Evaluating Strategic Innovation

– A case study across Atlas Copco's divisions

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KTH Industrial Engineering and Management

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Abstract

Many senior executives state that innovation is closely tied to company success, but only one third of senior executives are satisfied with how their company measures innovation. To measure innovation in companies that have different types of business and products is complex. Senior management wants Key Performance Indicators (KPIs) on a group level that are cross-functional between the business units. Due to a shortage of such KPIs, further research is needed to find KPIs that measure innovation cross-functionally between different business units.

The empirical study in this thesis was mainly performed by conducting a case study at Atlas Copco, a Swedish company in the industrial sector. A high number of qualitative interviews were conducted with the management across Atlas Copco's three business areas, and 19 divisions. The interviews emphasized understanding the innovation and the products of each business unit, and the tools available for measuring innovation there today. By analyzing the information gathered with support from theory regarding innovation, performance measurement, and the Balanced Scorecard (BSC), two KPIs named Product Vitality Index (PVI) and BNP are proposed.

The PVI measures the revenue from new product offerings, and provides a good measure of innovation success in the short term. The idea with the PVI is for the executive group management to have an overview of the overall product portfolio, and to make sure that deteriorations from this product portfolio are detected early. The second KPI is called BNP, and measures the allocation of long term and short term R&D projects. The idea with the BNP is for the executive group management to get a sense of the overall innovation progress of the company, and to determine if the allocation of R&D project types is strategic for the future. The intention is that the combination of these two KPIs will allow the executive group management to better monitor strategic innovation, and to steer the Atlas Copco organization towards a position in the future where the company's innovation competitiveness remains strong.

To come up with the proposed KPIs, I used an approach that I have named "*Find Lowest Common Denominator" (FLCD)*. What the FLCD approach symbolizes is that cross-functional KPIs should focus on finding what business units have in common. It is easy for employees within the organization to put too much focus on highlighting the differences between the business units, and the problems that these differences create. It might be more important to find manageable definitions based on the Lowest Common Denominator (LCD), and to provide clear and hands-on examples to handle the differences, instead of introducing complicated and quantifiable definitions that employees have difficulty to understand, accept and work with.

Acknowledgements

First of all, I would like to thank Anders Pehrsson, my supervisor at Atlas Copco, for making this thesis possible, as well as giving me his constant support and sound advice in times when I needed it the most. I would also like to thank the people at Atlas Copco Group Controlling & Accounting, for taking valuable time to explain how Atlas Copco is organized, and to connect me with the right people in the scope of the project. My time at Atlas Copco would not have been the same without you.

Thanks are also in order to Håkan Kullvén, my supervisor at The Royal Institute of Technology, for his encouragement and support, as well as to my seminar group, for valuable feedback during the course of the project.

At last, I would like to thank all the other persons, at Atlas Copco, at The Royal Institute of Technology, and elsewhere, who have, in one way or another, been involved in, and contributed to, this master thesis.

Stockholm, June 2010

Niclas Forsman

Abbreviations

B2B	Business to Business
B2C	Business to Consumer
BA	Business Area
BOM	Bill of Materials
BPC	Business Planning and Consolidation
BSC	Balanced Scorecard
CMT	Construction & Mining Technique
COGS	Cost of Goods Sold
CT	Compressor Technique
ERP	Enterprise Resource Planning
F&A	Finance & Administration
FLCD	Find Lowest Common Denominator
GAC	Group Accounting Code
IT	Industrial Technique
KPI	Key Performance Indicator
LCD	Lowest Common Denominator
NPS	Net Promoter Score
PCM	Product Committee Meeting
PGC	Product Group Code
PLC	Product Life Cycle
PTD	Power Tools Distribution
PTM	Product Team Meeting
PVI	Product Vitality Index
R&D	Research & Development
SSR	Sales Stock Reporting Code

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Chapter 1 Introduction

In this chapter the background is presented, along with the problem discussion, and the problem formulation. The chapter also contains the study's purpose, demarcations, an ethical discussion, and the disposition of the thesis

1.1 Background

It is important for companies across all types of industries to follow up and to improve business operations. In order to do that, companies use performance indicators that apply for the particular business they operate in. By using appropriate performance indicators, senior management can get a comprehensive overview of the business they run in an easy and straightforward way. By looking at the performance indicators, senior management can also follow up performance of different functions in the company, such as engineering and marketing. In order to steer the business towards a desirable position in the future, performance indicators are essential. Kaplan and Norton (1996) summarized this as:

"If you can't measure it, you can't manage it"

Atlas Copco is a Swedish company in the industrial sector. One of Atlas Copco's core competitive advantages is their innovation capabilities. Innovation is clearly anchored in the core of the company, by being both a strategic direction and a core value in the Atlas Copco organization. Ronnie Leten, CEO of Atlas Copco, puts it like this (Atlas Copco, 2010, p. 6):

"Innovation is a deeply embedded part of Atlas Copco's company culture, and we have to actively work to make sure it stays that way"

Atlas Copco has developed a Key Performance Indicator (KPI), as one of several steps, to measure and evaluate strategic innovation. Giulio Mazzalupi, a former CEO of Atlas Copco, initiated the PVI in 2001. The KPI measures revenue from new product offerings and is called the Product Vitality Index (PVI). This specific KPI, revenue from new product offerings, is considered as the most indispensable performance indicator among senior executives (Andrew & Michael, 2009). Below, the company explains why it is critical to secure new and more innovative products to maintain their world leading position (Atlas Copco, 2009, p. 5):

"This area is important because to continuously launch new products is the best way of assuring we can maintain good margins. Additionally, product development is the key to reducing Atlas Copco's main environmental impact; the energy consumption, during the use of our product."

The PVI was implemented with intention to be used on a group level. However, the various natures of the different business units in the Atlas Copco organization complicated the measurement of the KPI on a group level. The CFO and the Vice President Group Controller believe that the PVI can be improved and standardized throughout the organization. They are also clear that this KPI alone not is sufficient to successfully measure strategic innovation at Atlas Copco.

1.2 Problem discussion

It is well-known and accepted in theory, as well as in corporate practice, that innovation is crucial for the long term survival and growth of any company. Innovation is important to the degree that many senior executives state that innovation is closely tied to company success. Since companies invest much money and many resources in innovation, to get a return is critical (Wall, 2010). The senior management survey *"Measuring Innovation 2009 – The Need for Action"* shows that only 32 percent of senior executives are satisfied with how their company measures innovation (Andrew & Michael, 2009). This is alarming, because poor measurement practices result in bad or incomplete information, wasted resources, and a lower return on innovation investments (Wall, 2010). The survey also recognizes that most companies struggle with implementing a measurement system that accurately measures innovation. James Andrew, co-author of the survey, explains (Wall, 2010):

"Most companies recognize the importance of measuring innovation and readily admit their shortcomings, but relatively few companies seem to be working as aggressively as they need to be to improve their capabilities in this area"

Companies need to know whether their investments in innovation are paying off, and measurement is a key part of that (Wall, 2010).

In the academic world, innovation management is a relatively immature science. Fagerberg (2003) states that in spite of its obvious importance, innovation has not always received the academic attention it deserves. Innovation did, for example, not start to emerge as a separate field of research until the 1960s. However, Fagerberg (2003) claims that research concerning the role that innovation has had on economic and social change has proliferated in the 21th century. He further states that no single discipline deals with all aspects of innovation and that, in order to get a comprehensive overview of innovation, a cross-disciplinary perspective is a must.

To measure and evaluate innovation in large companies that have different types of businesses is complex. These companies generally have different types of products and different types of innovation processes. Senior management still wants Key Performance Indicators (KPIs) that are cross-functional between different business units. There exists, as far as I am concerned, no hands-on method that solves this problem. Therefore, further research is needed to find KPIs that measures and evaluate strategic innovation, and that works cross-functionally across different businesses units.

1.3 Problem formulation

What Key Performance Indicators (KPIs) can be used to measure and evaluate innovation effectiveness at Atlas Copco, and how can these KPIs be constructed in order to be cross-functional between different business units?

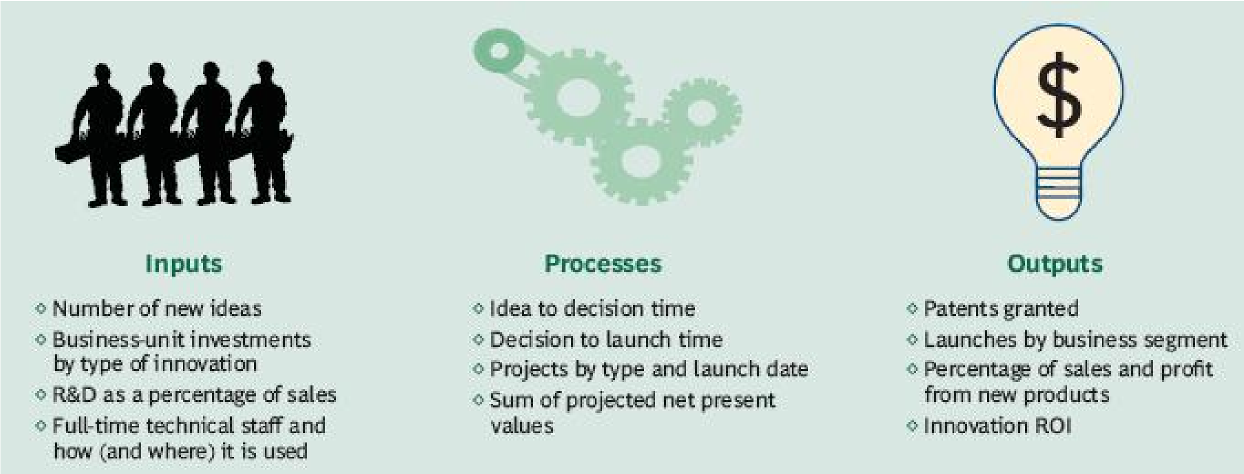
1.4 Purpose

The purpose of this thesis is to come up with a measurement system that makes sure that the divisions across Atlas Copco have an up to date product portfolio, and that deteriorations from this product portfolio are detected early. This thesis is executed, primarily, with the aim to be used and practiced by Atlas Copco. Secondly, it should work as a starting point for companies facing similar problems that Atlas Copco does. A more profound understanding of evaluating strategic innovation is intended to contribute to Atlas Copco, other industrial companies, organizations with interests in the industrial sector, as well as researchers in the field of innovation.

1.5 Demarcation

The innovation process comprises all activities required to take an idea and turn it into cash. The benefit for a company to measure innovation efforts is to gain insight into what is happening, how well the company is doing, and why, in order to take the appropriate actions. Companies need to measure three dimensions in order to do this; inputs, process performance, and outputs. See Figure 1 at the next page for examples of these dimensions.

Figure 1. The three dimensions to measure innovation



Source: (Andrew & Michael, 2009)

Inputs include both the financial and the non-financial resources that the company commits to innovation. Examples are money, the number of people, and how much time they are devoting to the effort. Process performance refers to if processes are running on schedule, and if they are functioning as designed. Companies might look at the idea to decision time, and time to market. The third dimension to measure is outputs, which are the cash profits, and indirect benefits generated by innovation. Indirect benefits include issues such as knowledge acquisition, and brand enhancement.

In order to have an overview of innovation efforts, a company should measure all three of inputs, process performance, and outputs. However, due to time constraints and limited resources, I had to narrow down the focus of this thesis. This thesis emphasizes measuring inputs and outputs, and does not focus on measuring process performance. The consequence of that no Key Performance Indicator (KPI) measures process performance is that issues such as idea to decision time, and time to market are not evaluated. The main reason to exclude process performance is that the problem formulation from Atlas Copco concerned outputs. The demarcation may also be explained with the terms effectiveness and efficiency. Effectiveness is defined as *"producing a desired or intended result"*, according to the Oxford English Dictionary (Soanes & Stevenson, 2005). Effectiveness should not be confused with efficiency, which translates as a *"measure of the ability of an organization to produce and distribute its products. In accounting terms it is quantified by a comparison of the standard hours allowed for a given level of production and the actual hours taken"* (Law & Owe, 2010). Effectiveness is normally described as *"doing the right things"*, while efficiency as *"doing the things right"*. Effectiveness is therefore more strategically oriented than efficiency. This thesis emphasizes effectiveness, and will not measure whether the business units are also efficient. The proposed KPIs consider whether the objectives and goals of the business unit are reached. To measure both efficiency and effectiveness would require a solution that also considers whether the innovation process is productive, cost efficient, timely, and well-organized.

1.6 Ethical discussion

Atlas Copco has internal information that they do not want competitors and the public to have access to. Most of this information covers specific business areas, and specific divisions. During the course of the project, I was granted access to some of this internal information. In order to keep the private information confidential, as well as being able to provide as much information as possible, a coded system will be used. The three business areas are coded with the letter BA, and the numbers 1 to 3. The business areas will, in occasions that the information is confidential, be named BA1, BA2 and BA3. In a similar way the divisions are coded with the letter D, and the numbers 1 to 19. The numbers for each business area and division have been randomly selected. The information is, as far as possible, presented with groups and categories as reference, to limit the amount of information that can be traced back to a specific individual.

1.7 Disposition

This thesis report is made up of the eight different chapters, which are described below.

Chapter 1, *"Introduction",* gives a brief introduction to the background of the project, as well as the problem formulation, purpose, and the demarcations surrounding it. The chapter also provides an ethical discussion, and the disposition of the thesis.

Chapter 2, *"Methodology",* introduces the scientific approach and method that forms the foundation of the study. The workflow is presented, as well as the different sources of information. The chapter ends by accounting for the concepts reliability and validity.

Chapter 3, *"The Company",* describes the background of Atlas Copco, the geographic coverage of the company, the market environment, the organizational structure, and the brands under the Atlas Copco umbrella.

Chapter 4, "*Literature review",* contains theory concerning the life cycle of a product, innovation, and performance measurement. The theories were used as support during the course of the project.

Chapter 5, *"Empirical study"*, describes the object of study in respect of its products, organizational structure, innovation process, and project types. It also describes the PVI, and provides information regarding the definitions needed to improve it. The chapter finally provides additional input from other sources than the object of study regarding definitions, as well as other types of KPIs that are used to measure innovation effectiveness.

Chapter 6, *"Analysis"*, starts out with improving and standardizing the PVI. The second step is to find KPIs that complement the PVI. The chapter ends with a summary of the proposed KPIs, and gives recommendations concerning how they should be defined and structured.

Chapter 7, *"Conclusions and discussion"*, contains conclusions regarding the proposed KPIs and the implementation of them. The chapter also discusses the reliability, validity, and generalizability of the study, and gives recommendations for future research.

Chapter 8, *"References"*, acknowledges the literature and references that were used during the course of the project. The literature and references are categorized in the categories books and articles, internet sources, and interviews.

Chapter 2 Methodology

This chapter introduces the scientific approach and method that forms the foundation of the study. The workflow is presented, as well as the different sources of information. The chapter ends by accounting for the concepts reliability and validity

2.1 Scientific approach

Since the view of knowledge and existing theory clearly affects how the thesis will be performed, the scientific approach for this study is described briefly. I question if existing theory fully can be applied to successfully evaluate innovation effectiveness at Atlas Copco. There exists no dominant theory in the field of innovation, existing theories are sometimes contradictive, and since innovation is a complex area to evaluate, the construction of good Key Performance Indicators (KPIs) most likely differs between different companies. The study primarily seeks the answer to the problem from the qualitative knowledge within the object of study, Atlas Copco. Nevertheless, existing theory is used to support the findings in the empirical study, to help come up with appropriate definitions, and to design and validate the proposed KPIs.

The study has approached and penetrated the reality, more than being an objective attempt to shield itself from the surrounding environment. Qualitative studies are certainly not generalizable from the definition used by the positivistic research ideal. It is difficult to generalize the results to other environments in qualitative studies, since the object of study might not be representative of the whole population (Bryman, 2002). However, a generalization of the results from the positivistic approach is not the ambition of this study. Generalizability might be looked at from a different angle. The results from qualitative research could instead be generalized to theory, and not to populations (Mitchell, 1983). May it not be the quality of the theoretical conclusions formulated from the qualitative data that is important when assessing the generalizability of a qualitative study? The findings in this thesis are customized to fit the object of study. Nonetheless, hopefully, the findings in this study can provide guidelines, or work as a starting point, for companies facing similar problems as Atlas Copco does.

In finding the definitions used in the KPIs, I have used an approach that I have named "*Find Lowest Common Denominator" (FLCD)*. The terminology and the definitions used today are different across the Atlas Copco divisions. What the FLCD approach should symbolize is that cross-functional KPIs should focus exclusively on finding what the business units have in common. This is important because I noticed that many employees during the course of the project, both at Atlas Copco and elsewhere, put too much focus on highlighting the differences between the business areas, and the problems that these differences creates. It might be more important to find manageable definitions based on the Lowest Common Denominator (LCD), and to provide clear and hands-on examples to handle the differences, instead of introducing complicated quantifiable definitions that employees have difficulty to understand, accept and work with. I think that the FLCD approach can be helpful in future research in similar contexts.

2.2 Scientific method

The study design in this thesis is a case study. The basic form of a case study contains a detailed and thorough study of one particular case (Bryman, 2002). Stake (1995) concludes that case study research concerns the complexity and the specific nature that the particular case shows. A case study is an effective approach to understand an organization, and to acquire a deeper understanding of a complex phenomenon (Yin, 2003). This understanding is essential to solve the problem, since previous research states that evaluation systems must be customized for every organization in order to be successful (Tangen, 2004). Flyvbjerg (2006) points out that the outcome of a case study can be generalized if the researcher is careful with the selection of appropriate object of study. This means that the findings in this study may be used to help other companies facing similar problems as Atlas Copco does.

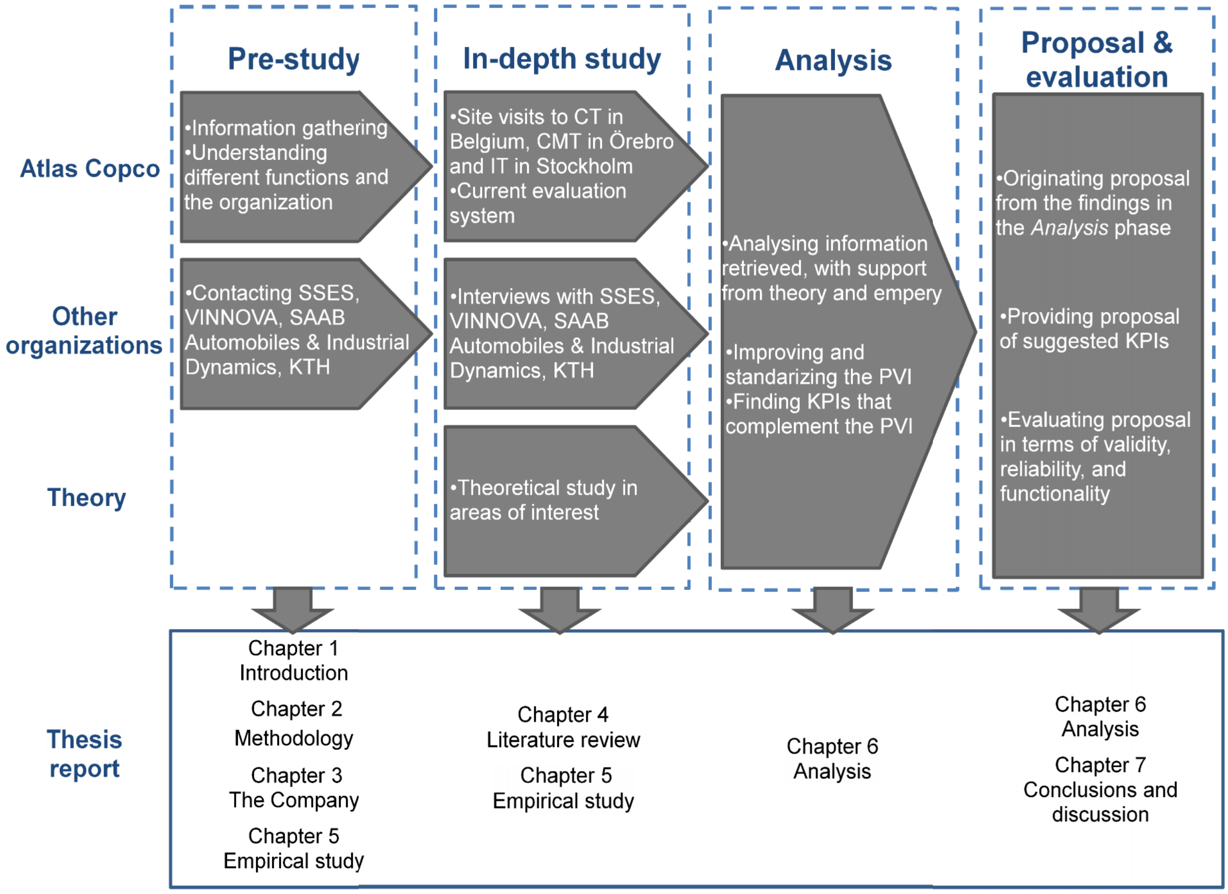
2.3 Workflow

The workflow during the project can be divided into four main phases. The four phases are:

- Pre-study
- In-depth study
- Analysis
- Proposal & evaluation

The workflow and details about each phase is illustrated in Figure 2 below.

Figure 2. Project work flow



Source: Own

In the pre-study, the aim was to acquire knowledge about the problem to solve, and to understand how the Atlas Copco organization is structured. Focus was also put on understanding the innovation process. I also contacted the external organizations Stockholm School of Entrepreneurship, VINNOVA, Industrial Dynamics, KTH, and Saab Automobile, in order to get additional thoughts about innovation, and to see how these organizations defined a new product. The information acquired from this phase was used in the chapters "*Introduction*", "*Methodology*", "*The Company*" and "*Empirical study*" of the thesis report.

The second phase, in-depth study, primarily focused on site visits throughout the Atlas Copco organization. Site visits were made to Compressor Technique (CT) in Antwerp, Belgium, and Construction & Mining Technique (CMT), and Industrial Technique (IT) in Stockholm. The main purpose of the site visits was to get in-depth knowledge from the divisions regarding their innovation process, what they considered to be a new product, and the available tools for measuring innovation there today. A secondary purpose was to establish a personal contact with the employees possessing the knowledge, and interest, to help me with the project as it proceeded. These personal contacts turned out to be valuable in order to improve the proposed Key Performance Indicators (KPIs), and to communicate the proposed KPIs out in the organization. At the end of the in-depth study, a theoretical study was conducted in order to understand existing theory in the areas of interest. The purpose was to get a comprehensive academic view on these areas. I chose not to conduct the theoretical study before the site visits, because I wanted to be as objective as possible when conducting the interviews, and to have an open mind when investigating the object of study. The information acquired from this phase was used in the chapters "*Literature review*" and "*Empirical study*" of the thesis report.

In the analysis phase, the information gathered in the pre-study, and the in-depth study, was analyzed. The base of the analysis was to understand the Product Vitality Index (PVI), and to find the definitions needed to improve and standardize it. The next step was to find KPIs that complemented the PVI. The analysis was performed by analysing the empery retrieved from the object of study, external information from other organizations, and existing theory. The information acquired from this phase was used in the chapter "*Analysis*" of the thesis report.

In the fourth and final phase, proposal & evaluation, the focus was put on providing a proposal to the problem that was initially posed by Atlas Copco. The proposal originated from the findings in the analysis phase, and contains an improved PVI, as well as an additional KPI that complements the PVI. The next step was to evaluate the proposal in regards of validity, reliability, and the functionality at the divisions across Atlas Copco. This was an iterative process, and the initial proposal was modified slightly in order to fit the company better. An evaluation was also done regarding benchmarking possibilities, vertically across the divisions, horizontally across business areas, and against competitors. The information acquired from this phase was used in the chapters "*Analysis*" and "*Conclusions and discussion*" of the thesis report.

2.4 Choice of theory

The theory chosen can be categorised into three different areas. The first one is the Product Life Cycle (PLC), which describes the life cycle of a product. The PLC was chosen since it provided a conceptual view of the life of any of Atlas Copco's products. The second category is innovation, and includes existing theories concerning innovation. Innovation theories were chosen in order to understand what should be regarded as innovation, and what should not. Worth noting is that there exists no dominant theory in the field of innovation, and existing theories are sometimes contradictive. The third area is performance measurement, and includes theory regarding performance measurement, Key Performance Indicators (KPI), The Balanced Scorecard (BSC), and evaluation of innovation processes. These theories were chosen in order to understand performance measurement, to be able to improve the Product Vitality Index (PVI), as well as to have the possibility to complement the PVI with other KPIs.

2.5 Empery

The study was performed at Atlas Copco, across their three different business areas Compressor Technique (CT), Construction & Mining Technique (CMT), and Industrial Technique (IT). The business areas consist of a total of 19 different divisions, with headquarters located in different cities in Sweden, Belgium, France, Germany, and the US. During the project, I was based at the Stockholm office. To complement the study at Atlas Copco, additional interviews and mail conversations were conducted with The Stockholm School of Entrepreneurship, VINNOVA, Industrial Dynamics, KTH, and Saab Automobile. These organizations were chosen, primarily, in order to get a better understanding of how to define a new product. This definition proved to be essential in order to improve and standardize the Product Vitality Index (PVI). The study at Atlas Copco was mainly conducted through qualitative interviews with employees at different positions. Thus, the information originates from primary sources, and is not previously printed and available for the public. One advantage of this approach is that it builds upon the maintained competence and know-how among the employees. Naturally, nobody knows the company better than the people that work there.

2.5.1 The Study at Atlas Copco

The pre-study, described in Section 2.3, was performed by going through internal documentation, and by conducting interviews. The Group Business Controller for each business area provided access to large amounts of company information, and gave an introduction to available information systems. In order to understand the innovation process better, interviews were conducted with the Vice President Engineering for some of the core divisions across the three business areas. The interviews in the pre-study were unstructured and made in person if the person was located in Stockholm, otherwise over the telephone. The interviews were in most cases booked in advance, and were planned to last half an hour. The language spoken was Swedish or English, depending on the language preferences of the interviewee. The respondents were at the beginning of the interview briefly informed about the scope of the project. Since the answer to the problem could originate from innumerous topics, unstructured interviews were a suitable approach to use. In unstructured interviews, the interviewee has the opportunity to associate freely, and the interview can go in any direction that is preferred at the moment. The high number of total interviews conducted made me decide not to record and transcribe the interviews. However, notes were taken during all interviews, and a summation of each interview was compiled at a later point in time. The interviewees during the pre-study were:

- Vice President Engineering BA3
- Vice President Engineering D1, D3, D4, D10, and D19
- Vice President Group Controller
- Business Area Controller BA1, BA2, and BA3

In the in-depth study, described in Section 2.3, site visits were made to as many divisions as the travel arrangements allowed. For example, divisions headquartered in France, Germany, and the US were excluded. In order to get an unbiased picture, three different functions were interviewed at each division; engineering, marketing, and business control. All interviews were made in person, either in the person's office, or in a meeting room. Due to the tight traveling schedule, and the limited availability of the interviewees, some interviews were conducted individually, while others were made with a group of people at the same time. I did not find that this had any negative impact upon the willingness to contribute with information, but to interview people in a group could pose an unwillingness to associate freely. The interviews were booked in advance, and were scheduled to last for an hour. The interviews were semi-structured, and information about the scope of the project, and the topics to be discussed, were given to the interviewees in advance. The interviews were held either in Swedish, English or Spanish, depending on the language preferences of the interviewee. The high number of interviews conducted made me decide not to record and transcribe the interviews. However, notes were taken during all interviews, and a summation of each interview was compiled at a later point in time. The interviewees during the in-depth study were:

BA1:

- Vice President Engineering BA1
- Vice President Engineering D12
- Vice President F&A BA1
- General Manager Logistics BA1
- Logistics Manager BA1

BA2:

- Vice President Engineering D3, D9, D15, D16, and D17
- Vice President Business Control BA2
- Group Business Area Controller
- Vice President Business Control D3, D9, D13, and D17
- Vice President Marketing D3, D9, D15, and D17
- Business Area Project Manager BA2
- Vice President Business Development D17

- Product Manager D9
- Vice President Logistics BA2
- Logistics Manager BA2

BA3:

- Vice President Engineering D1, D10, and D18
- Vice President Business Control BA3
- Vice President Business Control D18
- Vice President Marketing D1, D10, and D18
- Vice President D1
- Logistics Manager BA3

In qualitative interviews, the risk that the researcher affects the interviewee is reduced (Bryman, 2002). It is not desirable that the researcher controls the interviews too much, since it then is a risk that key input is overlooked. It may be more beneficial to let the interview move in different directions, and to find out what each person feel as relevant and important. That various themes are central to different people is demonstrated by previous research. The way to efficiently evaluate innovation may be buried deep within the interviewee's consciousness, and may therefore be missed if the interview structure lacks flexibility. (Bryman, 2002).

2.5.2 Information from other sources

Early in the project, I had an idea to do a benchmark of another large industrial company. I wanted to see how the problem to evaluate strategic innovation was addressed by competitors, or other players in the same industry, and how they defined a new product. The targeted companies were primarily large Swedish industrial companies. After going through the annual reports, and talking to people at the companies, I realized that they did not have a clear standard for me to benchmark. A stringent way of defining how innovation should be measured, and what a new product is, did not seem to exist in the industry Atlas Copco operates in, at least not a definition that was communicated externally outside of the companies. However, I found out that the automotive industry is far more transparent, and that there is a standard way of releasing new car models. Therefore, I contacted Saab Automobile to see how they benchmarked themselves against competitors. After recommendations from my supervisor at KTH, I also contacted three organizations outside of the business world; The Stockholm School of Entrepreneurship, VINNOVA, and Industrial Dynamics, KTH. I mainly targeted these organizations to understand how they defined a new product. By mail conversations, and by semi-structured interviews over the telephone, with representatives from these organizations, several stringent definitions of what should, and what should not, be considered as a new product were received. The definitions from persons within the same organization could differ, strengthening my suspicion that the definition of a new product is subjective, and differs depending on the person who answers the question. Overall, the definitions would be difficult to implement and put into practical use at Atlas Copco. However, they worked as a good reference point for me of what the academic world considered to be a new product, when analysing the input from Atlas Copco.

2.6 Critical evaluation of method

In order to secure the quality of the study a critical evaluation was performed regarding the concepts reliability and the validity. The critical evaluation of the study and possible sources of errors are presented in Section 7.3. The concepts reliability and validity are accounted for below.

2.6.1 Reliability

Reliability refers to the precision of measurement. A study with a high reliability should be able to be replicated to provide similar results, indicating that the quality of the measurement method is high. The consistency of results should generally uphold under longer periods of time, assuming that the measured variables have not changed significantly. (Bryman, 2002).

2.6.2 Validity

Validity refers to if the measured results accurately reflect the underlying true value. A high level of reliability does not necessarily indicate a high validity, as a factor may be measured correctly but provide irrelevant results to the intended purpose of the measurement. However, a study with high validity must have high reliability measurements. (Bryman, 2002).

Chapter 3 The Company

In this chapter a description of Atlas Copco is given. A background of the company is provided, followed by the company's geographic coverage, the market environment, the organizational structure, and the brands under the Atlas Copco umbrella

3.1 Background

Atlas Copco was founded in year 1873. In close cooperation with customers and business partners, and with over 135 years of experience, Atlas Copco today is the world leader in its line of businesses. The business concept is to be a world-leading provider of industrial sustainable productivity solutions. Products and services range from compressed air and gas equipment, generators, construction and mining equipment, industrial tools and assembly systems, to related aftermarket, and rental services. The company's vision is to become and remain First in Mind–First in Choice®. This means that Atlas Copco should be the company that customers and other stakeholders think of initially, and choose. To reach the vision, Atlas Copco works according to three strategic directions:

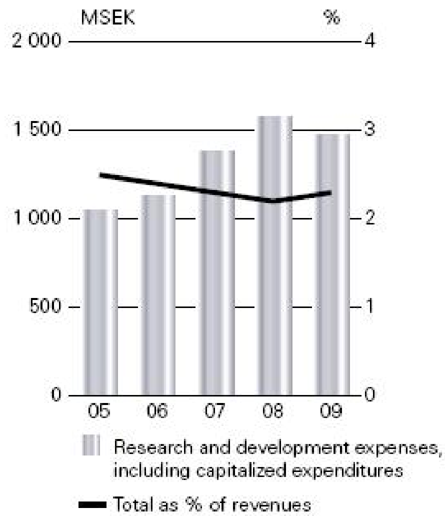
- Organic and acquired growth
- Innovations and continuous improvements
- Strengthened aftermarket

Atlas Copco has three core values that express what the company stands for. The core values can be seen as guidelines helping the employees to meet the needs of their target groups. The core values are (Atlas Copco, 2010, p. 11):

- *Interaction*: The ability to listen to, and to understand, the diverse needs of the customer
- *Commitment*: Being fully committed to the customer's business
- *Innovation*: There is always a better way to do something. Atlas Copco is continuously striving to arrive at better and more efficient solutions to raise the customer's productivity

Innovation is clearly anchored in the core of Atlas Copco, by being both a strategic direction, and a core value of the company. Approximately five percent of the employees are employed in R&D. In the year 2009, the amount invested in product development was approximately SEK 1.5 billion, corresponding to 2.3 percent of total revenues (Atlas Copco, 2010, p. 17). R&D expenditures in the years 2005 – 2009 are illustrated in Figure 3 below.

Figure 3. Atlas Copco's R&D expenditures (2005 – 2009)



Source: (Atlas Copco, 2010, p. 17)

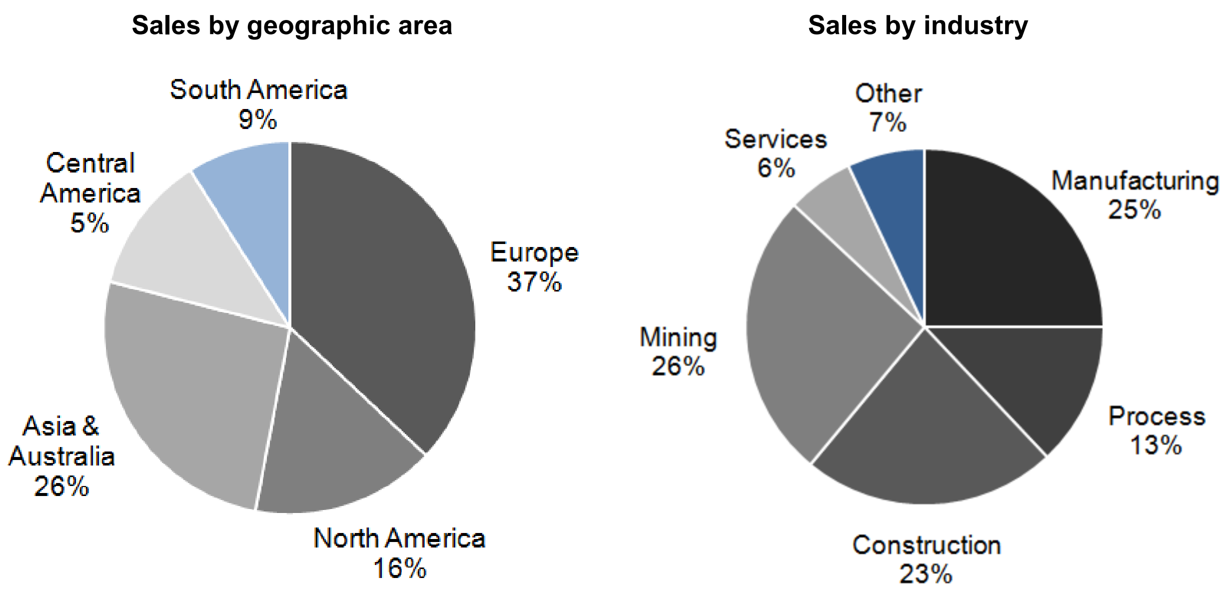
3.2 Geographic coverage

Atlas Copco manufactures and assembles products in 23 different countries. Manufacturing is concentrated to Belgium, Sweden, the US, Germany, France, and China. Through a worldwide sales network Atlas Copco reaches more than 160 countries, and distribution centers[1] have been established in strategically important locations. For example Power Tools Distribution (PTD) in Belgium supports the business area Industrial Technique (IT), as well as several divisions within Construction & Mining Technique (CMT). PTD services customers worldwide with direct and daily deliveries. Compressor Technique (CT) has its own distribution center strategically connected to the manufacturing divisions in Antwerp. CMT has a similar approach for its main divisions in Örebro.

3.3 Market

Atlas Copco's global sales span more than 160 markets. Of invoiced sales, approximately 98 percent is attributable to countries outside of Sweden. Atlas Copco's customer base is 100 percent Business to Business (B2B), and customers are mainly in the manufacturing, mining, and process industries. Revenues in year 2009 amounted to approximately 64 BSEK. Revenues distributed over geographic area and industry in year 2009 is shown in Figure 4 below.

Figure 4. Sales divided by geographic area and industry (2009)



Source: Modified from (Atlas Copco, 2010, p. 3)

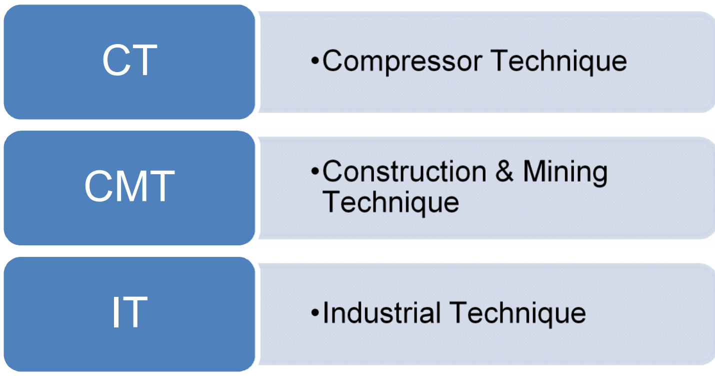
Europe is Atlas Copco's largest market, providing 37 percent of revenues in 2009. The trend today is that emerging markets increase their share of revenues on the expense of Europe and North America. For example, sales in Asia and Australia are growing rapidly, and accounted for 26 percent of revenues in 2009. On a product type basis, a growing share of revenues is attributable to aftermarket, and rental services.

3.4 Organizational structure

Atlas Copco is organized in three different business areas called Construction Technique (CT), Construction & Mining Technique (CMT), and Industrial Technique (IT). CT has its headquarters in Antwerp, Belgium, CMT, and IT in Stockholm. The three business areas are illustrated in Figure 5 at the next page.

[1] A central warehouse located in strategically important locations

Figure 5. Atlas Copco's three business areas



Source: Own

In 2009, CT contributed 51 percent of revenues, while CMT contributed 41 percent, and IT contributed 8 percent (Atlas Copco, 2010, p. 3). At the end of year 2009, Atlas Copco had approximately 29 800 employees that were located in more than 80 countries (Atlas Copco, 2010, p. 18).

3.5 Brands

Atlas Copco owns approximately 50 brands. For full details of all Atlas Copco brands, please see Appendix A. Some of the brands are global, but the majority of the brands serve geographically limited regions. The products are differentiated and marketed through different distribution channels, depending on the local circumstances. The multi-brand concept plays a significant role in Atlas Copco's success, because the need of different customer segments may be satisfied more efficiently. However, each brand must signal membership in the Atlas Copco Group. The Atlas Copco brand generates approximately 82 percent of the total revenues. The message that Atlas Copco wants to convey with its brands is (Atlas Copco, 2010, p. 140):

"We are committed to your superior productivity through interaction and innovation"

Chapter 4 Literature review

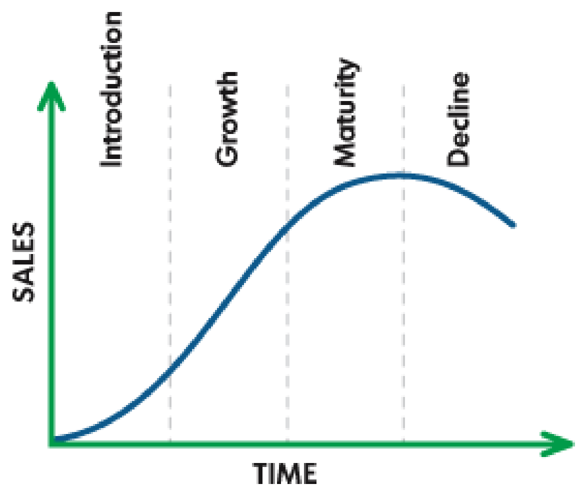
This chapter contains theory concerning the life cycle of a product, innovation, and performance measurement. The theories were used as support during the course of the project

The theory in the literature review can be categorised into three different areas. The first one is the Product Life Cycle (PLC), which describes the life cycle of a product. The PLC is useful, since it provides a conceptual view of the life of any of Atlas Copco's products. The second category is innovation, and includes existing theories concerning innovation. Innovation theories are important in order to understand what should be regarded as innovation, and what should not. Worth to notice is that there exist no dominant theory in the field of innovation, and existing theories are sometimes contradictive. The third area is performance measurement, and includes theory regarding performance measurement, Key Performance Indicators (KPIs), The Balanced Scorecard (BSC), and evaluation of innovation processes. These theories are useful in order to understand performance measurement, to be able to improve the Product Vitality Index (PVI), as well as to have the possibility to complement the PVI with other KPIs.

4.1 The Product Life Cycle

The Product Life Cycle (PLC) is based upon the stages of the biological life cycle. Each stage may be symbolized by the life that a plant follows in the nature. At the introduction stage a seed is planted, and at the growth stage the seed begins to sprout. This is followed by a maturity stage, where the plant shoots out leaves and puts down roots. Eventually the plant begins to shrink and die at the decline stage. In theory a product follows the same pattern. The PLC is illustrated in Figure 6 below, followed by a description of each phase from a marketing perspective.

Figure 6. The Product Life Cycle



Source: (Hill, 2007)

In the introduction stage, the need for immediate profit is not a pressure, and the product is promoted to create awareness in the market. A limited numbers of product are generally available in few distribution channels (Best, 2009). In the growth stage, competitors are attracted into the market, selling similar products to work as substitutes for customers. Products become more profitable, and companies may form alliances and joint ventures with each other because of tougher competition. The volume sold during the introduction and growth stages is derived from both market demand, and from market share. Towards the end of the growth stage, market share stabilizes and gains in volume can now be achieved only by gains in market share (Best, 2009). The products that survived earlier stages tend to spend their longest life time at the maturity stage, where sales growth slowly declines and eventually stabilizes. Companies attempt to differentiate their products by for example functionality, or branding. Generally the competition is intense, and price wars are not uncommon (Best, 2009). At this point, the market supply has met the demand and the market ultimately saturates with declining volumes as a consequence. Due to lower margins some companies leave the market place. Profits can be improved by reducing marketing, and by increasing the price of the product (Best, 2009).

PLC analysis is widely used in many applications. The PLC concept has several advantages. It allows appropriate action to be taken at an early stage, in order to generate revenue, or to lower costs. It can also promote long term rewarding and, in contrast to short term profitability, it can work cross-functionally across business units and support decision-making at every stage of the life of the product (Susman, 1989). The PLC concept has also been thoroughly criticized. Life cycle costing, a technique to establish the total cost of ownership, has had considerable theoretical development but few practical applications. In reality few products follow such a prescriptive cycle as the PLC suggests (Adamany & Gonsalves, 1994). For example, some unsuccessful and short lived products may go directly from the introduction to the decline stage. Much criticism against the PLC concept concerns its use in marketing. Some researchers question the use of the bell-shaped sales curve as a default, or self-evident, behavior of sales. For example, Dhalla & Yuspeh (1976) claims that the popular PLC theory leads managers to kill off brands that could be profitable for many more years to come. Gardner (1987), among other researchers, has been skeptical towards classifying the PLC as a theory, because a theory must contain a systematically related set of statements, and include some law-like generalizations that are empirically testable. Another practical critique towards the PLC concept is that it is difficult to tell which stage a specific product is in.

4.2 Innovation

In the following sections, different innovation theories are presented. Innovation is important in this thesis, because a good understanding of innovation, the very concept to evaluate, is needed, as well as a framework to define a new product.

4.2.1 What is innovation?

Firstly, it is important to straighten out the differences between the meaning of the terms invention and innovation. Fagerberg (2003) explained the differences between invention and innovation like this:

"An important distinction is normally made between invention and innovation. Invention is the first occurrence of an idea for a new product or process while innovation is the first attempt to carry it out into practice"

Invention refers to a new concept, or product, that is derived from an individual's ideas, or from scientific research. Innovation on the other hand represents the commercialization of the invention. This is important to clarify because an invention may have little, or no, economic value. An invention can be monetized and transformed into an innovation only if a target customer, an application, and a market exists for the invented product. For example, Xerox invented the first personal computer before Apple or IBM did, but they did not recognize the potential commercial value of the invention, and did not profit from their technological breakthrough (Smith & Alexander, 1988). When IBM put their first personal computer on the market, the IBM team led by Bill Lowe, who was under pressure to complete the project in less than a year, was actually under explicit instructions not to invent anything new at all (IBM).

Schumpeter defined innovation as “new combinations” of existing resources (Fagerberg, Mowery, & Nelson, 2005). He further classified five different types of innovations (Fagerberg, Mowery, & Nelson, 2005):

- New products
- New methods of production
- New sources of supply
- Exploitation of new markets
- New ways to organize business

In economics, most focus has been on the first two of these; new products, and new methods of production (Fagerberg, 2003).

4.2.2 Incremental versus radical innovation

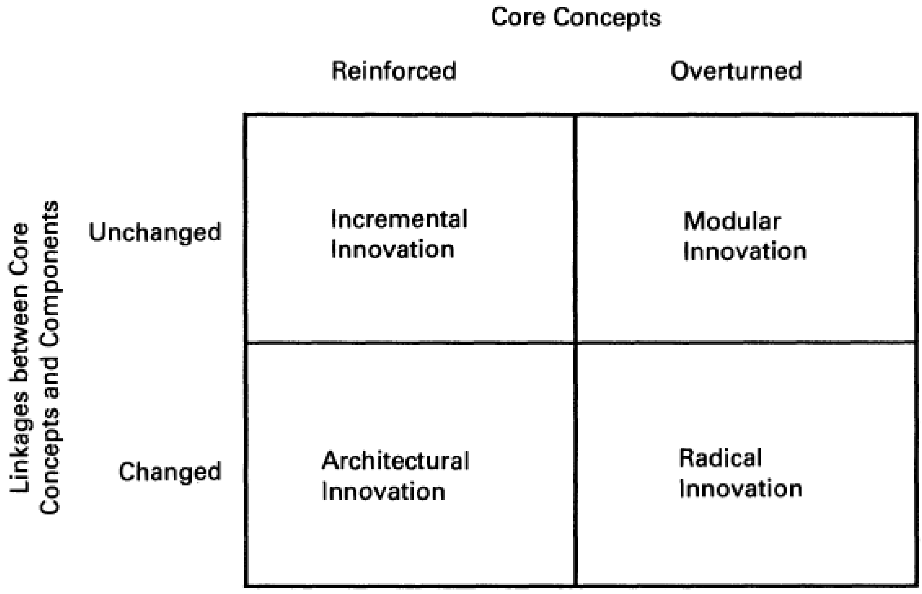
The distinction between refining and improving an existing design, and to introduce a new concept that departs in a significant way from the past practice, is a central notion in the existing literature on technical innovation (Mansfield, 1968), (Moch & Morse, 1977) and (Freeman, 1982). The incremental and radical dichotomy has been used to make this distinction by many authors, with a number of different terminologies. Incremental innovation introduces relatively minor changes to existing products, and exploits the potential of the established design of the product. In a competitive sense, incremental innovation often reinforces the dominance of established firms (Nelson & Winter, 1982), (Ettlie, Bridges, & O'Keefe, 1984), (Dewar & Dutton, 1986) and (Tushman & Anderson, 1986). Although incremental innovation uses no dramatically new science, it generally calls for considerable skill and ingenuity, and it has significant economic consequences over time (Hollander, 1965). Radical innovation is, in contrast, based on a different set of engineering and scientific principles, and often opens up whole new markets and potential applications (Dess & Beard, 1984), (Ettlie, Bridges, & O'Keefe, 1984) and (Dewar & Dutton, 1986). Radical innovation often creates difficulties for established firms on the market, and can be the basis for the successful entry of new entrants, or even the redefinition of an industry (Cooper & Schendel, 1976), (Rothwell, 1986) and (Tushman & Anderson, 1986). This is because radical innovations destroy existing competence and change the technological trajectory fundamentally (Tushman & Anderson, 1986). Radical innovation has a lot in common with the concept creative destruction that was established by Schumpeter. Schumpeter (1942) studied how market innovations affected the capitalist system. He argued that there exists a process that incessantly revolutionizes the economic structure from within, by destroying the old structure, and creating a new one. Schumpeter (1942) meant that this creative destruction was an essential fact about capitalism itself, and that every company had to cope with this process in order to survive.

Because they require different organizational capabilities, radical and incremental innovations have different competitive consequences. Incremental innovation reinforces the capabilities of established firms, while radical innovation forces established firms to ask a new set of questions, to draw on new technical and commercial skills, and to solve problems in new ways (Burns & Stalker, 1966), (Ettlie, Bridges, & O'Keefe, 1984) and (Tushman & Anderson, 1986). It is important to note that the organizational capabilities of a company are difficult to create, and costly to adjust (Nelson & Winter, 1982) and (Hannan & Freeman, 1984). The main critique against the radical and incremental dichotomy is that it simplifies technical innovation. Henderson and Clark (1990) argued that the distinction between radical and incremental innovation has produced important insights, but that it is fundamentally incomplete. The critique is explained in the next section.

4.2.3 Architectural and modular innovation

Clark (1987) argued that there is growing evidence that numerous technical innovations involve apparently modest changes to the existing technology, but that they have had dramatic competitive consequences. Henderson and Clark (1990) came up with a framework for defining innovation that emphasizes the components of a product, and the way that these components are integrated into the product architecture. The framework is illustrated in Figure 7 below.

Figure 7. A framework for defining innovation



Source: (Henderson & Clark, 1990)

The horizontal dimension in Figure 7 captures an innovation's impact on the components, while the vertical dimension captures an innovation's impact on the linkages between the components. Radical innovation and incremental innovation are extreme points along these dimensions. Radical innovation establishes a new dominant design, and hence, a new set of core design concepts, where the components are linked together in a new architecture. Incremental innovation refines and extends an established design, and improvements occur in individual components, but the underlying core design concepts and the links between them remain the same. Figure 7 shows two further types of innovation called modular innovation, and architectural innovation. Modular innovation changes only the relationships between the components, such as the replacement of the analog with the digital telephone. Since an analog dialing device easily may be replaced with a digital one, this is an innovation that changes a core design concept without changing the product's architecture. Architectural innovation, in contrast, changes the core design concepts of a technology and modifies the product's architecture, but leaves the components and the core design concepts unchanged. The essence of an architectural innovation is the reconfiguration of an established product's architecture, where the existing components are linked together in a new way. The important point is that the core design concept behind each component, and the associated scientific and engineering knowledge, remain the same, which is not the case for a radical innovation.

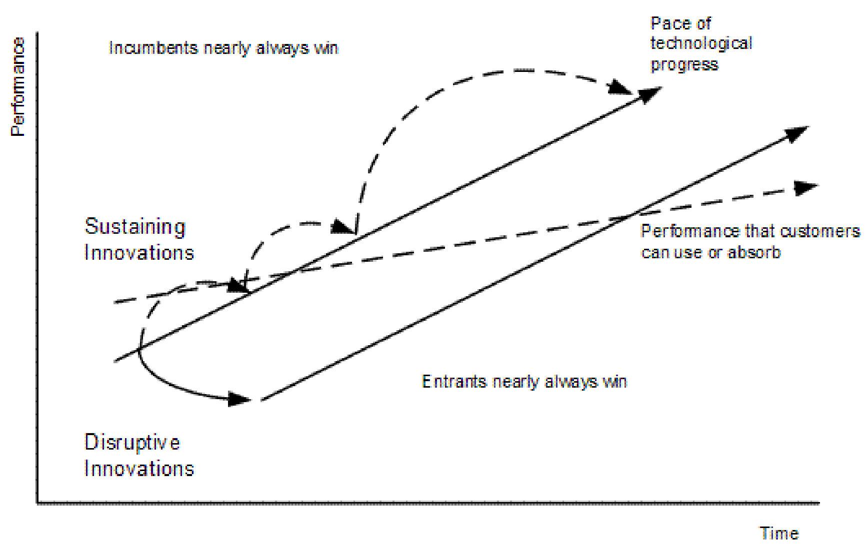
An understanding of architectural innovation might be useful in order to discuss the effect that technology has on competitive strategy, and to understand technically based rivalry in a variety of industries (Henderson & Clark, 1990). Incremental innovation tends to reinforce the competitive positions of established firms, because it builds on their core competencies (Abernathy & Clark, 1985) or is competence enhancing (Tushman & Anderson, 1986). These distinctions may explain why established firms often have a surprising degree of difficulty in adapting to architectural innovation, because architectural innovation presents established organizations with a different challenge. Much of what the company knows is useful and needs to be applied in the new product, while some of what the company knows is not only unusable, but may actually hurt it. To recognize what knowledge is useful, and what knowledge is not, as well as acquiring and applying new knowledge when necessary, may be quite difficult for an established firm, because of the way knowledge is organized and managed. This is especially true for architectural knowledge (Henderson & Clark, 1990). An example of architectural innovation could be a company that builds ceiling fans that has the knowledge, suppliers and components to build table fans. By starting to group existing components in a new architecture, this company could start to build table fans, thus creating a new market. Companies that do not understand how to group components in the new architecture are not likely to survive on the new market. Henderson and Clark argued that it is important for companies to listen to what their customers want, but it is as important to see new customers and new applications (1990).

There has been some critique against the model presented by Henderson and Clark. Christensen (1997) investigated why some innovations, not radical or architectural in nature, could make market leaders fail and small entrants succeed on the market, on the contrary to what the model suggested by Henderson and Clark predicts. Christensen's findings won ground shortly after they were presented in 1997, and they are presented in the next section.

4.2.4 Disruptive innovation and innovator's dilemma

The term disruptive technology was introduced by Harvard Business School professor Clayton Christensen in the year 1995 (Bower & Christensen, 1995). Christensen separated innovation in two categories, that he named sustaining, and disruptive, innovation. Sustaining innovation improves the performance of the existing products and enhances customer value. It hardly results in the downfall of established firms on the market. Some sustaining technologies are incremental in nature, while others are radical (Christensen, 1997). Disruptive innovation, on the other hand, will often have characteristics that traditional customer segments may not want initially, because they result in worse product performance in the short term. However, some marginal or new customer segment values the product, and eventually puts it on the mainstream market. Christensen (1997) argued that it was these disruptive technologies that precipitated the failure of the market leading companies that he studied. Products based on disruptive technologies are typically cheaper, simpler, smaller and more convenient to use. Christensen's disruptive innovation model is illustrated in Figure 8 below.

Figure 8. The disruptive innovation model



Source: (Anthony, Johnson, Sinfield, & Altman, 2008)

Figure 8 shows sustaining innovations that improve the existing technological trajectory, and disruptive innovations that create a new technological trajectory which, in time, creates a new market. Christensen studied disruptive innovation that lead to the failure of established firms, in industries such as the disk drive industry. The first disk drive was developed by IBM in the 1950s, and was the size of a refrigerator. Until the 1980s, the disk drive market was driven by sustaining innovation that improved the capacity and cost per megabyte. In the 1980s, some new entrants emphasized size, and developed smaller disk drives. The leading producers could easily have followed this trend, but they did not, because their main customers, the mainframe manufacturers, did not want smaller disk drives. After some time, the new entrants found an application for their product in the computer industry, and manufactures such as DEC and HP were willing to pay a premium price in order to get smaller disk drives. Since the new technology was immature, the performance of the smaller disk drives improved at a much higher pace than the traditional technology. When the market became profitable, the new entrants witnessed their market being invaded by traditional disk drive players, but it was already too late for the traditional players to react effectively, and they eventually exited the new market. The example with the disk drive industry creates what Christensen (1997) refers to as the innovator's dilemma. It is dangerous to rely only on bringing to the market what the customer thinks that she wants. By shelving the new disruptive innovation, since their mainstream customers showed no interest in it, the leading players missed out on the opportunities that the new technology offered. By being close and loyal to their existing customers, and by listening to them exclusively, the leading companies might not recognize disruptive innovations that serve marginal customers. It may seem natural that large companies are not interested in small customer segments, since these markets do not offer significant growth opportunities. However, as Christensen (1997) showed with the disk drive industry example, the leading companies missed out on the profit by waiting until the market was large enough to be attractive. The conclusion seems to be that disruptive innovation may evoke new markets before customers have articulated, or even identified, a need for the product, or services, themselves. Disruptive innovation can cause great companies to fail, if they are ignorant to new opportunities.

4.3 Key Performance Indicators

A Key Performance Indicator (KPI) is a measure of performance (Fitz-Gibbon, 1990). KPIs help to define and measure progress towards organizational goals (Reh, 2006). KPIs are typically tied to these goals by using concepts such as the Balanced Scorecard (BSC), described in Section 4.5 below. KPIs are used as a performance management tool, and should give the employees of the organization a clear picture of what is important and what they need to achieve. KPIs are needed, because once a company has analyzed its mission and defined its goals, it is necessary to measure the progress towards those goals. Since KPIs should reflect the critical success factors of an organization, they will differ depending on the organization.

A good KPI should be definable and quantifiable (Reh, 2006). Many performance indicators pass those criteria, but that does not by definition make them a key to the organization's success. When selecting KPIs, it is critical to limit them to those factors that are essential to reach the organizational goals. Reh (2006) argues that it is preferable to define the KPIs and stay with the same definition from year to year, unless the underlying goals of the company changes. He also highlights the importance of keeping the number of KPIs low, in order to keep everyone's attention focused on achieving the same KPIs. This does not necessarily mean that a company will have a low number of KPIs in total. A better approach could be to have for example three or four KPIs on a group level, while the same amount of KPIs are used at a more local level of the organization. The important part is that these KPIs support the overall goals of the company (Reh, 2006).

4.4 Performance measurement

"The most powerful purpose of measurement is to improve, not to prove"
(Spitzer, 2007)

The purpose to measure and evaluate something is that it makes it easier for the company to distribute resources to specific, and important, areas of interest. The purpose is also to give a snapshot of the company, and an idea on how to improve in the future. Spitzer (2007) points out that it is as important to decide what not to measure, as it is to choose what to measure, in order to be able to focus the resources to a limited number of areas of interest. Merchant and Van der Stede (2003) point out that it is important to identify the factors that results in reaching the established goals, and to have the Key Performance Indicators (KPIs) closely connected to these goals, in order to reduce the risk of steering the organization in an undesirable direction.

When a measurement system is established, the behavior and priorities among employees are altered, because the employees tend to focus on what is monitored and controlled (Giertz, 1999) and (Tangen, 2004). Parker (2000), among others, argued that measuring performance is a critical tool for evaluations and decision-making, because it gives the possibility to:

- Identify success
- Identify whether customer requirements are met
- Understand processes
- Identify where problems and waste of resources exist, and where improvements are necessary
- Ensure that decisions are based on fact and not on supposition, emotion, or intuition
- Evaluate improvement actions

Parker (2000) furthermore argued that effective performance measurement:

- Reflects results
- Contains normalised measures that can be used in benchmarking
- Is practical and easily understood by all
- Provides continuous self-assessment
- Uses reliable and robust material
- Provides benefits that exceeds the costs
- Has clear ownership of all measures

The first step when to choose what to measure is to define what factors that make the company successful, and how the company creates value (Spitzer, 2007). When these success factors have been agreed upon they can be broken down into measurable measures. By knowing the company's goals, and by understanding what should be done to reach them, appropriate performance indicators can be found (Parker, 2000).

The problem attributable to performance measurement systems mainly depend upon the following three factors (Merchant & Van der Stede, 2003):

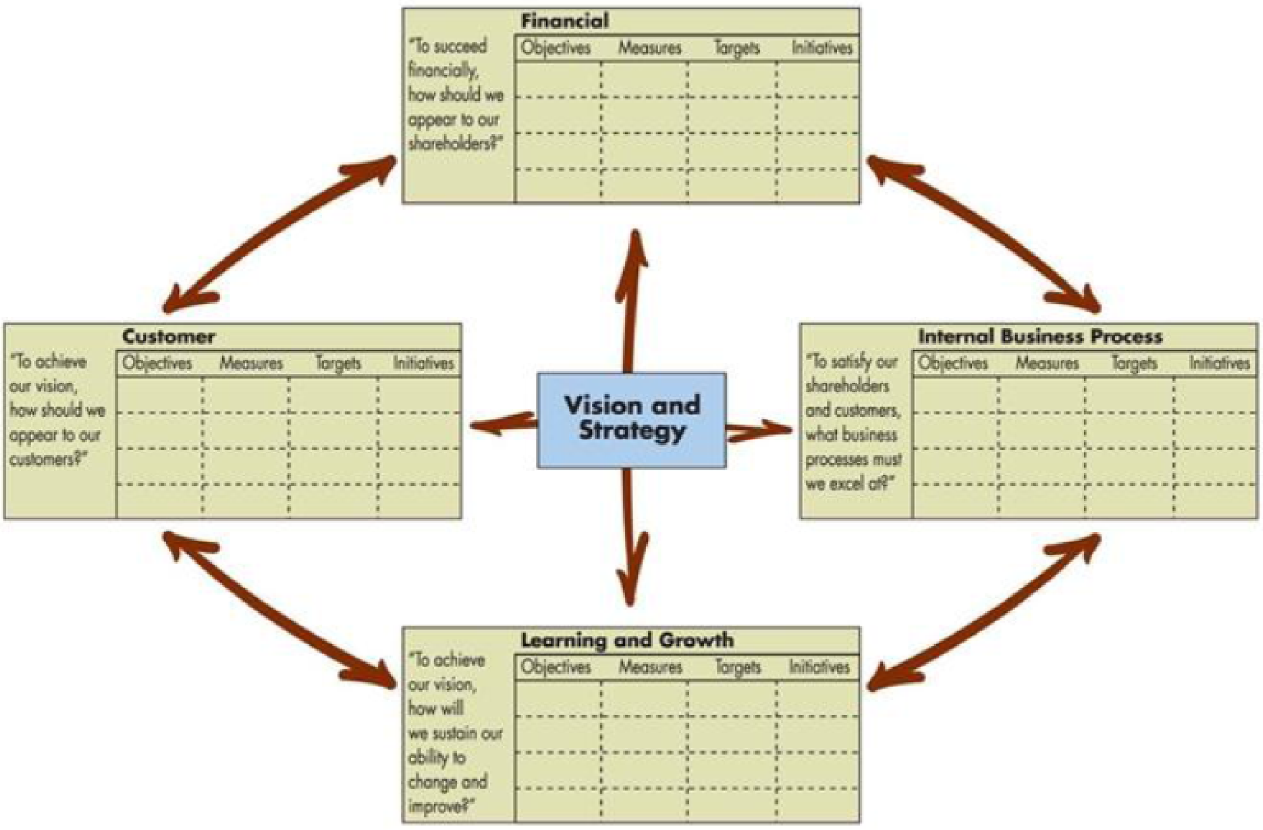
- Lack of understanding of what direction to lead the organization
- Lack of motivation
- Personal shortcomings

It is crucial that knowledge about the goals exists among the employees, and that the employees are able to affect the outcome of the result (Bruzelius & Skärvad, 2000). The motivation among the employees is strengthened if continuous follow-up is a standard procedure (Latham & Locke, 2002). It is important to understand that people often have a negative attitude towards being evaluated. One main problem is that the employees that are evaluated generally don't have the opportunity to influence the very goals that they are judged against (Spitzer, 2007). Negative attitude among employees may results in attempts to manipulate the system (Merchant & Van der Stede, 2003). Giertz (1999) stresses that acceptance from all involved parties is a prerequisite in order to introduce a successful measurement system, and Spitzer (2007) stresses the importance of an entrepreneurical climate that is built upon transparency, thrust, and co-operation. For senior management to create a perfect measurement system that is hard to manipulate, is expensive, as well as close to impossible. The key may instead be to create a measurement system that the involved employees do not feel the need to manipulate. Spitzer (2007) states that this can be achieved by making the system transparent and by making sure that the employees recognize the benefits that the system brings. In this way the risk that employees oppose the system is reduced.

4.5 The Balanced Scorecard

The Balanced Scorecard (BSC) is a tool that was introduced in the 1990s, in order to evaluate companies from more than the financial perspective. Since the businesses of companies became more complex, it was not enough to rely solely on financial management control measures (Ax, Johansson, & Kullvén, 2005). The BSC was developed with the premise that an exclusive reliance on financial measures in a management system is insufficient, because financial measures are lagged indicators that report on the outcomes from past actions (Kaplan & Norton, 1992). The BSC approach retains measures of financial performance, but supplements these with measures on lead indicators of future financial performance (Kaplan & Norton, 2001). The purpose of the BSC is to provide a tool to monitor and control an organization with a limited number of performance indicators. The purpose of using a limited number of performance indicators is to limit the amount of information, and to make the performance indicators comprehensible and manageable for senior management. The original BSC model that Kaplan and Norton (1992) introduced focused on four perspectives; customer perspective, financial perspective, internal process perspective, and innovation and learning perspective. Their suggestion was that senior management should focus on these four perspectives and thereby get an overview of the company. The BSC is illustrated in Figure 9 below:

Figure 9. The Balanced Scorecard



Source: (Kaplan & Norton, 2007)

Kaplan and Norton (1996) argued that the four perspectives balance internal and external performance indicators, which is a prerequisite to achieve high profitability, and effectiveness. By using more than the financial perspective, the company protects itself from suboptimization. Kaplan & Norton (1996) emphasize the importance of understanding the relationships between the four perspectives. The BSC takes its standpoint in the strategic vision of the company, and bases the performance indicators on strategic goals. By choosing BSC perspectives that suits the strategic vision of the company, the strategic goals are broken down to hands-on activities (Kaplan & Norton, 1996). Other perspectives than the original four may be used as long as they are a good fit to the company's strategic goals (Ax, Johansson, & Kullvén, 2005). Breaking down strategic goals into activities, results in a tool that focuses on performance now, but also on performance in the future. The BSC has received positive response in the business world. For example, Apple Computer was one of the early users of the BSC to measure and evaluate strategic innovation (Ellis, 1997). The largest critique against the BSC is towards the mechanic assumption that the company's strategy is fixed, instead of recognizing strategy, and vision, as something that is bound to change (De Haas & Kleingeld, 1999).

4.6 Evaluation of innovation processes

In the 1990s, the performance indicators chosen by industrial companies to measure and evaluate innovation branched out from being purely financial to include non-financial performance indicators, such as customer satisfaction, and quality. One advantage with these new performance indicators is that they are of a higher strategic importance to senior management than some traditional performance indicators (Ellis, 1997). Performance indicators intended to measure the innovation process are difficult to define, because the innovation process is often non-linear, and unpredictable. On the one hand, there is the ability for senior management to influence and plan innovation activities. On the other hand, there is the possibility for employees involved to be able to be creative, and flexible. These two aspects must be weighed against each other in order to find a good balance (Ellis, 1997). Because of the difficulty to find a good balance, a trend in the late 1990s became to develop plausible cause-and-effect relationships between inputs and outputs. By looking at the innovation process as a black box, the intention was to measure the outputs given by certain inputs. For example, how many new products that are released in the market given a certain amount of money invested in R&D (Ellis, 1997). Ellis (1997) noted that it seems important that a performance indicator measuring innovation is tied to that the company is putting the right products on the market. Uttal, Kantrow, Linden and Stock (1992) stated that new products, when measured as a percentage of sales, provide one of the most comprehensive non-financial measures of innovation effectiveness. The authors argued that this is a good measure, since if the customer is not satisfied with the product, or if it isn't available in a timely fashion, the order would not have been placed with the company.

Another management practise to stimulate effective innovation is the use of cross-functional innovation teams. These teams could include R&D, engineering, manufacturing and marketing (Ellis, 1997). Without cross-functional teams, an innovation project moves in a steady, but slow progression, from marketing down through the functional stages of research, development, engineering, and finally out through manufacturing to the customer. By implementing cross-functional teams, overlapping allows each function to begin earlier, and to contribute to reduce the overall time from coming up with an idea to delivering the product to a customer. Cross-functional teams solve upstream and downstream coordination problems, lower cost, reduce cycle-times, shorten lines of communication, and bring the most knowledgeable into the decision path (Lutz, 1994). Ellis (1997) suggested that that the outcome of innovation cannot be measured just by outputs of the product development and product management departments themselves, but that it must be measured on the results of the company as a whole.

The interval to measure and evaluate something in industrial companies is often governed by the accounting cycle (Ellis, 1997). Patterson (1993) traced the sampling need of innovation to be at least twice as frequent as the highest rate of change expected. For example, if changes are expected every second month a time interval of one month would be appropriate.

Chapter 5 Empirical study

This chapter describes the object of study in respect of its products, organizational structure, innovation process, and project types. It also describes the PVI, and provides information regarding the definitions needed to be made to improve it. The chapter finally provides additional input from other sources than the object of study regarding definitions, as well as other types of KPIs that are used to measure innovation effectiveness

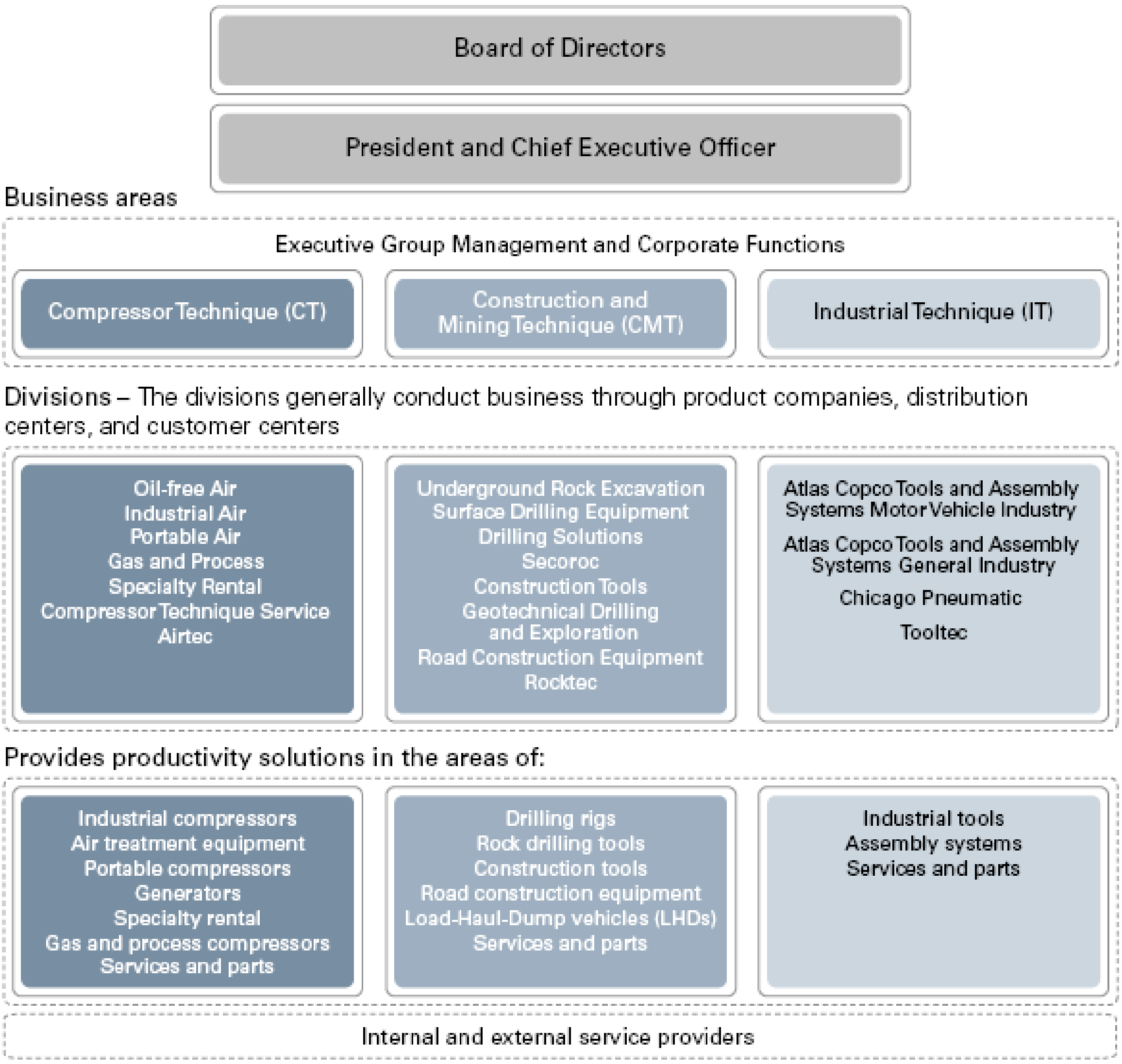
5.1 Description of the object of study

Since the measurement and evaluation of innovation should be customized to the individual organization, the object of study is thoroughly described in order to make the analysis and the results distinct and comprehensible. The object of study, Atlas Copco, is described in the following sections.

5.1.1 Organizational structure

Since innovation should be measured cross-functionally across the three business areas, and their divisions, it is important to understand the organizational structure of Atlas Copco. The organizational structure of Atlas Copco is illustrated in Figure 10 below:

Figure 10. Atlas Copco's organizational structure (2010)



Source: (Atlas Copco, 2010, p. 11)

The company's operative organization is based on the principle of decentralized responsibility and authority. Atlas Copco is organized in three focused, still integrated, business areas. The three business areas are Compressor Technique (CT), Construction & Mining Technique (CMT), and Industrial Technique (IT). The role of a business area is to develop, implement, and follow up on the objectives and strategy within its businesses (Atlas Copco, 2010, p. 11). The three business areas operate through a total of 19 divisions, as seen in Figure 10. CT has seven divisions, CMT has eight divisions, and IT has four divisions. The divisions have their own operational and consolidated profit responsibility, and they develop their own objectives, strategies, and structure within the scope of the business area. The divisions carry out their business through the distribution centers, the customer centers[2] and the product companies[3].

5.1.2 Products

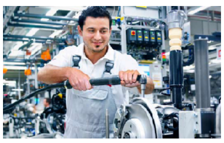
It is important to understand what types of products that Atlas Copco produces, and how these products are categorized. The reason for this is because one task is to define what types of products that should be included in the improved Product Vitality Index (PVI), and what types of products that should not. The different business areas and their products are described in Figure 11 below, as well as the aftermarket segment the three business areas offer.

Figure 11. Products divided by the business areas and aftermarket

Compressor Technique: CT develops, manufactures, markets, distributes, and services oil-free and oil-injected stationary air compressors, portable air compressors, gas and process compressors, turbo expanders, electric power generators, air treatment equipment (such as compressed air dryers, coolers, and filters), and air management systems. Main customers are the manufacturing and the process industry.

Construction & Mining Technique: CMT develops, manufactures, and markets rock drilling tools, underground rock drilling rigs for tunneling and mining applications, surface drilling rigs, loading equipment, exploration drilling equipment, and construction tools. Main customers are the construction and mining industry.

Industrial Technique: IT develops, manufactures, and markets high-quality industrial power tools, assembly systems, and aftermarket products and services. Main customers are the manufacturing and in particular the automotive industry.



Aftermarket: Atlas Copco provides an extensive aftermarket offering, including preventive maintenance, service and repair, consumables, and spare parts, as well as monitoring and improvements of customers' full energy systems. CT groups service activities for all divisions in a separate shared services division. At CMT and IT, each division is responsible for its own service activities.

Source: Modified from (Atlas Copco, 2010, p. 2)

5.1.3 Grouping of products

In order to decide what products that should be included in the PVI, it is necessary to understand the Atlas Copco product range. The company uses two main ways of grouping products. These ways of grouping products have been explained in interviews with Group Business Controllers for the business areas. The first way is what type of product it is. There are currently four types of products:

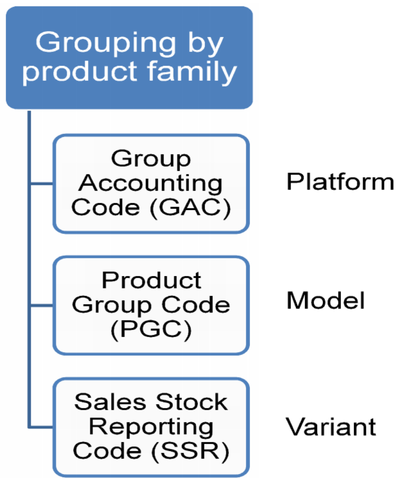
- Equipment
- Aftermarket
- Rental
- Consumables

[2] Separate business entities responsible for the sales in a specific geographic area, normally a country
[3] Separate business entities responsible for the manufacturing of products

Equipment is physical products that are sold to the customer, and could be for example a portable compressor. Aftermarket products are sold to the customer after she has bought the equipment. Aftermarket offerings include for example spare parts, preventive maintenance, service and repair of the equipment, and full-scale monitoring and improvement of a customer's entire energy system. Rental products are products that Atlas Copco owns and rent to the customer, in exchange for a fee. Examples are high pressure dryers for offshore companies or mining equipment for mining companies. In an interview with the Vice President Business Control for a rental division, the interviewee explained that the main reason that customers rent equipment instead of buying it, is because the future demand of for example compressed air is uncertain. Sometimes extra capacity is needed for a short period of time, and to rent this capacity is often more cost-effective than to buy a machine and risk not being able to utilize it to a high degree at a later point in time. Spare parts are specific parts that may be replaced when the physical product has broken down. Consumables are parts that by default are needed to be replaced in the operation of the physical product. Examples are a drilling bit, an oil filter, or the oil itself. The products included in the PVI today are of the product type equipment. Aftermarket, rental and consumables are not currently included, but some of these categories could be included in the future.

The second way of grouping products is by product family. This way of grouping is based upon how similar the products are, and from which platform they have been developed. The question here is to decide how deep down the product family tree that Atlas Copco should measure the products in the PVI. Currently, different depths of measurement have been chosen by different divisions. The advantage of more detailed numbers by going deep down the product family tree must be weighed against possible problems with access to information, administrative time, and risk of manual errors. See Figure 12 below for an illustration of grouping products by product family.

Figure 12. Grouping of products by product family



Source: Own

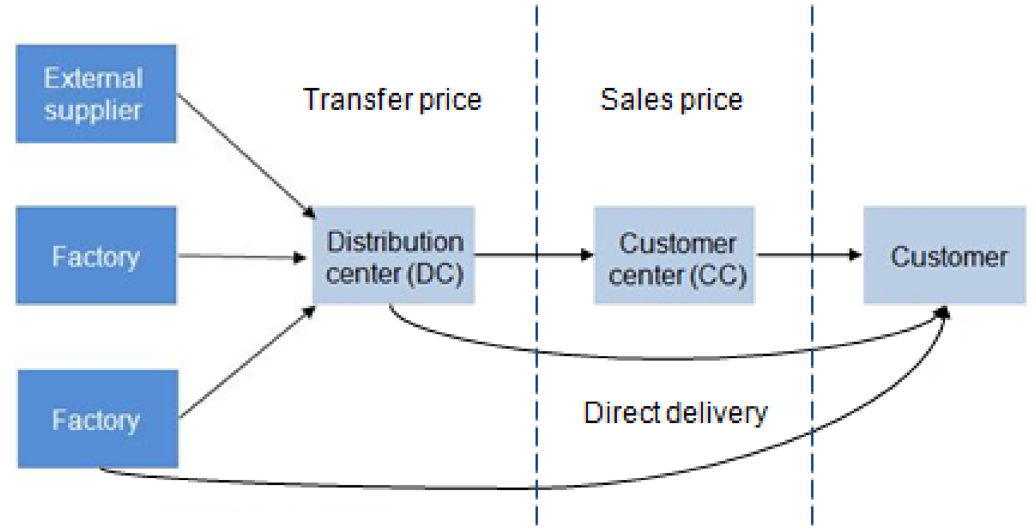
The Group Accounting Code (GAC) is the broadest grouping of products by product family. For example, the code 10A represents surface rock drills and all surface rock drills are built from the same technological platform. The Product Group Code (PGC) is a more detailed code and includes a model of a specific platform. For example, there exist several models of surface rock drills. The Sales Stock Reporting Code (SSR) is more detailed than the PGC, and it represents variants of the same model. For example, a model of a surface rock drill comes with several available options, thus creating a range of possible variants to be made.

In interviews with the Corporate Controller, he explained that there existed some negative opinions towards the system with using GACs. The problem with GACs is that they can only cover one dimension. The shortcomings of using GACs have had impact on the executive group management of Atlas Copco, because in 2009 an initiative begun towards a new mapping of products in the new Business Planning and Consolidation (BPC) system called SAP, which is used on a group level. When interviewing the Corporate Controller, he said that the main purpose with the transition is to replace the old GAC's with new codes in four dimensions; product type, business type, brand, and organization. The GACs only allow one dimension, and the limitations with the structure became evident when products were sold by different divisions, in different markets, and under different brands. The new mapping of products is more flexible than the old one.

5.1.4 Value chain

During the interviews with the Group Business Controller for a business area, as well as the Vice President F&A for another business area, different types of sales price were mentioned. Since the PVI is based upon revenue, it felt important to understand the sales channels, and in particular the method of pricing between different players in the value chain. Atlas Copco develops, manufactures, markets, distributes, and services products within their product range and is therefore present in all parts of the value chain. The value chain differs slightly for different business areas and for different divisions but a generic illustration is shown in Figure 13 below:

Figure 13. The value chain



Source: Own

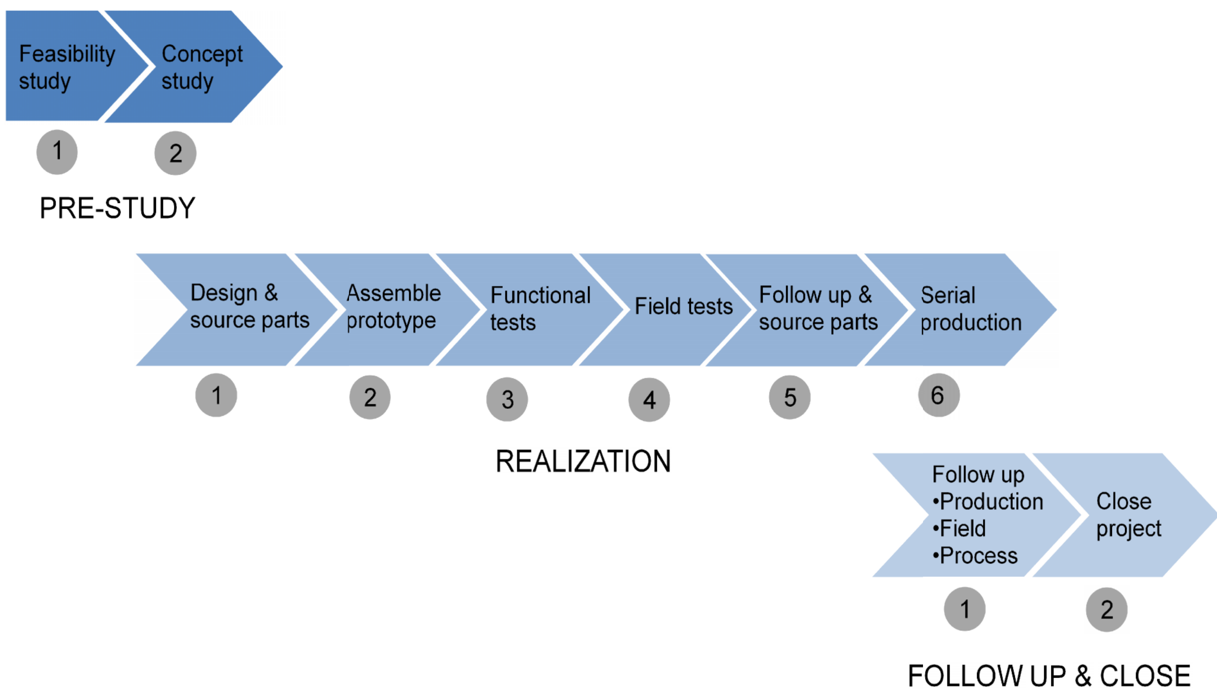
Products are manufactured in Atlas Copco's own factories. Some specialty products are produced and delivered to Atlas Copco by external suppliers, but this is rare. Atlas Copco has a number of distribution centers strategically situated over the world that works as central warehouses. The Logistics Manager for BA1 explained that most products pass through a distribution centers on their way to the final customer. Exceptions are some products that are sold under a few of the Atlas Copco non-premium brands. The product is delivered to the final customer in one of two ways; either by direct delivery from a distribution center or a product company, or by a customer center. For example, in BA1 approximately 75 percent of the products are delivered to the final customer by direct delivery, and approximately 25 percent via the customer centers. It is important to stress that the distribution centers are central warehouses in the logistics chain, and that they have no direct contact with final customers in the sales process. Approximately 85 countries are served by the customer centers, in order for the sales force to have local knowledge and to be close to the customers they serve. One of the Vice Presidents of Finance and Administration mentioned that the goal is that the customer centers should not keep any inventory themselves.

The sales price used to calculate revenue of the sold products in the PVI today is the transfer price between the distribution center or the product company, and the customer center. The exception is if the product is sold directly from the distribution center or the product company, to the final customer. This means that revenues calculated in the PVI are based on Cost of Goods Sold (COGS)[4], and costs such as sales and administration costs are not taken into account. It could be an advantage to connect the products sold to the sales price that is paid by the final customer. The Vice President Business Control BA2 explained that it happen that the customer centers keep products in inventory that are delivered from the distribution centers or the product companies, and that a possible disadvantage with using the transfer price is that it may not accurately represent the real sales to the final customer. A data warehouse called SalMon was recently initiated to monitor the final sales. SalMon works for most divisions within Atlas Copco and measures the sales from the customer centers to the final customers. This means that the sales price is the final price paid for the product. The initiator of the SalMon project, the Business Area Project Manager BA3, estimated that approximately 80 percent of the final sales are monitored today. SalMon can measure the age of the product portfolio based on the final sales price, but the accuracy is not exceptional. This became apparent for example when showing the results for specific divisions to the Vice President Marketing and the Vice President Engineering of the divisions. When showing the divisions their respective chart, made by the application "*Product ageing overview"* in SalMon, their response was that the results are less accurate than the PVI made by the divisions today. To see the "*Product ageing overview"* for division D3, please see Appendix C.

5.2 The innovation process

To be able to measure innovation effectiveness, I emphasize understanding the innovation process at each division. Even though declared in Section 1.5 that the focus is put on Key Performance Indicators (KPIs) related to inputs in and outputs, and not on KPIs measuring process performance, the process nevertheless is the machinery generating new products from the inputs provided. Let us put some light on the black box. An R&D project at Atlas Copco goes through three main phases; pre-study, realization, and follow-up & close. The three phases are illustrated in Figure 14 below.

Figure 14. The three phases of R&D projects at Atlas Copco



Source: Modified from (Atlas Copco, 2008)

[4] COGS are the direct costs attributable to the production of the goods sold by the company. The amount includes the cost of the materials used in creating the product along with the direct labour costs used to produce the product, while it excludes indirect expenses such as distribution costs, and sales force costs

The description of the innovation process is generic, and it is important to understand that some steps differ between different business areas and divisions, and that a different terminology is used by them. The description of the innovation process comes from compiling information from the Vice Presidents Engineering interviewed and from internal documentation at Atlas Copco. In the next sections, each phase is described in more detail.

5.2.1 Pre-study

The pre-study always starts with the demand side. This means that the customer's needs are the main focus on what should be innovated, and this is managed by the marketing people that are heavily involved in this phase. In the pre-study, activities are executed in order to create the best course of action for the realization of the project, and to make necessary preparations for that course of action. Processes in the pre-study are a feasibility study and a concept study. The main purpose of the feasibility study is to gather and evaluate all expectations on the project, and to prepare the concept study. Activities involves stakeholder analysis, to define what products will be replaced and what new models to make, to investigate how to fulfill product cost demands, to investigate the need for a new technology, and to find possible suppliers and eventual partners. The output of the feasibility study is a project time plan, a budget, as well as documentation on how to proceed in order to fulfill the main expectations of the project. The concept study transforms the expectations to project goals and ensure that these goals are achievable. A balance between the requirements, the costs, and the risks is agreed upon, and all project documents needed are prepared.

5.2.2 Realization

After the pre-study, the decision to start the project is taken and the project moves into the realization phase. The first process is design & source parts. In this process the design and specification of all components for the prototype[5] is performed, a production sequence is set up, and suppliers and sourcing arrangements are made, before the Bill of Materials (BOM)[6] is released. At the assemble prototype stage, the prototype is assembled, and the project status is secured before starting the functional test. At the functional test stage, fulfillment of the product specification is verified and adjustments are done if necessary. Customer tests are performed to verify fulfillment of customer expectations, and preparations are done for the field test. The purpose of the field test is to validate the product's operating performance in the normal working environment. This is done with one or a few specific final customers. Parameters studied are reliability, serviceability, productivity, and operating cost. At the end of the field test, a decision regarding approval for market release is taken. Based on the previous stages and activities, there is a follow-up and a sourcing of parts, where preparations and sourcing of parts are done for the serial production. Decisions regarding phasing out old products are also taken. The last stage in the realization phase is the serial production, which contains the assembly and delivery of the first serial products. The new products are implemented in full serial production in the factories, and serial delivery is started. Old products are phased out at this stage if applicable.

5.2.3 Follow-up & close

The third and final phase is follow-up & close. The main purpose of this phase is to ensure a high quality of the new products, and the processes needed to generate them. This is performed for internal processes, like production, as well as externally with final customers. In the last stage the project is closed. The main purpose of formally closing the project is to be able to evaluate the outcome of the project in relation to the goals set up at the concept study, where project preparations were made. It is important to reflect upon lessons to be learned after closing the project. When a project is closed, the responsibility of the new product is in the hands of the production function.

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[5] The first product in its kind and mainly used to verify and validate requirements specified in the product specification, and that it is possible to produce as planned

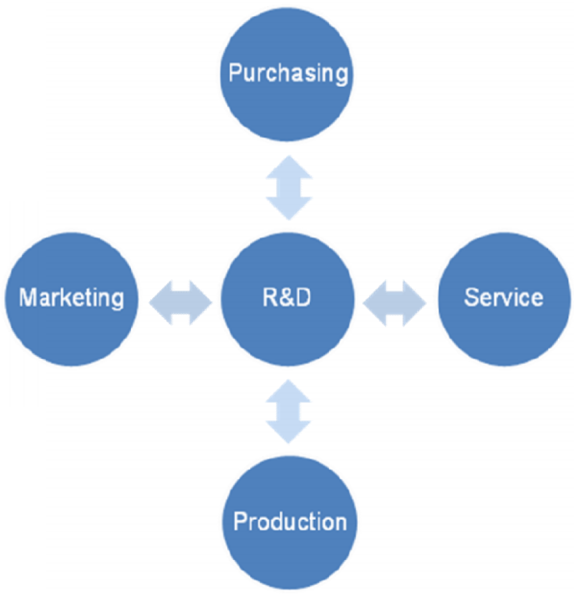
[6] Bill of Materials (BOM) is a list of raw materials, sub-assemblies, components, and the quantities of each needed to manufacture the final product

The type of activities, and the amount of time and money put on each activity, depends on the size of the project. The size of the project is usually decided upon by the total man hour used, total budget, and the decision forum of the project. Large product upgrades and adding of new products are classified as a larger project than smaller upgrades, such as an engine exchange, or a new option in an existing product. It is important to stress that the R&D process as such is the same for the entire company, but that it is performed differently at different business areas and at different divisions. For example, at one business area the process[7] is process-driven, with strict deadlines and little flexibility to change the course of the project once the project has been initiated. One advantage with a process-driven approach is that the project always moves forward with few dissipating activities. One disadvantage is that the demand and specifications may change during the project, and the strict process thinking makes it difficult to cope with these changes. At another business area, the deadlines are a bit more floating in order to cope with uncertainties. One disadvantage with this flexible approach is that the time line seldom is held, and dissipating activities may be performed, since there are no distinct milestones and distinct project deadline in the planning.

5.2.4 Functions in the innovation process

Since the proposed KPIs should measure innovation, it is important to understand the different functions in the innovation process. The primary functions included in the innovation process are, according to the Vice President Engineering at several divisions, research and development, purchasing, production, marketing, and service. These functions work cross-functionally, meaning that they work together in, and have shared responsibility for, the innovation process. The interaction between the functions is a critical factor for successful innovation. Illustrated in Figure 15 below is an interaction scheme between the functions included in the innovation process.

Figure 15. Interaction scheme between different functions in the innovation process



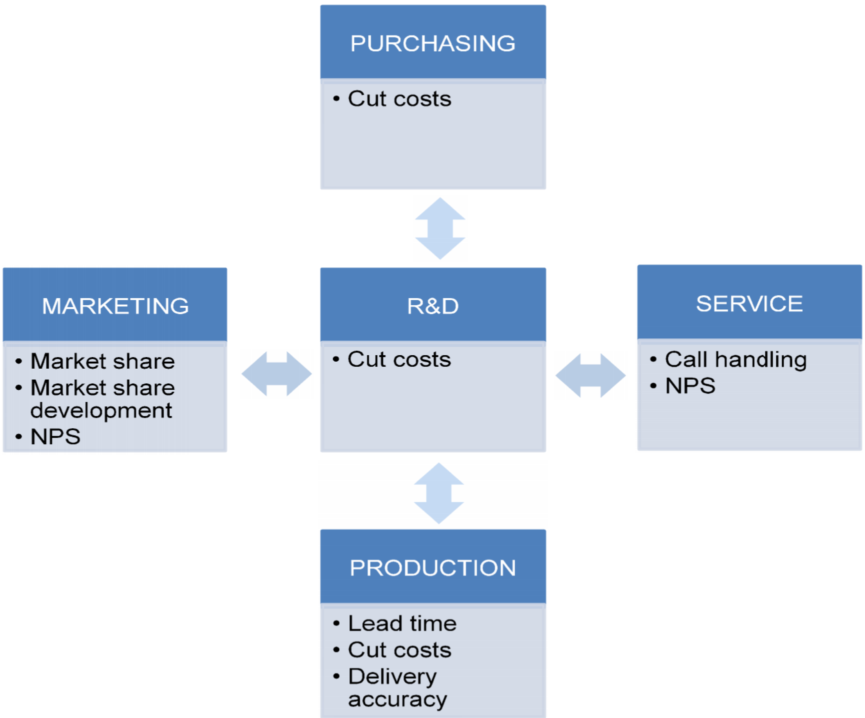
Source: Own

There are different kinds of meetings between the functions. The terminology is different between different business areas and divisions, but one example from BA2 of different types of meetings regarding the development of new products, are Product Team Meeting (PTM), and Product Committee Meeting (PCM). In the PTMs, project representatives from each function participate. There can be more than one person attending from each function. The purpose of the PTMs is to coordinate the project activities, to make sure that everybody knows the next steps to take, and brainstorm solutions to problems that have arisen. PTMs are held every two

[7] Established and documented routines or methods, designed to be used regularly and give predictable results

weeks. The PCMs are held once a month, and the project management participates on those. The purpose with the PCMs is to monitor the progress against the targets, the time line, and the budget, and to take necessary steps in order to finish the project. An issue at a PCM could be that engineering needs more money in order to finish the feasibility study. If the budget is breached, decisions must be taken at the PCM due to this change. The names of the meetings, and the interval between them, differ between business areas and divisions. There are several KPIs in place today on a local level to measure and to follow up the innovation process. This is probably a consequence of the fact that the executive group management has few global operational KPIs, and the operational management is the responsibility of each division. On local level there are different KPIs for each function in the innovation process, and the efforts of each function are separately evaluated against targets. Some examples of used KPIs on local level are illustrated in Figure 16 below, in order to get a sense for how each function is measured.

Figure 16. Examples of KPIs on a local level used at the different functions



Source: Own

Marketing emphasizes two areas. Firstly, what market share each product family has, and secondly, how this market share has changed over time. Marketing also measures the Net Promoter Score (NPS)[8]. Purchasing has put cost savings in focus, which is achieved for example by buying components cheaper from the suppliers. For service, it is important to handle incoming calls efficiently in order to satisfy the customers calling, and to look at the NPS. For production, it is important to produce and assemble the products with a short lead time[9], and to deliver the products to customers on promised time. On an operational level, the product company manager, and/or the divisional president, evaluates R&D on the achieved output. For example, the R&D function should cut costs in the development process. It is challenging to find a substantial KPI for evaluating the R&D function on a group level, according to the Vice President Group Controller. KPIs used on a group level today are the Product Vitality Index (PVI), and a KPI measuring R&D costs as a percentage of total revenues.

[8] Formula measuring customer retention and loyalty by subtracting the percentage of customers who would not recommend the brand or product from the percentage who would promote the brand or product
[9] The time period between the initiation of the first process of production and the completion of the last process of production

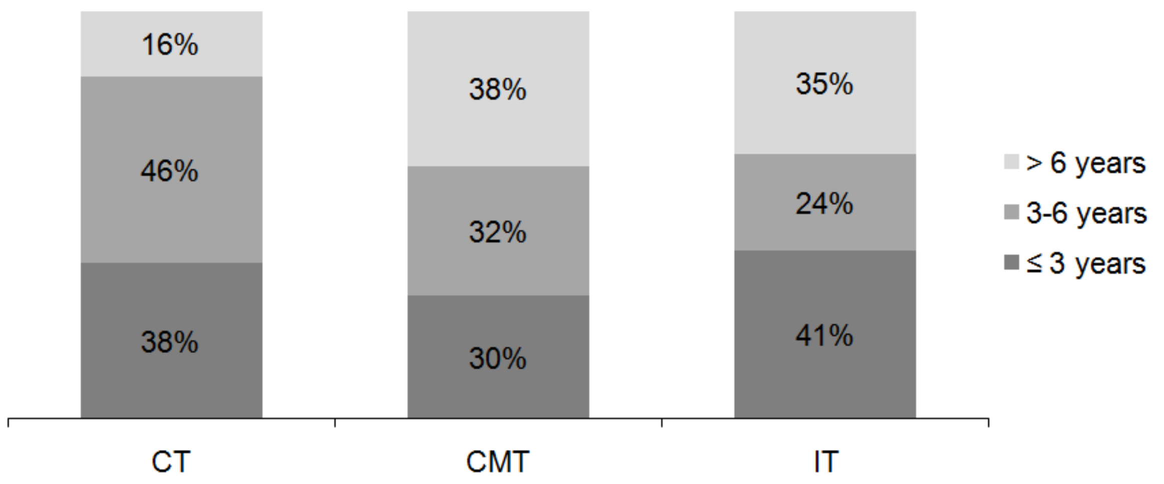
5.3 The Product Vitality Index

The Product Vitality Index (PVI) is a Key Performance Indicator (KPI) that measures revenues from new product offerings. It was initiated in 2001 by Giulio Mazzalupi, the CEO of Atlas Copco 1997–2002. Gunnar Brock, the CEO of Atlas Copco 2002–2009, advocated the use of the PVI during his time as CEO, and in the last year, with Ronnie Leten as the CEO, the PVI has been communicated out externally at capital market days, and the Atlas Copco annual report. KPI measuring revenue from new product offerings is a powerful tool to measure if the right activities are done in innovation. The choice by executive group management to focus on the PVI to measure innovation effectiveness is supported for example by the fact that a KPI that measures revenue from new product offerings is considered the most indispensable KPI among senior executives (Andrew & Michael, 2009). To improve and standardize the current PVI, in order for it to work cross-functionally, would provide better insight in the outputs of the innovation process. In the following sections, a thorough investigation is done regarding the concepts behind the current PVI, and its benefits, and challenges are discussed. Issues related to definitions and administrative work is also ventilated.

5.3.1 Concept and measurement

The intention with the PVI is for the executive group management to have an overview of the product portfolio, and to make sure that it is vital and up-to-date. The reason that the executive group management want to have a good view of this, is because the company must have a strong product range compared to their competitors in order to remain the market leader. The PVI shows how revenues are distributed over the product fleet, by grouping products in three different categories depending on their age. See the PVI as measured at the end of year 2009 in Figure 17 below. For further details of the PVI, please refer to Appendix B.

Figure 17. The PVI (December 31, 2009)



Source: Modified from Atlas Copco

The first category includes products with maximum age of three years. The revenues of these products are summed up and then compared to total revenues for all products sold. As seen in Figure 17, 38 percent of total revenues for Compressor Technique (CT) came from products with a maximum age of three years, while 16 percent of total revenues came from products older than six years. The revenue is based on transfer prices and is, as discussed in Section 5.1.4, usually not equal to the price the final customer pays. Using the transfer price could lower the accuracy of the measurement.

5.3.2 Divisions included

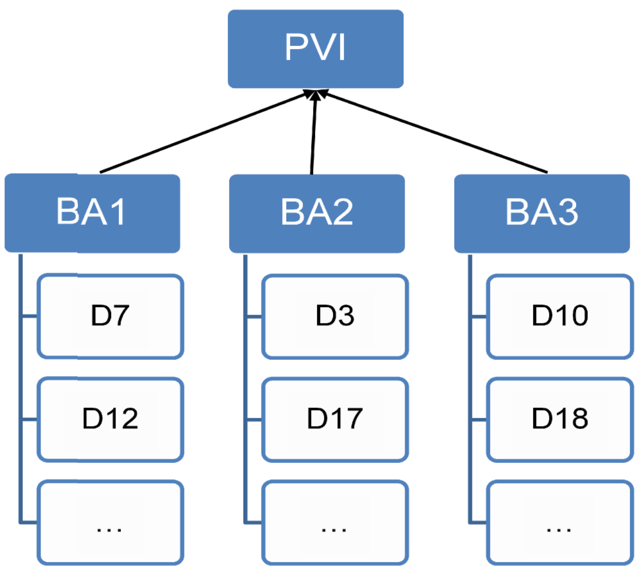
Today, the PVI is used across all three business areas. Twelve divisions are included in the PVI today, according to the Vice President Group Controller. That means that seven divisions are excluded, and they are so due to several reasons. People from some of the excluded divisions were interviewed, in order to investigate the possibility to include them in the PVI in the future. The characteristics of the excluded divisions are accounted for below.

One division within each business area is an internal provider of core components that are used in the final products. Airtec develops and manufactures compressor elements for divisions within CT, Rocktec develops and manufactures rock drills, rotation units, and automation products for divisions within Construction & Mining Technique (CMT), and Tooltec develops and manufactures final products for the divisions within Industrial Technique (IT). Airtec, Rocktec, and Tooltec have other divisions within its business area as customers, and the components from these divisions are sold to an internal sales price. The internal sales price is fixed, and was determined in the past according to the Vice President of division D1. These three divisions have R&D and product development only, and the components that the divisions deliver are part of the final products for other divisions. The fact that these divisions are a part of the other divisions, in that they contribute in the making of their final products, and that they do not commonly sell to the final customer, poses a problem. Rental divisions are also excluded from the PVI. In interviews with a Vice President Division Controller, the interviewee explained that in the rental business, the key is the utilization of the product fleet, and not the age of it. Hours of use are more important than the product age. The final customers need additional capacity for a short period of time, and as long as the machines are reliable, the customers do not care much whether the products are new or old. Effort is put on finding new customers and new applications for existing products, rather than on finding new products. Service divisions are also excluded from the PVI today. Service divisions are a part of the other divisions, because they provide service kits, maintenance and monitoring of energy systems for the other divisions' products. Service divisions are excluded mainly because service products are different from physical equipment, because they are intangible. Some divisions are also excluded because their product range contains a large majority of consumables. As described in Section 5.1.3, consumables are parts that by default are needed to be replaced in the operation of the physical product. Examples are a drilling bit, oil filter or the oil itself. However, to develop, for example, more functional and better looking oil-filters are done today, and could be a good idea to measure in the future.

5.3.3 Reporting

The PVI is intended to measure the innovation output vertically across the divisions in each business area. The intention is to aggregate the results from the divisions to a business area level, and thus measure the innovation output horizontally. See Figure 18 below for the procedure of aggregating the PVI to a business area level.

Figure 18. Aggregating the PVI to a business area level



Source: Own

The PVI is measured on a divisional level across all three business areas. All divisions are requested to report the PVI data to the Vice President Business Control for respective business area. The Vice President Business Control then compiles the divisional data to an aggregated bar chart for the business area. Which function that has the reporting responsibility for the division is not standardized, and the divisions themselves may assign the reporting to the specific function that they find appropriate. This has an advantage, since the employee with the best knowledge and experience to compile the PVI can be assigned the task regardless of position. Some divisions have assigned the reporting of the PVI to the marketing function and others to the engineering function. One disadvantage with the choice to leave the assignment of the task to the divisions is that people from different functions generally have a different academic background, and different views on how to measure something. This may result in differences in the results, and stricter guidelines from executive group management might improve the accuracy of the measurement. One of the Vice Presidents Engineering described how different functions may think like this:

"What equals 2 plus 2? If you ask an engineer he will say 4.0. If you ask a marketer he will say 5 and if you ask a business controller he will respond: "what do you want it to be"?"

This example has driven the differences to the extreme, but the possibility of potential differences between the functions is worth to consider, when discussing whether executive group management, or the divisions themselves, should decide who should be assigned to compile the PVI.

5.3.4 Challenges of the current PVI

During most of the interviews during the pre-study, and the in depth-study, the PVI was discussed. The interviewees were, as mentioned in the chapter "*Methodology"*, either within the function engineering, marketing, or business control. The three functions interviewed recognised similar problems with the PVI, and there existed no prominent differences between the different business areas and different divisions concerning what was important to consider when improving and standardizing the PVI. The two largest challenges were to standardize the definition of a new product, and to standardize the definition of the birth date of a product. These two issues are discussed in Section 5.4, and Section 5.5, respectively. Two other concerns were that it was unclear who was actually measured by the KPI, and that the short term perspective of the PVI could have a negative impact on long term innovation success. The Vice President Marketing and the Vice President Engineering for several divisions meant that who was evaluated by the PVI needed to be made clear. They discussed if the PVI should be a KPI for the R&D function, a combination of functions or the whole division. In interviews with the Vice Presidents Engineering at several divisions they meant that too much short term focus on developing new products could lead to maintenance and fixes piling up in the future. With this they meant that too much focus on increasing the number of projects related to new product development would result in an increase in projects related to taking care of existing products in the future. This is because new products usually have childhood diseases that need to be corrected. A high number of quality problems with existing products on the market tend to lower customer satisfaction, and customers stop promoting the products to people they know. This is severe, since it eventually leads to a bad reputation, and that customers stop buying the products. The technological and playful nature of some engineers makes such opinions natural, but also the Vice President Marketing for some divisions meant that relying on the PVI was too short-sighted.

5.3.5 Expectations on the future PVI

During the interviews, people expressed many opinions concerning what could be improved in the PVI. The following bullet points summarize the main opinions. The new PVI should:

- Be simple
- Be automatic
- Have a precise definition of a new product

- Have a precise definition of the birth date of a product
- Come with clear examples
- Take future estimates into account
- Not have too much short term focus
- Make it clear which function or functions that are measured

5.3.6 Evaluation of the results

The overall opinion from the interviewees was that a good balance of the product portfolio is different for different business areas. This view is shared by employees from all functions, even though it became most apparent in the interviews with the Vice Presidents Marketing at several divisions. Not one single interviewee suggested benchmarking the three business areas. Several persons within both marketing and engineering advised strongly against benchmarking the business areas. The Vice President of division D17 expressed:

"It is impossible to benchmark BAs within Atlas Copco"

The most common reasons among the interviewees to why a benchmark should not be made between business areas were:

- The type of business is different
- The product range differs
- The volumes sold of the products differs
- The product life differs
- The customers have different preferences

The Vice President of division D17 expressed:

"We should benchmark against competitors on BA level"

The Vice President Group Controller also stressed the importance of primarily looking at the competitors. Atlas Copco is as a market leader and since the company is always challenged, and is under tough competitive pressure, it becomes crucial to keep track of competitors. A comparison with competitors is difficult, because there is little transparency between companies in the Business to Business (B2B) industry that Atlas Copco operates in. The Vice President Group Controller, however, argued that the Vice President for the business areas and the Vice President for the divisions have a good sense of how the competition performs in releasing new products on the market.

The Vice President Marketing and Vice President Engineering for the service division D15 argued that they could be one of several drivers of what is a good balance of the product portfolio, on both a business area level and a divisional level. The Vice President Marketing stressed:

"We advocate evolution of products instead of revolution. If more innovation could be achieved with a minimum number of new components that would benefit the products' life cycle costs"

He argued that new products result in hidden costs related to training, and spare parts needed to be held in inventory. Innovation focusing on revolution, and on releasing a lot of new products, may imply hidden costs in these areas. Too much short term focus on developing new products would lead to maintenance and quality problems piling up in the future. The Vice President Marketing and the Vice President Engineering for the service division D15 also pointed out that the higher the share of new products in the PVI, the lower the Net Promoter Score (NPS), and the lower the customer satisfaction. It may be an advantage that the goal balance is agreed upon by people from different functions, in order to get an as complete picture as possible, and to not suboptimize in one area while other areas suffer. What is productive for one division or function could be counterproductive for another one.

5.4 Definition of a new product

One of the largest challenges with the Product Vitality Index (PVI) is to standardize the definition of a new product. It is important to find a definition that works for the products of all divisions included in the PVI. This is important because the outcome of the PVI relies heavily on *how* a product is defined as new.

5.4.1 Atlas Copco's definition

In Atlas Copco's annual report for 2009 the following definition of a new product can be found (Atlas Copco, 2010, p. 8):

"Customers should be offered products and solutions that increase their productivity and reduce their costs. New products and solutions should provide extra benefits for the customer compared to existing products or to the competition"

This definition clearly express that a new product is seen from the customer point of view, and not from the company's. A new product is a product that adds customer benefit. What is important to note is that the definition of a new product is quite subjective, and it may be interpreted differently by different people. The Atlas Copco organization is decentralized and, since no guidelines yet exist, the divisions have come up with their own definitions of what a new product is. This may have its advantages, since the divisions differ in many aspects. A disadvantage is that it will be difficult to make any comparisons between the business units if the definitions are not the same. Often the definition exists in the head of the person who is responsible for measuring the PVI, and it is not documented. As one of the Vice President Marketing compiling the PVI put it:

"I put 30 minutes of my time on compiling and reporting the vitality index. It is merely a follow-up on a group level and is of no use to our division." … "If I am in a good mood the number of new products may be high and if I am in a bad mood the number of new products may be low. The definition is too subjective"

The example shows that it could be an advantage to involve the divisions more in the PVI, and to make them see that the PVI can benefit them instead of just measuring them. The way of defining a new product is more similar within the business areas, because the cooperation between divisions within the same business area is much more common. Between the business areas, the differences may be large. The example below shows how the two divisions D4 and D10 classify existing products as new in the PVI. D4 and D10 are divisions in different business areas.

- D10 views existing products as new when the product has an important customer benefit. Small changes to product variants, quality improvements, and cost savings will not change the birth date

- D4 views existing products as new regardless of the change. If the shape of the shell is changed, and/or the product comes in a new color, the product is defined as new

This shows that, since guidelines regarding definitions of a new product have not yet been fully implemented from higher organizational levels, the divisions have chosen different approaches in the definitions they use for what is considered to be a new product in the PVI.

5.4.2 Definitions from other organizations

In order to get additional thoughts and opinions regarding innovation, and a definition of a new product, other organizations than the object of study were contacted. These organizations are The Stockholm School of Entrepreneurship, VINNOVA, Industrial Dynamics, KTH, and Saab Automobile.

VINNOVA

VINNOVA is a public authority under the Ministry of Enterprise, Energy and Communications (*Sv. Näringsdepartementet*). VINNOVA's purpose is to act as a proactive player in the Swedish innovation system in areas where R&D is of critical importance for future growth. According to Kaj Klarin (Interview, 2010), Director at VINNOVA, the organization defines a new product as:

"A new product might be totally new on the market OR a known product that is used in a totally new application"

This definition is strict. Either the product is brand new, or it is an existing product used in a new area, or context. This definition has significant similarities with architectural innovation, discussed by Henderson and Clark in Section 4.2.3.

The Stockholm School of Entrepreneurship

The Stockholm School of Entrepreneurship is recognized around the world as a leading academic facility in the area of innovation and entrepreneurship. The member institutions are KI, KTH, SSE, Stockholm University, and Konstfack, thus combining top academic institutions in the field of medicine, technology, economics and design. Ulf Lindgren (Interview, 2010), Dean and Executive Director at the Lorange Institute of Business in Zurich, proposed that a description of what a new product is not might be a good way to start. A new product is not:

- An extension or adjustment of an existing product or technology
- A copycat of an existing product already developed by someone else

The first bullet point seems to rule out most improvements of existing products. After declaring what a new product is not, Lindgren (Interview, 2010) further proposed the following definition of what a new product might be:

- A new solution to an existing problem
- A new technology (disruptive or not) that has its own distinct intellectual property and concept
- A new functionality of an existing product that resolves different problems and/or meets other customer needs than the existing products do

The first and third bullet points are customer driven and clearly influenced by a market pull, while the second bullet point is more of a technological push. Customer benefit seems critical for Lindgren. Note that Lindgren has incorporated Christensen's innovative term disruptive innovation in his definition, that is, innovation traditional customer segments may not want initially because they result in worse product performance. For further details on disruptive innovation, please refer to Section 4.2.4.

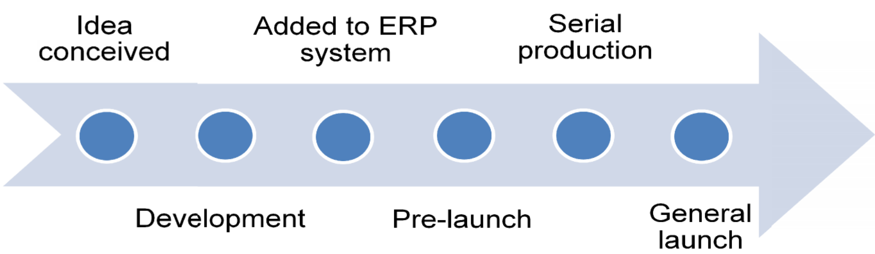
The automotive industry

Benchmarking applied to innovation thus far has been directed mainly toward the automotive industry (Ellis, 1997) and (Krause & Liu, 1993). The automotive industry is the most complex of all industries in the industrial sector. The classification of a new product is standardized and there is statistical data and sales data available. For example, BIL Sweden (2010) releases monthly statistics on newly-registered automobiles in Sweden. In the statistics the number of automobiles sold is declared for each model. For example, 608 cars of model VOLVO XC60 were registered in April 2010. The sales price for each model is public information, and the transparent system makes it easy for the automotive companies to benchmark themselves against competitors. According to Knut Simonsson (Interview, 2010), Director Brand and Marketing at Saab Automobile, the reason for the transparent system is that the automotive market is a Business to Consumer (B2C) market, with regulations that protects the customers, and gives them transparent information. Simonsson (Interview, 2010) believed that there are no regulations for a similar system in a Business to Business (B2B) market that companies like Atlas Copco operates on.

5.5 Definition of the birth date of a product

One of the largest challenges with the Product Vitality Index (PVI) is to standardize the definition of the birth date of a product. This date is critical because it determines at what point in time the product will begin to contribute revenue in the PVI. Depending on the criteria of the birth date, the point in time that this happens will be different. The main two criteria of selecting the birth date of a product are how well it describes the starting point of when the product contributes revenue, and the access to this data. Several dates are possible, and it is difficult to say that one date is the optimal to use. Today, the divisions use the date that they find most appropriate, and this commonly differs slightly between the divisions. Examples of the different types of dates that exist in the new product development process are illustrated in Figure 19 below.

Figure 19. Examples of dates in new product development



Source: Own

Possible dates are, for example, when the idea is conceived, when the product is first entered into the Enterprise Resource Planning (ERP) system, when a new product is sold for the first time, when a new product is pre-launched, when serial production of the new product starts, and when a new product is generally launched. The time between different dates can be long. For example, the Logistics Manager BA1 said that the time from when the product is added to the ERP system to the general launch can be anything from one month to several years. Today, the birth date of a product is measured on year only. According to the Vice President Marketing at several divisions, most products are released in the spring and in the autumn. He explains that a new product that is released in May 2009, and a new product released in September 2009, both will get the birth date 2009 in the PVI.

5.6 Other KPIs used to measure innovation effectiveness

During the interviews and in the theoretical study, it became clear that the expectations on a Key Performance Indicator (KPI) to measure innovation are many. As seen in Section 5.3.6, the expectations on the Product Vitality Index (PVI) are many and it may be worth to consider if the PVI alone can take all those expectations into consideration. It might be unlikely that there exists a super KPI that meets all these expectations, and if such a KPI is desirable. For example, the PVI measures the revenue from new product offerings, which focuses on the short term product offerings. One expectation that is difficult to meet for the PVI is to measure innovation success in the long term. As important as new product offerings are to stay competitive in the short term, generating new technologies and new platforms is crucial in order to stay competitive in the long term. The desire to have several KPIs is evident in the Atlas Copco organization. Hans-Ola Meyer, CFO, clearly stated in an email:

“The vitality index is one way of illustrating innovation and product development”

On a group level, there are currently one additional KPI that measures innovation except from the PVI. This is an input KPI that shows R&D costs as a percentage of total revenues. For example, for year 2009, this KPI was 2.3 percent (Atlas Copco, 2010, p. 17). The advantage with this KPI is that it is easy to understand, easy to measure and communicate, and the information is accessible in a simple way. One disadvantage with the KPI is that it says little about how the invested money is used. Investing large sums of money, for Atlas Copco approximately SEK 1.5 billion in 2009 (Atlas Copco, 2010, p. 17), does not alone imply that the investments were successful. However, the money creates the opportunity for successful innovation, and the KPI plays an important role in measuring the financial resources used as input in the innovation process. In this way, the KPI complements the PVI, since there certainly is a connection between the financial resources invested in innovation projects, and the new product offerings generated from them. To measure innovation in the long term perspective is desired by the Vice President Marketing and the Vice President Engineering at several divisions. It is also one of the main expectations on the improved and standardized PVI, as seen in Section 5.3.5. One possible solution to incorporate a long term perspective in the PVI, which came up in an interview with a Marketing Manager, was to estimate future new product offerings, as well as future revenues, for these products. Future revenues are easily accessible in projects related to new product development, since there is always a sales estimation of the products in the documentation used for the R&D project. This is because when a demand for the product has been identified, marketing must also estimate the future revenues of the product, in order to secure that it is profitable to develop the product. A birth date can also be estimated because it is possible to tell when the product is likely to be launched, when serial production starts or any other date chosen as birth date. The disadvantage of doing future projections about revenue from new product offerings is that all projections are uncertain. An innovation project commonly lasts for several years, and the demand and circumstances might change during this time period. The actual revenues are likely to differ from the estimated revenues due to this, and the birth date may also be difficult to estimate accurately. However, the benefits of having a PVI that incorporates future new product offerings are high, because it adds all the products that are currently in the pipeline. An alternative would be to look complementary KPIs that in their nature have a more long term perspective. In the next section, other KPIs to measure innovation effectiveness is therefore presented and discussed.

5.6.1 KPIs used at other companies

It is important to stress that companies struggle to find KPIs for measuring innovation effectiveness. For senior management, the uncertainty regarding which KPIs to use to measure innovation is high. The below quotes of CEOs in the US show the general frustration that senior management have with KPIs that are used to assess the contribution of R&D efforts to company performance (Bean, 1990):

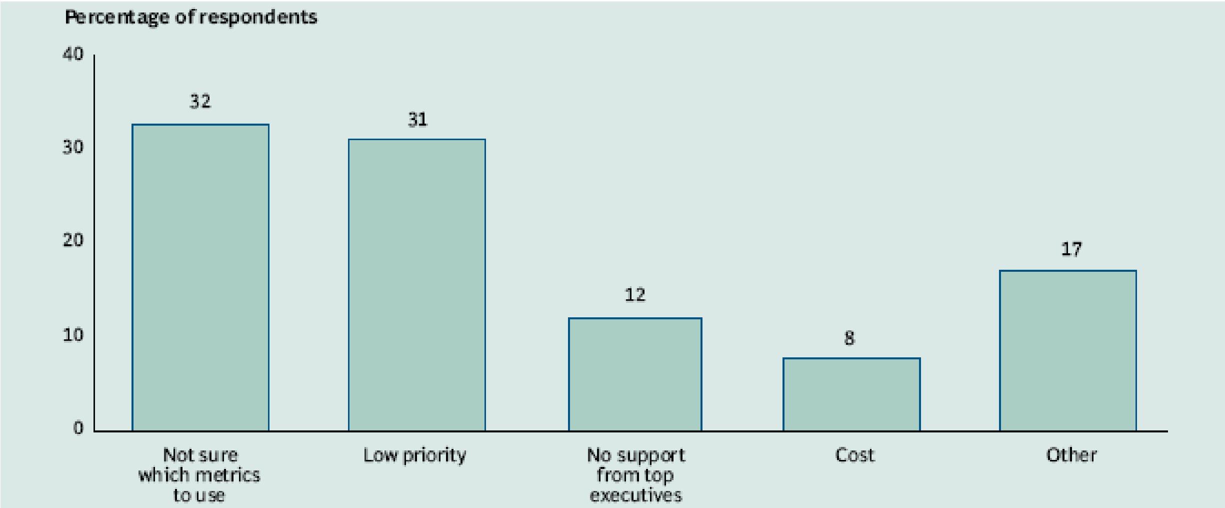
“Look at them all, but don’t trust any of them”

“There is a lack of suitable measures of current R&D productivity”

“There is a need for development of a common language with which R&D and corporate management can communicate”

Another senior management survey shows that only 32 percent of senior executives are satisfied with how their company measures innovation (Andrew & Michael, 2009). When asked the question *“If you think innovation should be rigorously measured, why doesn’t your company do so?”* senior management answered as illustrated in Figure 20 at the next page.

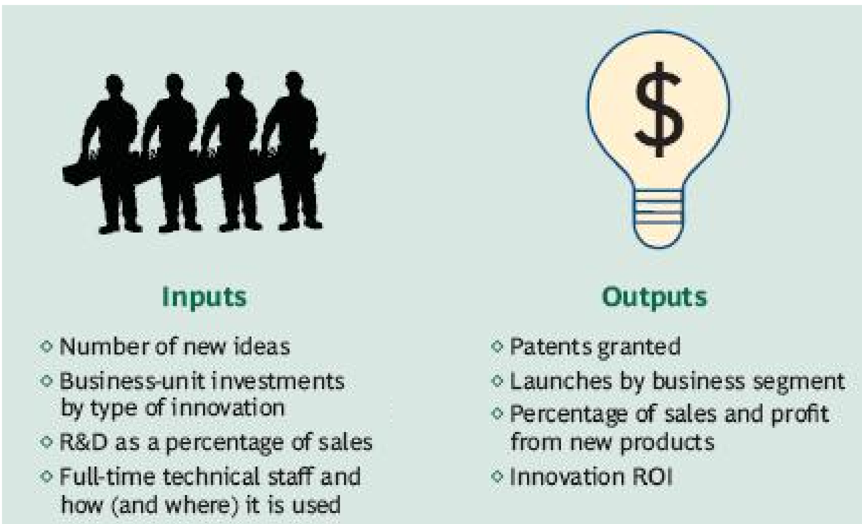
Figure 20. Reasons to why companies don't measure innovation



Source: (Andrew & Michael, 2009)

As described in Section 3.1, innovation is highly prioritized, and well anchored, in the Atlas Copco organization. There is also support from executive group management to measure innovation, strengthened for example by that the initiative of the PVI came from a former CEO. Since this thesis puts focus on measuring the inputs to, and the outputs from, the innovation process, the focus will be put on those types of KPIs. In Figure 21 below are some examples of inputs and outputs in the innovation process.

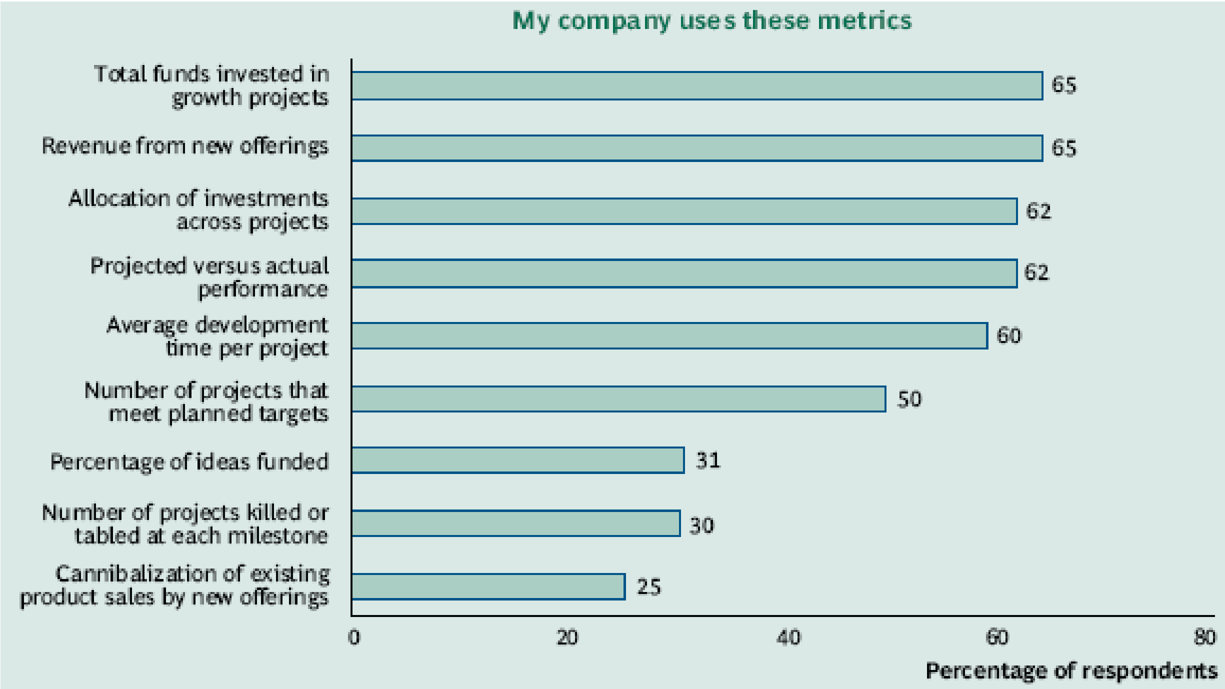
Figure 21. Inputs and outputs in the innovation process



Source: Modified from (Andrew & Michael, 2009)

Inputs might include both financial and non-financial resources that the company commits to innovation. Examples are money, the number of people, and how much time they are devoting to the effort. Outputs might be the cash profits, and indirect benefits that innovation generates, such as knowledge acquisition, and brand enhancement. Naturally, companies have a vast number of KPIs at their disposal. What might be more interesting is to look at what KPIs they actually use. Figure 22 at the next page illustrates the most popular KPIs to measure innovation that are used by senior executives.

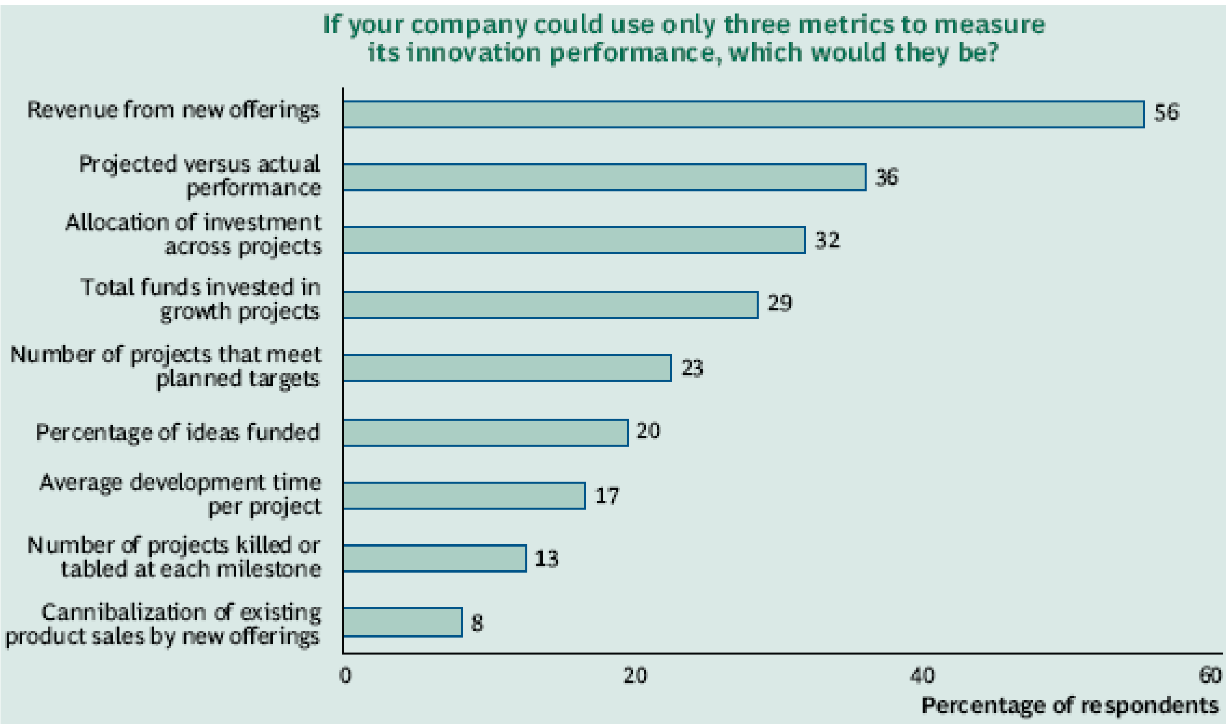
Figure 22. The most popular KPIs used by companies to measure innovation



Source: (Andrew & Michael, 2009)

Tied for first place is total funds invested in growth projects, and revenues from new product offerings. Allocation of investments across different types of project is placed third. The PVI measures revenues from new product offerings, and its popularity at other companies indicates that it ought to be a substantial KPI to use. If senior management has to rate the most indispensable KPI to measure innovation, the popularity of KPIs measuring revenues from new product offerings increases. See Figure 23 below for an illustration of the most indispensable KPIs to measure innovation.

Figure 23. The most indispensable KPIs used by companies to measure innovation



Source: (Andrew & Michael, 2009)

As seen in Figure 23, a KPI that measure revenue from new product offerings is the most valued KPI by senior executives. Projected versus actual performance is a process performance KPI, and is therefore not of interest in this thesis, as described in Section 1.5. Other popular KPIs are allocation of investment across projects, and total funds invested in growth projects. These two are both input KPIs. Total funds invested in growth projects is similar to the KPI used at Atlas Copco that shows the R&D costs as a percentage of total revenues. As described later, in Section 5.7.1, the R&D costs of Atlas Copco are only attributable to projects related to base development and new product development. Since projects attributable to taking care of existing products are not included, the R&D costs may be seen as invested in growth projects. Some other popular KPIs, like the number of projects that meet planned targets, and the average development time per project, are also process performance KPIs and not of interest in this thesis. The main concern with any KPI that should complement the PVI is that it should be cross-functional between the divisions. During the interviews, I tried to identify common areas of interest that people talked about. One area stuck out; the types of R&D projects that exist. Since most divisions have similar distinctions of R&D project types, a KPI concerning innovation projects might work well at Atlas Copco. Therefore the next section explains the different types of R&D projects that exist at Atlas Copco.

5.7 Types of R&D projects

The terminology of different types of R&D project differs a lot between the divisions, and it might be confusing to provide too much detail about the different names, and the grouping of projects that exist. What is important to note is that is seems like the decentralization of the organization, and the specific nature of the business, have created a need for different number of projects, as well as different ways of naming them. However, by ignoring the names and the amount of projects, there exist four types of generic R&D projects. These four types of generic R&D projects are based on the interviews with the Vice President Engineering for several of the divisions.

- *Base development projects* are long term projects which outcome may not be attributed to specific products. Instead, base development concerns new technology, or a new platform, for a number of new products
- *New product development projects* are attributable to one or several new products, or a face-lift of existing products
- *Product care projects* fix problems or quality issues for one or several existing products. The problems might be that the design creates ergonomic problems in manufacturing, or service problems causing that the technician is not able to do the service as intended. Both these problems demand a redesign of the product
- *Customer specific projects* are order driven products that result in a customized product that is sold to one particular customer, and generally in low volumes

The first three project types are used by all divisions included in the Product Vitality Index (PVI) today. All these divisions develop new technology and platforms, generate new products, and maintain and improve existing products. That the grouping and terminology of these three project types are different can be illustrated with an example from BA1. BA1 has a project type called R&D projects. R&D projects are projects that are executed with the purpose to generate new products. If a new technology is needed to produce the product, this technology is developed. From these definitions, R&D projects always seem to contain new product development, but they may also contain base development, if the technology does not exist to produce the new product. After the Vice President Research & Development of the business area explained that the business is quite immature compared to the other business areas, the grouping of these two project types seemed clear. At this business area, some type of new technology is more often needed in new product development projects than at the other business areas. Therefore, it might not be the same benefit for this business area to separate these two kinds of projects, and to assign different R&D employees to the different projects. Customer specific projects are only used by divisions whose type of business has made the products less standardized. The Vice President Marketing at a division took an example of products used in underground mines. The characteristics of the rock material, and the size of a tunnel, differ greatly between countries. Therefore the customers are selective in the specifications of their products, and they want to be able to be precise in defining certain parameters of them. Having many types of options is not enough. Other characteristic of customer specific products is that they are quite advanced and expensive, in order to make a profit despite the low volume sold. Divisions that sell standardized products in high volumes have less, or no, need for the customer specific projects.

The overall opinion by the interviewees was that the distinction between the projects is easy in some situations, and difficult in other situations. Certain projects are difficult to place in one project type, and the decision-making process becomes more subjective than objective. According to the Vice President Engineering BA3, the reporting of the R&D project types is not crystal clear. For example, it is sometimes difficult to decide if a project should be a new product development project, or a product care project. He explains that he uses this line of reasoning when deciding whether a project is a new development project or a product care project:

”Why do I do this project? If I do it because I think it’s fun, good, important, and provides benefits such as lower cost, higher performance and the decision is mine all along, then it is new product development. If I am imposed to do the project due to breakdowns, new laws and regulations, bankrupted suppliers or other unforeseen events, then it is product care”

To summarize, base development projects, new product development projects, and product care projects are used by all divisions. Even though there seems to be some difficulty to place a few projects in one specific project type, the fact that all divisions use these three project types is promising. It might be possible to create a Key Performance Indicator (KPI) based on project types that works cross-functionally between the divisions. In order to create such a KPI, it is necessary to understand how the different project types are reported, both in the financial accounting and on an operational level.

5.7.1 Reporting of different types of R&D projects

Below, the operational and the financial reporting of the R&D project types are accounted for.

Operational reporting

The operational reporting is done by the divisions on a monthly basis. At the end of each month, every employee in R&D reports the man hours spent on each R&D project. Since the reporting to a large extent is built on trust, it is sometimes difficult to know if the actual figures are accurate. For example it might be tempting to report less time on product care projects, since product care projects often implies that there is something wrong with existing products. By getting better numbers reported, the business controller for the divisions remains satisfied and unaware of the problem that the actual numbers are worse. When interviewing the Vice President Engineering BA3, he said that this could be a problem at some divisions. He said that he had a good operational overview, and that the time reported and the actual time spent on each project type could differ.

Financial reporting

The financial reporting to group level is done on a monthly basis. It is important to understand how base development, new product development, and product care are reported financially. The Vice President Group Controller explained that there exists no stringent connection between each project type and a specific item in the reporting. He explained the financial reporting as:

“We are writing about product line cost that includes “modification & re-design”, the rest is included in the R&D costs”

In an interview with a Product Company Controller for division D18, he gave a clear example of the financial reporting from his division. The numbers are specific for division D18, but the way of reporting is a group standard. See Figure 24 below for how R&D costs are reported and grouped financially.

Figure 24. Financial reporting of base development and new product development costs

238C Development, design & initial co	-5 218	Net R&D costs
2381 Research & developm. costs	-4 239	Gross R&D costs
2382 Less capitalized dev. costs(int	402	Capitalized costs
2383 Depreciation, cap. developm.	-1 380	Cost of depreciation on capitalized assets
2384 Other initial costs	0	
2389 Restructuring costs - R&D	0	

Source: Modified from Atlas Copco

Base development and new product development costs are included in the R&D costs, and are reported under the common item *"Research & development costs"*. An important principle in the financial accounting is capitalization of project costs. New product development projects can, if certain criteria are met, be capitalized[10]. This means that the costs are not expensed in the period that it occurred. Instead it is transferred to the balance sheet as an asset. This asset is later expensed in the income statement when the new products are launched on the market[11]. This is usually done with equal amounts over a three-year, or five-year, period. This is done to even out the costs of a new product development project, with the actual revenue that the products of the project will generate in the future, and it is done according to the International Financial Accounting Standards (IAS). This shows that the concept of new product development projects is well established on a group level. There is, however, no way to keep track of the costs related to base development projects and new product development projects, because it is not mandatory according to group policy to report these two project types separately. The separate cost for base development and new product development is not known at a group level according to the Vice President Group Controller. The total project costs are, in most cases, not known at a divisional level either, because there is no need to report it separately in the current accounting structure. On an even more local level, each product company knows its own base development and new product development costs. Each division has a number of product companies, but the total project costs for all product companies are not monitored today. Costs related to product care projects are reported differently. See Figure 25 below for how the product care project costs are reported financially.

Figure 25. Financial reporting of product care costs

207 UNADJUSTED GROSS PR	**44 484**
208 Total Adjustments	-6 815
20811 Net warranty costs	-82
20812 Goodwill repair	0
20814 Obs. & scrapping fr. stock (ol	0
208141 Chg in provision fr Obsol.	296
208142 Scrapping from Stock	-622
20815 Stock taking differences	-73
20816 Other costs for quality proble	-560
2082C Transport costs	-1 351
2084 Standard Price diff.	-243
20841 Transfer Price correction	0
2085 Restructuring costs - COGS	0
2087 Total overhead variance	-3 329
2088 Standard Cost variance	-665
2089 Other Adjustments	-186
209 OPERATING GROSS PRO	**37 669**

Source: Modified from Atlas Copco

10 The most important criterion is that the project costs must be above a certain amount
11 The effect of this is represented by the item 2383

Again, the numbers are specific for division D18, but the way of reporting is a group standard. The costs for product care projects are reported in the Cost of Goods Sold (COGS), and are related to modification and redesign of existing products. Modification and redesign costs are pre-calculated as a percentage markup, and are allocated to the standard cost for production. For example, if COGS are SEK 100 million for a division, a markup of one percent gives a pre-calculated cost of SEK 1 million. Since the percentage markup is estimated, there is likely to be a variance compared to the actual product care project costs at the end of the period. This under or over absorption is reported together with all the other manufacturing cost variances in the "*Total Adjustments"* to COGS, under the item called "*Total overhead variance"* in Figure 25. If the actual product care cost in the end was two percent of COGS, then the variance will be SEK 1 million, giving a total of product care project costs of SEK 2 million. The total product care project costs for a division is not mandatory to report in the accounting to group level, and it is thus not known at a group level according to the Vice President Group Controller. The total product care project costs are in most cases not known at a divisional level either, because there is no need to report it separately in the current accounting structure. On an even more local level, each product company knows its own product care project costs. Each division has a number of product companies, but the total product care project costs for all product companies are not monitored today.

The fourth category, customer specific projects are reported as a part of COGS. Customer specific costs are thus not classified as an R&D cost, but as a cost attributable to the production of the product.

Chapter 6 Analysis

This chapter starts out with improving and standardizing the PVI. The second step is to find KPIs that complement the PVI. The chapter ends with a summary of the KPIs, and gives recommendations concerning how they should be defined and structured

The analysis is done in two major steps. The first step is to improve the Product Vitality Index (PVI), and to find feasible definitions in order to standardize it, and to make sure that it works cross-functionally across the business units. The second step is to find and construct a feasible complementary Key Performance Indicator (KPI) to the PVI, which is strong in the aspects where the PVI is weak. The second step became natural, since it became clear during the interviews that a good complement to the PVI could improve the measurement of innovation effectiveness, and because the idea of using a KPI looking at different R&D project types seemed to work perfectly in order to improve the measurement of innovation.

6.1 Improving the PVI

The main issue with the Product Vitality Index (PVI) seems to be that people look at it from different perspectives. The executive group management wants the PVI in order to make sure that the innovation continues, and to secure that the production portfolio is not outdated. Locally, the divisions have no comprehensive overview of the total product portfolio, and there are no distinct guidelines to follow. Atlas Copco’s business model with decentralized business units makes steering towards organizational goals challengeable on a group level. There are a limited number of operational Key Performance Indicators (KPIs) on a group level, and the responsibility to steer towards organizational goals is performed by the business areas and divisions themselves. The business areas and divisions are used to decide how to measure and evaluate their efforts by themselves. At the same time, it is important for the executive group management to be able to measure innovation effectiveness with the same definitions, in order to steer the total product portfolio towards the organizational goals of the company. In the next nine sections, different critical areas are analyzed, and at the end of each section a recommendation is given of how the PVI should be improved in that area.

6.1.1 Who should the PVI measure?

It might be easy to initially praise or criticize the employees in R&D for the success or the failure of the innovation efforts. However, it became clear when talking to interviewees from different functions that the R&D function cannot be put explicitly responsible for the outcome of the innovation process. The Vice President Marketing at several divisions, among others, emphasized the importance of developing products that there is a need for in the market. In general, new product development requires most coordination and effort from the functions. The idea of a new product usually comes from the marketing function, which has detected a specific demand from the market. In product care activities, the functions concerned are coordinated. For example, if the shape of the shell of a compressor creates ergonomic problems for assemblers in production, R&D and production are coordinated to arrange meetings, in order to create a better design and to solve the problem. On the other hand, if there is a quality issue with a drilling rig, service and R&D are coordinated to solve this problem. In both these examples, R&D has little possibility to anticipate and plan for the problem. The need comes from another function, and the R&D function is merely used to solve the problem. All functions want R&D to be aligned with their interests. For example, the production function would ideally want all engineers to work on helping the production lines. However, it is easy to understand that to assign all R&D effort to make the production lines more efficient is a bad strategic allocation for the longer term, since R&D must also develop new products that the market requires, solve quality issues of existing product in the market, and develop new platforms and technologies. The common factor in all R&D projects is that R&D is a support function to the other functions, and R&D activities depend to a large extent on the needs of the other functions.

Furthermore, there does not seem to be a standardized substantial KPI to evaluate R&D. When discussing this with the Vice President Group Controller, his explanation was that it is difficult to find such a KPI. This is the problem facing the executive group management at many companies, as described in Section 5.6.1. Interviews with the Vice President Engineering and Vice President Business Control at several divisions indicated that they are aligned with this view. They all see the problems with not having KPIs to follow up R&D. However, they have a difficult time to come up with hands-on solutions on how such KPIs should be constructed. Most interviewees brought up that the PVI measures R&D efforts poorly. The engineering function can be seen as a support function to the other functions, and has little impact on the decision regarding what products to actually develop. Since the PVI measures the revenue distribution of these new products, it more accurately seem to measure the joint effort of all different functions involved in product development. It is the co-operation and interaction between these functions that results in success, or failure, of the new products released in the market. With this view, the PVI for a division would measure the divisional effectiveness of product development, and would not be a KPI for R&D. The PVI could successfully be used to measure the joint effort of all involved functions in putting new products on the market. Therefore the proposal is that:

"The PVI should measure the divisional performance and evaluate the joint effort of all involved functions in the innovation process that generates new products"

6.1.2 How should the PVI be used?

It is important to understand that the PVI may be constructed with assumptions strengthening what Atlas Copco want to show. Some divisions are more conservative in their definition of new products, while others are more open-minded. No way is right or wrong, and what definitions to use in the PVI may depend on what the executive group management wants to show with the output. However, if the definitions and the construction of the PVI are standardized throughout the organization, the aggregated output on a business area level would be more accurate. Regardless of what the PVI should show, it is important to know what to measure in order to reach the strategic goals, and to measure this and nothing else. It is also important to determine who should be the receiver of the information. Should the information be used internally at Atlas Copco, or mainly reach external actors? From several interviewees it was confirmed that the PVI is used actively in customer presentations and to motivate workers internally at some divisions. The message was that the division is innovative, and that the share of new products is high. However, today the information from the PVI is clearly also used to communicate an innovative spirit towards external investors. See for example the following sentences by Ronnie Leten, CEO of Atlas Copco, in the annual report for 2009 (Atlas Copco, 2010, p. 7):

"The share of revenues generated by products introduced in the past six years is currently around 70 % in the Group. On a scale of three years, there is room for improvement but we believe we are the undisputable leader"

A reasonable conclusion is that focus has been put on minimizing the number of older products in the product portfolio. This clearly showed when some of the Vice Presidents said that an idea of how to use the PVI was born years ago, by the former CEO Gunnar Brock. What Brock wanted to achieve was to release more new products on the market. He advocated that when salesmen from Atlas Copco meet with customers, they should always have some new features to discuss about the products. As one of the Vice Presidents Marketing expressed it:

"When we go out to have coffee with a customer we want to talk about new products and new features. If we do not talk about this the customer will quick as hell try to lower the sales price"

It seems natural that if there are no new features to show for the customer, the discussion will soon turn into a price discussion. By keeping the discussion on these new features, the salesmen will be more successful in keeping price cuttings out of the discussion, and the customer will get a feel that Atlas Copco is an innovative organization that provides a steady flow of new products with new features.

Since communicating the innovativeness of Atlas Copco is one of the purposes of the PVI today, and because I think that this is important, it is recommended that it continues also in the future. However, the PVI could benefit Atlas Copco in more and better ways than to solely communicate the innovativeness of the company to external parties, and I strongly advise that the PVI is used internally to a larger extent. This is because it could help the executive board to monitor divisional performance in a good and continuous way, and it would make the divisions more willing to provide accurate numbers. The PVI could be a strong tool for the business area managers, the divisional president and other divisional managers, in order to have an up to date product portfolio, and that deteriorations from this portfolio are detected early. Therefore the recommendation is that:

"The PVI should primarily be used internally by the executive group management, the business area management, and divisional management. At second hand the PVI should be used towards investors and other external parties"

6.1.3 What price to use when calculating revenues

As described in Section 5.1.4, the sales price used to calculate revenue of sold products in the PVI today is the transfer price, which is commonly the price between the distribution center or the product company, and the customer center. This means that the revenues calculated in the PVI are based on COGS, and costs such as sales and administration costs are not taken into account. If there are different margins between products, there could be a different outcome depending on whether the transfer price, or the sales price to the final customer, is used. Therefore, it could be an advantage to connect the products sold to the sales price paid by the final customer. Another possible disadvantage with using the transfer price is that it may not accurately represent the real sales to the final customer. A data warehouse called SalMon was recently initiated to monitor the final sales, but since SalMon comprises roughly 80 percent of final sales, and because the accuracy of the system is not 100 percent, it cannot be used in the PVI today. With SalMon running as it should, and with more entities connected, Atlas Copco would have a system that could be used to automate the calculations, and that could use the sales price to the final customer. It is important that 100 percent of the final sales are monitored, and that the monitoring is accurate. SalMon might solve the small eventual differences between the transfer price and the final price, and in the future more focus could be put on implementing the system across the whole organization, and to make it run smoothly. Today, however, the accuracy of the system may not be sharp enough to be used in the PVI. The recommendation regarding what price to use when calculating revenues is:

"The transfer price should be used in the PVI for calculating the revenues from sold products. The sales monitoring system SalMon provides a good platform that might automate the compilation of the PVI in the future. SalMon is built based on the sales to final customer and in the future the sales price to final customers might therefore be implemented"

6.1.4 Products to include

As described in Section 5.1.3, there are four types of products; equipment, aftermarket, rental, and consumables. For all of these, there exists a drive to develop new products except for rental, because rental has no need to rent out the newest products on the market. The benefit of developing new products is small, since the customers only are interested in extra capacity for a shorter period of time. The PVI can be used to measure equipment, aftermarket, and consumables, since there is an important customer benefit to release new products for these product types. However, there might be an advantage to take one step at a time and include only equipment for now, because the procedure of using this product type in the PVI is well-known throughout the organization already. There will be a lot of other changes for the organization to cope with regarding the PVI, and it could be important to begin with using only one type of product. However, a growing share of revenues is attributable to aftermarket, and a strengthened aftermarket is one of Atlas Copco's three strategic directions. As a second step, a good idea might be to introduce the aftermarket and the consumable product types in the PVI as well. There are two main ways to do that. Either to have one PVI that comprises all three product types, or to have one separate PVI for each product type. It might be good to evaluate different alternatives before deciding on how to do this. The recommendations regarding what products to include are:

"At a first stage, only equipment should be included in the PVI. At a later stage, aftermarket and consumables could be appropriate to include"

Regarding the depth of measurement down the product family tree, model level is a good compromise. Measuring on model level gives detailed numbers without creating problems related to access to information, administrative work, and manual errors. An example of a code that could work to measure on model level is the Product Group Code (PGC).

"Products should be measured on model level, for example by PGC"

6.1.5 Divisions to include

The divisions to include are closely related to the types of products that are included in the PVI. Service and rental divisions are excluded at the first stage, as well as divisions with a majority of consumables. There is however nothing permitting many of these divisions to be included at a later stage, when the respective product type is included as suggested in Section 6.1.4. The three divisions that are focused on R&D and provide core components to the other divisions are also excluded. The main reason for this is that innovation builds upon commercialization of a product, and these divisions do not have a dedicated sales team that sells the developed components. The components are sold at a later stage by a salesperson from another division as a part of the final product. However, even though the divisions are excluded from the aggregated PVI, there might be an idea to use the PVI as a divisional tool for these divisions to measure the innovation at the respective division. The recommendation regarding what divisions to include in the PVI is:

"At a first stage, only the divisions which sell equipment to the final customer should be included in the PVI. At a later stage, divisions with service and consumables could be appropriate to include. Airtec, Rocktec, Tooltec, and rental divisions, should not be included in the PVI"

6.1.6 Definition of a new product

The most problematic issue about improving the PVI is to define a new product. The theoretical definitions provided by VINNOVA, and Stockholm School of Entrepreneurship are clear and strict. They contain few details, and are therefore difficult to use in a practical sense. A new product is a totally new product on the market, or an existing product that is used in a new application. Ulf Lindgren (Interview, 2010), Dean and Executive Director at the Lorange Institute of Business in Zurich, states that a new product is not:

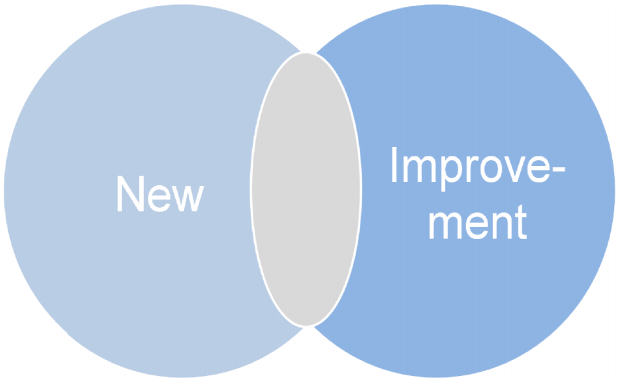
"An extension or adjustment of an existing product or technology"

At the same time, Lindgren (Interview, 2010) says that a product is:

"A new functionality of an existing product that resolves different problems and/or meets other customer needs than the existing products"

This theoretical definition seems to be closely connected to customer benefits and what is important for the customer in a new product. A phase lift or a large enough adjustment of an existing product should count as new, because the customer most likely gets a benefit from these actions. The difficult part is to define what degree of improvement of an existing product that should count as the existing product being new again. Figure 26 at the next page illustrates this phenomenon.

Figure 26. The grey zone when defining a new product



Source: Own

Products that are brand new on the market are new products, and improvements of existing products are not new products. However, there exists a grey zone between these two, when going from the extremes towards the middle. Even though the theoretical definitions from VINNOVA and The Stockholm School of Entrepreneurship initially sound clear, it is difficult to describe such a complex problem as defining a new product, by just one or a few sentences. Let me take an example from an imaginary division. The division has 100 products that belong to the product type equipment in their product portfolio. Every year about 10 new products are released. 30 of the products haven't undergone any type of change, and should not be classified as new. On the remaining 60 products, different amounts of product modifications have been done. Some of the products have undergone changes related to maintenance and quality issues, while others have undergone changes related to improving the product. However, the wide spectrum of improvements creates a grey zone, and it might be difficult to provide transparency of this grey zone with a set of objective definitions, because the types of improvements usually differ between the different business units.

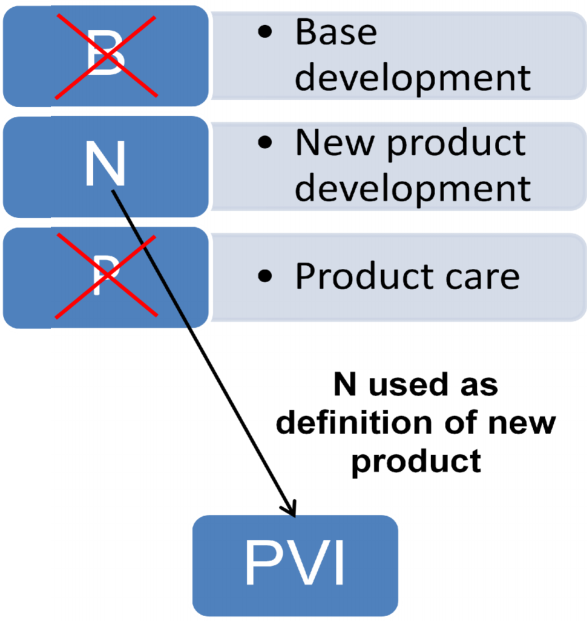
I examined many types of detailed and quantifiable definitions, when trying to define what type of improvements that should be large enough to be considered as a new product. One initial thought was to measure the percentage of articles changed in a product, and compare this with the total number of articles in it. A large percentage of changed components would indicate a large change in the overall product. However, having this technological oriented measure as a driving force would probably result in negative consequences, since it would reward changing a high number of parts in the new products developed. This would create large amounts of articles to keep in inventory, and would eventually lead to service and quality problems of the existing products. It was also difficult to know if a large change in components added any extra value or benefit for the customer. Not necessarily. In a similar way, it is difficult to say that a certain amount of money or hours spent on a project gives the customer added value or benefit.

The solution emphasizes two core criteria. The first one is customer benefit. A new product should in this sense be a product that shows improved customer properties, and if it does not, it should not be considered a new product regardless of the resources invested in the project and the technological input. Even though a change in a product, or a component in it, may save time, effort, or money for Atlas Copco as a company, it should not be considered a new product if the price is not lowered for the customer. If Atlas Copco for example finds a cheaper supplier of electrical motors this reduces the manufacturing costs of the product. However, it is unlikely that this cost reduction will be transferred to the customer by offering a lower price of the product, and by that contributing a customer benefit. The second criterion is that the definition should be kept simple in order for it to work at all divisions, and to be easily understood by the people there. By having a complicated definition the risk that the divisions will not use it is high. The terminology and the definitions that are used today are different across the divisions, and it is important to find manageable definitions that work. To find the definition, I emphasize what mathematicians call the Lowest Common Denominator (LCD). Instead of introducing a complex and detailed definition of a new product, I chose to use an easy and hands-on definition. The definition used for a new product in the PVI is a product that runs with a new product development project. The recommendation for a definition of a new product is:

"A new product in the PVI is a product that runs with a new product development project"

See Figure 27 below for the connection between the project types and the definition of a new product in the PVI.

Figure 27. The definition of a new product in the PVI



Source: Own

Base development projects are discarded as new products, because the outcome may not be attributed to some specific products. Instead, the base development concerns new technology, or a new platform, for a number of new products in the future. Product care project are discarded because they do not add any customer value. They are done to fix problems or quality issues and do not add any benefit for the customer, since the customer takes it for granted that the product she buys works properly. By using the definition of a new product development project, there are two big advantages. The concept of a new product development project is already incorporated in the organization on a group level, and there is no need to force a new definition onto employees. Also, the understanding and implementation among the employees will be facilitated, since the definition of a new product development project conceptually is implemented in the organization on a group level already. The definition will work well and be easily understood because the R&D function across all divisions at Atlas Copco thinks in the way of base development, new product development, and product care. Even though they might be called different names at different division, these concepts exist at all divisions. Also, since the costs for base development, new product development, and product care projects must be reported in the financial reporting, the business controllers makes sure that the employees in all functions understand, and work according to, these concepts.

In order to bring clarity to the definition of a new product in the PVI, it is important to define the three different types of project. The customer specific projects are excluded because they are quite uncommon and only occur at some divisions. However, divisions that use customer specific projects can of course continue to measure these at their divisions. Here are the recommendations for the three R&D project types:

"Base development is long term projects which outcome may not be attributed directly to specific products. Base development concerns new technology, or a new platform, for a number of new products in the future"

"New product development is the development of an entirely new product or a face-lift of an existing product. The product must give added customer benefits"

"Product care fixes problems or quality issues for an existing product and demands some kind of redesign of the product. The problems might be that the design creates ergonomic problems in manufacturing, or service problems causing that the technician is not able to do the service as intended or due to legal regulations"

The definition of a base development project makes it clear that the products that later benefit from base development should run with a new product development project, at a later point in time. If a new product is a product that has successfully undergone a new product development project, then the definition of a new product in the PVI would be an entirely new product, or a face-lift of an existing product that gives added customer benefits. A new product in the PIV would not be base development for a new technology, or a new platform, a redesign of a product that originates from other sources than the customer, or a customized product.

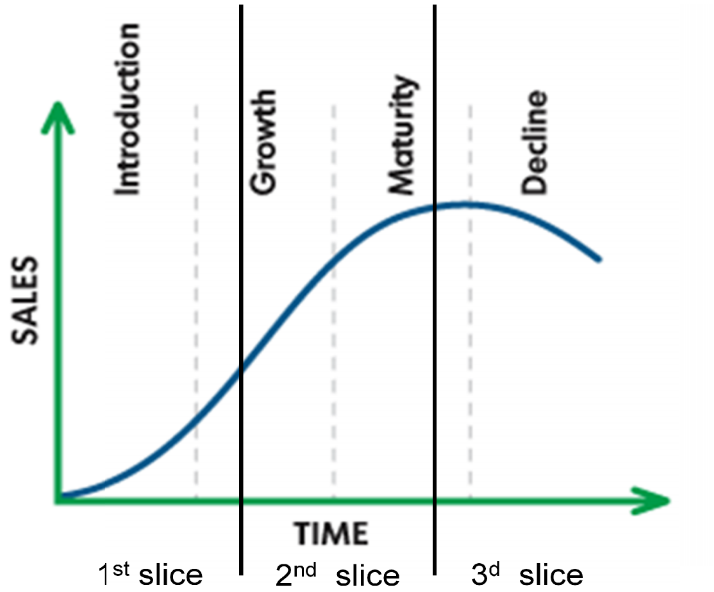
The choice of using the definition of a new product development project in the PVI is objective. However, the uncertainty among employees deciding how a R&D project is to be classified must be reduced, not by complex definitions, but by clear examples applicable to specific situations. It should especially be made easier to decide if a project is a new product development project, or a product care project. According to me, objective definitions regarding a new product development project and a product care project are difficult to implement on a group level at Atlas Copco, because the nature of the business and the products of the divisions are too different. However, it is important to lower the subjectivity by providing clear and sufficient examples of what a new product is, and what a new product is not. A good idea is for all business areas and divisions included in the PVI to compile these examples together, and to make sure that they are agreed upon by all business units and functions. The most important part is the customer benefit that the product has for the customer. Some examples what a new product is not are:

- By definition a new article number in the Enterprise Resource Planning (ERP) system
- Redesigns that are due only to quality problems
- Redesigns that are due only to ergonomic problems, or breakdowns in production
- Redesigns that are due only to facilitate aftermarket services
- Redesigns that are due only to laws and regulations
- Redesigns lowering costs unless the customer benefits by a price cut
- A product with a similar component from a new supplier
- A product with new components due to a bankrupted supplier, or other unforeseen events
- A customized product sold to one particular customer and in low volumes

However, these examples are not written in stone, and could instead be considered as a foundation of a discussion. For example, redesigns concerning the environment, such as compressors that are carbon free, may be seen as a regulatory concern but at the same time these compressors are new products because the customers want more environmental compressors. The more clear and hands-on the examples, the better decision the person who determines the R&D project types can make. The goal is for this determination to be the same, regardless of business area and division.

An alternative solution that is worth to give some thought, and that completely removes the need for a definition of a new product, is the Product Life Cycle (PLC), described in Section 4.1. See Figure 28 at the next page for how the PLC may be used in the PVI.

Figure 28. An alternative definition of a new product in the PVI



Source: Own

The idea is to split the PLC in three equal slices, and that each slice would replace the previous categories used. Instead of having absolute categories based on years, the marketing department would determine where each product family is in the life cycle, and assigns it to the correct slice. When a product goes through an improvement, it would after that improvement belong to a different stage of the life cycle and thus to a different slice, and the PVI would change. This would be an advantage since the product life cycle differs between different products. The solution works well in theory, but the practical use might be limited. When talking to the Vice President Marketing at some main divisions, it became clear that where the products are in the PLC is monitored. However, to be able to cut the PLC in three distinct slices, and to place each product family in the correct slice, would be close to impossible to do accurately on a regular basis. The opinions from the Vice President Marketing at the divisions corresponds well to the academic critique towards the PLC described in Section 4.1, that the assumption that the bell curve accurately describes sales of a product over time is questionable, and that the PLC's practical use in specific situations is limited.

6.1.7 Definition of the birth date of a product

There are several dates to use as a birth date of a product. Some examples are when the product is first registered in the ERP system, when a new product is sold for the first time, when a prototype is tested, when a product is pre-launched, when a product is generally launched, or when serial production of the new product is started. For more details of the different types of dates in the product development process, please refer to Section 5.5. Since the birth date of a product should be aligned with the point in time that it starts to generate revenue, a marketing approach is a must. It may be a disadvantage to choose, for example, when the product is first registered, or when a prototype is tested, because these dates do not say much about when the products are ready to be sold. Since the focus in the definitions is put on the customer perspective, the production start of serial production is also ruled out. A first time sell, or a small scale launch, will generate some revenue, but these dates may be far from when the product is known to larger customer segments on the market. The most natural choice is therefore the general launch date of the product. This date is also easily accessible, since all functions in the product development process know when the product will be released on the market. A general launch may be defined for example as releasing the product on the market in three different geographic areas, such as countries.

Today launch date is measured by year only. That means that it doesn't matter whether a new product is launched for example in January or December of 2008, and the birth date will be 2008 for both cases in the calculations of the PVI. For products with high revenue streams in particular, a good distribution of the revenue between different years is important, and therefore a more precise definition of measurement is needed. Measuring launch dates by month seemed feasible, when discussing the topic with the interviewees. The Vice President Marketing at several divisions, in particular, said in the interviews that the birth date should be measured on a quarterly or monthly basis. Measuring on a yearly basis distributes the revenues unfairly, and to measure on a monthly basis effectively corrects this problem. The recommendation is therefore that:

"The birth date of a product is the month that the new product is generally launched on the market"

6.1.8 Evaluation of the results and comparison

Since the PVI measures the divisional performance, it is important that the results of the PVI are evaluated against previous results for the division. In this way the division can make sure that deteriorations are detected early. The best way to assure that the divisions have an up to date product portfolio, is to benchmark competitors' product portfolio, to the degree that it is possible to do so. The overall opinion from the interviewees was that it is difficult to compare the PVI between business areas, due to the different nature of the business and products. A better idea would be to benchmark divisions within the same business area. This is a better idea, because the nature of the business and the product range is similar for some divisions within the same business area. However, it could be difficult to benchmark all divisions in the same business area. In interviews with the Business Area Project Manager BA2, this problem was highlighted. In B2 division D17 has a mass production approach, while division D3 has a more customized approach. The Business Area Project Manager BA2 meant that this should give different proportions between innovation input and revenue output, since the volumes sold differ. This is most likely true, because the volume sold clearly affects the amount of revenue. The conclusion is that it is a good idea to benchmark divisions within the same business area, but that it might not be appropriate to benchmark all divisions within the same business area. It is important that the divisions benchmarked have similar businesses, similar product ranges, and similar volumes sold.

In addition to comparing appropriate divisions within the same business area, it would be beneficial to do a benchmark against competitors. This is easier for some divisions than it is for others. For example, for several divisions there exist only one or a few competitors, and Atlas Copco and one or two competitors make up 100 percent of the total world market. In interviews, it became clear that it may be feasible to benchmark divisional performance against competitors. This is because Atlas Copco's divisions monitor the sales of the competitors and the product releases made by them. However, for divisions that are active in a market with more competitors, and lower market shares, the mapping of sales and product releases of competitors is more difficult to do. It is important to remember that the sales figures and the sales divided by different products is not publicly available information. The Business to Business (B2B) market that Atlas Copco operates in, is not as transparent as Business to Consumer (B2C) industries, such as the automotive industry described in Section 5.4.2. It is not possible to see the sales breakdowns per model as it is in some B2C industries, such as the automotive industry. The B2C industries are more transparent, because of legal and regulatory issues. Until the B2B industry Atlas Copco operates in becomes more transparent, benchmarking against competitors will be difficult for many divisions, but is still essential in order to stay competitive. The recommendation is that:

"The PVI should primarily be used to, continuously, evaluate separate divisions over time. Secondarily, it should be used to benchmark competitors. In third hand, it may be used to compare divisions with similar business, similar products and similar volumes sold of the products. The PVI should not be used to compare business areas"

An important recommendation is that divisional management use the PVI to follow up on the progress towards the targets, by looking at their divisional product portfolio, and that the divisions has an overview of how they progress towards the goals, which helps them to detect deteriorations early. A comparison between the business areas is not recommended. However, there must be a good balance of the product portfolio that each business area should have as a goal. The same is true for a division. It is therefore interesting to look at what factors that creates a good balance of new and older products.

6.1.9 Finding a good balance of the product portfolio

It would be useful to have a unique goal balance between the product age categories for each business area and division. This can be done in several ways, but three recommendations are:

- To keep track of the competitors, and stay ahead of them, to be competitive
- To look at what drives the customers, and customer preferences
- To make sure that the goal balance is agreed upon by people from different functions, to get an as complete picture as possible, and to not suboptimize in one area while other areas suffer

To keep track of the competitors is the most important way of finding the correct balance of the product portfolio. After all, it is the competitors' products that the company has to beat in order to stay competitive. As mentioned before, to keep track of the competitors is easier for some divisions than for others. Since the definitions in the PVI emphasize customer benefits, it might be important to look at customer drivers, and customer satisfaction. For example, it could be useful to look at the customer satisfaction for each category in the PVI. How satisfied are customers with the new products, and how satisfied are they with the old products? If customers of a specific division are unsatisfied with the new products, and satisfied with the old products, that could give an indication of that the new product development needs improvement. To understand what drives the customers, I contacted the Communication Managers for each business area and asked them for the key drivers for their customers. The answers are illustrated in bullet points in Figure 29 below, and are for the Atlas Copco premium brand. Non-premium brands may have a different set of drivers:

Figure 29. The customer drivers for the three business areas (Atlas Copco premium brand)

BA1

- Improved quality in the customers process
- Increased productivity
- Improved ergonomics and safety
- Reliability and ability to provide service
- Total cost of ownership
- Increased flexibility in production

BA2

- Reliable performance
- Energy efficiency
- Total cost of ownership
- Reduced carbon emissions into the atmosphere
- High quality service

BA3

- Reliability and availability of the equipment
- Local support, such as technical service and logistics
- Productivity and performance
- Ergonomics and safety
- Total cost of ownership
- Delivery time and accuracy
- Past experience of Atlas Copco equipment

Source: Interviews with Communication Managers at Atlas Copco

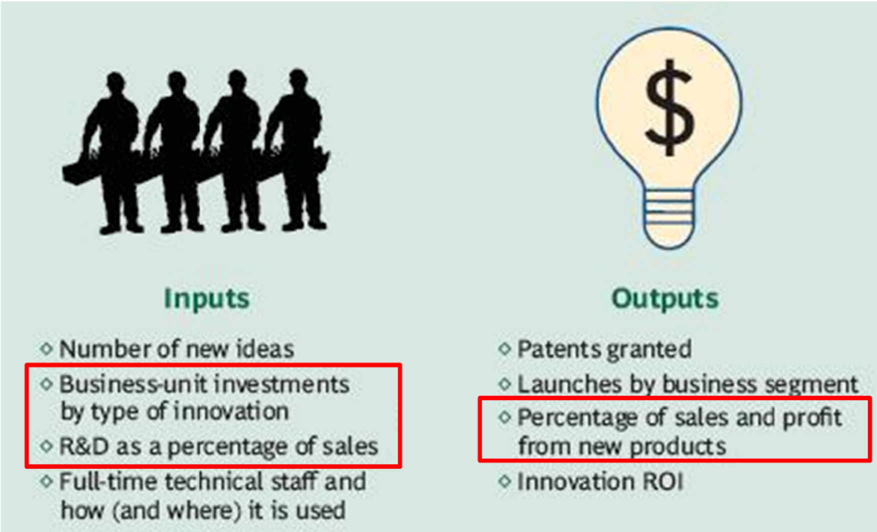
Many of the key drivers for customers are similar for the business areas. For example ergonomics and safety, local support, and total cost of ownership are valued by customers of all business areas. Nonetheless, the differences may provide some guideline regarding the balance of the product portfolio. In BA1, the reliability and performance of the products seem to be less important than for BA2 and BA3. Reliability and performance are valued by customers in BA1, but their expectations on the life of the product are relatively lower than for the other business areas. This is further strengthened by the fact that the life cycle of the products for BA1 is significantly lower than for BA2 and BA3. A product portfolio for BA1 is therefore more likely to have a higher percentage of products that are younger than, or equal to, three years. BA1 also has a key driver called increased flexibility in production, indicating that the products from BA1 solve production problems in an industry that changes, and that is not fully matured. BA2 has a key driver called reduced carbon emissions into the atmosphere. Because of rules and regulations regarding the environment, as well as ethical and other reason, the customers value products that are energy efficient, or entirely free from the need of fossil fuels. BA3 has the longest life time of the products, and the reliability of the equipment is crucial. The customers are interested in products that they can trust will work, and are less likely to invest in new and unproven products. This could suggest a lower percentage of products younger than, or equal to, three years. If the different key drivers were ranked for each business area the usefulness of the results might be higher.

The last activity that might help to find a goal balance of the product portfolio is to make sure that the goal balance is agreed upon by people from different functions, in order to get an as complete picture as possible, and to not suboptimize in one area while other areas suffer. One example here is the service divisions who argued that new products results in costs related to, for example, training, and spare parts needed to be held in inventory. Innovation focusing on revolution and releasing a lot of new products with too much radical innovation may imply hidden costs in these areas. The service divisions rely on the equipment of other divisions and should not be interfering in the development of this new equipment. However, if constructive input in the product development, as well as other cross-functional co-operation, should increase, this might lower the lifetime cost of the product. For further details on this discussion, please see Section 5.3.6.

6.2 Finding KPIs that complement the PVI

In the chapter *“Analysis“,* the second step is to find a good complementary Key Performance Indicator (KPI) to the Product Vitality Index (PVI), that is strong in the aspects where the PVI is weak. The second step became natural, since it became clear during the interviews that a good complement to the PVI could improve the measurement and evaluation of innovation effectiveness, and because the idea of using a KPI looking at different R&D project types seemed to work perfectly in order to improve this measurement. Also, a goal to have one KPI covering all aspects of innovation is not recommended. In Figure 30 at the next page, inputs and outputs KPIs are illustrated.

Figure 30. Inputs and outputs KPIs to be used at Atlas Copco



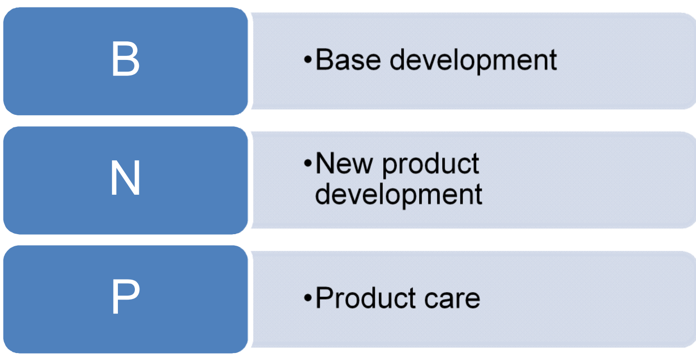
Source: Modified from (Andrew & Michael, 2009)

Two KPIs on a group level used today are the input KPI R&D as a percentage of sales, and the output KPI percentage of sales from new products. As discussed in Section 5.6, one of the areas that business areas and divisions had in common, and emphasized by interviewees, was project types. Since most divisions have similar distinctions of R&D project types, a KPI looking at the allocation of investments across different types of projects is a good choice to complement the PVI.

6.2.1 The BNP KPI

The BNP is introduced because more KPIs than the PVI are needed in order to be able to monitor innovation. From interviews across different divisions at different business areas, it became clear that the terminology and use of documentation before, under, and after R&D projects differs. However, employees across all functions of Atlas Copco think in the way of base development projects, new product development projects, and product care projects. The abbreviation BNP refers to these three types of project, by taking the first letter of each project type into the name of the KPI. Even though they might be called different names at different division, the concepts exist at all divisions. Also, since the costs for base development projects, new development projects, and product care projects must be reported to the group level in the financial accounting, the business controllers make sure that the employees across the functions understand, and work according to, these concepts. Even though this thinking exists in the organization, there is no proper monitoring of the distribution of the three project types. Atlas Copco could benefit strongly by introducing a KPI that monitors and follows up on the distribution of R&D project types. See the BNP KPI below in Figure 31.

Figure 31. The BNP KPI



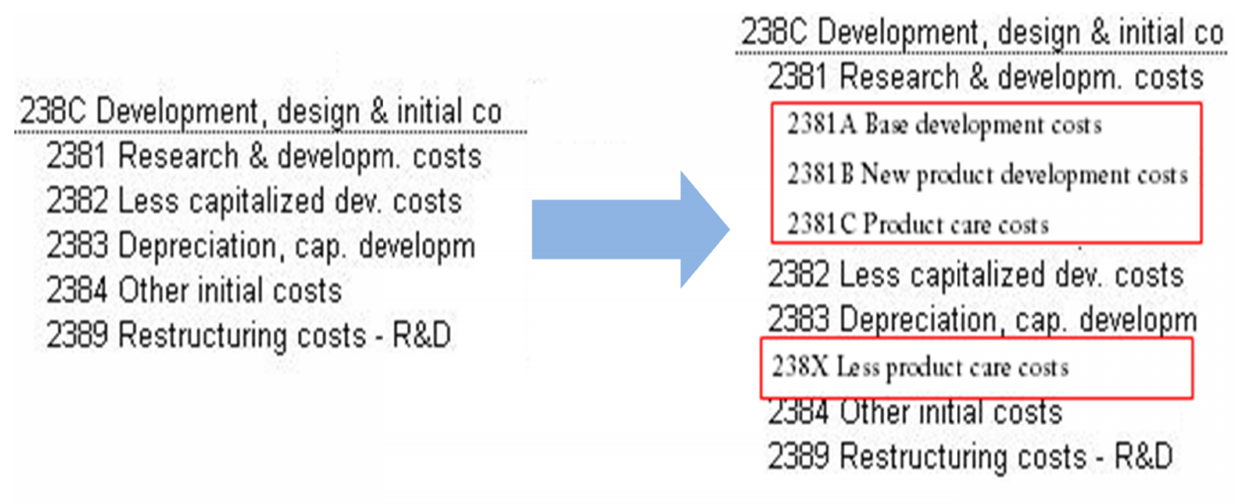
Source: Own

The idea with the BNP is to look at the distribution of the R&D projects at a division. The distribution is determined by looking at the cost for one project in relation to the cost for all three project types. For example the percentage for base development is determined by the cost for all base development projects in relation to the cost for all base development projects, new product development projects, and product care projects. The percentages show the distribution of the three types of project. One big advantage with the BNP is that it measures the total development of the innovation as a whole. The BNP considers all types of innovation project, while the PVI focuses on growth projects.

6.2.2 Changing the financial reporting of R&D project costs

The Vice President Group Controller made it clear that there exists no standard or requirement for reporting base development project costs, and new product development project costs separately. The implication for this is that the divisions do not need to keep separate track of the distribution of base development projects and new product development projects. As described in Section 5.7.1, it is not mandatory for a division to report base development, new product development, and product care costs separately in the accounting to the group level, and it is thus not known at a group level. The total project costs are in most cases not known at a divisional level either, because there is no need to report it separately in the current accounting structure. However, this data is retrievable. In order to monitor and to keep track of the separate projects costs on a group level, the recommendation is to change the financial reporting structure that is used at Atlas Copco. Figure 32 shows a conceptual suggestion of how this could be done in the current reporting system.

Figure 32. The change of the financial reporting to separate R&D project costs



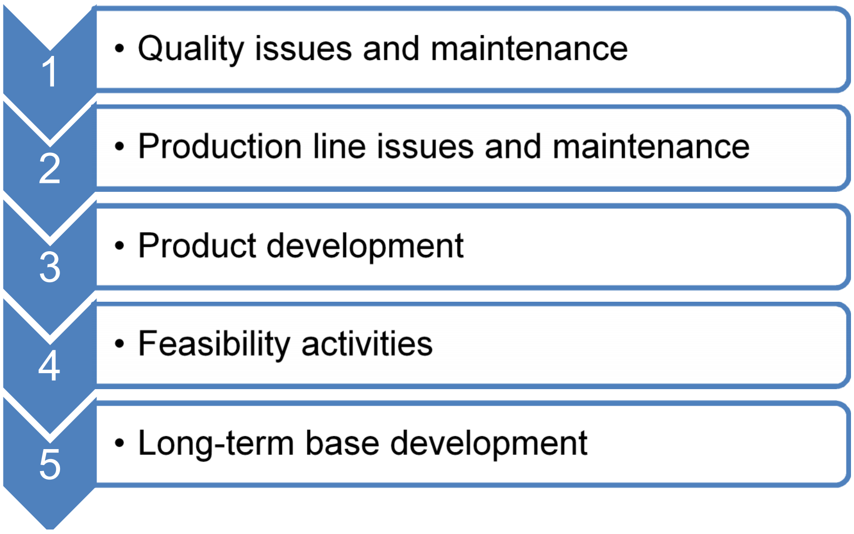
Source: Modified from Atlas Copco

The purpose of the change is to separate the costs related to base development projects, new product development projects, and product care projects. Base development costs and new product development costs are already a part of R&D costs. A good approach is therefore to make three sub-levels to the accounting item 2381, and name them after the project types. The items 2381A, 2381B and 2381C will in the new reporting structure be the input for calculating the BNP. Since project care costs are added only to gather the information in one place, the product care costs are subtracted, so that the overall sum does not change.

6.2.3 Finding a good balance of R&D project costs

In order to find a good balance of the distribution of base development, new product development, and product care project costs, it might be useful to look at the priorities of the R&D function. From the interviews with R&D managers, I would put the priority of activities within the R&D function as illustrated in Figure 33 at the next page.

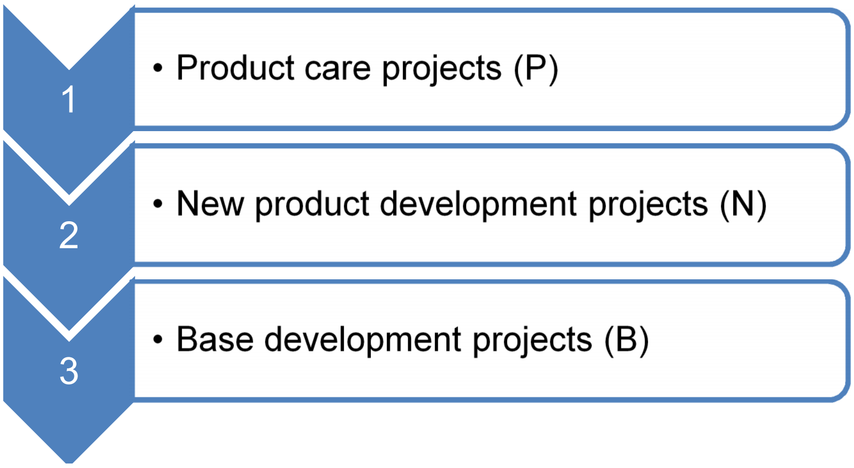
Figure 33. The priority of activities of the R&D function



Source: Own

To fix quality problems on existing products is the most prioritized R&D activity, and long term base development of a new technology, or platform, is the least prioritized. To improve existing products, or developing new products, is prioritized higher than base development, but not before fixing problems with existing products. If we translate this into prioritizing R&D projects it would look like illustrated in Figure 34:

Figure 34. The priority of R&D projects

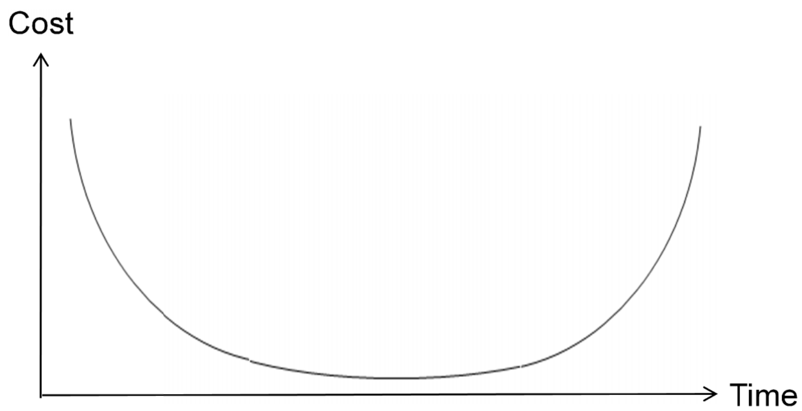


Source: Own

This means that the short term activities are prioritized first, which seems quite natural. If there are quality problems with existing products, effort should not be put on long term base development projects. What it comes down to in the end is to make the customer happy and to keep customer satisfaction at a maximum. However, it is important to understand that if the R&D function gets to decide on their own, the list of priorities would probably change. Many of the interviewees that were engineers emphasized that base development projects were not prioritized high enough, and that they wanted to spend more time on projects related to new technologies and product platforms. In the future, it is essential to improve and be innovative in these areas, and in order to be so the time and effort spent on base development projects must increase. However, the nature of most engineers, and their passion for technology, is important to keep in mind before being blown away by their conclusions. There are both advantages and disadvantages with spending much time and effort on developing new technology.

Regarding base development projects, a high percentage means that much effort is put on long term innovation, and on finding new technologies. A low percentage means that less focus is put on this, which might threaten the long term innovation success. A high percentage of new development projects mean that much effort is put on bringing new products to the market, while a low percentage means the opposite. A high number of new development projects may lead to a higher number of product care projects in the long term, because most new products have childhood diseases. A higher percentage of product care projects means that there are quality issues with existing products, ergonomic problems in production, service problems, or legal issues, due to legislation in different countries. See Figure 35 below for a schematic development of the product care costs during the lifetime of a product.

Figure 35. The development of product care costs during the lifetime of a product



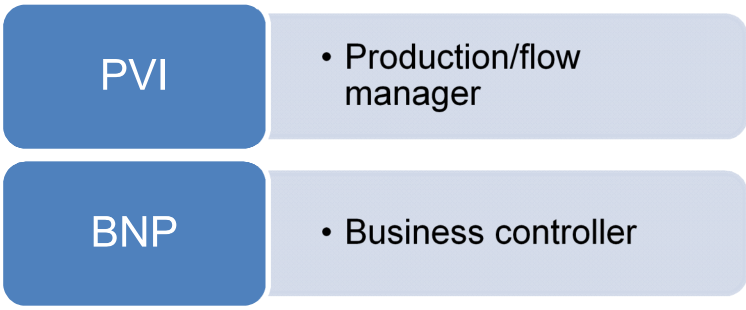
Source: Own

Product care costs are the highest in the beginning, and towards the end, of a product's lifetime. Most new products have childhood diseases that need to be fixed after they have been released on the market. Towards the end of their life, product care costs are a prerequisite to keep them alive, and still attractable for customers to buy. A good approach is to minimize the childhood diseases, and thus the product care costs of a product at an early stage of the Product Life Cycle (PLC), and to introduce a new product and phase out the old product before the product care costs piles up towards a late stage of the PLC. If this is done correctly, the vitality of the product portfolio is enhanced. All divisions want to keep the product care project percentage as low as possible, but an accepted level of product care projects must be determined in order to cope with the reality. The total product care costs for a division are the aggregated product care costs of all the existing products. Since the product care costs change during the lifetime of the product, an acceptable product care cost could differ from division by division, depending on the current vitality of the product portfolio.

6.3 Who should compile the KPIs?

The outcome of the Product Vitality Index (PVI) may differ depending on which function is responsible for measuring it. This is clearly showed by the stereotype example of how different functions calculate something, described in Section 5.3.3. It would be preferred to be consistent in what function that should be responsible for construction, and maintaining, the PVI. The problem with the engineering, marketing, and business control functions is that they all are partial, and that they have an incentive to provide good numbers. It might therefore be an advantage to assign a production/flow manager to be responsible for the PVI. A production/flow manager has access to the information, and is more objective in the issue. Regarding the BNP, the divisional business controller is a recommendation. The persons suggested to be responsible for the Key Performance Indicators (KPIs) are illustrated in Figure 36 at the next page.

Figure 36. The function to be responsible for each KPI



Source: Own

Regarding the intervals of measurement, they ought to be aligned with the reporting from the divisions to the group level. This reporting is done monthly. However, a monthly interval is most likely not necessary. A suggestion is therefore that the KPIs are reported quarterly.

6.4 Summary of the proposed KPIs

The solution proposes two different Key Performance Indicators (KPIs), to be used in order to measure and evaluate innovation effectiveness at Atlas Copco. Both KPIs can be constructed in order to work cross-functionally between different business units. The two KPIs complement each other, and have the intention to provide an overview of the strategic innovation at the company. In the short term, the vitality of the product portfolio is monitored and deteriorations from this portfolio are detected early. In the medium and long term, the innovation competiveness is secured by having a good allocation of base development, new product development, and product care projects.

The first KPI that is proposed is an improved Product Vitality Index (PVI), which has more standardized definitions that the current one. The PVI is used to measure the innovation success of the release new products. The vitality of the product portfolio is monitored and deteriorations from this portfolio are detected early. The recommendations given regarding the PVI are summarized below:

Who should the PVI measure?

The PVI should measure the divisional performance and evaluate the joint effort of all involved functions in the innovation process that generates new products.

How should the PVI be used?

The PVI should primarily be used internally by the executive group management, the business area management, and divisional management. At second hand the PVI should be used towards investors and other external parties.

What price should be used?

The transfer price should be used in the PVI for calculating the revenues from sold products. The sales monitoring system SalMon provides a good platform that might automate the compilation of the PVI in the future. SalMon is built based on the sales to final customer and in the future the sales price to final customers might therefore be implemented.

What types of products should be included?

At a first stage, only equipment should be included in the PVI. At a later stage, aftermarket and consumables could be appropriate to include. Products should be measured on model level, for example by PGC.

What divisions should be included?

At a first stage, only the divisions which sell equipment to the final customer should be included in the PVI. At a later stage, divisions with service and consumables could be appropriate to include. Airtec, Rocktec, Tooltec, and rental divisions, should not be included in the PVI.

How should a new product be defined?

A new product in the PVI is a product that runs with a new product development project.

When is the birth date of a product?

The birth date of a product is the month that the new product is generally launched on the market.

How should the results be evaluated?

The PVI should primarily be used to, continuously, evaluate separate divisions over time. Secondarily, it should be used to benchmark competitors. In third hand, it may be used to compare divisions with similar business, similar products and similar volumes sold of the products. The PVI should not be used to compare business areas.

The second KPI that is proposed is called the BNP, and monitors the allocation of different types of R&D projects. The abbreviation BNP refers to these three types of project, by taking the first letter of each project type into the name of the KPI. The innovation competiveness is secured by having a good allocation of base development, new product development, and product care projects. The recommendations given regarding the BNP are summarized below:

What is a base development project?

Base development is long term projects which outcome may not be attributed directly to specific products. Base development concerns new technology, or a new platform, for a number of new products in the future.

What is a new product development project?

New product development is the development of an entirely new product or a face-lift of an existing product. The product must give added customer benefits.

What is a product care project?

Product care fixes problems or quality issues for an existing product and demands some kind of redesign of the product. The problems might be that the design creates ergonomic problems in manufacturing, or service problems causing that the technician is not able to do the service as intended or due to legal regulations.

Besides these recommendations, it is suggested that the financial reporting structure is changed, in order to separate the costs related to base development projects, new product development projects, and product care projects. A good approach to achieve this is to make three sub-levels to the accounting item 2381, and name them after the three R&D project types.

Chapter 7 Conclusions and discussion

This chapter contains conclusions regarding the proposed KPIs and the implementation of them. The chapter also discusses the reliability, validity, and generalizability of the study, and gives recommendations for future research

7.1 Conclusions

This study, which has been conducted at Atlas Copco, highlights the complexity of measuring and evaluating strategic innovation cross-functionally across different business units. The specific nature of the businesses makes it difficult to create a generic Key Performance Indicator (KPI) with standard definitions, which works despite the different nature of the business and the products. The intriguing part with constructing these cross-functional KPIs is the potential value and benefit they will have for an organization when they work properly. The proposed KPIs in this thesis are designed for Atlas Copco, in order to provide the executive group management with a measurement framework that ensures an overview of the vitality of the overall product portfolio. Deteriorations from the overall portfolio are to be detected early, and the innovation success of specific business units can be rewarded, while appropriate actions can be taken at others where innovation staggers.

The proposed KPIs, to be used by Atlas Copco to evaluate strategic innovation, are the Product Vitality Index (PVI) and the BNP. The PVI was constructed with the intention to improve the current PVI and to standardize the definitions, in order to provide reliability and accuracy to the measurement. The PVI measures the revenue from new product offerings and provides a good measure of innovation success in the short term. One weakness with the PVI is that it neglects innovation success in the long term. As important as new product offerings are to stay competitive in the short term, generating new technologies and new platforms is crucial in order to stay competitive in the long term. The second KPI is called BNP and measures the allocation of long term and short term R&D projects, thus complementing the PVI in a good way. The idea with the BNP is for the executive group management to get a sense of the overall innovation progress of the company, and to determine if the allocation of R&D project types is strategic for the future.

Hopefully, the set of these two KPIs will allow the executive group management to better monitor strategic innovation and to steer the Atlas Copco organization towards a position in the future where the company's innovation competitiveness remains strong. The two KPIs complement each other, in order to achieve this, but they are also intertwined in another way. The BNP requires clear definitions of base development, new product development, and product care R&D projects. To facilitate the understanding of the concept "a new product", the definition of a new product is the same as the definition for a new product development project. The concept of a new product development project is already incorporated in the organization on a group level, and there is no need to force a new definition onto employees. This definition of a new product is meant to work well, and be easily understood, because the R&D function across all divisions at Atlas Copco thinks in the way of base development, new product development, and product care.

In finding the necessary definitions, I used an approach that I have named "*Find Lowest Common Denominator" (FLCD)*. The terminology and the definitions used today are different across the Atlas Copco divisions. What the FLCD approach should symbolize is that cross-functional KPIs should focus exclusively on finding what the business units have in common. This is important because I noticed that many employees during the course of the project, both at Atlas Copco and elsewhere, put too much focus on highlighting all the differences between the business areas, and the problems that these differences creates. It might be more important to find manageable definitions based on the Lowest Common Denominator (LCD), and to provide clear and hands-on examples to take care of differences instead of introducing complicated quantifiable definitions that employees have difficulty to understand, accept and work with. I think that the FLCD approach can prove successful in future research in similar contexts.

7.2 Discussion

The purpose of this thesis is to come up with a measurement system that makes sure that the divisions across Atlas Copco have an up to date product portfolio, and that deteriorations from this portfolio are detected early. The focus in the problem formulation is that the proposed Key Performance Indicators (KPIs) are working cross-functional between business areas. During the empirical study and the literature review, it became clear that this problem is complex, because it is not easy to find useful KPIs that work cross-functionally and that are objective in their nature. Regarding the definition of a new product, I tried to use as much of the competence inside the company as possible, in order to find a definition that works for Atlas Copco. Regardless of how clear the guidelines are, there will always be some subjectivity in making the choice what a new product is, and what a new product is not. The Product Vitality Index (PVI) relies to some extent on the competence of the organization, and it is strongly advised that the subjectivity is reduced by providing clear and hands-on examples for situations that are likely to occur at the divisions throughout the organization.

To design a good measuring system is a continuous process, and the KPIs proposed in this thesis can be seen as a step in a longer process that already runs in the Atlas Copco organization. It is therefore important that the proposed KPIs are tested and evaluated by Atlas Copco, in order to improve them. Appropriate changes should be implemented in order to enhance the KPIs, and to make them more reliable. My hopes and wishes is nonetheless that the KPIs, as they are proposed in this thesis, are valid and reliable enough to be used in order to give a relevant picture of the vitality of the product portfolio at every level of the company where they are put into use.

In order to evaluate the strategic innovation of Atlas Copco, the monitored product portfolio must be compared to something. In order to find a good balance of the product portfolio, the company is advised to benchmark competitors, study the drivers and preferences of their customers, and to have an open and cross-functional dialogue between all functions involved in the innovation process. Regardless of the methods that Atlas Copco chooses in determining a good balance, it is important that the goal balance of the KPIs should reflect the strategic goals that Atlas Copco has regarding innovation. The KPIs are simply a framework used in order to steer the company towards these strategic goals. If the strategy of the company changes, it is essential that the framework is updated in order to cope with the change.

Finally, I want to make it clear that this thesis focuses on KPIs measuring outputs and inputs. The thesis excludes KPIs that measures process performance, and concepts such as time to market have not been studied. It is important to highlight that a successful strategic innovation relies on all three of these. This became apparent in the empirical study in particular, where some of the interviewees pointed out that a more efficient innovation process that results in the capability to put the right products on the market in a timely fashion might be the most important aspect of strategic innovation. A company may allocate resources effectively to base development, new product development, and product care, but without having an efficient and effective innovation process, the desired outputs measured and evaluated by any KPI will be nothing else but desires.

7.3 Critical reflections

In order to secure the quality of the study a critical evaluation was performed regarding the reliability, validity and generalizability of the study. The results of the evaluation of these three areas are described below.

7.3.1 Reliability

The data used to in the solution of this study were provided either directly from Atlas Copco's databases, or from employees within the organization. The data that was taken from databases is considered to have a high reliability, since this data is used in public publications, such as annual reports. The data provided by employees may be less reliable, since it is more subjective, due to the fact that it comes from one or a few persons. I have tried to verify this type of information with other persons in the organization to the highest degree possible.

Another critique is that the empirical data collected from a more extensive area could have provided more insights. The thesis was conducted on a group level and includes Atlas Copco's three business areas, with a total number of 19 divisions. Many divisions might be affected by the outcome of the project, but due to time constraints and the travel arrangement, the focus in the in-depth study, described in Section 2.3, was primarily put on the main divisions of each business area. By being able to extend the site visiting tour to include all divisions, the reliability of the study would likely have increased.

7.3.2 Validity

The interviews have been semi-structured or unstructured. I think that this has been a successful approach, because the same topics were discussed in each interview, but the focus of the interview was steered in a direction that was most giving at the moment. In this way, I was able to compare the answers between divisions afterwards, as well as address specific problems that the person has a lot of knowledge about, and interest in. This ought to have strengthened the validity of the study.

The choice of places to visit during the in-depth study, and the selection of interviewees, were performed in such a way that they are representative for the business area in question. Before the interviews, I tried to be as prepared as possible by digesting the information available about the divisions and the interviewees. According to Bryman (2002), getting accustomed to the environment of the interviewees beforehand strengthens the validity of the interview. During the interviews, I tried to react only on responses worth exploring additionally with follow-up questions. The questions were asked with simple and clear sentences in order to avoid being too directional. In the case that the information was too extensive, deep, or complicated to understand initially, I asked for the permission to do a shorter follow-up interview at a later point in time. This ought to have strengthened the validity of the study. The fact that the interviews conducted were not recorded and transcribed may have impacted the validity of the study in a negative way.

7.3.3 Generalizability

The proposed Key Performance Indicators (KPIs) are developed to fit the Atlas Copco organization, and to measure and evaluate innovation effectiveness there. Since cross-functionality between different business units was a prerequisite of the KPIs, both the Product Vitality Index (PVI) and the BNP have been structured with the aim to be as objective as possible. It might therefore be possible to implement and use the proposed KPIs at other industrial companies, but in order to do so efficiently, the definitions underlying the KPIs must be modified to reflect the overall strategic goals regarding innovation of the new company.

7.4 Implementation

When designing the Product Vitality Index (PVI) and the BNP, and when constructing the definitions and reporting structures, one important issue was to make sure that the Key Performance Indicators (KPIs) are possible to implement with a reasonable amount of effort. After all, a perfect KPI in a theoretical sense of speaking will remain flawless only in theory, if it does not work in practice. With that said, the initial implementation of the proposed KPIs should be seen as a first step in a longer process that makes the KPIs a part of the organization, and that makes them run smoothly. Below are some recommendations for the implementation of the KPIs:

- Include only equipment at a first stage
- Change the definition of a new product and the birth date of a product
- Provide clear hands-on examples regarding the distinction of new development projects and product care projects
- Change the financial reporting structure in order to separate base development costs, new product development costs, and product care costs
- Involve and engage the divisional managers, and make them recognize the value that the KPIs can have for the divisions
- Involve cross-functional management teams when deciding upon the goal balances, so that the targets are agreed-upon by all functions

7.4.1 The Way We Do Things

Atlas Copco has a database called *"The Way We Do Things"*, that collects group-wide strategies, group standards and shared best practices within all different functions. The information is stored electronically and is available to all employees. Wherever they are located, Atlas Copco employees are expected to operate in accordance with the principles and guidelines provided. A suitable way to facilitate the implementation of the PVI and the BNP is to put up the practices, definitions, and examples concerning the PVI and the BNP, and such changes that the implementation of these two KPIs will imply, in *"The Way We Do Things"*.

7.5 Future research

Firstly, I invite future researchers to carry out a study of Key Performance Indicators (KPIs) in a similar cross-functional context, which focuses on process performance. This is because it is valuable for many companies to structure generic KPIs that work cross-functionally across different business units and industries. By adding this third dimension of measuring innovation to the two dimensions studied in this thesis, such studies may lead to new interesting findings and insights regarding measurement and evaluation of strategic innovation. It would for me personally be intriguing to complement this study with a study that focuses on process performance KPIs that should be used cross-functionally across the divisions at Atlas Copco.

There could be a higher consensus between the academic world and the corporate world regarding definitions such as innovation, and a new product. Studies that bridge the gap between these two worlds, in these types of issue, are most welcomed. Finally, I think that a study that manages to break down the innovation success of a company to hands-on activities, regardless of what these activities may be, will reach a breakthrough in the field of strategic innovation.

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Berggren, Per. Vice President Product Development, Dynapac Division. Telephone interview. Nacka, January 19, 2010.

Bergqvist, Josephine. Business Controller, CT Business Area. Personal interview. Antwerp, Belgium, February 9, 2010.

Beyts, Dirk. Vice President Technical Support and Engineering, Compressor Technique Services Division. Personal interview. Antwerp, Belgium, February 9, 2010.

Blomkvist, Pär. University Teacher, Industrial Dynamics, KTH. Telephone interview. Nacka, February 22, 2010.

Bogaerts, Bob. Product Company Controller, Portable Air Division. Personal interview. Antwerp, Belgium, February 11, 2010.

Chen, Min. Marketing Intelligence Systems and Pricing, Oil-free Air Division. Personal interview. Antwerp, Belgium, February 9, 2010.

Coosemans, Ludwig. Business Area Project Manager, CT Business Area. Personal interview. Antwerp, Belgium, February 8, 2010.

De Beul, Luc. Vice President Engineering, Oil-free Air Division. Telephone interview. Nacka, January 22, 2010. Personal interview. Antwerp, Belgium, February 9, 2010.

Duthu, Liselotte. Vice President Business Control, CT Business Area. Personal interview. Antwerp, Belgium, February 10, 2010.

Fairest, Sean. Vice President Marketing, Compressor Technique Services Division. Personal interview. Antwerp, Belgium, February 9, 2010.

Forstorp, Johan. Product Company Controller, Surface Drilling Equipment Division. Personal interview. Örebro, February 26, 2010.

Gant, Craig. Vice President Division Controller, Specialty Rental Division. Personal interview. Antwerp, Belgium, February 8, 2010.

Hartwig, Sverker. Vice President Research & Development, CMT Business Area. Personal interview. Nacka, January 18, 2010 and January 29, 2010.

Hedqvist, Anders. Design & Development Manager, Surface Drilling Equipment Division. Personal interview. Örebro, February 25, 2010.

Hermansson, Karin. Group Business Controller, IT Business Area. Personal interview. Nacka, January 19, 2010.

Holmin, Mats. Research & Development Manager, Pneumatic Tools. Personal interview. Nacka, February 2, 2010.

Johansson, Bo-Göran. Vice President Marketing, Surface Drilling Equipment Division. Personal interview. Örebro, February 25, 2010.

Johnsson, Jon. Corporate Controller, Group Controlling & Accounting. Personal interview. Nacka, February 3, 2010.

Klarin, Kaj. Director, VINNOVA. Email interview. Nacka, February 23, 2010.

Koyen, Gunter. General Manager, Power Tools Distribution. Personal interview. Hoeselt, Belgium, February 11, 2010.

Laps, Guy. Vice President Engineering, Portable Air Division. Personal interview. Antwerp, Belgium, February 11, 2010.

Lennfalk, Sofia. Group Business Controller, CMT Business Area. Personal interview. Nacka, January 28, 2010.

Lindgren, Ulf, Dean and Executive Director, Lorange Institute of Business, Zurich. Email interview. Nacka, February 18, 2010.

Malan, Kobus. Vice President, Rocktec Division. Personal interview. Örebro, February 25, 2010.

Malmborg, Per. Logistics, Atlas Copco Tools and Assembly Systems. Personal interview. Nacka, January 29, 2010.

Meyer, Hans Ola. CFO, Atlas Copco. Email interview. Nacka, January 27, 2010.

Moens, Erik. Vice President, Product Engineering Airtec Division. Personal interview. Antwerp, Belgium, February 10, 2010.

Nilsson, Ulf M. Vice President, Design & Development Underground Rock Excavation Division. Telephone interview. Nacka, January 22, 2010. Personal interview. Örebro, February 26, 2010.

Nordin, Staffan. Vice President Marketing, Underground Rock Excavation Division. Personal interview. Örebro, February 25, 2010.

Pehrsson, Anders. Vice President Group Controller, Atlas Copco. Personal interview. Nacka, January 29, 2010.

Persson, Lars. Research & Development Manager, Rocktec Division. Telephone interview. Nacka, January 21, 2010. Personal interview. Örebro, February 25, 2010.

Pettersson, Kjell. Vice President Business Control, CMT Business Area. Personal interview. Nacka, February 18, 2010.

Rakotoarivelo, Stéphane. Vice President Research & Development, Atlas Copco Tools. Personal interview. Nacka, February 17, 2010.

Roettger, Eckart. Vice President Marketing, Industrial Air Division. Personal Interview. Antwerp, Belgium, February 9, 2010.

Simonsson, Knut. Director Brand and Marketing, Saab Automobile AB. Telephone interview. Nacka, March 9, 2010.

Thijs, Whim. Product Manager, Portable Air Division. Personal interview. Antwerp, Belgium, February 10, 2010.

Van Elshocht, Raf. Product Company Controller, Oil-free Air Division. Personal interview. Antwerp, Belgium, February 9, 2010.

Vandaele, Stijn. Coach Logistics, Industrial Air Division. Personal interview. Antwerp, Belgium, February 12, 2010.

Vandevoorde, Manuel. Vice President Engineering, Industrial Air Division. Personal interview. Antwerp, Belgium, February 9, 2010.

Vandingenen, Kurt. Vice President, Industrial Air. Personal interview. Antwerp, Belgium, February 10, 2010.

Vertriest, Stefaan. Vice President Logistics, CT Business Area. Personal interview. Antwerp, Belgium, February 12, 2010.

Waes, Sam. Divisional Communications Manager, Portable Air Division. Personal interview. Antwerp, Belgium, February 11, 2010.

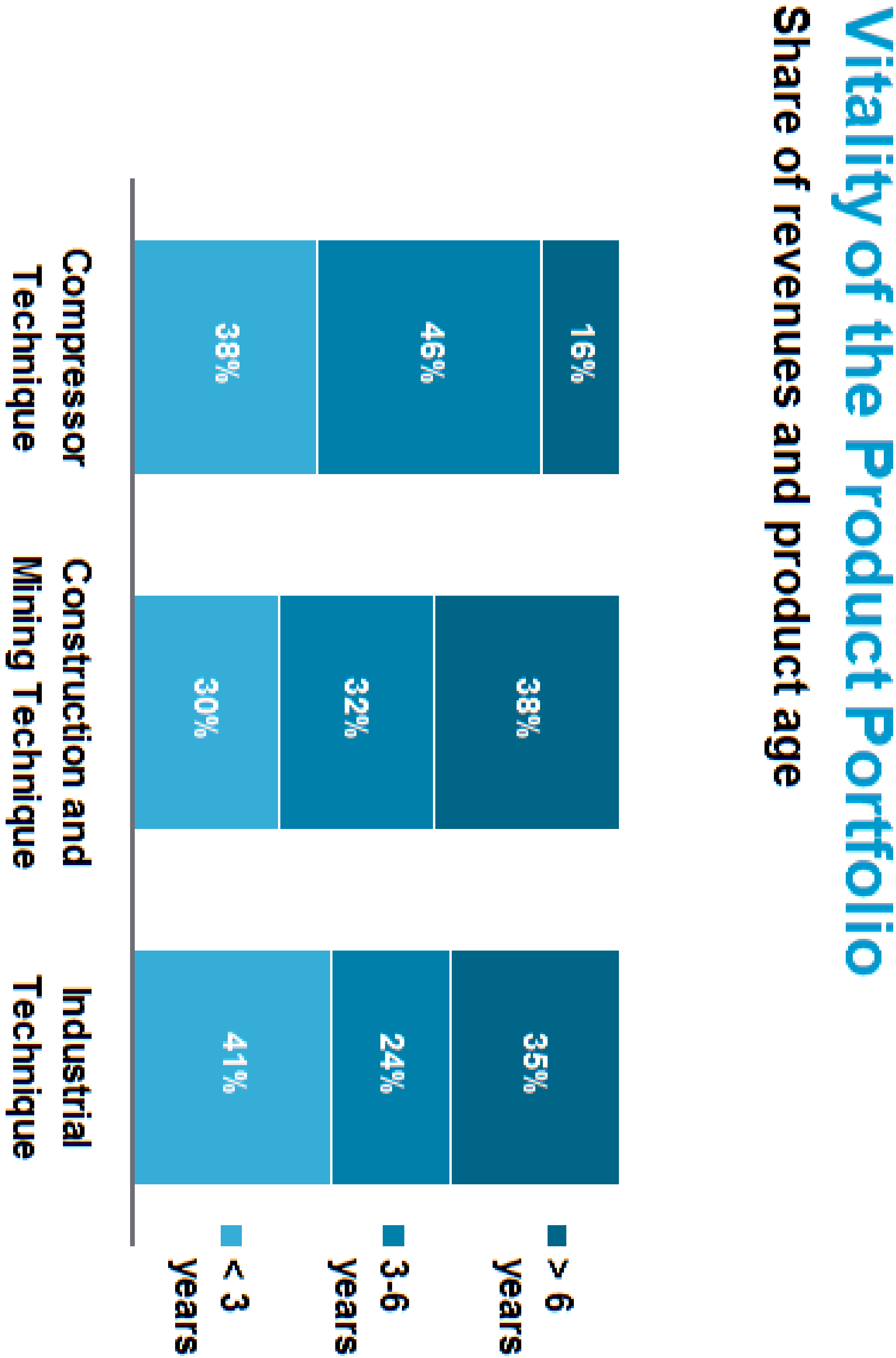
Wedar, Anna. Vice President Finance & Administration, Atlas Copco Tools. Personal interview. Nacka, February 5, 2010.

Åstrand, Manfred. Technical Manager, Craelius Division. Telephone interview. Nacka, January 22, 2010.

Öberg, Fredrik. Market Support Manager, Rocktec Division. Personal interview. Örebro, February 25, 2010.

Appendix A – Atlas Copco brands

Appendix B – The Product Vitality Index



Appendix C – Product ageing overview in SalMon