created. The VBM includes also the 40-20-40 rules (figure 14) the first 40 % is *preparations*, more precisely purpose, communication, agenda, information and presentation of issues. The KPI’s in this section is not yet implemented. The 20 % is *meetings*, which consist of actually making decisions. The last 40 % is *follow-up*, which involves creating the action log, supplying feedback and follow-up the last action log. (KAB, 2013; Westergård, 2013; Nilsson, 2013)

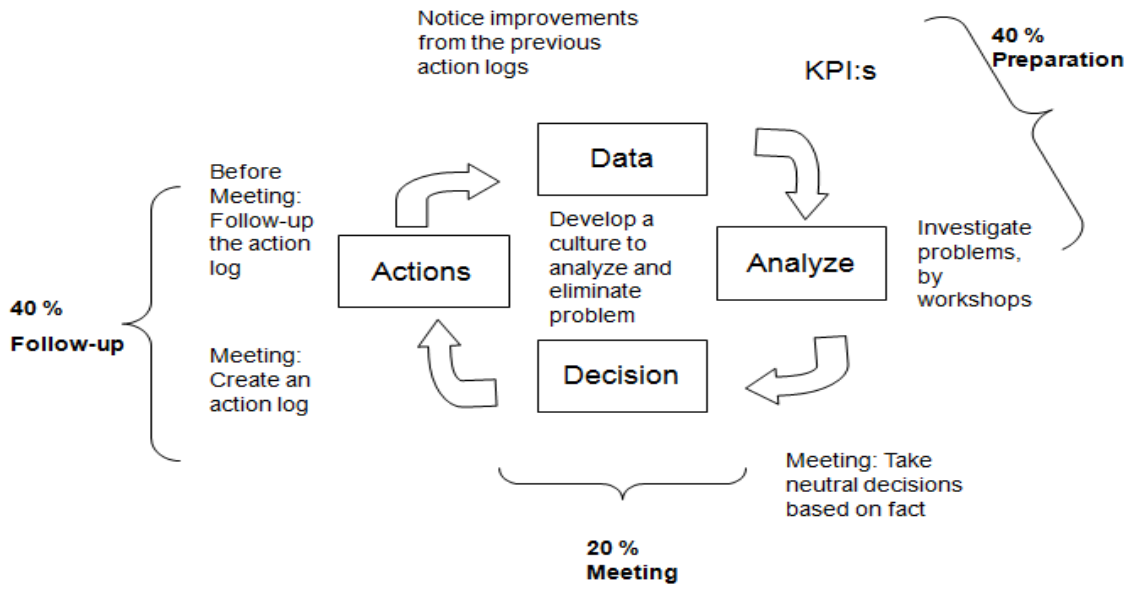

Figure 14: Visual Boards (KAB, 2013)

There are differences between the VBM's for instance, between departments and projects, project and projects. However, the difference is only the content of the problems, the meeting procedure is performed accordingly to the prescribed routines, which is described above. (KAB, 2013)

4.3.1 The Streamline

This group consists of employees from the whole organisation. The purpose is to create a fundamental understanding regarding the central tools, which is a part of the work approach for the future projects within KAB. In order to achieve this purpose the streamline should create: (1) to define the responsibilities and interfaces between the project- and the line organisation, (2) to control the project with the implementation of VBM's for the project managers and subproject managers, (3) increase the transparency from the project management level to the operational level, (4) standardize KPI, (5) ensure that all projects is complying with the current project- and planning process by guarantee the delivery of TG and the implementation of DG and (6) a consistent and efficient meeting structure to facilitate information dissemination and clarity where the decision derives. The streamline has concluded that five KPI is sufficient to control the project. The streamline conducts weekly meetings and reports back to the project management organisation on a weekly basis. (Otterlund, 2013; Lussi, 2013)

4.3.2 Management Control and Reporting System (MCRS)

This is a group, which consists of employees from both technical and administrative departments. The target for the MCRS is to ensure that the visual boards meetings will conduct in an efficient way, all the managers shall act accordingly to the defined standards. Furthermore, to guarantee that the line organisation use the adequate KPI's and applies it correctly in their VBM's. It is also the MCRS task to control that the line organisation holds their meetings in as the routines prescribes. The human resource and the financial departments have their own KPI's, which the MCRS scrutinise. However, the concerned departments design and control the KPI. The MCRS has weekly meetings in conjunction with the streamline and the administrative departments to ensure the collaboration regarding KPI and between the project and the line organisation. After this meeting the MCRS conducts a follow-up meeting, where the discussion concerns the chain effect of the visual boards of the project and line organisation. Further, reports the MCRS on a weekly basis to the COO office. (Öhrn, 2013)

4.3.3 Earned Value Management

The company applies a tailored version of the international Cost/Schedule Control Systems Criteria (C/SCSC) standard as a project controlling system based on the Earned Value Management (EVM). The standard used is to ensure to achieve an effective management control system, procedures and supplies management with information needed of the project status. The company use the Percentage of Completion (PoC) method for the project profit recognition in its income statement. This method requires a high quality in the recognition of the project status as the profit recognition is based on the prognosis of the project within the company. The EVM is used by the project management reporting towards the company management and customers. (KAB, 2013)

There are eight important steps within the EVM (se figure 15): (1) to *define work:* demand, desired targets on function, quality final assessment, define the organisations- and product structure (Se figure 6), (2) assign *responsibility:* to owners, (3) define the *plan*: this is performed through planning activities/ events and milestones, (4) *authorize work*: distribute within schedule, (5) *execute & monitor the work*: is measured in current- and comparable price levels with the estimated cost and also define which activities/events/milestones that are partially or fully implemented, (6) *report*: to measure the created value, this is calculated by the actual cost in accordance with the estimated cost, (7) *analyse*: current status reports of problems or possibilities and decision or adjustments and (8) *revise*: when an authorised

change is received, all affected, work-authorisation, budge planning and scheduling documents are updated in a timely manner to reflect the change. (KAB, 2013)

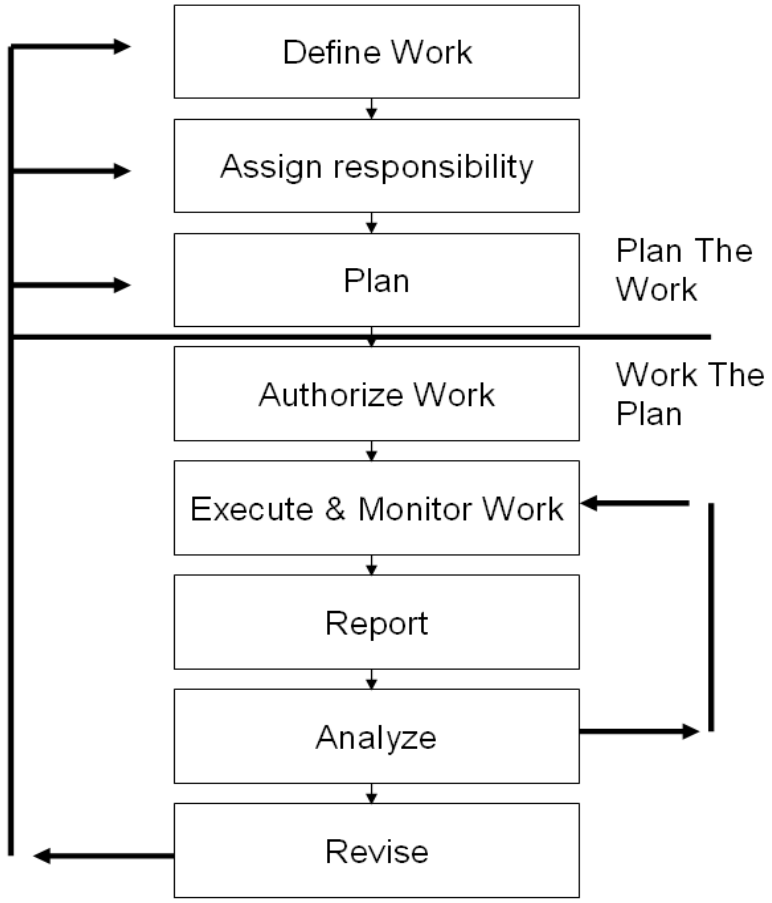

Figure 15: 8 Steps for EVM

4.4 Five KPI

The streamline concluded that the company should use five KPI for its project management in order to facilitate the project control. The first three are EVM-based and includes variables such as man hours, labour cost, material and total price. The fourth KPI “delivery accuracy” concerns the quality of engineering work and the fifth includes the quality “deviations” in drawings. (Otterlund, 2013; Westergård, 2013)

4.4.1 KPI - Price

An example (figure 16) will now follow to enlighten how EVM works. The company has received a contract of 12 systems for the total budget of 12 BNSEK. One system is estimated to take one month to produce. The estimated value/cost (blue fat line) will constitute as the

baseline of the work scope, within the *Budgeted At Completion (BAC)*. However, at the 1st of June (Time Now) the project management will be aware that the actual cost (orange fat line) is higher than the estimated value/cost and will take necessary action to mitigate the risk of the project. The company should have produced five systems of 5 BNSEK, but it has only produced four systems to the value of 6 BNSEK. The company has produced one system less than estimated value/cost to the actual cost of five systems. The total cost of Estimate To Completion (ETC) is 13. This means that the earned value (red fat line) is only 3, 8 BNSEK. The delayed delivery is highlighted by the earned value within the analysis of the time now and by the ETC. Furthermore, the analysis will confirm the overrunning cost and the delay in schedule by variances within the EVM. (Otterlund, 2013)

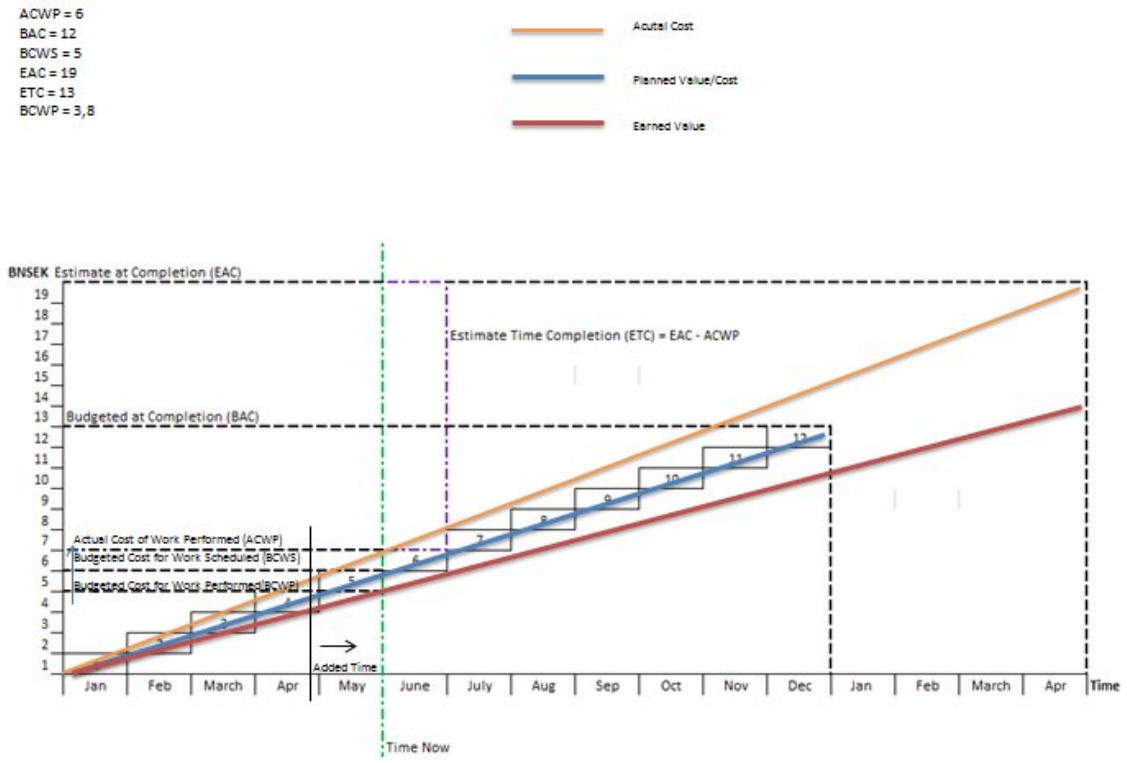

Figure 16: Earned Value Management - Price

The first KPI that KAB applies is based on the EVM, which aims to measure the budgeted cost and time. At the time now the management analyse and report the actual status of the KPI. The calculation of KPI earned value is calculated at each time now as follows;

Budgeted Cost for Work Performed (BCWP):

$$\frac{\text{Actual Cost for Work Performed (ACWP)}}{\text{Estimate at Completion (EAC)}} \text{ X Budgeted at Completion (BAC)} = \text{Budgeted Cost for Work Performed (BCWP)}$$

$$\frac{6}{19} \text{ X } 12 \quad = 3{,}8$$

Cost Performance Index (CPI), which is calculated:

$$\frac{\text{Budgeted Cost for Work Performed (BCWP)}}{\text{Actual Cost for Work Performed (ACWP)}} = \text{Cost Performance Index (CPI)}$$

$$\frac{3{,}8}{6} = 0{,}63$$

The next KPI is the Scheduled Performance Index (SPI), which is calculated:

$$\frac{\text{Budgeted Cost for Work Performed (BCWP)}}{\text{Budgeted Cost for Work Scheduled (BCWS)}} = \text{Scheduled Performance Index (SPI)}$$

$$\frac{3{,}8}{5} = 0{,}76$$

The CPI is 0, 63 and the SPI is 0, 76, the value of the KPI's indicates to the project management the actions needed to be taken with the necessary decision to be on track with cost and schedule. The closer the value of CPI and SPI is to one the better. These EVM-based KPIs is updated on a monthly basis analyse and reported by the project management on steering committee meetings. (Otterlund, 2013)

4.4.2 KPI - Man-hours

The purpose of this KPI (figure 17) is to supply the management information regarding the man hours and time, these variables can then be expensed to the concerned line manager. The example will now continue with the same conditions of producing 12 systems in 12 months, but with the addition of information that it takes 12 000 man hours to complete. The 10 steps of EVM are applicable in this KPI as well. One system is estimated to take one month to produce. The estimated man hours (blue fat line) will constitute as the baseline of the work scope, within the *Budgeted At Completion (BAC)*. However, at the 1st of June (Time Now) the project management will be aware that the actual man hours (orange fat line) is higher than

the estimated man hours and will take necessary action to mitigate the risk of the project. The company should have produced five systems of 5000 man hours, but it has only produced four systems to the value of 6000 man hours. The company has produced one system less than estimated man hours to the actual cost of five systems. The total cost of Estimate To Completion (ETC) is 12 000 hours. This means that the earned value in hours (red fat line) is only 3, 78 hours. The delayed delivery is highlighted by the earned value within the analysis of the time now and by the ETC. Furthermore, the analysis will confirm the overrunning cost and the delay in schedule by variances within the EVM. (Barbu, 2013)

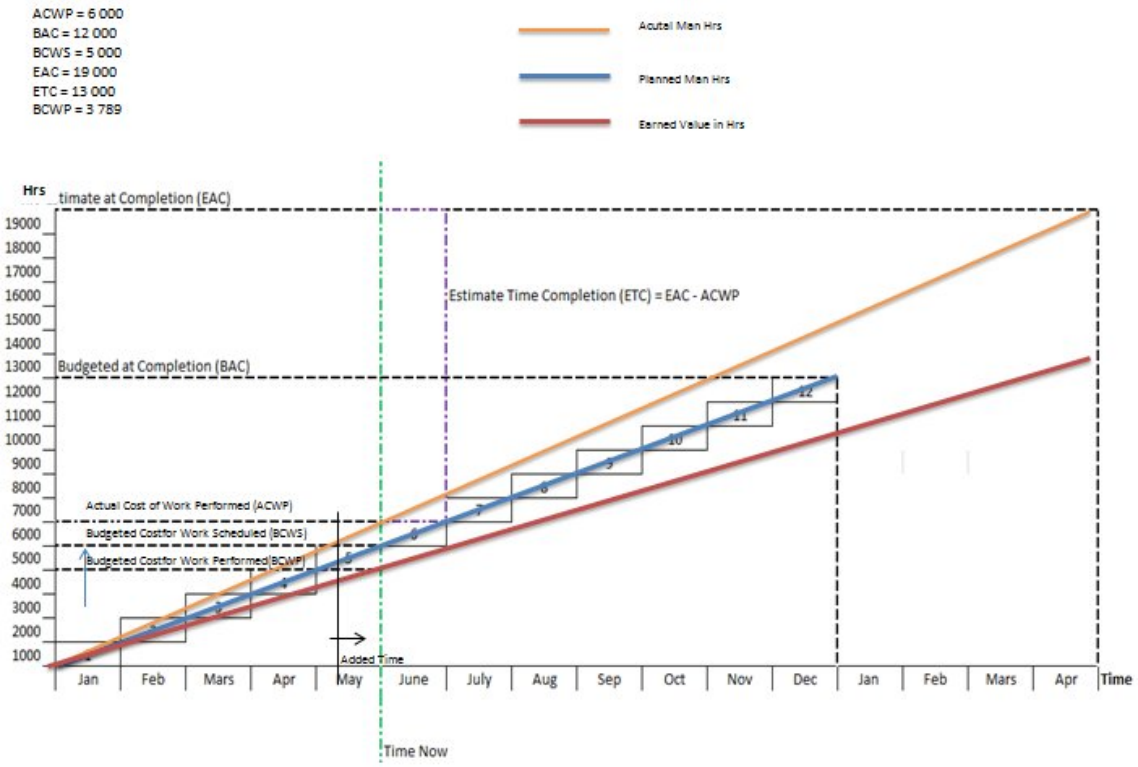

Figure 17: Earned Value Management - Man Hours

The first needed is to calculate the BCWP for man hours (BCWP calculation).

$$\frac{6\,000}{19\,000} X\ 12000\ = 3\ 789$$

The next step is to calculate the CPI:

$$\frac{3789}{6\,000} = 0{,}63$$

And the SPI:

$$\frac{3789}{5\,000} = 0{,}76$$

This KPI is also connected to the Enterprise Resource Planning System (ERP) within the company. A submarine has over 1000 system/parts system, which has been disable into three different detail areas both concerning the man hours for, which the subproject managers and group leaders is responsible for. (Barbu, 2013; Otterlund, 2013)

4.4.3 KPI - Material

The purpose of this KPI (figure 18) is to supply the management information regarding the material consumption and time, these variables are can then be expensed to the concerned line manager. The example will now continue with the same conditions of producing 12 systems in 12 months, but with the addition of information that it takes 600 units of material to complete. The 10 steps of EVM are applicable in this KPI as well. One system is estimated to take one month to produce. The estimated material consumption (blue fat line) will constitute as the baseline of the work scope, within the *Budgeted At Completion (BAC).* However, at the 1st of June (Time Now) the project management will be aware that the actual material consumption rate (orange fat line) is higher than the estimated material consumption and will take necessary action to mitigate the risk of the project. The company should have produced five systems of 250 units of material, but it has only produced four systems to the value of 300 units of material. The company has produced one system less than estimated material to the actual cost of five systems. The total cost of Estimate To Completion (ETC) is 650 units of material. This means that the earned value in hours (red fat line) is only 205 units of material. The delayed delivery is highlighted by the earned value within the analysis of the time now and by the ETC. Furthermore, the analysis will confirm the overrunning cost and the delay in schedule by variances within the EVM. (Otterlund, 2013)

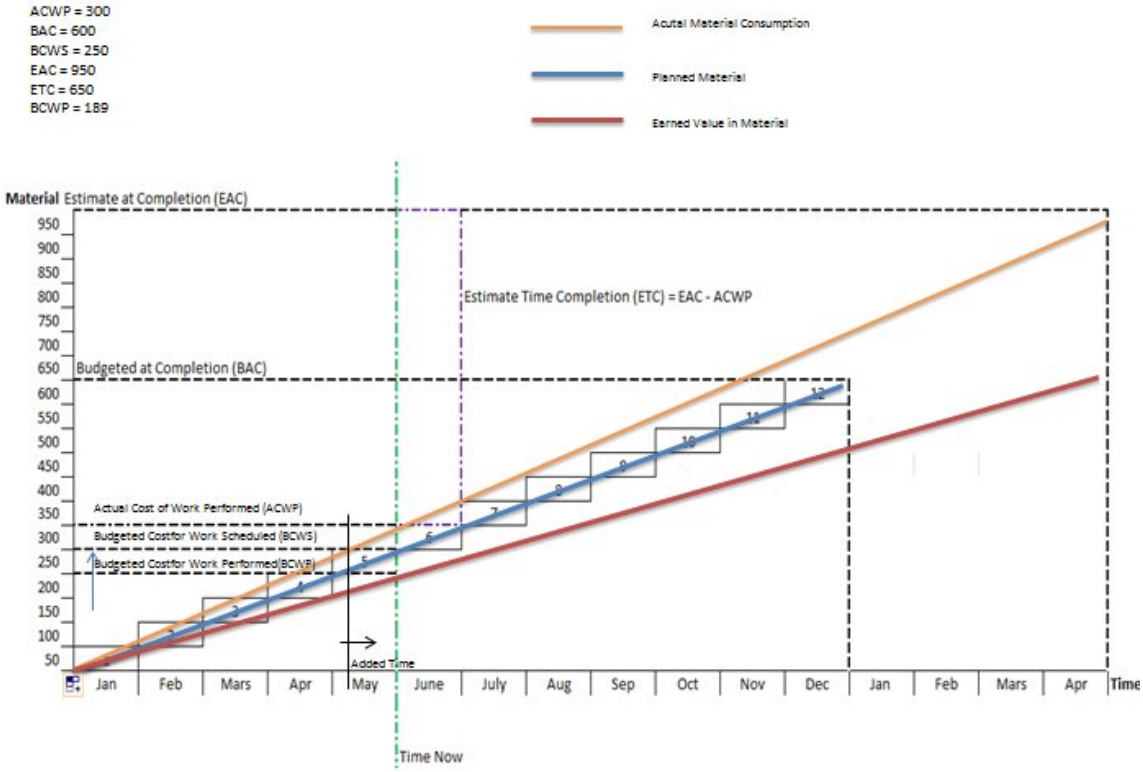

Figure 18: Earned Value Management - Material

The first needed is to calculate the BCWP for man hours (BCWP calculation).

$$\frac{300}{950} \text{ X } 600 \quad = 189$$

The next step is to calculate the CPI:

$$\frac{189}{300} = 0{,}63$$

And the SPI:

$$\frac{189}{250} = 0{,}76$$

4.4.4 KPI - Delivery Accuracy

The KPI “delivery accuracy” (figure 19) is measured and reported by the responsible quality manager to the project management and the product submarine. The purposes of the KPI are to supply follow-up for the project status by creating ratios for the project management and

propose quality improvements. According to the Quality manager, (2013) the traditional serial production uses regularly parallel ratios such as scrape ratio, rework overhead costs, delivery accuracy and revision overhead costs etc. The definition of this KPI is referred to as:

- To the generally extent, which the delivery of the customer order could be made at the agreed delivery date.
- The proportion of deliveries, which occurs within the agreed delivery date
- The company's ability to deliver to ordered quality of the correct product at the agreement time.

The company emphasizes the time variable in this measurement. However, the KPI is adjusted to the current circumstances within the company, for instance to meet a project oriented organisation and to include the iron-triangle. The following demands on the KPI from the organisation are to focus on the internal deliveries, the KPI should be reported to the control group, follow-up should be performed continuously and the measures should be easy. The measurements objective is developed in conjunction with the projects certain project events, which are linked to the TG and internal deliveries. It is further stated that variables time, budget and frequency should be included. The quality manager and the project leader will summon the concerned departments for a follow-up meeting, to judge the validity of the reports. The reporting is conducted by dividing KPI into quality, time and budget, which is then delivered to the product submarine management on a six month basis.

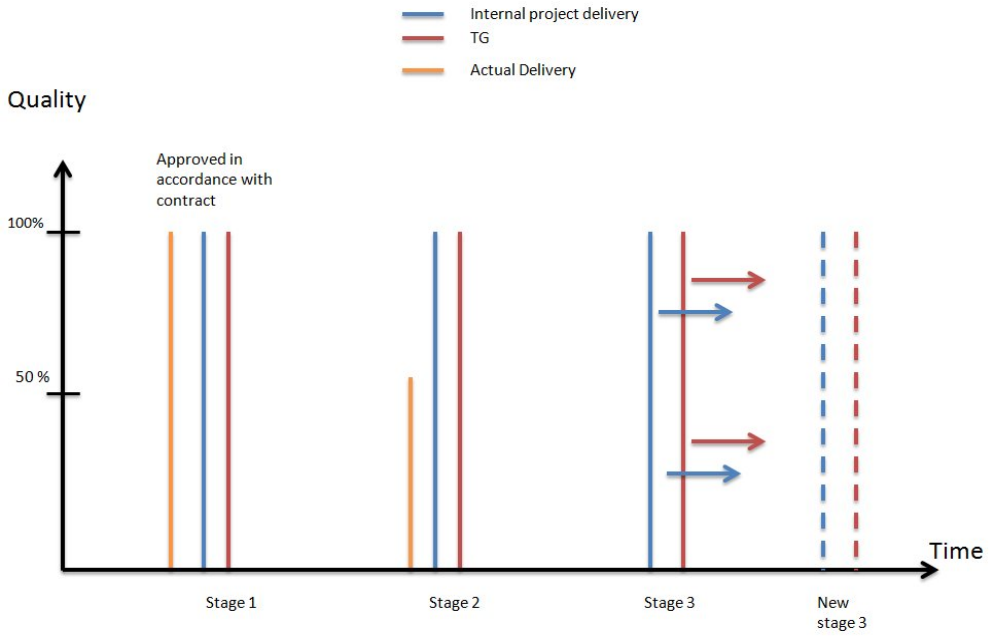

Figure 19: Delivery Accuracy

The company has three internal deliveries that are closely linked to the TG and it concerns the system information within the design phase (figure 19). Missing deliveries in this stage might jeopardize the master plan and entail in heavy delays, for this reason it is important to control the delivery accuracy. According to the figure 17 the first internal project deliveries have been approved in accordance with the contract (TG). However, in the stage 2 the deliveries have only achieved 50 % of the desired quality, which is insufficient of the internal project deliveries targets. This might result in that stage 3 has to be rescheduled or it demands more resources in between the period of stage 2 – 3 in order to solve the problem. (Westergård, 2013)

4.4.5 KPI - Deviations

The purpose of this KPI is to capture the amount of deviation within the project and to highlight, which processes that requires improvements. However, the KPI has not yet reached the maturity level to be subject for a closed review. (Westergård, 2013)

The EVM-based KPI's are based on a military international standard for cost and control of major projects and tailored for KAB's operations. The other two KPI's are internal developed by the KAB during ages of project control of naval vessels. The EVM-based and the delivery accuracy KPI's are previously applied measurement tools and supports the KAB project control, though there is no natural connection between the measurements. However, the delivery accuracy measurement is in the evaluation phase and is partially implemented within the project as a KPI. Further, there is currently no existing model of the KPIs within KAB. The streamline is continuously working to develop such a model for the company in conjunction with the efficiency program "*Kraft 2.0*".

5. Analysis

This section provides an analysis from three different perspectives, namely the organisation;, identify critical activities and key performance indicators. This includes explaining why and what factors may affect KAB's design of KPIs.

5.1 Organisation

There are several similarities within the empirical findings and the combined theory. For instance, KAB is making a clear distinction between the responsibilities of the line and project organisation. This organisational matrix is in line with Söderlund (2008), which uses the terminology of operational and strategic control within the organisation. Furthermore, emphasizes Söderlund (2008) two fundamental issues to control a project. The project form is suitable for KAB, mainly because the product is unique, concerns a limited time and the scope of work requires many different specialist competences. The company applies a solid process to appoint a project manager where the project sponsor demands through a task specification to be responded by a project specification from the project manager. This process is in accordance with Söderlund (2008) and relates to clarify the targets and decentralises responsibilities to the project manager. These prescribed routines from KAB are well established in order to prevent future uncertainties. Another fundamental issue concerns to judge the project progression, which the KPI's is indented to cover. The company already applies TG and DG, which represents control tools to measure the project progression. The reason for why KAB is applying an extensively and accurate process to select a project manager for this type of project with the above defined specification, might be that the product is highly complex with large coordination challenges including many boarder lines surround the project. The company has also a long tradition of designing and producing the product, which generates a focus on minor adjustments in order to make the business more effective and efficient. KAB's product is more similar to companies that operate with large nonrecurring projects, such as the bridge between Malmö and Copenhagen; a comparison towards the serial production industry is not sustainable.

The KABs current organisational matrix is based on a strong project organisation to be supported by the line organisation. KAB has through the age's experience of both strong line and project organisation in its business. The competences within this organisation matrix tend to shift during the different phases of the project, which makes the situational KPIs applicable. KAB has also in the past for different major projects reflected the organisational

structure by the organisational structure of the customer for the concerned contract. This in turn will also require the use of situational KPI's.

With the current organisational matrix it is vital for KAB to focus on the project oriented KPI for time to time reporting of the project status. The line organisation is then concentrating on supporting the project organisation with necessary KPI for KAB processes.

KAB (figure 12) is making a clear distinction between the different project process phases such as market, tender, design and production. This is in line with Macheridis (2005) (figure 2). The market and tender process can be interpreted as the definition phase that includes task e.g. project definition studies. The planning, implementation and reflection phase is consistent with the design, production, verification and maintenance stage of KAB's processes. It is also emphasized by Macheridis (2005) that during the project life cycle the process should be ongoing influenced by the projects financial status. This could be seen within the "*company business control"* in KAB, for instance, within the tender stage, to submit attractive tenders to customer in order to increase the sale of the company. There is a need for KAB to establish a reliable master schedule regarding, for instance resources before the start up process beginnings, mainly due to the life cycle of the project. It is also important to predetermine the responsibility to decrease the existing uncertainty. During the first phase of the business control process there should be a comprehensive need to conduct a well-elaborated estimate. Before closing the estimate KAB will accomplish a risk analysis for evaluating the overall risk within the tender.

KAB is applying two different kinds of projects: either internal or a custom oriented. The custom oriented project is a combination of Söderlund (2008) classification of development project and business project (figure 3). KAB's customer oriented project is normally including complex technical solutions, and fits the "*description*" of the business project. The customer oriented project may also involve development of new systems. Regarding the "control principle" in the figure 1, the two definitions of Söderlunds (2008) projects are within KAB combined into the customer-oriented project. The usual procedure is that KAB signs a contract with the customer to deliver in accordance with the contract. The contract is equivalent with the iron-triangle, mainly, because the quality, time for delivery and the budget is prescribed within the contract. Further, KAB is applying EVM, which highlights the variance between time, cost, man hours and material in detail, this is consistent with the development projects. KAB is also applying a combination concerning the "control

challenges", the project management is conducting meetings, follow-ups and propose potential changes on regularly basis within the contract in conjunction with the customer including KAB's suppliers. However, KAB's line organisation is responsible for the technical solutions by supplying the project organisation with necessary personnel competences. KAB defines that customer satisfaction is made when the project delivers quality, in time and cost to the customer in accordance with contract. This definition is in line with both of the CSF within Söderlund's (2008) model. There are a number of similarities regarding the "*Kraft 2.0*" program with the modification project, such as the improvements should be continuously. However, the "*Kraft 2.0*" comprise in the total operating business of the company.

The project organisations responsibilities (figure 6), which illustrates the collaboration between the line and the project organisation regarding to control the resources. The line organisation will supply the project management with the sufficient resources in order for the project managers to achieve the established targets. According to Söderlund (2008) the project manager can control the assigned resources. This is in line with KAB, where project management controls *what* and *when*. The company applies "*the company business control*" and the project process is a part of this model. This is consistent with the statements of Söderlund (2008) that the project model shall apply and describes the processes within a company in order to facilitate the control. The different phases are described (figure 12), the processes are decomposed into different steps such as evaluations and the project specification, and this is consistent with the statements of Margretta (2002). According to Söderlund (2008) it is important to establish a jointly language when introducing a new PMS. KAB uses the "*Kraft 2.0*" and the VBM as basis to communicate the corporate values and strategy towards the organisation.

The KAB is applying milestones (DG and TG) for its business control process as gatekeepers to ensure that the criteria are fulfilled in accordance with the contract (appendix 1 and 2) (Söderlund, 2008; Cooper, 1990). The COO Office, which consists of the COO and specialists both from the administrative and technical departments. The COO Office must approve the TG before the project can proceed, thus the strategic control is combined with the operational control. Consequently, the COO Office can adjust the project management with necessary adjustment to ensure the project progression (Cooper, 1990). The empirical findings is consistent with the current theory, reasons for this might be that KAB has refined its processes in order to support the work to be performed.

5.2 Identify Critical Activities

The empirical findings suggest that KAB have a united definition of project success as to the contrary in the theory (Belassi & Turkel, 1996). This definition means that the product should be delivered in time at the prescribed budget and to the right quality in accordance with the contract. This is consistent with the iron-triangle, however, Belassi & Turkel (1996) provide that the iron-triangle as an only target is insufficient. The KAB is acknowledging the CSF concerning the need of the top management support to the project management (Avots, 1969). This could be seen with the precise process of selecting the project manager (Rubin & Seeling, 1967). KAB has clarified the responsibilities among the line and project organisation, this is emphasized by Schultz et al. (1987) as a CSF. Regarding Clarke's (1999) definition of KSF is in line with the MCRS and VBM group to effectively improve the meetings. KAB has also recognized the consequences of lack of communication and the VBM in conjunction with the MCRS will increase communication between the employees in an effective way (Prada, 1996). KAB is consistent with the theory to breakdown the goals (TG and DG), product and organisation (WBS) into minor parts in order to facilitate creation of targets and estimation (Clarke, 1999). The scope and objectives of the project within KAB is established by the estimate, which is implemented in a master schedule. In this stage situational KPI could be identified for later phases. This is in line with Clarke's (1999) reasoning.

According to Neely et al. (2002) and Kaplan & Norton (1992) the PMS should be connected to the company's strategy and vision. KABs company vision and mission is consistent with both a technical and financial perspective. However, the strategy can only be analysed from a design phase and from the project management perspective. The line organisation's KPI is not included in the scope of this paper. KAB provides unique products, which is in line with first two statements with sentence, "*innovative products and service*". The mission is also focusing on customer and the company's definition of a satisfy customer. This is in line with all the targets of the KPI's. The human resources KPI's is including to "*create value for employees/employee development is especially important"* and the "delivery accuracy" includes "*other stakeholders*" for instance, suppliers and sub-suppliers. The corporate values is not included in the KPI's, but is communicated ongoing throughout the VBM. However, there might exist requirements for the project management to also measure the employee's satisfaction. Since, the product is highly complex and relay heavily on specialist know-how this constitute as a real CSF, for instance if the employee are unsatisfied they might move to

another company and the market for specialist is very small, which in turn might expose the company for long-term risks.

According to the performance prism model an organisation consists of both the business performance review and the performance measurement system review. The KAB's project organisation can be interpreted to be consistent as the business performance review aspect. The streamline within KAB should therefore thoroughly consider the formulation of the KPI targets in order to not change the targets too frequently, thus creating uncertainty for the employees (Ghalayini & Nobel, 1996; Fisher, 1992). An indication for this might be that the VBM concerns more about argumentation regarding the definition of measurements instead of valuable problem discussion. The streamline is conducting weekly follow-ups and this is in line with the frequency of measuring the performance aspects (Najmi et al., 2005; Najmi et al., 2012). The streamline conducts also coherent meetings in conjunction with the MCRS to communicate the company strategy towards the operational level. KAB's processes are well entrenched in the organisation (figure 12). The MCSR will ensure that the project organisation uses reliable measures, however, the group should also emphasize the importance that the adequate personnel receive the concerned information (Najmi et al., 2012). Otherwise, the consequence might be that the useful information is wasted. In accordance with Lynch & Cross (1991a;b) the company applies VBM where the stress that the visual boards consists of both information that should be follow-up and estimated information. The ToR within the VBM requires that the meetings participant establish an action plan, which is also highlighted by Neely et al. (2002).

One of the streamlines tasks is to standardize the KPIs for the project management in the design phase. It is acknowledged within the company that it also requires additional new KPI's when the production phase starts. The deviations KPI, which is not yet developed is highly interesting for the production phase e.g. how many inaccuracies is associated with the drawings vs. production. The EVM based KPI is also applicable here the material consumption, man hours and cost. According to Neely et al. (2002) should approximately 20 % of the KPIs be situational based. The streamlines purpose is to standardize the KPI's. Therefore, there might exist an extensive need for KAB to evaluate the KPI's before changing to the production phase and if required develop new situational KPI's as well. It is further stressed that the company is recommended to develop more situational KPI within the design phase in order to meet the special demands and requirements of the uniqueness of each project. The streamlines focus to only establish standard KPI's might need to be replaced by a

base of standard KPI's together with situational KPI's. The COO through the COO Office has the overall responsibility for the KPI, VBM and "*Kraft 2.0*". Neely et al. (2002), Kaplan & Norton (1996), Chan (2004) and Olve (2007) emphasizes that the introduction of a new PMS should have the top management support in order to increase the probability for success.

There may exist several reasons for a change in strategy of the company. For instance, the customer requirements may demand changes, or the EC may change the strategy of the company. If this occurs then the streamline should review their measurements (Neely at al., 2002). There might also arise situations with consequences that the streamline will be aware of regarding the KPI's e.g. if the "delivery accuracy" KPI is not conflict with either the operational or the company strategy. If there is a conflict this may yield a negative consequence for the line organisation e.g. more bureaucracy etc. According to Neely et al. (2002) is it hard to define stakeholder satisfaction, however, KAB has managed to supply a sustainable definition for the customers. It is stated by Bourne et al. (2000) that the implementation of KPI can be perceived as a process. Further, Kennerly & Neely (2003) provides that a success is dependent on the infrastructure. There is an extensively requirement for KAB to review the measurements systematically in order to discover deficiencies and to fine-tune the design. There should also be continuously improvement regarding the infrastructure to create opportunities (Najmi et al., 2012). KAB might consider appointing or expanding the streamlines tasks to counteract that the majority of the KPI cannot be reliable evaluated before introduced.

With the KAB's KPI's is currently not related to each other, consequently the streamline needs to develop a KPI model, which explains the relationship between the measurements. KAB may use the "*Kraft 2.0*" and the VBMs as a channel to communicate the strategy and corporate values. The performance prism can facilitate the grouping and separation of situational/standard KPI and highlight areas of concern. The prism may further, supply the company with an awareness of CSF in order to achieve success. However, the BSC-platform may also supply an example of KPI grouping with its perspectives (Macheridis, 2005). Furthermore, the fundamental structure of BSC is that the long-term strategy and vision is reflected in the measurements (Kaplan & Norton, 1992). Andersson (2005) emphasizes that the BSC is suitable for construction industry.

5.3 Key Performance Indicators

According to the literature there exist several definitions of KPI (Walsh, 1996; Radjukovic, 2010; Enqvist, 2013; Hapovana & Al-Jibouri, 2009; 2012; Parmenter, 2010). The paper will apply the KPD and KPO definition in the analysis, but these KPD must be carefully scrutinised in order to ensure that the indicators will not only measure the outcomes.

The operation of KAB is more suitable for KPD than the KPO. A reason for this is that information that only shows outcomes are less valuable from a control perspective, primarily since it will not offer alternative to adjustment (Walsh, 1996, Radujovic, 2010, Enqvist, 2013). The company requires information that presents the current situation and highlights risk of delivery etc. in order to prevent delays (Gibson & Hamilton, 1994). However, The KPI will not guarantee that the right action will be taken. The KPI supplies only where the risk of delays may occur, not what the adequate action should be, this task is for the managers to apply their professional judgement. The project management must have adequate information and time to judge the projects delivery capability to every TG or DG. The KPD offers a good solution to supply information in a timely matter to the project management of the ongoing work.

Hapovana & Al-Jibouri (2012), Hegazy & Hegazy (2012), Elshakour et al. (2012) and Chan & Chan (2004) further states that KPI is usually applied as a benchmarking tool. However, within the defence industry there a several factors, which makes the benchmarking difficult to use. There are very few actors within this line of business. Further, the information usually concerns both product safety and company security, which makes the desire to share information less likely. The products are very unique within the industry, thus the probability for comparison decrease. However, a few KPI may be benchmarked between the KAB's project portfolio. There might be several similar projects ongoing within KAB that enables comparison of KPI. The problems regarding access to information will be managed by internal benchmarking.

KAB's success definition is equivalent towards the iron-triangle, this connection is in line with Cha & Kim (2012). However, several researchers highlight the need to extent the iron-triangle as targets (Hapovana & Al-Jibouri, 2012; Chan & Chan, 2004). The target could include the process of the organisation (Hapovana & Al-Jibouri, 2012). KAB's success definition might be to narrow by excluding other stakeholders. The KAB needs to include the employees, since they are a vital CSF within the design phase and business. Further there are

two purposes for this measurement, namely to ensure that the company possess the adequate competence to solve the technical problems and to keep the employees satisfy, which prevents them from resigning. The measurement could comprise of an employee satisfaction indicator, and include factors such as satisfaction index and rewards system. It is emphasized that KAB's human resources already has a competence measurement, but it may needed to be adjusted within the KPI model.

KAB's three KPI cost, man-hours and material is based on the EVM, which provides an index of both cost and time variables. The advantages of the EVM-based KPI are that the scope includes the estimated completion in time, results and final costs. The KPI will also supply the project management with early warnings in terms of valuable anticipated information. Consequently the classification of the EVM-based indicators will be drivers. Further, advantages with EVM from the project management's perspective are easy to use and control the status of project. It will also supply reliable estimation of the financial results, which facilitates the forecasting of the financial effects. The EVM will give more adequate information of the delivery status, consequently reduce the cost of re-planning. The EVM requires supporting the ERP-systems as the information flow is substantial. However, there are a major short-coming of the EVM and it concerns the problematic to produce a reliable ETC. In order to create the ETC it requires highly skilled personnel in terms of competence and capabilities. The estimation should include the variables time, budget, materials, thus demands collaborations between the technical and the administrative departments. This in turn puts pressure on the project managers to cooperate, which facilitate the communication and understandable. Further, the projection of the estimate, which is constituted as the base for the entire baseline (BWCS) is needed to be performed highly accurately and precise than other equivalent measurements.

The "delivery accuracy" KPI (figure 19) concerns to measure the variables quality and time. KAB is starting by defining the scope of the KPI. The main advantages are that this measure highlights the date of the desired quality deliveries, both for internal project delivery and TG. It will also supply the project management with timely adequate information and provides sufficient time for reaction, thus the classification is a driving KPI. The targets include both the prescribed quality and time in order to receive necessary payments. However, it is the quality manager that oversees this KPI, hence the quality is in focus. Today, the KPI makes a separation of internal and external deliveries. Nevertheless, the KPI includes all deliveries, but not all deliveries are comprised within the TG or DG. The KPI should be more situational

tailored to include only the concern TG or DG, which can lead to delivery delays and the rest of the deliveries will be managed by another KPI. It is also emphasized that the time between the internal project delivery and the TG may constitute a risk, in terms of duration in time if not carefully considered.

The "*overtime work rate*" and "*rework rate*" KPI, which is introduced by Cha & Kim (2012) in figure 4, is applicable in KAB. Mainly, due to that this measurement seeks to highlight delays with no relation to the project phase. The defect frequency might be to production phase oriented to be applicable in the design phase. Furthermore, the other KPI's in figure 4 are covered by the EVM-based KPI's.

A major shortcoming of the measurement system is the basic assumption, which is the KPI is founded upon. If the KPI highlights an error in the system, for instance, that more employees are needed in order to improve the organisation, and the management is in line with this solution. However, the line management might be constrained in terms of recruitment by the top management and these are in turn constrained by the group strategy. This in turn results in that the KPI will still pinpoint the need for resources, but no adequate action can be taken even though the entire organisation is aware of the problem.

Within KAB's line of business it might be hard to locate suppliers with the adequate technical solutions. There might exist a requirement within the design phase to develop a KPI, which seek to measure the relationship between KAB and its suppliers. This KPI will ensure that the company has all the necessary suppliers before a certain decided TG/DG. Since, without suppliers KAB might risk heavy delays within the master plan. It is emphasized that this KPI shall be situational, mainly because the prioritisation list may shift between different contracts and project phases.

6. Conclusion

In this section a conclusion of the report is presented in order to highlight critical activities and recommendations. The section ends with a reflection and proposals for future research.

6.1 Findings

This papers purpose is to identify critical activities and develop situational key performance indicators in the design phase for advanced high-technology engineering and construction projects.

Within the engineering and construction industry it is important to have clear distinction between the organisational responsibilities in order to reduce uncertainties. A complex product that requires both specialist know-how and runs over a long period requires a detailed work breakdown of both the scope of work and the responsibilities of the organisation. This is highly important to breakdown a complex product and to connect a detail estimate including cost, material and man hours. It is further emphasized that project within the design phase requires gates and gatekeepers to facilitate the work breakdown, however, the awareness of the management that to detailed breakdown structure might jeopardize the project success. KAB has both connected the gates to the contract and internal milestones, which reduces the risk of delays. KAB perform also an extensively procedure to appoint a project manager, with the task and project specification, this is required in complex products to ensure that the project is feasible in an early phase. This line of business should not be confused with serial production, which rely heavily on a predetermine design.

There shall be awareness that the organisational matrix may shift during the different phases, consequently the KPI focus must be adjusted. The concerned company may also adjust its organisational structure towards the customer in order to facilitate the overall communication and collaborations. This will also form requirements for developing situational KPIs. It is also emphasized that engineering and construction companies perform a detailed and accurate estimate, which will form the baseline for the ongoing project.

Further, is that the target and strategy of an organisation is highly important to establish before developing situational KPI, since, the measurements shall reflect the strategy. It is further stressed that meeting, follow-ups and action logs are important tools for the project management to control the organisation. KAB applies the VBM for such purposes, which includes preparation, meeting and follow-up. However, KABs iron-triangle target is including the customer satisfaction, but it may lack to comprise the stakeholder as a group. This group

can consist of both suppliers and employees. The engineering and construction companies in the design phase relay heavily on specialist know-how of the employees, which is a CSF when the products is complex. There are very few suppliers within this line of business, which therefore require a KPI for monitoring the contractual progress and to ensure that there are more alternatives. The top management support is also an important factor that is required for success, but this is not only significant for the engineering and construction industry. The uniqueness and complexity of the products within KABs business might require a small base of standard KPIs and a complement of more situational KPI's in order to facilitate the control of the project. It is further recommended that the KPI shall be grouped in order to highlight areas of concern and the awareness of CSF, but this is asserted for all organisations.

There is also a need for companies within this sector to develop a review system of the measurement. Mainly, because most measurement cannot be evaluated before they are tested in practice.

The decision-makers within the companies must also acknowledge the main assumption of the PMS, which states that KPI can only supply guidelines, but the professional judgement of the managers is the key for success. The best suitable KPIs for the engineering and construction industry are the leading (KPD). Since, they will highlight the problems and offers time for the mangers to react proactively. There is an extensively need within the project oriented companies to develop a KPI model, which will show the relationships between the KPI and the connection. It is also recommended to define other early warnings KPI's supporting the EVM measurement system. The benchmarking towards other companies is not applicable within this industry, mainly because the complexity, safety and security will limit the possibility. However, the benchmarking may supply value to the organisation for the internal benchmarking of the project portfolio. The EVM-tool is suitable for long-term and complex projects, since it highlights the variance between the variables quality, budget and time. However, the short-coming of the EVM is the difficulties to establish the ETC. The technical situational KPI within the concerned industry should be connected to the contract in order to best reflect the customer satisfaction. The "delivery accuracy" KPI is also needed in complex and project with long life cycle in order to breakdown the deliveries into both contractual and internal milestones. The main systems shall be prioritised to ensure the project progression. Another relevant KPI might be the "*overtime work rate*", which enables the management to control the overhead cost.

6.2 Recommendations

The identified critical activities for success (figure 20) within KAB are that the target setting must be extended to include other stakeholders as well. The iron-triangle contemplates only the value of the customers and shareholders. It is further important for KAB to continuing developing its KPI-model to comprise the cause-and-effect relationship in order to increase validity of the KPIs. KAB should also create a base of several standard KPIs in conjunction with additional situational KPIs. It is further stressed that the development of KPIs requires both vertical and horizontal competence of its business. The company must also acknowledge that the KPIs may only be evaluated in practice, hence there is a comprehensively need to establish a well functioning review process. It is emphasized that the KPIs should be connected to the concerned contract.

The financial progress of projects could be benchmarked as a KPI within KAB's project portfolio, for instance, the EVM-based KPI price could be used for this purpose. In addition, it is important that the KAB establish a review committee in order to evaluate the implemented KPIs in the organisation. Since, it is difficult to predict the actual validation and the result of the process of implementing new KPIs. KAB should further develop the "deviation" KPI to include quality based issue in order to improve the company processes. This might be performed by measuring the total number of approved drawings in relation to the revised drawings of a project. Consequently, the result of this measurement will indicate if there is a requirement to review the processes or acquire more adequate competence to the project.

The employee constitutes as a vital part within the design phase. As a result two different KPIs could be developed from this CSF. The first KPI to be developed is a standard KPI, which aims to measure the satisfaction of employees in order prevent the employees from resigning, thus increases the risk of delays and deficiency in quality. This could be performed by introducing employee interview surveys simultaneously with an interval, which is determined by the project management.

The second KPI to be developed is a situational employee KPI, which aims to measure the personnel competence allocated to the project. Since, every project is unique due to its contractual demands for different competences and there might definitely be a competition for certain competences needed for every project within the company's portfolio. Project management must breakdown the contract as early as possible in order to identify the needed competence and connect these to the employee KPI. The employee competence KPI shall

ensure that the organisation possess the adequate personnel to manage this issues in accordance with the master schedule for all projects within the company's backlog of orders. It is important to acknowledge that competence of the employees can be divided into technical or project management competence.

As there is vital information needed for the KABs design work to be delivered by major suppliers, there is certainly a need for KAB to introduce a supplier KPI, which aims to define milestone deliveries of information in conjunction with the project master schedule.

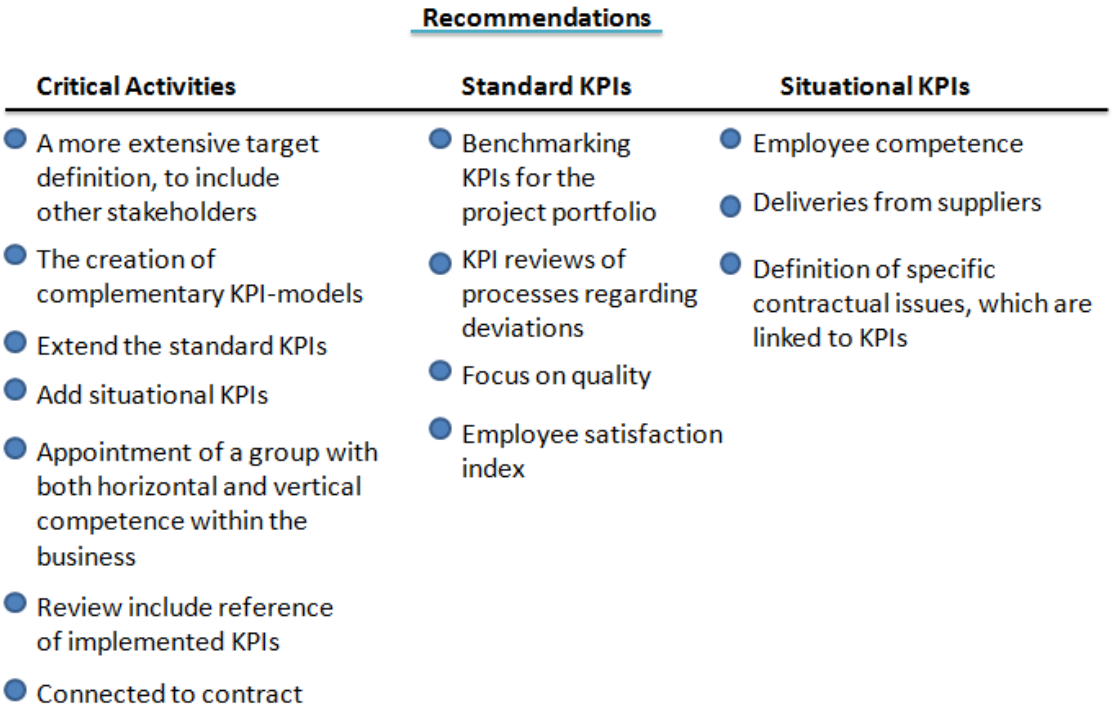

Figure 20: Recommendations

In conclusion, since engineering and construction companies are highly dependent on specialist know-how, a target that only includes customer and shareholders might be to narrow. Therefore this line of business must extent the target setting to include several stakeholders. It is further established that this industry needs to create a base of standard KPIs and complementary situational KPIs, mainly, due to the characteristics of the projects. It is further emphasized that the development of these KPIs shall include both horizontal and vertical issues.

6.3 Suggestion for Further Research

This above conclusion is founded on a single case study performed on one company, which operates in the engineering and construction industry in Sweden. There is a possibility that other companies within the same line of business acting in another countries might conclude in a different result. Therefore, it is emphasized that a further quantitative research is required to make generalisation conclusions of this line of business. There is also a need to perform a broader examination of the employees in order to make further suggestion of relevant non-technical situational KPI. This report has focused primarily on the project organisation, it is emphasized that if the line organisation is examined it may yield another result. It is also likely that different phases within the project life cycle will end up with another result. This report covers the situational KPIs, but it may result in a different conclusion if the extent of research includes the standardize KPIs. It is stressed that the researchers most likely have to possess technical competence within the product in order to locate valid connection.

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7. Appendix 1

7.1 Stage of TG

Stage TG1 – Send the quotation

This work should be finished and developed subsequently to the quotation process.

- Appoint a project sponsor and project manger
- Initiating a assignment specification
- Develop parts of the decision basis

Stage TG2 (DG 6) – Preparation of project

This should be complete

- Milestone plan TG and DG
- Delivery plan and communication plan
- Stakeholder list
- Updated risk analysis and project specification (PL)
- Budget/ Activity, time and material responsibilities
- Updated compliance list and a updated list of critical/strategically systems, room, equipment etc.

Stage TG3 (DG7) – Break down requirements and identify authentication method

This should be complete

- Updated delivery plan and implemented communication activities
- Updated risk analysis and quality deficiencies actions
- The economic status and monitoring of the budget in Earned Value Management (EVM)
- Lesson learned report and a summary of experiences

Stage TG4 – Competition of critical system and development of other systems.

- The same targets as previous TG

Stage TG5 – Competition of other systems and develop arrangements and construction

- The same targets as the previous TG

Stage TG6 (DG8) – Completion of arrangements, construction and demolition basis

- The same targets as the previous TG

Stage TG7:X – Produce hull and sections manufacturing (prepare start of section equipment)

- The same targets as the previous TG

Stage TG7:X-1 – Produce section equipment (prepare start to equip the entire vessel)

- The same targets as the previous TG

Stage TG8 (DG10) – Produce equipment of the entire vessel (implement IK and ICO)

- The same targets as the previous TG

Stage TG9 – Implement STW (continue IK and ICO and prepare HAT)

- The same targets as the previous TG

Stage TG10 – Implement HAT (continue with STW and prepare SAT

- The same targets as the previous TG

Stage TG11 – Implement SAT

- The same targets as the previous TG

Stage TG12 – Perform final inspection and deliver to customer

- The same targets as the previous TG

Stage TG13 – Finish project

- Project status report
- Protocol for delivery to the guarantee engineer
- Project finish
- Cost accounting
- Lesson learned report
- Suggestion for project improvement
- Protocol delivery to customer

Deliver of the TLS organisation.

7.2 Stage of DG

DG 1: Launch campaign

Decision: Shall the company start marketing activity/campaign for the product or service?

DG 2: Request For Information (RFI)

Decision: Shall Kockums provide information to a presumptive customer?

DG 3: Request For Quotation (RFQ)

Decision: Shall the company quote to a presumptive customer?

• Start quotation work

DG 4: Tender

Decision: Shall the company submit offer to presumptive customer?

• Tender reviewed and approved for delivery to customer

DG 5: Accept contract/order

Decision: Can the contract/order be accepted?

• The contract/order must have been reviewed and compared to the offer, including changes agreed during the negotiation.

• If any deviations, these must be documented.

DG 6: Ready for execution (Design process and Project process, TG2)

Decision: Are all preparations accomplished that are required for execution of the project?

• All documentation regarding the contract is compiled, including any changes added during the phase between tender and contract.

• Administrative preparations shall be ready, regarding organisation, resources, detailed plan for next phase.

DG 7: Approve requirement analysis and Strategic components (Design process and Project process TG3)

Decision: Are all requirements analysed and is the project ready for system procurement number 1?

- Methods identified for verification of all requirements.
- Contract proposal for procurement of system (Strategic components) are analysed in relation to requirement fulfilment.

DG 8: Approve technical solution (Design process and Project process TG6)

Decision: Is the technical solution decided and settled, before start of production?

- Design solutions and arrangements are decided.
- Reviews from a manufacturability perspective are performed
- Design reviews are performed.

DG 9: Ready to start production (Project process TG7)

Decision: Are all preparations accomplished, that are required to start production?

- Production plan and build description available
- Drawing packages available

DG 10: Ready for test (Project process TG8)

Decision: Is the project ready for commissioning and final testing?

- Installation work finalised and approved
- Installation controls performed and control plan signed and approved

DG 11: Close execution

Decision: Are all deliveries accomplished and approved?

- Deliveries accomplished and approved by the customer

DG 12: Finalise project (Project process TG13)

Decision: Can the project be finalised?

- Final report available
- Final delivery accomplished and approved by the customer

• Hand-over to “Maintenance” (TLS) performed