AN APPLICATION PORTFOLIO MANAGEMENT METHOD – FOR IMPLEMENTATION AT SCANIA CV AB
DESIGN AND VALIDATION WITH FOCUS ON TECHNICAL QUALITY ASPECTS

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**Abstract.** Information Technology (IT) has become a vital tool for most industrial businesses and Scania CV AB is no exception. As the importance of IT generally has increased, the usage and number of applications has grown as well. Applications are substantial assets for an organization that is heavily supported by IT. Consequently, a way of managing applications efficiently and sustaining the costs of applications rather low – doing more with less – is required. In addition it is also important, from a business perspective, that applications as part of IT are aligned with business strategies and goals.

Application Portfolio Management (APM) is a practice and a business-centric activity aimed to allocate IT resources to support business objectives and strategies; it helps determining the impact of applications and the relative importance of each application in the portfolio to the business. APM attempts to justify and measure the financial benefits of each application relative to the costs of the applications’ maintenance and operations.

Performing APM successfully is nevertheless a complicated issue, and something that many businesses are challenged with on a daily basis. New applications are constantly and regularly added, downloaded, purchased or self-developed – too often without any further control. In order to regain the control of the software that automates the business, and ensuring that the applications adds value and reliability to the company, Scania CV AB requires a rigorous and comprehensive method for an APM approach.

In this master thesis together with Camilla Palomeques’s thesis, such a method is provided. These two theses also offer a suggestion on how to proceed with the APM effort at Scania CV AB.

**Keywords.** Application, Application Portfolio Management, APM, Framework, Technical Quality, System Goals, Non-functional Requirements, Scania, R&D

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1 INTRODUCTION

The purpose of this chapter is to give an introduction to this master thesis by defining the problem area, the purpose of the thesis, its limitations and a presentation of the company where this thesis was conducted, Scania CV AB. Finally the thesis outline will be presented.

1.1 Background

Many companies today in the industrial and commercial sectors are highly dependent on their Information Technology (IT). IT investments therefore also constitute a large proportion of these organizations' annual budgets. Companies usually spend several percent of their total revenues on IT operations and most companies have several IT projects running simultaneously. At the same time, more and more companies want to do "more with less" and are therefore trying to develop new ways to use existing IT portfolios and keep pace with constant technological progress.

The organizational demands for a sound and healthy IT environment are constantly changing, not only in order to obtain advantages against competitors, but merely to survive in an increasingly competitive market. Knowing what you have and deciding what to do with it are questions that seem fairly straightforward to answer, nevertheless companies today struggle with those questions, and;

"If you can't measure IT, you can't manage IT".

- Modified from Andy Grove, Chairman Emeritus, Intel Corporation. (Sward, 2006)

The effect of a narrow and limited control of IT and the software that automates the business, e.g. applications and their related portfolio is that these have a natural tendency to grow, both in size and in number. As a result when an application portfolio is not managed effectively, duplicate functionality might enter the portfolio, as one of several consequences, which is not cost effective. Very often duplicate functionality is the result of a lack of information about available functionality within the current portfolio. (Vogelezang, 2002)

Application Portfolio Management (APM) is a practice that aims to synchronize business priorities and IT priorities, regain control over the usage of software, measuring the financial benefits of each application relative to costs, and also creating and sustaining a good inventory of available functionality in order to slow down the growth rate of the portfolio and even reverse it by actively removing unwanted duplicate functionality. APM helps to overcome the gap between business and IT by aligning IT investments and the use of IT according to business demands and needs, and is in short terms, a way for companies to answer what to measure and how, what to include in the portfolio and how to optimize the use of applications in the business so that the portfolio creates value to the company and its customers, internally as well as externally. (Vogelezang, 2002)

In this master thesis you will find key principles for successfully managing an application portfolio in addition to a framework which supports decision-makers in making better informed decisions for how to deal with their application portfolio today and in the future.

1.2 Scope and Delimitation

The main objective of this thesis is to create an Application Portfolio Management (APM) method for the evaluation of applications at Scania CV AB.

In order to determine the plausibility of the method an APM concept will be developed and tested on existing applications at Scania R&D and then revised and harmonized to reality if needed. This thesis will present how the concept considers technical quality aspects in APM and the test will focus on the technical quality evaluation. In Camilla Palomeque’s (2010) thesis the business value attributes of applications will be highlighted as a complement to the technical quality aspects.
An assumption made for this investigation is that the information required to evaluate applications should be possible to collect in the future, not only at present. Therefore this thesis could also serve as a suggestion on what information Scania will require in the future. The established method will be based upon theories on APM and software maintenance, but it will also consider requirements from R&D as well as other departments at Scania that manages IT as well. The reason for including other departments at Scania is due to the necessity to maintain a general approach on APM and by that consider demands and needs aside from only Scania R&D when developing the method. This will also be done in order to avoid sub optimization that could occur as various stakeholders would handle the information in the portfolio for the management method differently. The objective can be broken down into the following research questions:

In order to create an APM method,

- Which factors are important to consider when evaluating application portfolios in general and which of these are also important and suitable for Scania, based on their requirements and needs?
- How can these factors be examined in an APM method at Scania?

With the purpose of answering these questions an APM concept will be developed and then established as a method in the final chapter of this thesis. The following research questions will be asked when testing the plausibility of the concept by using applications at Scania R&D:

- Which applications at Scania are appropriate to be included in the R&D application portfolio?
- Is the APM concept feasible?
- Which factors are used to assess the application portfolio at Scania R&D?
- Are these factors (theoretical as well as empirical) appropriate and suitable for Scania R&D?

1.3 Scania CV AB

Scania CV AB is global manufacturer of trucks, buses, as well as industrial and marine engines. A great proportion of the company's operations also consist of products and services in the financial and service sectors, which in turn assures Scania's customers cost-effective transport solutions and maximum uptime. Scania develops, manufactures and sells trucks with a gross vehicle weight of more than 16 tons intended for long distance, construction and distribution haulage as well as public services. Buses and coaches are focused on high passenger capacity for use as tourist coaches and in scheduled intercity and urban traffic service. Bus and coach operations focus on delivering fully built vehicles based on Scania components to customers through its own bodybuilding operations and through collaboration with selected manufacturers of bus and coach bodies. Industrial and marine engines are used in electric generator sets, construction and agricultural machinery as well as in ships and pleasure boats. Scania's service-related products support transport and logistics companies in their business operations. These products encompass everything from parts, maintenance agreements and round-the-clock workshop services on various continents to driver training and IT support for transport planning. Financial services are also an important part of Scania's business. Customers are offered cost-effective comprehensive solutions, and are able to choose between loan financing, various forms of leases and insurance solutions.

Scania operates in approximately 100 countries and has more than 32000 employees. 15000 of these employees work in sales and services, approximately 10000 in production, 2600 in research and development and 5000 in administration and other activities. The head office and technical centre are located in Södertälje, Sweden. The corporate purchasing department, based in Södertälje is supplemented by local procurement offices in Poland, the Czech Republic, the United States, China and Russia. Production units are situated in Europe and Latin America.

Scania is divided into five main business areas: Finance & Business Control, Research & Development, Production & Logistics, Franchise & Factory Sales and Sales & Service Management. Every business area is supplied by its own IT Area that provides IT support services specifically for Scania.
14 R&D

This thesis has been performed at the Product Data Management and Strategic Initiatives department, UTIP, which is based in the Research & Development (R&D) and more accurately the UT area.

R&D focuses mainly on the development of heavy vehicles, services and efficient and cross-functional ways of working. The main objective for R&D is to provide a product portfolio determined by both customer needs and technological advances. The development process is therefore heavily influenced by modularisation of components and standardisation of interfaces which assures the high customisation of the product offering.

UTIP, a unit within UT is in charge of supporting the development process with proactive, strategic and operative support, by handling methods and tools to co-operate internally and externally for exchange of product data and technical product related documents. The main tasks consist of maintaining, coordinating and improving existing applications and methods for creating, approving, archiving, exchange and collaboration with products technical documentation. The UTIP-scope also includes working with the alignment between business and IT, a field or method known as Enterprise Architecture.
**Enterprise Architecture**

Enterprise Architecture (EA) is expressed as a set of principles, rules, standards and guidelines which reflect the business needs of an enterprise. EA describes current or future activities from different perspectives (processes, information systems, skills) in order to manage business development in the company's overall goals and aspirations. (Scania, 2010)

"...it is about understanding all of the different elements that go to make up the enterprise and how those elements interrelate"  
(Shenkerman, 2006)

A key purpose of EA is to ensure that IT-investments are in line with company policies, strategy alignment, and capture certain characteristics about applications, data, and infrastructure that make up the IT systems (ITIL, 2002), but it is also about handling the complexity that occurs within these systems when change is present and understanding the business from a holistic enterprise wide perspective to efficiently perform EA (Scania R&D, 2010).

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**Figure 2**: Scania R&D’s view on EA

The EA Program at Scania R&D has the mission to describe the architecture at R&D derived by the future need of R&D’s business. The architecture is used to direct IT projects towards a decided target state. This is a way for R&D to secure a trouble free IT environment and facilitate solutions for continuous improvements.EA is built on three cornerstones: Manage complexity and change, strategy alignment, and holistic enterprise wide perspective. Information, applications and processes are vital assets for EA, and it constitutes the tools needed for each step in the EA-figure above. (Scania R&D)

- **Strategy Alignment**: IT needs to be efficiently deployed to support the business objectives in order to maintain a well functioning company. An important task of an EA program is therefore to link business strategies that govern IT Coordination to Scania Business and thus achieve strategy alignment.

- **Holistic Enterprise Wide Perspective**: Different stakeholders have different needs, and businesses must therefore be described from different aspects, for instance strategies, processes, roles, resources, functions, applications, methods and information. (Scania R&D)

- **Manage Complexity and Change**: To effectively describe the current and target state of a large-scale enterprise like Scania requires the use and support of modeling techniques and standardized ways of modeling. Roadmaps facilitate this work by describing the process from current to target state architecture and aligning them with the business strategy.
There may be several reasons why a company chooses to face the challenge and start a successful EA program – the concern might be to increase operational efficiency, corporate agility, or business competitiveness. Moreover, a successful EA-program may increase the efficiency in the use of IT through the appliance of Application Portfolio Management, which is derived from IT Portfolio Management – a management tool that builds and shapes IT plans.

**IT Portfolio Management and Application Portfolio Management**

IT Portfolio Management is a tool that provides a comprehensive approach and methodology on how to balance and align IT and business, it identifies and realizes the business value potential, and thus maximizes superior value and return on IT investments while mitigating risk. IT Portfolio management also enables companies to create and maintain a sharp focus while having visibility and control of their investments across their organizations. (Handler & Maizlish, 2005) An important toolset for IT Portfolio Management is Portfolio Control, a portfolio is typically defined as a combination of assets that are expected to provide a certain return at an expected level of risk (or uncertainty) related to achieving that return. In the IT perspective, a “portfolio” could be seen as a portfolio containing applications or infrastructure (platforms/ servers, operating systems, networks, tools, etc.), IT projects or even a set of resources, skills and relationships (e.g. a set of vendor partnerships). All together, these IT asset portfolios are the “building blocks” that are used to deliver competitive advantage to the business by providing various services and capabilities. (Bondugula et al, 2005) Within the IT domain two categories of Portfolio Control can be distinguished, namely Project Portfolio Control and Application Portfolio Control. Both project and application portfolio approaches are similar to the one of a financial portfolio; they aim to find the best strategic combination of portfolio items and optimize their use (ITIL, 2002). Project Portfolio Control supports management decisions about changes to be made in the current portfolio and is in most cases controlled by the financial management (Vogelezang, 2008), it focuses on project characteristics and serves to catalogue, quantify, and manage projects efforts (Walker, 2007).

Application Portfolio Control on the other hand, supports and justifies active management of the coherent set of applications (Vogelezang, 2008), and focuses on application architectures. An application portfolio could be seen as an information system that contains key attributes about applications being utilised within the company, and thus includes applications of different kinds; in-sourced, outsourced, business and infrastructure applications, that is, all applications that are considered to be a corporate asset and a necessity in the daily operations should be included in the application portfolio. (ITIL, 2002) Application Portfolio Control is also known as **Application Portfolio Management** (APM). APM is a business-centric activity aimed to allocate IT resources to support business objectives and strategies. APM is also conducted in order to decide the future of applications by quantifying the condition of applications in terms of stability, quality, and maintainability, determining the impact of applications and the relative importance of each application to the business and finally allocate resources according to the applications’ condition and importance in the context of business priorities. (E.g. Vogelezang, 2008; Scania R&D, 2010)

Generally APM is also vital to aid strategic planning efforts and diffuse business and IT conflicts. When the management understands how applications supports their key business functions and the consequences of disruption and poor quality are identified, then it will also be possible to efficiently spend resources to support corporate priorities. (E.g. Walker, 2007)
1.5 Outline

This thesis, whose purpose is to create an APM method at Scania, is divided into seven chapters as illustrated in the Figure:

**Problem definition and scope**
- Thesis delimitation
- Research questions
- Requirements

**Concept development**
- APM method for optimization of applications
- Application portfolio

**Concept validation**
- Feedback on concept
- Data for analysis
- Updated portfolio sheet

**Method establishment**
- APM method for optimization of applications
- Application portfolio

**Chapter 1 – Introduction**

**Chapter 2 – Research method**

**Chapter 3 – Theoretical framework**

**Chapter 4 – Scania APM Concept**

**Chapter 5 – Case study: Scania APM Concept**

**Chapter 6 – Analysis**

**Chapter 7 – Establishment of Scania APM method**

*Figure 3: Thesis outline*

This first chapter gave a brief introduction to the topic and presented the purpose of the thesis and its limitations. The following chapter will describe the methodological approach in the report and the documentation outline. The third chapter provides the study a theoretical framework based on APM theories in order to address the objective. The fourth chapter presents a proposed APM concept based on the theoretical framework, but moreover Scania needs and requirements. In the fifth chapter the APM concept is tested in a case study at Scania R&D. The sixth chapter analyzes the results given from the case study in order to draw general conclusions and present a final APM method in the seventh chapter and final part of this master thesis, the purpose, improvements and changes, and also how the study can be used are answered and presented.
2 RESEARCH METHOD

In order to create an Application Portfolio Management (APM) method that will analyze and evaluate applications at Scania, an investigation has been performed at the R&D department at Scania. This chapter describes the methodological approach and methods used to collect required information in order to answer the purpose of this thesis. Initially the choice of topic is introduced to help the reader understand the scope in this report followed by the scientific approach adopted in this thesis. The final part discusses the objectivity, validity and reliability of the method used.

2.1 Scope and Methodological Approaches

The purpose of this study has been developed in consultation with the R&D department at Scania in Södertälje. The concern from R&D has been to get an external evaluation of the management of applications, and handling of the application portfolio at R&D in order to improve and optimize the maintenance of applications and portfolio overall. The evaluation was also requested as a way of highlighting other aspects of APM that R&D otherwise might not consider but that might be of interest and helpful when performing APM. This evaluation would then result in a more effective APM method, designed for Scania.

The process of creating a Scania-adapted APM method was divided in several steps, each of them containing different scientific approaches and each of them also generating different kinds of information which was then documented and finally summarized in this report. The development process of the method and documentation process is illustrated below:

![Diagram of method development process]

**Figure 4:** Creating the method and documenting the development process
The first step, “Problem definition and scope,” implicated information gathering and knowledge acquisition in the APM-field. Consequently, in addition to extensive literature studies also exploratory interviews were carried out to highlight the problem-area from several directions. The exploratory method is applied when the knowledge of the study-area is considered to be insufficient and the method is thereby used to collect and obtain adequate knowledge needed to study the problem and then highlight the problem area comprehensively. This can be done by conducting several exploratory meetings or interviews (e.g. workshops) where the problem area is discussed from different points of view and the information obtained is used to clarify objectives, needs and scope. (Wallén, 1996)

17 meetings (similarly to interviews) were held in an initial stage with personnel from the UTIP department and additional members of Scania R&D as well as representatives from other departments at Scania in order to clarify the present situation, problems, requirements and to discuss the challenges faced when managing applications. The explorative investigation also resulted in a list of applications, a number of their characteristics; their purpose, costs and responsibilities for the applications, and was then implemented in the created application portfolio, specifically developed for this thesis. The main deliveries from this step was the thesis delimitation, research questions and requirements given from the explorative interviews, workshops and discussions, and also the introduction to this vast area given from the literature study.

In the following step, “Concept design,” the knowledge gathered from the literature study and the problem definition and scope was used in order to design the APM concept. For the design of the concept a qualitative method was used in order to determine what the APM concept should contain – needs and requirements from Scania R&D, and clarifying how this content should be investigated and how it would be presented in the portfolio. Qualitative methods aim to seek knowledge of different relations and concepts by encompassing not only issues involving the written text, but everything in the interpretative process. (Kvale & Brinkman, 2009) A qualitative method helps clarifying a phenomenon’s characteristics or qualities but it can also elucidate an already known phenomenon and bring new and unexpected answers to the surface. Qualitative methods are consequently applied to find the categories, descriptions, or models that best describe a phenomenon or context of the wider world. (Strauss & Corbin, 1990)

The phenomenon in this thesis was the APM concept itself. What was needed for the concept development was information on what Scania expected and required the concept to contain and how this information would be used for different purposes. The concept was therefore modeled and verified during several workshops and meetings with representatives from the R&D department at Scania. All in all the total number of meetings were 37, including the meeting frequency from the previous stage; problem definition and scope. The final result from this step was an APM concept and surveys containing questions which identified key attributes to be implemented in the portfolio, used when performing APM, given from the workshops and discussions. These results also implied that the application portfolio was updated with new information. The surveys as well as the concept were then to be tested in a case study in the next step.

The third step, “Test of APM concept,” was constituted of a quantitative information gathering from a case study which was performed at Scania R&D. A quantitative method is applied when focus is on retrieving a good reflection on general, average or representative facts that are needed to answer the purpose/s of the study. In addition, quantitative methods can help to verify a qualitative study, something that was also done for this thesis. Quantitative methods are used by researchers to systematically collect empirical and quantifiable data and summarize these into statistical form, which normally answers questions of character how much, how many and how often. A quantitative approach is simplified by the use of surveys, since it is considered to be an efficient technique of collecting a lot of information, and by that, save time and allow a large number of respondents to participate (Wallén, 1996)

The test of the concept focused mainly on the different surveys that were sent out to representatives at Scania R&D. The surveys contained questions based on the chosen attributes to be investigated about applications characteristics, which are used when performing APM. The responses from all participants in the investigation were then gathered and compiled in excel-files and later on implemented into the application portfolio. In excess of the answers given in the surveys, the test of the concept also generated feedback on the questions asked which helped answering if the questions asked in the surveys and directly to involved participants would support the application assessment as wanted and expected.
The final step, **concept establishment**, began with a review of the data collected from the case study, with the purpose of validating the developed concept in the third step. The following guidelines and questions were used to analyze the APM concept:

- Were selected metrics right for Scania R&D given the responses from the surveys and feedback?
- Were the questions asked appropriate and understandable?
- Would there be a necessity for improvement? If so, what would be improved, redefined or maybe even added to the concept?

When these questions had been answered final adjustments were made and the final APM method was then established.

### 2.2 Data collection

The data collected for this report is constituted of primary and secondary data. Primary data equals the material gathered for defining the purpose, e.g. several interviews, participant observations and workshops, i.e. empirical data. The secondary data consist of documents and materials, mainly focusing on APM and application assessment theories, i.e. theoretical data. (Wallén, 1996)

#### Empirical Data

The empirical information used to create a suitable APM method for Scania is given in both the **concept development** stage and the **test of the APM concept**. For the development of the concept the empirical data is based on workshops and discussions with personnel at Scania R&D but also representatives from other departments at Scania. The reason for interviewing and involving personnel from other departments at Scania, e.g. Scania InfoMate, was due to the obvious interest in the method establishment from their part, but also the EA and APM field and the finding of a generic management method that would suit Scania overall and the maintenance of applications. The involvement of personnel outside R&D was also due to the consideration that these persons would contribute with valuable information on APM, which they also did. Discussions with supervisors and personnel at Scania R&D have not only enriched the case study where necessary but also the final establishment of the method. The diversity of interview objects has also highlighted other perspectives on the matter and is therefore considered to strengthen the objectivity and validity of the results of this report.

#### Theoretical Data

The initial work was dedicated to define and clarify the scope of this thesis in **problem definition and scope**. Therefore the scope definition also required intensive literature studies which then resulted in theoretical data focusing on theories of application management and EA to maintain a deeper understanding for the problem area, a condition for the **concept development** to be initiated and actuated. The theoretical framework is mainly constituted of methods and models and their definitions on their input variables in order to describe how the management of application portfolios is performed scientifically. Frameworks as The Open Group Architectural Framework (TOGAF) and IT Infrastructure Library (ITIL) have been utilized in this thesis as complementary disciplines and given comprehensible definitions in models and structures (for instance in 3.1 Definitions).

The main approach for the theoretical data has been done in accordance with Scania R&D’s indications of which scientific frameworks and best practices that may serve as a proper basis for this thesis, including models, well established IT standards, e.g. ISO/IEC and also standards developed within Scania. Secondary data is also largely influenced by previous works in this area, e.g. EA, IT Portfolio Management and naturally also APM frameworks by authors such as Johnson & Ekstedt (2007), Sommerville (2007), Ward & Peppard (2002), Vogelezang (2008), and Kogekar (2009).
2.3 Objectivity, validity and reliability

Whenever creating a report including one or several scientific approaches and techniques, the objectivity, validity and reliability of the methods used and the results generated from these have to be debated, that is, the quality of the report has to be disputed. This part aims to discuss these terms focusing on the methods used. The validity and reliability of the APM concept to be an established APM method, in more detail is however discussed in 6. ANALYSIS.

Given clearly identified guidelines from the beginning of the investigation these have undoubtedly also affected the outcome of this report and thus affected the objectivity. However, since it is a request from Scania to adapt a management method based on their specific needs and concerns, this has not been considered to be a problem nor affected the investigation negatively. Furthermore, when evaluating the validity and reliability of the thesis it is important to distinguish what is meant with each concept.

The validity is the measuring instruments' ability to measure what it claimed to measure, referring to how well the investigation has been conducted in order to answer the purpose of the study. (Lundequist, 1995) In this case, the purpose has been to create an APM method in accordance with Scania preferences and requirements and these have therefore also affected the development of theoretical framework and the design of the APM concept which was then to be established as a Scania method. Several methodological research approaches have been applied in order to fulfill the purpose of this thesis; an explorative method consisting of workshops and discussions (meetings), a quantitative method used to develop the concept and then establishing the APM method, and a quantitative approach in the case study using surveys as a means of collecting extensive empirical data and to test the concept.

The explorative approach can deduce problems of detecting more complex and perhaps unknown connections at the beginning of the investigation, which is the reason why this approach was conducted initially. But a problem with exploratory studies is the external validity, i.e. the result's generalization ability outside the study environment. These limitations that apply to exploratory studies have nevertheless been recognized but there is no intention to generalize the study's findings outside the environment to which the investigation is made in, and consequently the validity, regarding explorative results, have not affected the study negatively. The same problem of generalization concerns the qualitative method used in this report. Since qualitative studies produce information on a particular phenomenon no general conclusions can be drawn, only hypotheses (informative guesses). However, quantitative methods can help verifying which of such hypotheses are true.

A general problem with a quantitative approach, and moreover with surveys is that the questions used to analyze a specific phenomenon can be manipulated (Wallén, 1996), that is, that the content of the survey-questions, from a scientific point of view, might have been addressed in order to maintain "desired" answers rather than investigating other points of view that would have given answers that reflect and generate more accurate information on the current situation.

Reliability i.e. trustworthiness, measures how credible the results of a study are with respect to possible effects on the outcome by the interviewer or respondent. Reliability is considered high when the test produces the same results repeatedly or low if e.g. questions in a survey are formulated in an incomprehensible way, or if respondents have a lack of knowledge in the matter. Respondents can also misinterpret questions asked or try to formulate answers depending on what he or she believes the interviewer wants to hear. The intimacy created between interviewers and respondents can also affect responses, creating problems for validity and reliability. (Holme & Solvang, 1997) Interview objects might have tried to answer "correctly" according to their apprehension on what the interviewers expected, both in surveys and personal interviews. The most obvious problems in these cases are that interviewers have partially failed to create a trustworthy atmosphere, in which interview objects on their own initiative talk openly, or they have been unclear about what is wanted and therefore questions have been misinterpreted. (Wallén, 1996)

The following chapters will deal with the development of the Scania APM concept, the verifying of the concept and finally the establishment of the final method.
THEORETICAL FRAMEWORK

This chapter covers the study's theoretical framework which will be used in order to create an application management method at Scania assuming the following question:

- Which factors are important to consider when evaluating application portfolios in general?

The study is consequently based on Application Portfolio Management (APM) theories, which identifies critical factors and approaches needed for creating a suitable management method for Scania.

In this report vital words related to EA, APM and the concept of software maintenance are defined either based on TOGAF, ITIL, complementary theory from adequate literature, or from the glossary utilized within Scania. The need for clarifying the meanings of certain words in this thesis is crucial since the content of this paper has to be understandable among APM practitioners, as well as other stakeholders within Scania. In order for the reader to be able to understand and elucidate the interrelations between both different concepts as well as different chapters clear definitions also have to exist.

3.1 Definitions

The definitions presented are, as stated, based on well-established standards in accordance with TOGAF, which embraces ISO / IEC 42010:2007, and ITIL principles as well as standards employed by Scania R&D.

TOGAF is an EA framework that provides a comprehensive approach to the design, planning, implementation and governance of an enterprise information framework. This framework provides an agreed baseline for strategic planning and tactical decision making. TOGAF's EA methods focus on optimizing the use of people, processes and technology to meet common business objectives. The integration of the two provides an encompassing framework for delivery of IT services. TOGAF provides the structured framework for strategy and design of the organization and the roles, processes and tools required for service delivery.

ITIL is an integrated set of best practices that defines how service management is applied within an organization. Being a framework, it is completely customizable for APM within any organization that has a reliance on IT infrastructure. ITIL service management practices focus on governing, standardizing and simplifying the delivery of IT services to the business. (Carter, 2009)

System & IS/IT System

The system definition is based on the conventional definitions used within Scania R&D, which in turn are based on both the IEEE definition and the U.S. government treasury's EA framework's (TEAF) definition. According to IEEE a system is a collection of components organized to accomplish a specific function or set of functions (2010). Hence, a system may describe the organization; its employees, the services provided by the organization, its units etc, or describe an application and its relation to other components; platforms, databases etc.

IEEE's system definition describes an information system (IS) defined as a system where “people and organizations, using technology, gather, process, store, use and disseminate information” (The UK Academy of Information Systems, UKAIS, 1999), or similarly any combination of IT and people's activities using that technology to support operations, management, and decision-making” (Ellison & Moore, 2003).

IS and IT systems are often used interchangeably although there is a distinction between the terms. IS applies technology, while IT refers specifically to the technology used; essentially hardware, software and telecommunications networks. (Ward & Peppard, 2002) The combination of IS and IT systems is in this thesis defined as the “interacting collections of hardware, software, and communications components that accomplish a specific objective or set of objectives” (TEAF, 2000). This is also the definition that will be used throughout this thesis describing IS/IT system.
Capability
Capability is defined as the “ability that an organization, person, or system possesses” (TOGAF, 2009). This implies that the ability that (business) services deliver to the organization is the capability (Scania, 2010). Capabilities are typically expressed in general and high-level terms and require a combination of organization, people, processes, and technology to achieve common business goals, for example, marketing, customer contact, or outbound telemarketing. (TOGAF, 2009) In this report capability is retrieved through IT’s ability to support business services or business functions.

Service
A service is “an element of behaviour that provides specific functionality in response to requests from actors or other services. A service delivers or supports business capabilities, has an explicitly defined interface and is explicitly governed. Services are defined for business, information systems, and platforms.” For example, a business service is something a business performs that has a defined, measured interface and has contracts with consumers of the service. A business service is supported by combinations of people, processes, and technology. Services support functions, are functions, and have functions, but functions are not necessarily services. Services have more specific constraints than functions. A service could also be interpreted as a behaviour which is a synonym to activity. An activity is defined as “a task or collection of tasks that support the functions of an organization.” (TOGAF, 2009)
In this report a service, and moreover a business service, is an activity that provides specific functionality in response from actors or other services. An activity delivers or supports business capabilities, has an explicitly defined interface and is explicitly governed.

**Figure 6**: Business service

**Function**
A function is something that a business performs. One or several functions operate as a boundary for a service, but as explained in 3.1 Service, they do not necessarily have to be the services themselves. Functions do not have specific constraints unlike services (TOGAF, 2009). The functionality is the realization of the function, and this in turn is used by the business services to provide capability to the organization (Scania R&D, 2010) For example: one function of an email service may be to store and forward outgoing mails, one function of a business process may be to dispatch goods to customers (ITIL, v3).

**Figure 7**: Business function

**Process**
If the functions describe the “what”, then business processes are “how” a business carries out or executes its capabilities. Business processes produce a specified and defined business result. Davenport (1993) defines a process as a “specific ordering of work activities across time and space, with a beginning and an end, and clearly defined inputs and outputs”. Business processes are executed by a set of people (business roles) with or without the support of IT applications which provide functionality to automate specific steps in the business process. (Davenport, 1993)

According to the common terminology within Scania R&D the term process is defined as a set of tasks which transforms a certain input into a certain output, which is similar to Davenport’s definition. In this report the term
process therefore refers to the Scania terminology and Davenport’s definition since these are almost identical, including that a process supports functions and indirectly also the capability of the organization.

![Figure 8: Business process – supporting a business function that will create added value]

**Information**

“Information is any communication or representation of facts, data, or opinions, in any medium or form, including textual, numerical, graphic, cartographic, narrative, or audio-visual forms”. (TOGAF, 2009) In the IT-context an information object handles the information-flow (input and output information) from databases, processes, applications, platforms and other infrastructures that provides or necessitates communication in terms of information. (Scania, 2010)

**Actor**

According to TOGAF (2009), an actor defines a person, organization, or a system that is outside of the consideration of the architecture model, but interacts with it. The actor assumes a role to perform a task. Scania R&D (2010) considers the actor to be in the architecture model and is defined as a participant (regardless if it is a human or not) that belongs to the organization and acts by taking on a role to perform a task. A task may consist of using one or several applications in order to support the process and/or a business service. (Scania R&D, 2010) Even though these two definitions are rather similar this thesis will assume the Scania definition of an actor.
Figure 9: Defining the purpose of an actor

Figure 10: An actor can also use several applications to perform a specific task included in the business process

Application
Application is an ambiguous and imprecise word that could mean different things to different professional users but also different things within different academic fields. (Ward & Peppard, 2002) TOGAF (2009) defines an application as a "deployed and operational IT system that supports business functions and services; for example, a payroll. Applications use data and are supported by multiple technology components but are distinct from the technology components that support the application". TOGAF’s Integrated Information Infrastructure Reference Model (2009) further refines the definition. As the model states that an application platform is the entity that contains the hardware (of the IT system) in order to make programs work. This definition indirectly states that an application cannot contain hardware, and consequently according to TOGAF, an application is an IT system less hardware that supports a particular function or service.

Gartner (2004) defines an application as “a specific use for a computer or program, such as for accounts payable or payroll” which is quite similar to the earlier mentioned definition even if the application using this Gartner’s definition contains hardware. But Gartner also applies another word for particular components of the IT system, namely application program which is a “software program that performs a specific task or function. Application programs (generally known by the less formal term “applications”) contain instructions that transfer control to the
system software to perform input/output and other routine operations, working through an application programming interface" (Gartner, 2004). If one makes a clear distinction between the term application and the term application program then one could also make a clear distinction between the IT system that supports the business objectives and its components. A software program in this report is a sequence of instructions written to perform a specified task for a computer. (Stair & Reynolds, 2003) To summarize and encapsulate the TOGAF definition of an application this thesis uses the following definition;

An application is an IT system less hardware which contains either a software program or a collection of software programs, where the software in that particular IT system is organized to accomplish a specific function or a set of functions.

**Figure 11:** An application that is constituted of several application programs

Applications can further be divided into **business applications** and **infrastructure applications**. Business applications are applications that are specific to a particular enterprise or vertical industry and typically model elements of an enterprise's domain of activity or business processes. A business application is either a program that has a specific usage which can be directly traceable back to a specific process that supports the organization's business capabilities or a program that is not classified as a infrastructure application nor a as a part of a platform. Whereas infrastructure applications are applications that have most of the following characteristics:

- Widespread availability as Commercial Off-The-Shelf (COTS) software means that it is uneconomic to consider custom implementation.
- User interaction is an important part of the application's function.
- Implementations are based on infrastructure services.
- Implementations may include significant extensions beyond that needed to use the underlying infrastructure services.
- Interoperability is a strong requirement.
- Infrastructure applications help users to coordinate and plan their work and time. (TOGAF, 2009)

**Platform**

A platform is “a combination of technology infrastructure products and components that provides that pre-requisites to host application software” (TOGAF, 2009) which essentially consists of software and hardware. For example Gartner (2004) defines infrastructure as the underlying technological components that constitute an organization's system architecture. Furthermore the platform could be divided into two distinct platform components. The application platform is “the collection of technology components of hardware and software that provide the services used to support applications” while the as the communication infrastructure “provides the basic services to interconnect systems and provide the basic mechanisms for opaque transfer of data. It contains the hardware and software elements which make up the networking and physical communications links used by a system, and of course all the other systems connected to the network” (TOGAF, 2009).

**Figure 12:** IT infrastructure explained as a platform
Interrelations between the definitions

An IS system describes the interrelation between IT and people's activities using that technology to support operations, management, and the decision-making. The system-view visualizes how the organization, business services and functions internally and externally are related to its customers.

Business services or functions are supported by different business processes, and every process is constituted of one or many sub-processes and tasks which are performed by an actor. An actor is defined as a human being or a machine, a computer etc. whom uses IT systems to perform their tasks. The IT system in turn, consists of applications, application programs and IT infrastructure as in platforms.

The application itself is defined as an IT system less hardware where specific software programs (also known as application programs) within the application are organized in order to accomplish a specific function.

Figure 13: The interrelations between definitions

The defining of and insight in how services, functions, processes and actors interact with IT systems (application programs, applications and IT infrastructure) is vital for the understanding of the APM area which is mainly focused on the optimization of the usage of applications and application programs. APM complements an enterprise architect’s multi-faceted role and provides key information into the EA management process.
3.2 Application Portfolio Management

Application Portfolio Management is a management framework, primarily for IT decision makers, providing “many of the multi-faceted aspects that are required for an enterprise architect to be effective” (Walker, 2007). APM is defined as a “periodic objective assessment of organisations applications”) and is generally constituted of the following four steps (Kogekar, 2009):

- Applications inventory. The first step in APM is to identify and catalogue existing applications, their definition - what they do - and their costs.
- Applications assessment. The next step assesses applications in terms of business value, alignment with strategy, technical architecture or standards, costs and their ability to support the businesses intended functions and services.
- Recommendations and Roadmaps provide information needed to develop or re-develop application management strategies. The purpose here is to get prioritised action plans to optimize maintenance of applications by migrating, removing or replacing applications due to cost saving opportunities or duplication or overlaps. Another objective is to address health risks of the portfolio.
- Portfolio Governance is the final step in APM and concerns assigning “responsibility for governance including managing the repository, tracking recommendations as well as communicating the benefits. (Kogekar, 2009)

Figure 14: General APM process

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- Portfolio Governance is the final step in APM and concerns assigning “responsibility for governance including managing the repository, tracking recommendations as well as communicating the benefits. (Kogekar, 2009)

Taking on a portfolio view on technology assets makes it easier for companies to focus on strategic and operational objectives, business values, risks, resource constraints, and the associated tradeoffs, instead of focusing only on traditional metrics concerning only budgets and schedules. (Bondugula et al, 2005) However, the maintenance of an application portfolio that adds value and reliability to the company is a complicated issue, and something that many businesses are challenged with on a daily basis. New applications are constantly and regularly added, downloaded, purchased or self-developed - too often without any further control. (Scania, 2010)

By efficiently performing APM and thus establishing which applications receive same, lower or increased levels of funding, companies are able to optimize their application portfolios over time. The application assessment provides a basis for managers in their decision-making of which applications should be eliminated, kept or renovated. The primary focus is to ensure that the “business value and ownership costs are appropriately aligned and the portfolio is streamlined by rationalising duplicate or obsolete applications”. Application portfolios should strive to maintain the greatest business value and closest architectural fit with the lowest costs and risks. (Kogekar, 2009)

Two-by-two matrices are frequently practiced in order to help the assessment and recommendations and roadmaps phases of APM. Matrices help the management to make informed judgements about how IS/IT should be developed in the organisation; they identify key issues and ideas, and consider the common ground or areas of conflict amongst the various ideas expressed in the matrices. Moreover, matrix analysis approaches reduce an apparently infinite number of alternatives to evaluate to a manageable, relevant number of discrete options from which high level directions can be determined. Matrices demonstrate relationships which evolve over time, but which normally have to be managed to succeed simultaneously in the organisation. (Ward, 1987)

APM Tool: Legacy Matrix

Sommerville (2007) presents the legacy matrix, which assesses the business value and system quality of the applications in the portfolio, stating that these two aspects are the most important ones in order to achieve efficient APM. The legacy matrix is based on legacy system theories, meaning old systems. Large systems remain generally in use for more than 10 years, and smaller systems less. Naturally, the life time of different systems vary. However, various organisations still rely on software systems that are more than 20 years old and many of these old systems are still business-critical - they have an effect on the day-to-day running of the business. These old systems are called legacy systems; they include system hardware, support software, application software (legacy software systems),
application data, business processes, and business policies and rules. (Sommerville, 2007) Since companies invest a lot of money on software systems, which includes applications, it is also important to consider the life cycles of applications and that they are usable for a number of years. The age of applications has therefore a great impact on costs and requires a lot or less effort to effectively support and maintain them. In the beginning these cost levels are said to increase gradually, but eventually they rise increasingly faster until they go sky-high and the application becomes expensive legacy. (Vogelezang, 2002) Consequently, when companies set out to make changes in its IS’s, they may face problems with the existence of massive, complex and inflexible installed base of software.

A method to manage legacy system is by applying legacy system assessment, which is a strategic approach that will scrap, remain, redevelop or replace applications. These options are not exclusive; a system composed of several different programs also has several different options that may be applied to different parts of that system. (Sommerville, 2007) Warren (1998) suggests that assessing a legacy system means looking at it from two different perspectives: a business perspective and a system perspective. The combination of the business value and the system quality is then used to help inform the decision on what to do with the legacy system (Sommerville, 2007). Summarizing these different assessment approaches a legacy decision matrix can be illustrated in figure 15, analyzing 10 legacy systems:

![Figure 15: The Legacy Matrix](image)

- **Low quality and low business value** implies that keeping these systems running will be costly and the rate of return to the business (business value) will be rather small, so scrapping these systems might be an alternative.

- **Low quality and high business value** means that the systems make an important business contribution and cannot be scrapped. However, their low quality indicates that operational costs are high so these are candidates for system transformation or replacement if a suitable system is available.

- **High quality and low business value** means that the systems does not contribute much to the business but they are on the other hand not very expensive to maintain, so it is not worth the risk of replacing these systems. Therefore normal system maintenance may be continued or they may be scrapped.

- **High quality and high business value** systems must be kept in operation but their high quality means that it is not necessary to invest in transformation or system replacement, so normal system maintenance should be continued. (Sommerville, 2007)

The decision-making of software systems destiny is a dominant concern for those organizations that own legacy systems (Cimilitie et al, 1997). There are many factors, both external and internal affecting the business and produce new or modified software requirements as the business changes. As a result legacy systems incorporate a large number of changes which have been made over many years by many different people, and there is usually no single
A person that has a complete understanding for the system. Replacing legacy systems with new systems is risky, yet keeping them may imply increased costs. (Sommerville, 2007)

The basic idea of the legacy matrix of highlighting the importance of business value and system quality based on the lifecycle of applications; when to scrap, replace, redevelop or maintain applications, is also the fundamentals in many other APM theories and APM tools employed to efficiently perform APM. In particular Application Lifecycle Management (ALM) focuses on the lifecycle aspect.

**APM Tool: Application Lifecycle Management**

(software and) Application Lifecycle Management (ALM) is “the practice of controlling the introduction, configuration, and phase out of software and applications in the IT environment” (IT Management, 2010). The purpose of ALM is to manage those phases in a way so that business processes are not negatively affected by changes that inevitably occur over a product’s life time (IT Management, 2010) and help improve the return on IT investments and projects. The main goals of ALM are to increase the added value of the application for the business user; focusing on cost reduction, compliance and risk management. (Bakker, 2010)

Emphasizing cost reduction is important but should be handled cautiously since only focusing on this may lead to an imbalance in this area in terms of productivity. If cost reducing measures are continuously implemented it may affect tools and communication channels used by employees negatively. (Bakker, 2010) By identifying, what is important to do (based on the benefits identified), and then combining cost savings and productivity improvements this issue can be controlled (Ward & Peppard, 2002; Bakker, 2010)

Compliance requirements demand a high level of control, but addressing market changes and needs – internal and external requirements – is a difficult task and consequently also affects the overall control. Internal and external requirements naturally affect the business costs. ALM enables however an organization to meet these strict compliance requirements by linking requirements, quality metrics and the solution, which helps proving that the solution meets all the conditions. (Bakker, 2010) In addition it is also important consider what is applied being done based on the resources available, not only what is being required. The limiting factor here is normally people, in quantity or quality, particular skills or knowledge, but the same logic applies whatever is the limiting resource, the main issue in the end is to enable maximum return from the usage of that resource. (Ward & Peppard, 2002)

It is not entirely necessary or maybe even possible for organizations to exclude all risks (since the higher the risk the higher return) but these should be assessed continuously on the return they can provide (Bakker, 2010), in other words what is likely to succeed based on the risks of failure of each investment. Risk can either be allowed for as contingencies in cost and resources, or by reducing the expected benefits or, in some cases, both. (Ward & Peppard, 2002) The commitment from stakeholders and the combination of business and IT knowledge enable the right assessment of risks, making risks controllable or even desirable (Bakker, 2010)

The result of ALM is a development process with predictable results and sufficient flexibility to contribute to the main priorities of an organization; added value for users, cost reduction, compliance and risk management (Bakker, 2010).

The lifecycle of an application can be said to follow a general pattern where the first phase is described by the introduction or development of the software including development costs for the application and time-to-market. The challenge here is to decrease time-to-market in order to rapidly gain ROI. The following phase is defined by operational and maintenance costs for the application as it is integrated and optimized in production and business operations, increasing the added value to customers and stakeholders, i.e. costs are exceeded by the benefits of the investments. As the application lifetime increases and operational and maintenance costs are exceeded by the benefits of the application it finally enters a marginalization phase, where benefits and the application value decreases. The application will eventually be more expensive to maintain and support and it is consequently phased out.
Figure 16: The ALM graph

ALM helps to visualize an applications’ lifecycle, at which moment in time the value is added, when to increase resources to sustain the value and when it is time to phase-out the application (similar to when it is assumed as legacy). However, only defining the time-aspect is not enough if decisions are to be made based on both business value and system quality aspects, as the Legacy Matrix suggests. The time-aspect might be simple to define but the business value and system quality is much more complex. What does business value and system quality actually mean?

The interpretation of business value and system quality obviously varies between different companies and stakeholders (E.g. McFarlan, 1983; Vogezezang, 2008). Consequently, in order to understand APM and the assessment of applications based on business value and system quality, the following chapters aims to give a deeper understanding of mainly the business value of applications and thoroughly discuss the significance of business value and how it is investigated and measured. The system quality aspect is discussed in more detail in Nylén’s (2010) thesis. This thesis only presents a short summary of system quality in 3.6 Summary of the Theoretical Framework: Focal Points.

3.3 A Summarization of Business Value

This chapter presents a summary of Camilla Paloméue’s interpretation of the business value theory presented in her thesis. This is mainly done to enable the reader to gain a general understanding of how the APM concept presented in chapter 4.2 Main Features of the APM Concept are related and why the APM Concept looks like it does. For a more thorough review of the business value, the reader is referred to Camilla Palomeques thesis.

The business value concept is a key attribute of any application and one of the factors that determine how much will be invested in an application and how often it will be used. (E.g. Cimitile, Fasolino&Lanubile, 1997; Weill & Vitale, 1999; Sommerville, 2007)

Summarizing business value definitions, business value (BV) in this report is defined as the criticality of the application, the expected contribution from existing applications’ on future industry which will be described by the strategic importance, and finally the functional value of the application, which is explained by the functional suitability, accuracy and performance. Moreover, the criticality is explained in terms of the impact applications’ have on overall businesses (and more specifically the processes in the value chain they belong to), and the strategic importance as in assisting the business in meeting business objectives and goals and market in order to gain market share.
Figure 17: Business value

The criticality of an application can be investigated by posing questions of business impact analysis (BIA) type and the strategic importance by conducting a competitive impact analysis. In this thesis, the competitive impact analysis will from now on be translated into future impact analysis (FIA), with the only argument to not confuse the readers what is meant (not focusing on competitors only but more on the strategic and future analysis of the applications), and stating that FIA refers to the same content as a competitive impact analysis. The functional value is investigated by addressing performance, functional suitability and accuracy questions to users, who use the applications and are therefore the ones who experience these aspects of the application.

3.4 System Quality

System quality could be defined as a set of characteristics that reveal how well a system executes and behaves outside the business context. Exactly what characteristics which are used to measure system quality depends a lot what model that is being used and of course for what intention, but still big similarities exists as quality attributes measures about the same characteristics for all organizations no matter what the functional or business requirements are. Moreover, quality attributes or factors are considered non-functional as they don’t measure the application or the system’s functionality. (Johnson & Ekstedt, 2007)

Generally the system quality attributes have been referred to as “-ilities” or “-ities” e.g. usability, integrity etc (Chung & Sampaio do Prado Leitie, 2009). In this text all the words attributes, factors and goals will be used to describe such system quality characteristics.

System quality assessments include looking at all levels and components of the system and make an estimation of the quality of the application software and the system’s support software and hardware as well as the outer environment including certain processes and people. (Sommerville, 2007) As this thesis deals with applications and not systems, certain things that normally is considered to influence the technical quality of a system such as the humans and hardware been omitted when possible.

A Brief Overview of System Quality Reference Models

For quality attributes several commonly applicable reference models exist that describes a casual breakdown of what the models consider system quality. These, however, have different starting points and as the use of systems (or applications) have evolved some reference models are more or less relevant.

McCall was the first to introduce a quality model called the General Electrics Model of 1977 which included eleven factors and 23 quality criteria. It was mainly developed in order to help developers during software development.

Inspired by this model Boehm et al. (1978) introduced what a more comprehensive software quality tree of “non-functional requirements” called general utility. Boehm et al. (1978) was also the first to introduce a breakdown of more high-level characteristics into low-level characteristics. The as-is utility refers to how usable system or the application is today whereas the maintainability factor refers to how easy it is to understand, modify and to re-test.
The portability factor examines if the system can be used in a changed environment without modifications. Human engineering refers to how easy it is to use the system.

**Figure 18: Boehm’s software quality tree**

FURPS+ is a method developed by Robert Grady at Hewlett-Packard to assess the system quality of an application or a system and it is widely used within the software industry. FURPS+ is an acronym where F stands for functionality, U for usability, R for reliability, P for performance and S for supportability. As the reference model is broken down more factors are presented. I.e. performance includes various aspects such as speed, efficiency, availability, accuracy and resource usage. The + symbol shows that FURPS+ is an evolution of the original FURPS. (Chung & do Prado Leite 2009)

**Figure 19: The FURPS+ quality tree**

The technical report CMU/SEI-95-TR-021 (Barbacci et al., 1995) suggests four quality attributes as the primary, namely performance, dependability, security and safety. The technical report is however limited in its extent of the attributes it chooses to analyse as the scope of the system that the report focuses on as the report only focuses on critical systems. The breakdown of the attributes are also divided into concerns, factors and methods where factors are properties that have an impact on the attribute whereas concerns are parameters which are use to judge the system.
The most widely used standard is however, the ISO/IEC Standard 9126 (2010) classification. This standard measures both quality attributes and functionality attributes. As could be seen from the picture there is six general attributes: functionality, efficiency, reliability, usability, maintainability and portability which are considered important. A further breakdown of the functionality is also shown as it would help to understand the similarity between the ISO/IEC Standard 9126 and the next framework.

**Figure 20:** Quality attributes according to the technical report CMU/SEI-95-TR-021

**Figure 21:** ISO/IEC 9126 software quality attributes
The last reference model presented here, the framework by Johnson & Ekstedt (2007) consists of eight information system goals and it is based on the ISO Standard summarized above even if it does not follow the standard firmly. It includes performance, interoperability, availability, security, accuracy, usability, maintainability and functional suitability. Out of these eight, only functional suitability refers to the functionality aspect, whereas seven others refer to the quality aspect of the system. Thus, interoperability, accuracy and security are now a part of non-functional attributes instead of sub-attributes to functionality. The efficiency attribute have changed name to performance and the reliability attribute have changed name to availability but is essentially the same thing. Portability is in this reference model incorporated into the maintainability attribute compared to the ISO/IEC 9126 model.

![Diagram](image.jpg)

**Figure 22**: System goals according to the Johnson & Ekstedt framework

A finer breakdown of the different reference models’ attributes into sub-attributes would show that even if the terms used for the attributes differ across the reference models presented above most of the attributes presented in the first ones are also represented as sub-attributes in the later reference models even if perhaps another word for the same characteristic is used. Still, this the lack of consistency on what different terms really mean depending on which model that is used as no coherent nomenclature exist poses a problem.

A more severe problem is that there seem to be no consistency on how different sub-attributes are interrelated with higher-level attributes, as no conclusion about the right coupling between attributes and sub-attributes could be drawn if trying to combine the different models. This is especially serious if one chooses to ignore to attach different weights to different attributes according to one’s own or the business opinion and instead chooses to use the same weights as totally different results of the aggregated technical quality could be reached depending what model that is used.

Still, the worst by far inconsistency is that some attributes are considered belonging either to the functional dimension or the non-functional system quality dimension depending on reference model. E.g. is accuracy a functional attribute as stated by the ISO standard or is it a non-functional attribute as stated by Johnson & Ekstedt?

Consequently, combining different reference models is not an easy task. To simply count the amount of times certain words occurs in the different reference models and to weight their importance according to the frequency of the words used are likely to underestimate the problem of the interrelations of certain attributes to others in certain
reference models gravely. Such a count is also likely to be questionable as there is not evident that the hit rate of certain words would represent how important the attributes are in reality, especially if the need of Scania is taken into consideration. The count would also be difficult to do since many of the terms used in the models are similar but still not the same.

As most of the attributes from the majority of the reference models are found as sub-attributes in the comprehensive work of Johnson & Ekstedt, their reference model will be an excellent base to build on in order to be consequent if one neglects how to weight the different attributes against each other. Hence, this presentation of important attributes and their breakdown into sub-attributes will mainly be based on Johnson & Ekstedt’s set of information system goals and deviances around those in order to be able to do it in a pedagogical a distinct manner. Using Johnson & Ekstedt goals as a base is also justified on the basis that they are specifically adopted for the use within the enterprise architecture context and that they still are very similar to the most well-accepted standard, the ISO/IEC Standard 9126 (Johnson & Ekstedt, 2007).

However some of their system quality goals proposed by Johnson & Ekstedt (2007) are not proposed here, but instead presented under 3.3 A Summarization of Business Value and consequently in the thesis by Camilla Palomeque. The reason for that is twofold. Firstly, in accordance with the definition used for system quality and for business value used in this text some system quality goals such as functional suitability are felt to belong closer to the business value aspect compared to the more task-independent definition of system quality by Chung & do Prado Leite (2009). Secondly, these system quality goals not presented are felt to be more closely associated with technical quality according to Scania.

The attributes presented here will be broken down into sub-properties using influence diagrams. Of course an even finer breakdown of the goals that is presented in the next section could be done. However, such a breakdown has been deemed indefensible due to the extensive text and figures needed in order to make it understandable to the reader.

**Interoperability**

Interoperability is the ability of two or more systems or components to exchange information and use that information. There are two types of interoperability, namely syntactic interoperability - that the data is exchanged in compatible formats - and semantic interoperability - that the data has the same type of meaning for both the exchanging parties - and they both depend on the quality of the standards in use. It is important that the exchanged information between systems is compatible with receivers’ data formats and that data send is structured in a way that enables the receiving system to read the information. (Johnson & Ekstedt, 2007)

The standard’s explicitness refers to how well documented the standard is as a well documented standard is likely to mean less interpretations and thus less errors. If the standard is mature within the organisation - the organisation has worked with the standard and are used to it - less errors are also likely. Often data used by old applications is difficult to understand and manipulate; it can also be obsolete and/ or redundant. (Sommerville, 2007)

As interoperability refers to how easy multiple systems exchange information the widespreadness of the standard both at the enterprise as a whole, among dependant systems (standards’ coverage) and among software manufactures (openness of standards) are important factors as well.
Availability

The availability of a system refers to how often a system is ready to deliver its services for the intended users i.e. a combination of its mean time to failure and its mean time to repair (Johnson & Ekstedt, 2007).

The availability of a system depends on its reliability, its recoverability, the quality of the maintenance organization as well as the serviceability and the manageability. The quality of the maintenance organization is important as it affects the responsive repair activities and the proactive configuration work. Serviceability is what could seem like a similar attribute is the specific knowledge to perform effective problem determination, diagnosis and repair by certain experts. Reliability refers to the ability to perform under stated conditions for a stated period of time and recoverability the capability to by-pass and recover from a failure. Manageability refers to the management aspect which is competence to keep an environment under which the application or system can work in. (Johnson & Ekstedt, 2007)
Security
The most common definition of security is according to Ekstedt and Johnson (2007) the system's capability to preserve confidentiality, integrity and availability of its internal information.

Confidentiality refers to how well the system protects information from being viewed by unauthorized users whereas integrity refers to the degree to which the IT system protects information from unauthorized manipulation i.e. from data viruses or careless users. Lastly availability refers to how well the systems provide the authorized users the right information on the right time unaffected by i.e. viruses.

As could be seen in figure 25 the security of a system is dependent on a lot more than the typical thought of communications operations management. Communications operations management is management of the day-to-day operations of the IT-organisation.

E.g. as the human factor must be counted for when thinking about security the quality of the human resources security handling such as roles and responsibilities within the organisation and the access control quality which deals with E.g user access management as must be an integral part of the security too.

The security policy is the document that outlines the organization's approach to information security, but that's not all. Even more processes must be stated explicitly such as how to react when an incident happens (IS incident management) and how to think about security during acquisitions, development and maintenance of software. It is also important to live up to the documents and principles that the security approach is founded on. The quality of the organization could be seen as to refer to exactly that.

Asset management refers to the how the company manages such things as hardware, software, data and documents. (Johnson & Ekstedt, 2007)

![Security Diagram](image)

**Figure 25**: Security factors

A factor mentioned by Barbacci and others (1995) that appears unclear from this breakdown is the importance of dependency between different applications when evaluating safety, a factor not explicitly mentioned by Johnson & Ekstedt. Dependencies are included in the quality of acquisition, development and maintenance process under change control but since that property only is a sub-property the dependency factor is given a much lower weight in Johnson & Ekstedts' framework if weighted equally compared to the weight in Barbaccis' technical report. Moreover, more consideration for the effect of a failure i.e. the outcome in terms of money, health, confidence etc must be taken as there is closely this could also be considered a part of safety (Barbacci et al. 1995).
The aspect of failure is also something Scania acknowledges as Scania defines information security as parts of availability, traceability, confidentiality and correctness, where availability partly accounts for the aspect of failure. (Scania R&D, 2010) Scania's correctness attribute refers to the trustworthiness of the information that is used by the application and that is sent as output from the application whereas the traceability and the confidentiality aspects could be found with the same meaning within the Jonson&Ekstedt (2007) framework. Apart from those definitions Scania classifies the information content handled within the company as either public, internal, confidential or secret depending on how vital the information is. Depending on the security classification different ways of handling the information and different precautions must be considered. (Scania R&D)

It’s evident that a lot of other factors aside from the more technical ones have to be examined when assessing an applications security. The most obvious one is that the people using the applications must fully understand their importance for the security and their responsibilities. Even if the user of the application of course is excluded from the definition of an application it’s vital that the user must be considered when evaluating the general environment or an application. Surely, some applications are affected more than others when people do not follow the regulations set by the security department, as people could choose to do things not intended, in order to avoid irrelevant time consuming activities according to them.

Usability
According to ISO/IEC 9126 (2010), the usability of a system reflects how easy it is for a user to interact with and perform his or her tasks in the system. The standard further defines usability as the understandability, learnability, operability and the attractiveness of the system. (Johnson& Ekstedt, 2007) Nielsen (1993) instead divides usability into five sub-attributes which are learnability, efficiency, memorability, error and user satisfaction. Learnability is with what easiness the user first performs basic duties using the application the first time whereas efficiency is how fast the users perform all tasks when they have mastered the application. The memorability aspects examines how easy it is to remember how to use the application and the error examines different types of error aspects such as how often, the severity etc. The user satisfaction measures how satisfied the user is to use the system.

Below a picture of factors that affect usability according to Johnson&Ekestedt is presented.

![Usability factors](image)

**Figure 26**: Usability factors

The factor "Degree of Match between System and Real World" refers to the fact that the design and the interfaces of the system should be recognizable by the end users, thus the system should be designed for the end users. Quality of
aesthetics and minimalist design is also vital as the appearance of the user interface of course affects usability of the system. Since humans recognize things better than they recall things this should also be thought of when designing a system. This is for example the reason for being consistent and to use standards in the interface. This altogether is likely to lead to less need for help even if the quality of help and documentation always is vital if the company wants to make sure that the user will be able to perform a certain task because even though the system is designed to prevent error the system needs to make sure that the users are able to recover from errors for example by giving them feedback.

Feedback is also important for another reason. Humans also want to feel that system gives them freedom but at the same time that they have control of the situation. A way of making them feel more in control is to show the user what the system does by giving them visibility of system status i.e. giving the user feedback if the response time for the system is long.

Just feedback may not be enough though. Given that expert user is use the system often he also wants a way of speeding up commonly performed operations in order to be efficient without being less flexible (Johnson & Ekstedt, 2007).

Maintainability
Maintainability or modifiability as ISO/IEC 9126 (2010) defines it, is how easy a software system can be modified or adapted in order to: correct defects, meet new requirements, make future maintenance easier, or cope with a changed environment; are activities known as software maintenance.

As stated before Johnson & Ekstedt have chosen to expand this definition to also include the ISO/IEC 9126’s (2010) and Boehm et al.’s (1978) attribute portability as a sub-attribute to it, which is a natural thing to do as portability also has to do with coping with a changed environment. Some portability factors are for instance incorporated into the platform quality sub-attribute.

Maintainability is primarily influenced by six factors; the skills of the maintenance personnel, the maturity of the development and maintenance processes, the quality of supporting documentation, the quality of the system architecture, the quality of the software’s source code and the platform quality (Johnson & Ekstedt, 2007).

![Diagram of Maintainability factors]

**Figure 27:** Maintainability factors

It is easy to understand that the a high quality of the maintenance personnel and the maintenance processes affects the modifiability of the system but it is also vital to understand that quality of the development process affects the modifiability as a system designed using tools and standards in order to be modifiable in the first place of course is
easier to maintain (Johnson & Ekstedt, 2007). This is also the main focus of Boehm et al.'s (1978) reference model. As the maintenance of a system is typically 62% of the total cost of the system over its life cycle it is important to develop the system in order to make it easy to maintain (Brandt, 2000).

This modifiability easiness is also as one would assume close related to the system architecture quality and the quality of the source code. If the source code is badly structured, complex or simply huge, modification becomes harder. If the overall system architecture is bad i.e. having many relations to other systems, modifiability also becomes harder. (Vogelzang, 2008) exemplifies this by stating that a perfectly structured source code, with no branches of any kind, has a complexity of 1, while levels greater than 20 are considered to have high complexity, and levels in-between, 10-20, have an average complexity. The application size could be considered a substitute for system architecture complexity as an investigation of a portfolio of applications takes time (Vogelzang, 2008).

One prediction of the system architecture quality could be the application age that has an impact on the cost and effort to support and maintain applications (Vogelzang, 2008), as Sommerville (2002) also states in his legacy theory and therefore could be considered a proxy for various important aspects when assessing an application. The cost of support and maintenance together over time tends to be relatively high at the beginning because of set-up problems and teething troubles. When issues are solved the support and maintenance cost stabilize. Over the years the combined effects of accumulating maintenance and the heritage of retraced design decisions will show in the form of increasing cost levels. At first the levels will increase gradually, but eventually the cost levels will rise increasingly faster until the cost levels go sky-high and the application becomes expensive legacy. Based on this relation it can be predicted when an application should be replaced in financial terms. Costs and hours spent on applications are needed in order to create a proper cost function. Sometimes it is even difficult to find personnel who know the obsolete programming languages used in old systems (Sommerville, 2007).

Furthermore the quality of the supporting documentation affects the maintainability of the system as the documentation supports both the management and the maintenance personnel (Johnson & Ekstedt, 2007). If the existing documentation is incomplete, which is common it will be difficult to specify the application. This would make it difficult to understand the ad-hoc updating that often has been taken place in old systems or applications. In many cases the only documentation is provided by the source code; although even this may be missing. The lack of documentation is especially serious in large applications or systems where different parts of it were implemented by different teams, without consistent programming style. Even a completely new application might break existing rules. (Sommerville, 2007)

Last but not least the system modifiability is also affected by the platform as it needs to be able to operate on it. Undocumented, yet important business rules may be embedded in the system and a new application may break these rules, as changes of business processes require high costs. (Sommerville, 2007)

**Summarizing System Quality**

The system quality of a system or an application measures how well a system executes and behaves outside the business context. System quality goals have the same characteristics for all organisations no matter what the functional or business requirements are. However, there is no general consensus exact system quality consists of; instead different reference models suggest different attributes depending on the scope of the models. Also no particular reference model could be treated as a standard even if the ISO Standard 9126 is the most common one.

This of course poses certain problems which have become clearly pronounced during the examination of the reference models. There is no on consensus on the importance of the attributes that system quality is founded upon, how they are interrelated to each other and how to weight them against each other. Also the attributes proposed by the models depend a lot on the context in which the model was developed to be used for. And even if the most of the models have certain basic attributes which seems to generally acceptable the different reference models use different nomenclature.

In order to get an general and view of what attributes that may be considered important Johnson & Ekstedts' comprehensive breakdown of their system quality goals based on the Standard 9126 was used. It turns out, that most of the attributes proposed by the other reference models are included but at a lower level. How to measure and weight these attributes are however still open questions.

This thesis only considers interoperability, availability, security, usability and maintainability as system quality goals. This is because the other system quality goals suggested by the Johnson & Ekstedt (2007) framework (functional suitability, performance and accuracy) are felt to be more closely aligned to business value according to Scania R&D.
3.5 Measuring the Goals

According to many studies made on the application of metrics and models in industrial environments, measurement, in order to be effective must be focused on specific goals, applied to all life cycle products, processes and resources, and interpreted based on characterization and understanding of the organizational context, environment and goals. This means that measurement must be defined in a top-down fashion. It must be focused, based on goals and models. A bottom-up approach will not work because there are many observable characteristics in software (e.g., time, number of defects, complexity, lines of code, severity of failures, effort, productivity, defect density), but which metrics one uses and how one interprets them it is not clear without the appropriate models and goals to define the context. (Basili et al, 1994)

The Goal Question Metric (GQM) framework is a way to define and measure measurable goals. It is based on the assumption that the measurement process should be goal-oriented and that the process is defined hierarchically from the top to the bottom. The top of the structure is the goal whereas the latter is refined in a set of characteristics and questions which finally result in metrics at the quantitative level. (Basili et al, 1994)

According to Weill & Vitale (1999) every question has to deliver answers in a five-point scale with choices ranging from unimportant to crucial. Each choice is associated with a behavioral anchor, e.g. choice 3; “moderate importance” that is, noticeable impact if abandoned, or choice 4; “high importance” described as “major impact if abandoned”. The system usage answers are also presented in a five-point scale with choices ranging from never to several times a day, (Weill & Vitale, 1999), and so forth for every goal that is to be examined.
3.6 Summary of the Theoretical Framework: Focal Points

This chapter has highlighted the importance of business and IT alignment from an EA-perspective, and the role of Application Portfolio Management in this holistic field. Taking on a portfolio view on technology assets makes it easier for companies to focus on strategic and operational objectives, business values, risks, resource constraints, and the associated tradeoffs, instead of focusing only on traditional metrics concerning budgets and schedules. (Bondugula et al, 2005)

Application Portfolio Management (APM) is defined as a “periodic objective assessment of organisations applications”. The most prominent approach of APM includes variants of the steps basic information collection or similarly inventory, assessment, recommendations and governance. By efficiently performing APM and thus establishing which applications receive same, lower or increased levels of funding, companies are able to optimize their application portfolios over time. The main focus is therefore to ensure that the “business value and ownership costs are appropriately aligned and the portfolio is streamlined by rationalising duplicate or obsolete applications”. (Kogekar, 2009)

As seen, there many tools and frameworks presented applied as best practices for APM. This thesis has identified primarily the Legacy Matrix and ALM, providing guidelines for managers in their decision-making of which applications should be eliminated, kept or renovated. In Sommerville’s (2007) theory of legacy systems, the main purpose is to help decide whether to scrap, remain, redevelop or replace applications in order to optimize the usage of them. This thesis presupposes the same idea as the legacy matrix when evaluating applications and moreover application portfolios, where not only the business value aspect is depicted but also the system quality. In addition also the time-aspect of ALM is considered, explaining how the applications’ lifecycle can be illustrated graphically and when the phase-out stage of the applications is finally reached.

Business value (BV) is defined as the criticality of the application, the expected contribution from the existing application on future industry summarized in the strategic importance (e.g. Ward & Peppard, 2002), and the functional value of application, which is explained by the functional suitability, accuracy and performance (e.g. Johnson & Ekstedt, 2007). Furthermore, the criticality is explained in terms of the impact applications’ have on overall businesses (and more specifically the processes in the value chain they belong to), and the strategic importance as in assisting the business in meeting business objectives and goals and market in order to gain market share. The functional value expresses how well the applications support the intended work tasks of the business.

System quality, or from now on referred to as Technical Quality (TQ) in order to distinguish a system from an application, could be defined as a set of characteristics that reveal how well a application executes and behaves if both the business and the functionality aspect is taken aside (Johnson & Ekstedt, 2007). For technical quality attributes several commonly applicable reference models exist that describes a casual breakdown of what the models consider technical quality. These, however, have different starting points and as the use of applications have evolved some reference models are more or less relevant. There is no general consensus on the nomenclature, the importance of the attributes that system quality is founded upon, how they are interrelated to each other and how to weight them against each other even if many reference models are similar.

In order to get a general view of what attributes that may be considered important for a TQ assessment Johnson & Ekstedt’s comprehensive breakdown of their system quality goals based on the Standard 9126 was used as a base. It turns out, that most of the attributes proposed by the other reference models are included but at a lower level. With regard to what BV already consists of, TQ is defined as interoperability, availability, security, usability and maintainability.

![Figure 30: Business value](image-url)
Figure 31: Technical quality
4 SCANIA APM CONCEPT

The main objective of this thesis is to create an Application Portfolio Management (APM) method for the evaluation of applications at Scania. In order to establish an APM method, a concept has been developed based on Scania requirements and the scientific assumptions in the previous chapter, 3. THEORETICAL FRAMEWORK. The concept is presented in this chapter assuming the following questions:

- Which factors are important to consider when evaluating application portfolios in general and which of these are also important and suitable for Scania, based on their requirements and needs?
- How can these factors be examined in an APM method at Scania?

4.1 Scania Requirements

Not only theoretical aspects have to be taken into consideration when designing the APM concept, most notable is the fact that the concept must be suitable for Scania requirements and demands. This imposes a lot of restrictions for the development of the concept that inevitably will affect the end result, the final APM method, and in turn may depart from the scientific best outcome and best practice. Essentially the concept must be designed in order to be scientifically supported, practical, easy to implement, understandable and in accordance with previous work and standards used within Scania, and moreover Scania R&D which has requested this management tool. (Scania R&D, 2010)

First of all, an application portfolio will have to be created for Scania R&D, containing all R&D applications, since there is none established at the moment. Given that the method should help to manage the entire application portfolio at Scania R&D, a way of representing the portfolio situation as well as changes in the portfolio over time must be included. This view should be summarized, yet give an accurate snapshot of the entire application portfolio. (Scania R&D, 2010)

Secondly, since not all applications that would be included in the application portfolio will be possible to analyze due to the timeframe given for this thesis, the selected ones, approximately 15-20 applications, should appropriately represent Scania R&D in order to achieve high reliability and validity. Scania R&D has currently an overview of 155 known applications at R&D, but it is believed that there are many more unknown applications. Therefore a way of identifying which applications exist and determining which of these should be investigated but also included and managed in the portfolio must be established. A suggestion is to include all applications that belong to a functional area within the department (in this case Scania R&D) into the portfolio. (Scania R&D, 2010)

Thirdly, the final method must be able to provide valuable and usable inputs for the analysis of applications and guide Scania R&D on how to perform the analysis without being too static due to the objective of being able to exercise the method for evaluating most of the applications at Scania R&D. Thus, the method shall give an overview of a range of different aspects that need to be taken into consideration when evaluating
applications in the portfolio; e.g. costs, security issues, maintainability aspects, business benefits etc. (Scania R&D, 2010)

With the purpose of creating a comprehensible method there is also a need for a thorough investigation, which in this case requires a considerable amount of information gathering. A fourth requirement therefore regards the collection of data the method requires. An overwhelming amount of information to be collected can be an extremely daunting task for APM since it sometimes may cause problems for the effectiveness of APM and consequently also EA. A request from Scania R&D is therefore that the concept should be simple, user-friendly and require minimum workload to ensure that the information in the application portfolio is continuously updated. Based on this demand, the distribution of surveys used during the investigation should be done properly and the questions limited to approximately 15 (Scania R&D, 2010).

The final result should reflect Scania R&D’s goals and organizational situation within Scania, which is why the method shall also assume Scania costumed approaches to facilitate the implementation of the method. In order to accomplish this, the method proposed shall take previous EA efforts and standards at Scania R&D into consideration. (Scania R&D, 2010)

The implementation and managerial aspect has evidently also further implications on the APM concept as such. First of all the final method presented must be comprehensible but most of all manageable and explicable in order to be accepted among petitioners at Scania. This is a serious challenge due to the fact that every application in the portfolio needs to go through every step in the method, and every application should be analyzed to the full extent. (Scania R&D, 2010)

There are also other requests from different stakeholders which are also taken into consideration in this thesis, these are presented below:

- It is highly desirable that a way of increasing the know-how on the dependencies between applications should be established (Scania, 2010)
- It is also desirable that the method should help the user to identify redundant applications (Scania, 2010)
- It is desirable but not necessary that the general method which is established for R&D should be easily adapted at other units within Scania (Scania, 2010)

Based on these preferences and requirements an APM concept has been developed.
4.2 Main features of the APM Concept

The Scania-adapted concept is constituted of the three main steps:

<table>
<thead>
<tr>
<th>Application Portfolio Management Concept</th>
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<tbody>
<tr>
<td>Basic Information Collection</td>
</tr>
<tr>
<td>Qualities Assessment</td>
</tr>
<tr>
<td>Overall Assessment and Recommendation</td>
</tr>
</tbody>
</table>

**Figure 32: APM Concept**

By conducting each step in the APM concept information is retrieved, collected and implemented into the application portfolio which captures templates that captures essential metrics necessary to gain visibility into the portfolio. These templates summarize general application attributes, cost estimations (e.g. application costs, license costs), security information, legal agreements, etc. The portfolio also provides information on applications technical specifications and business importance, their architectural fit and operational performance.

Furthermore, using the information collected and the information about qualities assessed a standardized overall assessment of the application is done in order to be able to recommend how to manage the application in a long-term perspective.

**Basic Information Collection**

The initiating step establishes the application portfolio by determining which applications should be included in the portfolio, their terms, scope and definition. However, in order to be included in the portfolio an application must fulfill the basic requirement of supporting a business area within a specific department at Scania. For example if the department is responsible for power train development, the applications included must also be related to this business area, and so forth.

The basic information collection also captures other general attributes of the applications, e.g. infrastructure characteristics, costs, licenses etc. This information is considered to be mandatory data input in the application portfolio and is complemented by different stakeholders within the organization that have knowledge in these areas. Security issues are for example complemented by security responsible, while InfoMate (Scania IT support) is responsible for costs and license agreements. Not all portfolio data is necessarily critical for the following assessment phase but is of interest for different stakeholders. The portfolio is then updated when new applications enter it or when a new portfolio assessment is performed. When all the necessary data is gathered the following step, qualities assessment, may commence.
Qualities Assessment
The qualities assessment step assesses every application’s business value (BV) and technical quality (TQ) characteristics. There are several of these aspects to take into consideration when evaluating a portfolio, however, not all aspects are found critical for Scania, and consequently only those who are considered to be the most important ones are assessed in this thesis (Scania R&D, 2010). A BV assessment will describe how critical the applications in the portfolio are for the business to run properly, how strategically important they are for current and future industry competitiveness, and also how well the applications support the businesses intended functions. (Ward & Peppard, 2002; Scania R&D, 2010) McFarlan’s theory about applications criticality and strategic importance is examined for this purpose along with Johnson & Ekstedt’s theory about accuracy, performance and functional suitability which assumes to depict the user’s perception of the value of the applications explained as the functional value.

![Figure 33: Defining business value (BV)](image)

A TQ assessment will capture more technical aspects of an application by investigating availability, interoperability, maintainability, security and usability aspects. (See 3. THEORETICAL FRAMEWORK for a thorough analysis of both business value and technical quality aspects).

![Figure 34: Defining technical quality (TQ)](image)
The BV and TQ of each application are investigated in three different surveys, logically dispersed among those stakeholders that will be able to answer the questions in each of them. Each survey contains questions of both BV and TQ aspects, but each with different focus:

**The first survey** will focus on a more subjective assessment of the BV of an application, the criticality and strategic importance primarily, but also the technical aspects security and availability since the person answering the business value questions will hopefully also be able to answer questions on the security and availability aspects, according to Scania R&D (2010).

**The second survey** goes more in-depth with the technical aspects of the applications, investigating the maintainability and interoperability of the applications. In this case there is a need for an application-expert.

**The third survey** will focus on the usability, performance and accuracy of the applications, and is therefore addressed to the users of the applications. Users are the ones that exercise the application in the daily business and should therefore contribute with application and business knowledge. (Role Definitions, 2007)

Below follows a detailed explanation of the TQ questions. For a review of the BV questions used in the APM Concept, the reader is referred to Camilla Palomeque’s report.

### Technical Quality Questions

The technical quality questions highlights the questions based on security, availability, interoperability, maintainability and the usability goals presented in 3.4 System Quality. The questions presented are first sorted according to which survey they belong to. Then they are sorted according to the technical goal they are a part of.

At first questions belonging to the first survey are presented. Those questions are the ones handling the security and the availability aspect. The first question concerns security.

- **Application type** – How would you describe the application?

  The first question serves to give input to the analysis of the overall assessment and recommendation as well as the bubble charts later on as different applications have different needs depending on their type (Sommerville, 2007). Perhaps there are some interesting correlations between different types of applications and the answering of the other question alternatives too. The question alternatives are based on TOGAF (2009).

- **Does the application meet the classified security demands (e.g. on traceability, access control, encryption) for the information being sent?**

  Security is one of the non-functional attributes that occurs in most of the literature that deals with technical quality and it’s also considered a main attribute (Johnson & Ekstedt 2007; Barbacci et al., 1995; ISO/IEC Standard 9126, 2004). It is also considered an important aspect at Scania R&D as good security decreases the likelihood that important information about their processes or product goes missing (Scania R&D, 2010).
Since one of the objectives was to keep the amount of questions low security issues was summarized to one Scania R&D, 2010). The idea is that respondent is able to answer to this comprehensive question as it follows the information handling standard at Scania.

The second question was concerning availability.

- **Does the application meet the agreed accessibility standards (which shall be specified in the Service Level Agreement, SLA)?**

High availability is considered an important aspect of the technical quality goals although not always seen as a main attribute (Johnson & Ekstedt 2007 Barbacci et al., 1995; ISO/EC Standard 9126, 2004; Chung & do Prado Leite, 2009). If an application’s function is considered critical, availability becomes even more important (Ward&Peppard, 2002). To use the service level agreement (SLA), which defines the amount of time the application should be up and running, as a basis for analyzing the requirements is also recommended by ITIL (2002). As Scania uses service level agreements and also measures availability and compares it to the state value in the SLA, referring to that particular SLA is an easy way to summarize an otherwise complex measurement.

The second survey which is the more in-depth technical survey covers mainly interoperability and maintainability. The questions in the second survey are also based on Johnson & Ekstedt’s (2007) technical quality goals as well as the ISO/IEC Standard 9126 (2004) to a greater extent than the questions in the first.

Interoperability, which is the ability of two or more systems or components to exchange information and to use that information (Johnson & Ekstedt, 2007; ISO/IEC 9126, 2004) is considered important as it enables and simplifies modularity if used correctly, one of the main principles of Scania’s strategy. The following questions will be answering the interoperability level of an application;

- **Is the format of the information sent and received from the application standard at Scania according to the TBL?**

  How well does the communication between this application and other applications work, i.e. is the origin of data sent in compatible data formats and is the content of the file organized in a standard way so that the information receiving applications know how to read the information?

The first interoperability question examines how easy-connected this particular application is to other applications at Scania (with minor changes) in general which could be considered a proxy for the application’s modularity, whereas question two examines syntactic and semantic interoperability (Johnson & Ekstedt, 2007). This is important as that question measures the as-it-is status concerning interoperability instead of the future potential.

TBL is a document that defines which technologies that are used internally to provide an IT environment for business applications. It acts as gross list that has to be conformed to when implementing new or maintaining old IT solutions, i.e. setting the rules and describes which applications, platforms and infrastructure components are aloud at Scania. (Scania, 2010)
When concerning the expression “is the contents of the file organized in a standard way” it refers to how the information is to be interpreted. For instance is the data at row three in a txt file referring to variable y in both the application that writes the information and the application that reads the information. If that is not the case, then of course it could mean problems.

The rest of the questions in the second survey refers to the maintainability aspect of the application, an technical attribute that is considered utterly important by both Scania but also by the scientific community and it is therefore also mentioned in the overwhelming majority of reference literature, even if synonyms for maintainability may be used (Johnson & Ekstedt 2007; Barbacci et al., 1995; ISO/EC Standard 9126, 2004; Chung & do Prado Leite, 2009; McCall, 1977; Boehm et al., 1978). Maintainability affects both the functioning of the application and the cost of supporting it (Sommerville, 2002). Its importance is also one of the reasons for having that high amount of questions associated with this attribute. The other reason is that it was demanded is that it is quite complex to measure (Johnson & Ekstedt, 2007; Vogelezang, 2008; Scania, R&D).

The amount of dependencies an application has to other applications or platforms affects the maintainability of an application if consideration must be taken to other applications functioning when redeveloping an application or repairing an application, something that often means a more complex environment than expected and thus increases financial aspects and time necessary to reach the target state. (Sommerville, 2007)

If the overall system architecture is bad i.e. having many relations to other systems, modifiability becomes technically harder. (Vogelzang, 2008)

The amount of the dependencies that an application has to other applications, platforms etc. is something a technical expert should have knowledge of. An element in this second survey is therefore to visualize these dependencies in a dependency map depicted in the picture. The dependency map is also used to as a helper to answer the first maintainability question.

- How many dependencies does this particular application have with other applications, application software and databases?
As could be seen in the figure 35 – the dependency map, the word dependency refers to both platforms (such as programming languages, databases, operating systems etc.) and other applications that the application needs to be able to function properly.

The reason for having a dependency map is also important since the dependencies affect the true criticality of an application by illustrating how criticality propagates through a system of applications. Critical applications may need certain data from another application to work properly. This relationship is therefore important to consider.

A single application may influence several business processes and functions or it may be difficult to modify (change or adopt it elsewhere) and migrate to other platforms which as a result affects the overall business value and technical quality. Hence, even if an examination of the dependency map hardly illustrates the business value or the technical quality relative to other applications it serves as an excellent tool for discovering potential problems before they appear. The map may also facilitate the forecasting and decision if the applications’ platforms are supported according to the technological baseline (TBL), which is the planning horizon for technical support, and consequently if the application is supported in the future. As before TBL is a document that defines which technologies that are used internally to provide an IT environment for business applications. It acts as gross list that has to be conformed to when implementing new or maintaining old IT solutions, i.e. setting the rules and describes which applications, platforms and infrastructure components are aloud at Scania. (Scania, 2010)
The following maintainability questions from a technical quality point of view are based on those assumptions:

- Are all platforms (e.g. programming languages, operating systems, hardware) that the application runs on standard at Scania in accordance the Technological Baseline and does tools exist to migrate the application from one platform to another?

The technological baseline at Scania essentially describes if a platform are supported by InfoMate (technical support) and if it will be supported in the future. An unsupported application is likely to experience more problems than a supported one and the cost of maintaining the application also becomes a lot more expensive. (Sommerville, 2007; Ekström, 2010; Johnson & Ekstedt, 2007)

- Does the application run on platforms which are not updated as the developer releases new stable versions?

This question refers to the problem of having old applications (Sommerville, 2007; Vogezezang 2008; Johnson & Ekstedt, 2007) that become harder and harder to maintain due to increasingly larger and more complex code and relations with other applications, but also the fact that the platforms becomes outdated. Since the application age theory was heavily challenged by Scania's technical experts, the idea of referring to an application as old was dropped (Ekström, 2010). Instead the modernity of the platform acted as a proxy for that.

- Does sufficient knowledge about the application and sufficient tools exist to maintain and further develop it if necessary?

With knowledge less and less well-functioning tools to redevelop and maintain an application those two actions also becomes increasingly difficult, and also more expensive as experience outside the company has to hired (Vogezezang, 2008; Sommerville 2007; Johnson & Ekstedt, 2007). More complex applications are also likely to mean that less knowledge on how to maintain they exist.

- How well documented (except user help) is the application? (The documentation applies to changes in the application, programming code, descriptions of the application's structure but also both functional and non-functional requirements)

Even with enough knowledge in programming and enough tools knowledge of the current situation needs to be known in order to know how to change the application in order to reach the target stage. Better documentation of the current situation i.e. the application's current structure therefore helps the programmer on where to start making changes and how to avoid making more changes that necessary. (Vogezezang, 2008; Sommerville, 2007, Johnson & Ekstedt, 2007; Boehm et al., 1978)

The last three questions are about usability which is considered important as it affects well-being of the personnel and thus the effectiveness of the processes in the long run. They are consequently in the third survey that was answered users.

- How easy is it to use the application for its intentional purpose?
This question represents the fundamental part about usability, which is how easy it is for a user to interact with and perform his or her tasks in the system (ISO/IEC 9126, 2004). In order to work with the application without feeling frustrated, one needs to work with ease.

- Is there any help function available when needed (that is routines, manuals, expert users and/or support)?

A fundamental aspect of being able to learn is that help or documentation is available if one cannot learn by himself or by trial and error. If there is no help available, not even for basic instructions or functions, it may be very difficult to solve problems to present themselves when using the application (Nielsen, 1993; Johnson & Ekstedt, 2007).

- How easy is the application of learning through available tools such as education, internal training courses, manuals, quick reference guides?

Even though help is available an application may be more or less hard to learn depending on the overall quality of the application’s interface and menus and depending on what services the application provides but also depending on the overall quality of available help. (Johnson & Ekstedt, 2007)

**Question Structure**

First and foremost, a majority of the questions in the qualities assessment step have been thoroughly deliberated with Scania representatives. Even though some question remind of one another these have been considered important to include in the investigation. The questions investigating the business value (BV) and technical quality (TQ) in each survey are followed by four alternatives or metrics and one do not know/not relevant alternative/metric, based on the assumptions given in 3.5 Measuring the Goals.
Figure 36: Illustration of to measure the goals given the questions and their metrics

The answering alternatives or metrics are statements that are attached different points in accordance with Weill & Vitale (1999). Every metric is ranged from 0-3, with a higher number for a more distinct answer, that is, if the aim is to measure criticality the number 3 will reflect very critical and 0 not critical at all. The “do not know/not relevant” answer does not influence the calculated average values, but instead the final evaluation of the BV and TQ respectively is affected since the true value will not be reflected appropriately. However, when later analyzing possible “do not know/not relevant”-answers in the results, this limitation will also provide an insight to which questions and thus attributes are affected negatively by this fact, but also in the future will it be usable for the management to detect which applications and their attributes that need to be analyzed further and maybe even respond to or take action on these. All metrics are based on factors considered important in order to reach the specific goal, factors that increases the likelihood of reaching the goal or statements that measures if the goal has been reached or not, based on the 3. THEORETICAL FRAMEWORK.

As the metrics are attached the values are rather arbitrary instead of being based on exact scientific examinations the answers to the questions could be said to be composed of ordinal data in reality, which means that one could know that alternative statement a is better statement b but not exactly how much better
statement a is compared to statement b). It essentially means that the right value for statement a) could be 2.8 for instance compared to the set value of 3 or that statement b could maintain a value of 2.3 in reality instead of the set value of 2. Furthermore it means that the average or the standard deviation calculated for a specific question cannot be interpreted to something useful in reality. When examining the questions statistically only type value should be utilized. (Dahmström, 2005) Below follows examples of this reconstruction:

Goal: Security

- **Question**: Is it possible to track the users' actions?

**Metrics**

- ✓ No
- ✓ Yes, it is possible to track when the user log on to the application
- ✓ Yes, it is possible to track any changes the user does
- ✓ Yes, it is possible to track what the user have accessed (looked at)

Depending on the different metric or statement chosen, a different value is assigned to the question. The statement "No" corresponds to 0, the statement “Yes, it is possible to track when the user log on to the application” corresponds to 1, the statement “Yes, it is possible to track any changes the user does” corresponds to 2 and the last statement “Yes, it is possible to track what the user have accessed (looked at)” corresponds to a value of 3. As could be seen from the example one could question the fact that it is possible to track any changes the user does is twice as valuable as if it was possible to track when the user log on to the application only. It is however difficult to question the fact that it is better to be able to track any changes the user does compared to being able to trace if the user was logged on only.

The fact that the ordinal statements are attached points and treated interval data of course has its implications. It is problematic as it lessens the reliability of the application goals as the exact values becomes more difficult to interpret even if the negative effect dampens as more and more questions are summed up. This is because the deviations from the value attached to a statement are likely to be positive for some questions and negative for other questions and that those questions are likely to cancel each other out if a goal is the aggregated sum of a lot of questions. Despite the fact that ordinal statements lead to reliability issues, there are also good reasons for attaching values to statements as a method too, even if arguments are more practical rather than scientific.

- First of all, the question becomes understandable and often takes shorter time to answer since the respondents knows what is being asked for. That does not necessarily mean that the respondent knows how to answer a particular question, although the likelihood increases since he/ she knows what is being asked of him/ her.
Another important aspect is that the answers give less opportunity for making mistakes or for letting a respondent's particular mood influence the answer, especially if the respondent does not believe that the questions asked truly represents the key aspects for determining how good an application is technically and business wise.

As the questionnaire needs to be short or at least seem short at first sight to gain acceptance according to the requirement petitioners at Scania, multiple statements as question alternatives provide more room for measuring more factors that are likely to affect the wellness of the application without making the questionnaires seem too long. This is particularly important since it means that more information can be collected in the application portfolio in a quick and effortless way.

Even if the answers become more difficult to interpret quantitatively (and statistically) they become a lot easier to interpret qualitatively, which can be very important throughout the assessment phase of the proposed concept. It's also easier to interpret a statement since the answer gives you a statement of the situation for an application rather than a number. Finally it becomes easier to identify the lowest acceptable level as this can be translated into a particular alternative and not just a sum or a weighted average of values asked to respondents. When considering the weighting of the different questions in order to measure a specific goal or the weighting of the specific goals in order to measure the wellness of the application portfolio in a quick and effortless way.

- The first assumption is that each BV goal is of equal importance when calculating the BV and that each TQ goal is of equal importance when calculating the TQ value.
- The second assumption is that each question for a specific goal is of equal importance.

Thus, all the BV goals have been given similar weights to the other BV goals and all the TQ goals have been given similar weights to the other TQ goals. Each BV goal represent 1/3 of the BV value at maximum whereas each TQ goal represents 1/5 of the TQ value at maximum. The same principle follows the questions that each TQ or BV goals constitutes of. If the BV goal strategic importance for instance is calculated by 3 questions, each question represents 1/3 of the BV goal strategic importance.

The combination of the weighting described earlier together with the fact the "do not know/ not relevant" answers do not influence the calculations also makes the principle of averaging values suitable for calculating both the goals and the BV and the TQ values. The usage of average values has two advantages over a static additive formula with different predefined weights. First of all the value for each goal - no matter if its maintainability or criticality - has a maximum value of 3. As a result it is easier to get an understanding if the value is good or bad compared to if the value first one is 15 and the second one is 10 for an instance. Secondly if averaging is applied, it becomes a lot easier to implement the idea of that unanswered or "do not know/ not relevant" should not influence the calculated values. If for example a TQ goal is measured as the average of 3 questions and only 2 are answered, only the average of the 2 questions answered could determine the value of the system quality goal without the need for having a complicated system that changes the weights for each particular question. Therefore the principle of averaging at the same hierarchical level is used.
Figure 37: Example of how functional value (FV) is measured and its questions weighted

This principle could be exemplified by the goal Maintainability. Maintainability which is one of the five TQ goals consists of five questions. Each question has four statements valued from 0-3. Thus the maximum value for a question is three. The maximum value for maintainability on the other hand is the average of the five question values:

\[
\frac{1}{5} q_1 v + \frac{1}{5} q_2 v + \frac{1}{5} q_3 v + \frac{1}{5} q_4 v + \frac{1}{5} q_5 v
\]

These values are also 0 at minimum and 3 at maximum. If instead the third of the maintainability questions would be answered by the alternative “do not know/ not relevant” only the questions with values attached to them would be the population averaged. This would still result in 0 as the minimal value and 3 as the maximal value equals:

\[
\frac{1}{4} q_1 v + \frac{1}{4} q_2 v + \frac{1}{4} q_3 v + \frac{1}{4} q_4 v
\]

The same principle holds when calculating the TQ value or the BV value. When calculating the TQ value the five TQ goals are averaged. Depending on if four or five maintainability questions had been answered each question would be weighted as either:

\[
\frac{1}{20} q v \text{ or } \frac{1}{25} q v \text{ of the total TQ value.}
\]

When BV and TQ results have been complemented in the portfolio, there is enough information given to advance to the following step, overall assessment and recommendation, where the high-level management
decide whether the results from the qualities assessment-phase are adequate or not and how they will affect the future maintenance of the applications.

**Overall Assessment and Recommendation**
An overall assessment and recommendation require a comprehensive approach and knowledge about business strategies and future investments. The Application Council at Scania manages all software used at Scania, and are therefore also the ones that would best perform this assessment and recommend (or decide) a future direction for the applications (Scania R&D, 2010).

Different applications need to be evaluated under different conditions. It may be several factors that influence how maintenance and the future development of the application should be handled even though it is given high or low ratings in the surveys. If an application is given a high functional value it does not necessarily have to indicate an overall high BV. If it is not critical neither strategically important the BV adequacy may be low instead of high. There are also other aspects to consider which indirectly affects the applications, e.g. as the market changes the strategic importance may also change, and thus the value of the application. (Ward, 1987)

However, even though applications are evaluated under different conditions, what still remains the same for all applications is that the evaluation should be based on the business contribution of the application and not the application itself as some of the underlying processes may be more business critical than others (Ward & Peppard, 2002). Assuming these standpoints the overall assessment and recommendation step is illustrated below:

![Figure 38: Overall Assessment and Recommendation process](image_url)
The reasoning from the first step “business value” to the final step “recommended direction” can be visualized in the decision-tree below:

![Decision Tree]

**Figure 39:** The decision-tree. The red bold line gives an example of how a recommendation can be reached.

The decision tree is constructed as to follow the main steps of the overall assessment and recommendation process in Figure 38: **Overall Assessment and Recommendation process** and is only a visualization of how the recommended direction is reached.

In order to be able to make an overall assessment and then a recommendation, primarily the BV of an application is decided if adequate or not in two steps. The first step requires a compilation and evaluation of the BV attributes.
Figure 40: Business value adequacy: step 1

The results given from the qualities assessment step is compiled and the Application Council discusses the results:

- Are the results as expected? Why or why not?
- Which BV attributes were given high or low scores? And why is that?

Given the results from the qualities assessment and the councils’ point of view the applications need to be determined as retaining adequate or not adequate BV. The second step is to decide whether the BV is adequate or not based on the results from the first step.

Figure 41: Business value adequacy: step 2

A critical application has normally a high BV. This is also true for an application which is expected to contribute greatly to future business goals. However, having a high functional value only may not be enough for an overall high BV; instead criticality, strategic importance and the amount of users may be more important (Sommerville, 2004). Given these assumptions, the criticality and strategic importance will always be prioritized above the functional value. Albeit the functional value is not as decidedly important as the criticality and strategic importance it is still indispensable to consider this aspect.

- If the application was originally developed or bought in for a specific business process, which over time changes due to that the business environment changes, it could affect the usage of the application if it no longer supports the intended work tasks satisfactory (Cronk & Fitzgerald, 1999; Weill & Vitale, 1999; Sommerville, 2007). This will naturally be overviewed in the functional value assessment in the previous APM step, giving the businesses point of view on this matter. Changing the outdated business process in order to solve the problem is not an easy task; neither changing the
application in order to adapt to the new business demands effortlessly. Either way, if the application does not support the intended work tasks satisfactorily it will obviously indicate a low BV because new processes cannot be introduced.

- Performance problems may also have a significant effect on the applications. If the performance of the application is considered low, and inhibits users and business activities to proceed at normal pace, it will indicate a low functional value.

When the BV adequacy has been determined, the TQ adequacy is evaluated. Also the TQ adequacy is determined in two steps.

**Figure 42: Technical quality adequacy: step 1**

The first step is to decide which application quality attributes that are most relevant given the results from the BV assessment. Generally the TQ and especially the maintainability factor, is important in order to minimize the cost and justify that it is more profitable to retain than disposing the application (Ward & Peppard, 2002). Furthermore there are also useful guidelines here to be taken into consideration.

- If the application is critical for the business but not expected to benefit future businesses, then availability becomes the most important aspect.

- If an application is undependable and important business processes are affected by the downtime or when people in the organisation are sidetracked from other tasks to solve the problems then the application may have low overall value (Sommerville, 2007)

- An application with a high expected contribution to future business but is less critical today is likely to benefit from few dependencies with other systems as no decision regarding whether to spread the application to a wide range of users is likely to have been taken. The easiness to phase-out or migrate the application as it could be both unsuccessful and successful in the future is therefore important. Likewise maintainability factors becomes important if the application is likely to be changed over time in order to adapt to new business demands as new processes may have to be introduced.

- An application which has both a high expected contribution to future business goals and is critical today is also likely to benefit from giving a high weighting on the security attribute (Scania R&D, 2010). Another issue to take into consideration is personnel skills. If only a
limited number of people understand how the application operates it may be difficult to solve problems that occur frequently and to many users. There is also an uncertainty factor to take into account if those persons are not available for some reason. However, it may also be that only a limited number of people who are allowed to use the application, and if this is the case then the application has an overall high value anyway. If knowledge is generally low for many users and this is not the most favourable mode, then as expected, the application maintains a low overall value. (Ward & Peppard, 2002)

- Applications that are considered to be valuable but not critical to business strategic success or critical for daily operations should only have a quality that is maintained in relation to the cost of failure as to keep the total cost of ownership low, these applications are often outsourced.

- The TQ is often more important than the functional suitability and a way of keeping the total cost low could be to adjust the business activity to fit the application instead of doing the opposite. (Ward & Peppard, 2002)

When the first step is reasoned through the TQ adequacy is decided in the following step:

![Figure 43: Technical quality adequacy: step 2](image)

Does the application need to improve its TQ or can valuable resources be spent on more important improvements? To put it in another way, given resource restraints, is the applications TQ adequate enough?

Once the BV and TQ value have been decided whether adequate or not, there are three scenarios to take into consideration depending on the determined values:

![Figure 44: The final three scenarios: substitute, application lifecycle, and resources](image)
• **Substitute** Again the redundancy aspect is considered; however this time, it is investigated after having assessed all applications. The reason for clarifying the redundancy again is because it is likely that the awareness of all applications and their functionality initially may be low. Once all the applications in the portfolio and their ability have been identified it is probably more likely for the Application Council to be more informed on the current portfolio situation and its content.

ALM advocates that it is important to identify **what is important to do** and combining cost savings and productivity improvements. By identifying redundant applications cost reductions can also be effected since not only other similar applications are recognized but also other ways of doing the same things twice. Consequently, by replacing or phasing-out applications, costs can be decreased and duplicate functionality be removed from the portfolio (Vogelezang, 2002).

• **Application Lifecycle** The second scenario concerns the application’s lifecycle, visualized and based on ALM theories also considering Scania's standard Technology Baseline (TBL) if the technology is future compatible. The lifecycle of an application can graphically be illustrated as below:

![ALM graph](image)

**Figure 45: ALM graph**

Even though the graph only represents a general point of view, all applications in some way move along the graph over time. Though, it is vital to remember that different applications will naturally also move differently along the graph or even have another course than given above in figure 45. In this thesis the value represents the total BV of the applications, meaning criticality, strategic importance and functional value. The difference between the point of introduction and the breaking-point with the time-axle corresponds to the return on investment. From the breaking-point and further on illustrates when the
investment starts to pay off by adding value to the business and its customers and stakeholders. The value from the application increases then and finally reaches a peak from where it starts decreasing to a lower value and lower success. In order to try sustaining the value by smoothing the curve out it is important to increase costs of maintenance and support. The graph below illustrates how ALM affects the application lifecycle with increased maintenance and support costs. As seen, it might possible to prolong the lifetime of an application by performing effective ALM.

![Graph illustration of ALM affecting application lifecycle](image)

**Figure 46**: Performing efficient ALM could prolong the application lifetime and increase the value added.

When the application finally reaches a point where costs of supporting and maintaining the application exceed the costs of actually replacing or phasing out the application, it enters the end/phase-out phase.

Moreover, if the applications' lifecycle is not supported by the TBL, e.g. platforms are unsupported, then this naturally has to be considered and efforts and resources have to be invested in order to ensure that the application is in fact supported.

- **Resources**: What is capable of being done based on the resources available? Are there enough resources, financial as well as human, and also competence and skills to redevelop, maintain, replace or phase-out the application if needed? These are questions that also appertain to ALM theories.
If resources are limited in terms of people, skills and competence it may be especially important to educate the company's own employees, or enlist external help in order to be able to administrate and manage the applications.

When substituting applications, the application lifecycle and resources have been evaluated the ultimate step in the decision tree can be attained; the recommended direction. The high-level management will now make a well-informed recommended direction for the application:

![Figure 47: The final step in the Overall Assessment and Recommendation process: Recommended Direction](image)

The recommendation will help decide the applications' future direction, by recommending; maintain (and maybe roll-out the application if it is found possible and beneficial), phase-out the application, or redevelop or replace the application. By recommending a direction and acting on it, the portfolio and the usage of applications can be optimized.

The overall assessment and final recommendation can, as already stated, graphically be illustrated in the decision-tree. Even though the tree is over-simplistic and not all three final scenarios are taken under consideration when evaluating an application, it still presents an alternative way for a recommendation to be reached. E.g. if an application has both an adequate BV and TQ, the main following scenario would be;
Figure 48: Example of how adequate BV and adequate TQ could lead to a recommended direction – maintain

Consequently, even though there is a traced line of action in the decision-tree it is a case-to-case assessment. E.g. an application that has both low BV and TQ, thus rated inadequate, has no other substitutes and its lifecycle is not supported by the TBL, might still be worth keeping if maintenance costs are low and it is more expensive to actually phase-out the application than keeping it, at least until resources are available.
Summarizing chapter 4 SCANIA APM CONCEPT, this has presented the APM concept to be proposed and tested in the following chapter in a case study at Scania R&D using existing applications at Scania.
5 CASE STUDY: SCANIA APM CONCEPT

The APM concept created in the previous section has been verified in a case study at Scania R&D in order to test the plausibility of the concept. This section describes how the case study was performed and which results were gained, based on the following questions;

- Which applications at Scania are appropriate to include in the R&D application portfolio?
- Which factors are used to assess the application portfolio at Scania R&D?

In order to assemble all the information retrieved in each step of the concept an application portfolio was created as an excel-sheet. The information gathered throughout this case study is therefore not only presented here, but has also been implemented in compatible format into the application portfolio.

Vital information from Scania and the R&D department, along with personal opinions from Scania representatives (not only Scania R&D) provides a general picture of Scania businesses and the management of applications. Personnel that have participated in the case study was selected based on indications from R&D representatives, some of these were responsible for the maintenance of the applications that were investigated, and could thereby also compile lists of e.g. users of the applications. This part of the thesis is a compilation of surveys and personal opinions and represents the basis for the study's empirical results. Approximately 300 people at Scania (not only in Södertälje, but all of Scania) were involved in the investigation. Almost 30 people participated in workshops, discussions, normally lasting between 1-2 hours, and 272 people answered questionnaires used in the case study.

5.1 Basic Information Collection

The initiating step which according to the concept is to identify which applications should be included in the portfolio was conducted rather differently to what was introduced in 4.2.1 Basic Information Collection. In this case, a list of 155 applications was already compiled, and at hand, by Scania InfoMate covering applications used within the R&D area. R&D applications are currently grouped in different maintenance groups depending on the functionality provided, and maintenance groups are subsequently grouped in larger common functional areas in order to gather all similar or related maintenance groups into one single functional area. An R&D workshop in 2009 resulted in a mapping of R&D businesses and the main functional areas within business areas Powertrain Development, Truck, Cab & Bas Chassis Development, and Vehicle Definition, these were; Product structure and product business rules, product design, verification, maintenance, and common functions.

3 See 1.4. R&D to overview the main business areas of Scania R&D

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Each maintenance group within each functional area is assigned a business maintenance manager (BMM) who manages a number of applications; this person is responsible for application change requests and version coordination activities within the business and towards the IT provider. The BMM has an administrative role, requiring skills in planning, coordination, documenting and follow up as well as knowledge concerning the IT-product to be maintained. (Role Definitions, 2007) In order to ensure that the given application list was up-to-date several meetings with each maintenance groups’ BMM was conducted. These meetings resulted in an updating of the application list; the original number of 155 applications, not known to all BMM’s, was approximated to 200 instead. (Scania R&D, 2010)

Since the list as such contained more applications than each BMM could identify, the remaining applications in the list had to be verified that they actually fulfilled the APM concept requirement: applications included in the portfolio should belong to a functional area within the specific department, i.e. R&D. For each application in the list their possible use was presented and with this information at hand it was conceivable to determine which functional area they belonged to.

After deliberating with members of Scania R&D, an additional delimitation for specifically R&D was determined at this stage, in excess of already defined requirements in 4.1. Scania Requirements. The functional area “maintenance”, was not to be included in the case study because of practical reasons; in order to facilitate the investigation by reducing the work-load but also due to lack of information about those applications belonging to the maintenance-area. (Scania R&D, 2010) However, representatives from this area were included in an initial stage of the development of the concept (meetings and workshops), in order to give their opinion and verify that the concept would be suitable even for applications belonging to the maintenance-area.

Out of 200 applications plus only 23 were selected for further investigation, in consultation with each application’s BMM (noticeable is that all BMM’s are responsible for more than one application). Additional information regarding the 23 applications was also included in the portfolio since much of the information...
was non-existing, but also available information that was incorrect was updated in the portfolio. The selection of applications was based on the requirements given from Scania R&D; the investigation should cover as many functional areas within R&D as possible and at least 15-20 applications should be assessed and these should also represent R&D’s functional areas properly, with the exception for the maintenance-area that is excluded from the investigation. (Scania R&D, 2010)

**RESEARCH & DEVELOPMENT**

<table>
<thead>
<tr>
<th>Product structure &amp; product business rules</th>
<th>Product Structure &amp; Configuration Management</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product design</strong></td>
<td></td>
</tr>
<tr>
<td>Virtual Product Structure</td>
<td></td>
</tr>
<tr>
<td>Mechanical &amp; electrical design</td>
<td></td>
</tr>
<tr>
<td>Embedded Systems Design</td>
<td></td>
</tr>
<tr>
<td><strong>Verification</strong></td>
<td></td>
</tr>
<tr>
<td>Analysis &amp; Simulation</td>
<td></td>
</tr>
<tr>
<td>Testing</td>
<td></td>
</tr>
<tr>
<td><strong>Common functions</strong></td>
<td></td>
</tr>
<tr>
<td>Collaboration</td>
<td></td>
</tr>
<tr>
<td>Visualisation</td>
<td></td>
</tr>
<tr>
<td>Document Management</td>
<td></td>
</tr>
<tr>
<td>Issue Management</td>
<td></td>
</tr>
<tr>
<td>Requirements Management</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 50:** Areas and sub-areas that are investigated in this thesis

In the figure, the darkened functional areas e.g. Product Structure & Configuration Management, Testing, Visualisation, etc., declares which areas have been included in the investigation. Naturally a number of areas entail more applications than others, the selection of the 23 applications also considered this fact and in this case study a few areas are more represented than others, e.g. verification and product design.

For each application the names of application responsible, business operations etc. were identified and updated in the portfolio in the application inventory sheet.
As seen there are 10 tabs in the inventory sheet, however, the basic information collection focused mainly on the first three tabs: General, Business and Maintenance. Below is an explanation on what type of information is found in each tab:

- **General**: description of functionality and usage, application version, available in language, supplier, manufacturer, application category, estimated lifetime.
- **Business**: supported business process, business process owner, business category.
- **Maintenance**: e.g. maintenance group, product responsible, expert user.
- **Assessment**: qualities assessment
- **Security**: e.g. access control
- **Infrastructure**: status of infrastructure components, programming language, database type
- **Usage**: number of users
- **Licenses**: number of licenses, license type, costs
- **Operation**: operated by, availability demand
- **Cost**: maintenance, licenses, operations, total costs

The basic information and complementary information was collected from either the BMM for each application or from the online database SALT when data was lacking. SALT is an abbreviation for Software and License Tool, a database which overviews the number of packaged (automated installed) applications. Consequently, not all applications are found in SALT, e.g. applications that are developed in-house may be difficult to find if they are even registered at all. Application packaging enables standard, structured software installations targeted for automated deployment. SALT provides, for example, information on the application type, costs, hosts, which IT Area it belongs to, category, manufacturer, version number, description of the application, and also usernames. (Scania, 2010)
5.2 Qualities Assessment

The second step in the APM concept which is to collect relevant information on each application in the portfolio, assessing the business value (BV) and technical quality (TQ) of the applications, was performed by using questionnaires. Three types of roles were assigned to answer questions in three different surveys:

The first role, a system/process owner (SPO), had the knowledge to answer questions about the importance of the functions and the services performed with a more enterprise wide view - being able to decide the importance of the application to the business. A SPO has namely the complete responsibility for the application which is to be maintained, including the total economy and forecast responsibility. Furthermore, an SPO is responsible for the business process supported by the application and has the authority to change the business process and thereby change the requirements of the application. The SPO has the casting vote regarding new development, further development or termination of application(s) as well as service levels for operation and maintenance. A SPO must have deep knowledge about the business to be supported by the application and competence within the operations area and in the application. (Role Definitions, 2007)

The second role, the application responsible designer (ARD), represented the technical expert that was responsible for maintaining and especially changing and updating the applications. The ARD is responsible for having updated detailed knowledge about a part of the application, and has solid working knowledge of system requirements, the architecture of the system, and software design techniques (including technologies with which the system will be implemented), and also awareness of guidelines on how the design of the implementation, including the level of detail expected in the design before implementation should proceed. As there could be only one SPO and one ARD per application, their opinion was taken as final.

The third and final role, the user had the knowledge to answer questions on how effortless and how well the application solved the work tasks it was intended for, which naturally is connected to the functions and services demanded by the business in a more indirect way.

For each application, surveys was sent out to approximately 30-50 users for those applications with a large number of users (more than hundreds of users, in other cases thousands), and all users for applications with up to 30-50 users to maintain as high respondent-frequency as possible. There are applications widely used by both users and business areas, some of these are also more frequently used than others, as already pointed out. In addition, applications with a low number of users are in general more complex to use than applications with a large number of users. The complexity degree or the fact that it may not be necessary to authorize the practice of those applications to many more is mainly the reasons for keeping the number low. (Scania R&D, 2010)

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4 Selection of respondents is discussed in 2.1.1 Empirical Data.
The response frequency for users of the applications at R&D is illustrated below:

<table>
<thead>
<tr>
<th>Response frequency</th>
<th>SPO</th>
<th>ARD</th>
<th>Users</th>
<th>Expert user</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application 1</td>
<td>1</td>
<td>1</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>Application 2</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Application 3</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Application 4</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Application 5</td>
<td>1</td>
<td>1</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Application 6</td>
<td>1</td>
<td>1</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Application 7</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Application 8</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Application 9</td>
<td>1</td>
<td>1</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Application 10</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Application 11</td>
<td>1</td>
<td>1</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Application 12</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Application 13</td>
<td>1</td>
<td>1</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Application 14</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Application 15</td>
<td>1</td>
<td>1</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Application 16</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Application 17</td>
<td>1</td>
<td>1</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Application 18</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Application 19</td>
<td>1</td>
<td>1</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Application 20</td>
<td>1</td>
<td>1</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Application 21</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Application 22</td>
<td>1</td>
<td>1</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Application 23</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

*Table 1: Surveys response frequency*
In the case study, the users represented the following R&D areas:

**Figure 52:** Responses gathered from which R&D groups

The darkened boxes represent from where in the R&D structure responses have been gathered, in total 209 users responded to surveys. Sections N, R and Y uses more or less all applications available but specifically for section Y is that maintenance applications are used more frequently than anywhere else. The N and R sections are the most represented in this investigation, which is explained by the fact that these sections also use specifically those investigated applications more often the users from the Y-section.

Next follows the TQ results gathered from the SPO, ARD and users of the applications respectively. The BV results are found in the thesis by Camilla Palomeque.

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Note! UT is the organizational unit within Scania R&D that requested this thesis and also where it was conducted.
Technical quality assessment

The technical quality in all the three surveys; however, in the SPO survey only the application type and the security aspect were assessed. The User survey did examine the usability questions whereas the ARD survey did examine the interoperability, the availability, the maintainability and the security questions.

The text is structured as follows: first the response rate, the type value and the amount of responses for each alternative is discussed for each question found to have interesting results in order to be able to assess the suitability of the questions later on; secondly some averages for the different aspects are presented in order to give an understanding of the general application portfolio situation; thirdly the result for three applications used during the evaluation of the Overall Assessment and Recommendation Phase in the APM concept is presented in order to give input to that analysis but also to get a general feel of how the lack of responses affect the values given to the applications in the Qualities Assessment of the APM concept.

The following significant results for the suitability study of the questions were achieved:

Out of 24 applications three applications was considered to be infrastructure applications and 21 business applications given answers to the question “What type of application do you consider the application to be?”.

The security question “Does the application satisfy Scania classified security requirements (e.g. on traceability, access control, encryption) for the information being sent from the application?” almost no SPO understood. Only five out of 23 respondents did.

The availability question “Does the application meet the accessibility standard that was agreed upon (and is specified in the service level agreement)?” was quite hard to answer for 40 % of the ARDs even though it was their duty as employees to know the answer or to be able to quickly find out the answer to exactly that question asked. The amount type value of two and the median which was insignificantly higher seemed fine though.

The first interoperability question “Is the format of the information sent and received from the application standard at Scania?” did not show any extreme deviations from what could be considered normal given the small sample about 20 applications tested. The type value of three was quite big compared to the values of other alternatives in the question.

The second interoperability question “How well does the communication between this application and other applications i.e. is the origin of data sent in compatible data formats and file are organized in a standard way so that information receiving application know how to read the information?” however had much bigger deviations concerning the alternatives used to answer the question. Secondly, almost 50 % of the sample did not understand how to answer the question correctly or did not think that the question was worth answering. Lastly one of the alternatives given was not answered by anyone.

When concerning the maintainability questions given to the application responsible designers a lot of interesting results were found. Out of the five maintainability questions only one seemed to be without objections. Two of the questions namely: “How many dependencies does this particular application have with other applications, application software and databases?” and “Does sufficient knowledge about the application and sufficient tools exist to maintain and further develop it if necessary?” had many respondents that answered that they did not know the answer to the question. Moreover the maintainability questions “Are all platforms (eg programming languages,
operating systems, hardware) that the application runs on standard at Scania in accordance the Technological Baseline and does tools exist to migrate the application from one platform to another? "Does the application run on platforms which are not updated as the developer releases new stable versions?" and "How many dependencies does this particular application have with other applications, application software and databases?" had alternatives which had not been answered at all. Of course this could a coincidence as only a sample of 20 respondents was used. Some of the answers given concerning question "Does the application run on platforms which are not updated as the developer releases new stable versions?" also contradicted the intention of the question as the answers from the Dependency Chart. The question gave the answer that the platforms were of the most updated version whereas they were considered very old according to the chart.

The result from the Dependency Chart was of course more difficult to interpret as the result for the input, the output as well as the platform could be filled in with any name, which almost certainly were unknown to the writers of this thesis, and therefore was impossible to assess the reliability of. However, the lack of answers is also a measure. In fact only three out 23 respondents did fill the input, the output as well as the platforms. In total, 16 filled in the platforms, four filled in the input and three filled in the output. However, since the dependency map only works as a clarifying of which dependencies an application has with other components, and completes the basic information needed in the portfolio (e.g. platform-information) it is not in any way critical for the bubble chart, which on the other hand is entirely dependent on the results of the other questions in the surveys. The most common operating system was Windows XP and the most common programming language was COBOL.

All of the three general usability questions ("How easy is experienced application to use to carry out the tasks it is for?", "Is good help if necessary, i.e. crib sheets, routines, available expert users, get support?" and "How easy is the application of learning through available tools such as education, internal training courses, manuals, quick reference guides?") had a mix of responses that seemed likely if examining the alternatives given to the respondents. Also the amount of "Do not know" answers was low. The type value was both one and two.

If considering inputs from the respondents about the appropriateness of the questions some complaints were given about the type of usability questions but not of the alternatives proposed in the questions as such. A particular complaint has been about the non-working interface on the application which the user did not found to be examined in the usability questions given to them.

When the questions were summed up according to the weightings described in chapter 4.2.3. Question Structure the following result presented in the paragraphs below was found. As before the maximum value that could be reached is three and the minimum value possible is zero.

The total average of the total technical quality for all the 19 applications in the case study was ~2.05. Zero of the applications had a technical quality value less than one, whereas eight applications had a technical quality value between one and two. Out of the 19 eleven had values higher than two.

Concerning the availability the average value was ~2.27. In total 14 applications had enough data to provide answers. Out of these zero had less than one, nine had between one and two and five had a value that was more than two.
When it comes to interoperability only eight application responsible designers did leave an answer that could be used. The average was ~2.45. One of these answers had a value less than one, four out of these answers had a value between one and two and final three had a value higher than two.

The maintainability value was on average ~1.98. The amount of applications that did give this value was 18 in total. Out of these 18, two had a value less than 1, six had a value between one and two and teen had a value that was higher than two.

The usability result was a bit different as the average value for the total usability value for all 21 applications was ~1.35 only. Four applications had a value less one whereas 16 applications had a value between one and two. Only one application had a value that was more than two.

For application 19, application 21 and application 23 the following results were found during the case study:

<table>
<thead>
<tr>
<th>Interoperability</th>
<th>Application 19</th>
<th>Application 21</th>
<th>Application 23</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is the format of the information sent and received from the application standard at Scania?</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>How well does the communication between this application and other applications work, i.e. is the origin of data sent in compatible data formats and file are organized in a standard way so that information receiving application know how to read the information?</td>
<td>Do not know</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

**Table 2**: Interoperability results for application 19, application 21 and application 23

As could be seen from the picture above describing the interoperability answers the lack of answers influence the ability to judge that factor. Application 19 is given the highest value possible even though half of the assessment questions are unanswered.
Table 3: Availability results for application 19, application 21 and application 23

The availability result of two means that the applications meet the accessibility demands that were agreed upon, but not by much.

<table>
<thead>
<tr>
<th>Availability</th>
<th>Application 19</th>
<th>Application 21</th>
<th>Application 23</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does the application meet the agreed accessibility standards (which shall be specified in the Service Level Agreement, SLA)?</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>AVAILABILITY RESULT</td>
<td>2,00</td>
<td>2,00</td>
<td>2,00</td>
</tr>
<tr>
<td>Warning: Low Value (&lt; 2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Critical: Value (&lt; 1)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4: Security results for application 19, application 21 and application 23

The result from the security questions is coherent with the overall result discussed earlier. Not many SPOs did understand the question.

<table>
<thead>
<tr>
<th>Security</th>
<th>Application 19</th>
<th>Application 21</th>
<th>Application 23</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does the application meet the classified security demands (e.g. on traceability, access control, encryption) for the information being sent?</td>
<td>3</td>
<td>Do not know</td>
<td>Do not know</td>
</tr>
<tr>
<td>SECURITY RESULT</td>
<td>3,00</td>
<td>Do not know</td>
<td>Do not know</td>
</tr>
<tr>
<td>Warning: Low Value (&lt; 2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Critical: Value (&lt; 1)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 5: Usability results for application 19, application 21 and application 23

Apart from the fact that no results were achieved from the application 19 the results for the three applications are consistent with the results for the average of all applications. The usability questions seem to have a tendency to achieve a lower value compared to other aspects when the question was answered.
Table 6: Maintainability results for application 19, application 21 and application 23

The result for the maintainability questions is presented above. Even though a lot of questions were unanswered the values that were achieved were high.

<table>
<thead>
<tr>
<th>Maintainability</th>
<th>Application 19</th>
<th>Application 21</th>
<th>Application 23</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are all platforms (e.g. programming languages, operating systems, hardware) that</td>
<td>3</td>
<td>Do not know</td>
<td>Do not know</td>
</tr>
<tr>
<td>the application runs on standard at Scania in accordance the Technological</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline and does tools exist to migrate the application from one platform to</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>another?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does the application run on platforms which are not updated as the developer</td>
<td>2</td>
<td>Do not know</td>
<td>Do not know</td>
</tr>
<tr>
<td>releases new stable versions?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does sufficient knowledge about the application and sufficient tools exist to</td>
<td>Do not know</td>
<td>Do not know</td>
<td>Do not know</td>
</tr>
<tr>
<td>maintain and further develop it if necessary?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How well documented (except user help) is the application? (The documentation</td>
<td>Do not know</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>applies to changes in the application, programming code, descriptions of the</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>application's structure but also both functional and non-functional</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>requirements)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How many dependencies does this particular application have with other</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>applications, application software and databases?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MAINTAINABILITY RESULT</strong></td>
<td><strong>2,33</strong></td>
<td><strong>3,00</strong></td>
<td><strong>3,00</strong></td>
</tr>
<tr>
<td><strong>Warning: Low Value ( &lt; 2)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Critical: Value ( &lt; 1)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 7: Overall TQ results for application 19, application 21 and application 23

Above a summary of the TQ results for application 19, 21 and 23 are depicted. Even though some attributes do not contribute to the overall technical quality results most of the attributes that technical quality consists of did get values. As the average TQ result among all the applications (if weighted equally) was ~2.06 the results for the application 21 and application 23 should be considered normal. Application 19 had a higher value than the average.

5.3 Overall Assessment and Recommendation

The final step in the APM concept consists of an overall assessment of the results from the previous step, qualities assessment, and given the adequacy of the results making a well-informed recommendation on the future direction for the maintenance of the applications in the portfolio. In the case study this step was only tested together with the BMM’s for each application since there was no time left for the Application Council to perform this evaluation. The BMM’s was however regarded as an appropriate substitute for this assessment and their opinion was said to not diverge significantly from the council’s evaluation according to Scania R&D members.

The test was conducted as described in 4.2.4 Overall Assessment and Recommendation using only the results given from the qualities assessment of applications 19 (highest BV result), 21 (midrated BV result), and 23 (lowest BV result), all representing different functional areas within R&D and also given different rates in the qualities assessment. The limitation of only three applications was due to the timeframe given for this thesis. Testing all applications would have required extensively more time in order to do so. For each application the following assessment-process, starting with BV and then TQ, was performed;
First and foremost the BV adequacy was evaluated and determined based on the given results from the BV assessment, considering whether the results seemed plausible and consistent with reality and the BMM’s own perceptions. These results are however presented and explained in Camilla Palomeque’s thesis to a fuller extent.

**Figure 53:** Overall Assessment and Recommendation process

The application with the highest rate, **Application 19**, was given BV-rate of 2.44, i.e. 81% BV result, with both strategic importance and criticality highly rated. The only BV attribute that was not rated over 2 was functional value. However, since the functional value in this case was not critically low (below 1) nor considered more important than strategic importance and criticality according to the BMM, the BV result was all in all considered high and adequate for this application. (Scania R&D, 2010)

**Application 21** was one of the mid-rated applications (average was 1.83 i.e. 61%) with its 1.62 (54%) BV constituted of a high strategic importance value, satisfactory functional value but very low criticality. In this case the discussion revolved around the criticality and functional value rate; were these adequate enough? Would they affect the overall BV negatively? According to **Application 21**’s BMM the applications’ functionality is not critical for Scania businesses to neither run properly nor critical for Scania external customers, but it is on the other hand important for future needs and for internal customers at Scania. Consequently, in this case the criticality was not seen as the most vital aspect when determining the overall BV and the BV was therefore considered adequate.

**Application 23** had the lowest overall BV rate with only 0.33 out of 3 in value, i.e. only 11% BV. This result was considered as inadequate BV and in accordance with the general perception of the applications functionality.
provided; neither critical, not strategically important or supporting the intended work tasks satisfactory. (Scania R&D, 2010)

To sum up, both applications 19 and 21 resulted in adequate BV while application 23 did not. In the following step the technical quality of these applications were evaluated based on the BV results.

<table>
<thead>
<tr>
<th>Compilation of TQ Results</th>
<th>Application 19</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interoperability</td>
<td>3,00</td>
</tr>
<tr>
<td>Availability</td>
<td>2,00</td>
</tr>
<tr>
<td>Security</td>
<td>3,00</td>
</tr>
<tr>
<td>Usability</td>
<td>Do not know</td>
</tr>
<tr>
<td>Maintainability</td>
<td>2,33</td>
</tr>
<tr>
<td>Average TQ</td>
<td>2,58</td>
</tr>
<tr>
<td>TOTAL TQ %</td>
<td>86%</td>
</tr>
</tbody>
</table>

**Table 9**: TQ results for application 19

Application 19: TQ value is considered sufficient.

<table>
<thead>
<tr>
<th>Compilation of TQ Results</th>
<th>Application 21</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interoperability</td>
<td>1,50</td>
</tr>
<tr>
<td>Availability</td>
<td>2,00</td>
</tr>
<tr>
<td>Security</td>
<td>Do not know</td>
</tr>
<tr>
<td>Usability</td>
<td>1,81</td>
</tr>
<tr>
<td>Maintainability</td>
<td>3,00</td>
</tr>
<tr>
<td>Average TQ</td>
<td>2,08</td>
</tr>
<tr>
<td>TOTAL TQ %</td>
<td>69%</td>
</tr>
</tbody>
</table>

**Table 10**: TQ results for application 21
Application 21: TQ is considered to be sufficient.

<table>
<thead>
<tr>
<th>Compilation of TQ Results</th>
<th>Application 23</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interoperability</td>
<td>1,50</td>
</tr>
<tr>
<td>Availability</td>
<td>2,00</td>
</tr>
<tr>
<td>Security</td>
<td>Do not know</td>
</tr>
<tr>
<td>Usability</td>
<td>1,87</td>
</tr>
<tr>
<td>Maintainability</td>
<td>3,00</td>
</tr>
<tr>
<td>Average TQ</td>
<td>2,09</td>
</tr>
<tr>
<td>TOTAL TQ %</td>
<td>70%</td>
</tr>
</tbody>
</table>

Table 11: TQ results for application 23

Application 23: the overall TQ is high enough, thus adequate.

When the BV and TQ had been decided there were three alternatives to consider:
- Substitution, Application Lifecycle and/or Resources.

Depending on whether the BV or TQ was adequate enough three questions needed to be asked; are there any similar applications (“substitutes”) providing the same functionality that would be able to replace the one under consideration? Where is the application situated in the lifecycle graph? Is it supported by Scania’s TBL? Furthermore, it was also asked if there were enough resources to support, manage and develop the applications. The following results were gained:

Application 19: Scania is absolutely dependent on application 19 since there are no other applications that would be able to replace it today, and there are no known alternative commercial solutions that correspond to Scania’s requirements and demands. Based on this fact and the results gained from the BV and TQ adequacy determination, it is considered a critical application implying a high value to business and also absolutely vital for Scania in order to proceed with its operations now and in the future.

The application is supported by Scania’s TBL, and therefore also found in the value adding phase of the application lifecycle indicating that it will be necessary to perform efficient maintenance and development in order to sustain the value of the application. (Scania R&D, 2010)
Figure 54: Positioning of the applications 19, 21 and 23 in the ALM graph

There are financial as well as human (competence) resources that are able to develop and even replace the application if necessary, although replacing the application is a tremendously daunting and difficult task and will require extensive work effort and resources in order to do so. (Scania R&D, 2010)
Figure 55: Decision-tree for application 19
**Application 21:** As for *application 21* there are other ways (by using other applications) to carry out some tasks that this application also performs even more efficiently and satisfactory than what is experienced now. However, there exists no assembled application beyond this that performs all tasks together better than *application 21*. The application is not necessarily critical for business operations today but more critical in terms of strategic importance.

Moreover, it is not supported by Scania’s TBL, but since there are currently no other applications to exclusively replace *application 21* it is not positioned in the final end of the lifecycle (see Figure 54: *Positioning of the applications 19, 21 and 23 in the ALM graph*), but rather in-between the added value phase and the end phase. (Scania R&D, 2010)

Considering these facts, the application needs still to be redeveloped or replaced. Resources, financial as well as human (competence) exist at Scania R&D in order to act upon these conclusions. (Scania R&D, 2010)
Figure 56: Decision-tree for application 21
**Application 23**: Regarding application 23 there are no other applications that can replace it, but there is also need to do so since the functionality provided by the application is no longer considered necessary at Scania. Furthermore, the application is not supported by the TBL and with this conclusion at hand application 23 can be found in the end of the application lifecycle meaning it should be replaced or phased out. (See Figure 54: *Positioning of the applications 19, 21 and 23 in the ALM graph*) There are available resources, financial as well as human (competence) that would be able to replace or phase-out the application, the only obstacle of acting up on this today is lack of time (Scania R&D, 2010).

![Decision-tree for application 23](image)

**Figure 57**: Decision-tree for application 23
Given these assumptions and visualization from the decision-trees for each application it was then possible to recommend a future direction of the applications.

**Application 19: Maintain** The highest BV rated application, also with a high TQ should logically be maintained since there are no other applications to replace this one, the application lifecycle is supported and available resources to develop and manage the application in order to maintain the value of the application.

**Application 21: Replace** This application is given an adequate BV even though it is not rated as critical for Scania businesses to run properly, but in this case the strategic importance has been of more relevance when determining the overall BV. As for the TQ results which were considered acceptable, given the low amount of dependencies, no particular action needs to be taken. Replace seems therefore as the most reasonable direction. There are no other assembled applications to replace this one with although other existing applications are able to perform some tasks as application 21 is able to do. The technology is not supported by Scania TBL but there are resources that could enable a redevelopment or migration of the application in order to deal with this problem. This application should therefore be replaced to increase the TQ value (or replaced by another application that performs the same tasks and provides the same functionality as application 21, if there are any commercial solutions that would be able to replace this application).

**Application 23: Phase out**. This application is not critical, not strategic important nor given a high functional value score according to the case study results. The technical quality results of 69 % (compared to the average result of 68 % ) indicates that no further maintainability actions should be taken given the low requirements of a support application. There is no other application to replace this one with, and it is not supported by Scania’s TBL. In addition it is found in the end of the application lifecycle, therefore the only reason for keeping this application at Scania R&D would be if the costs of maintaining it are very low, but since there is no need for the application from Scania’s point of view, it does not create any added value to Scania’s internal nor external customers not today nor in a long-term future plan, this application should be phased out.
6 ANALYSIS

In order to fulfill the objective of this thesis, which is to create an APM method, the APM concept based on the theoretical framework and Scania requirements, and the results from the case study are reviewed and analyzed in this section assuming the following main questions:

- Is the APM concept feasible?
- Are the chosen factors (theoretical as well as empirical) used to assess the applications in the portfolio appropriate and suitable for Scania R&D?

Moreover, this chapter outlines and analyzes each step of the concept: is there a necessity of improvement? Where? What needs to be changed? The analysis also considers the validity and reliability of each step that constitutes the developed APM concept.

6.1 Basic information collection

The purpose of performing this step in a case study was to analyze whether the requirements given for the information collection and limitations for the application portfolio, e.g. that the applications had to belong to a functional area within the organizational unit, was sufficient, but it also showed that the original list that was available to start with did not correspond to the actual number of applications that were found when investigating it further. In addition the design of the portfolio is also analyzed below.

If the R&D application portfolio was to include all applications used by R&D and consider these equally important, as the concept suggests, it would imply that even applications that are not managed nor owned by R&D but practiced by R&D members would be included in the portfolio evaluation and that resources were to be devoted in order to do so. The following questions must then be asked:

- Would it be beneficial or even necessary for R&D to include those applications in such an extensive analysis?
- What would the results of this investigation lead to?
- Would members of Scania R&D even be able to perform a very subjective-oriented analysis as the concept requires with applications they do not manage, and how reliable would these analysis and conclusions be?

The answers to the questions above in this case is: no, it is not needed since unnecessary resources and time would have to be invested, and the results would not be significantly important for Scania R&D since there many other applications to prioritize, and ultimately it would neither be fair nor justified for Scania R&D to evaluate and make decisions about applications they do not even manage. Consequently there is a need for a more solid requirement that considers the importance of the applications for department, a prerequisite that
will delimitate the number of applications to be evaluated in the portfolio and that will consider those applications that are managed and administered by the department.

Given that the maintenance-area was excluded in the case study, a more thoroughly performed basic information collection step will in the future be required and all applications managed at Scania R&D, regardless of functional area, needs to be overviewed and information on these complemented where necessary, in order to really get a fully degree of capacity utilization of APM and a valid assessment of the application portfolio.

The limitation of applications was due to given requirements from Scania R&D and the timeframe given for this thesis. But, since only about 10% of the application portfolio was examined and complemented with basic information where needed, this has naturally also affected the outcome of the investigation. However, for this step the validity is not affected at all, since no conclusions were made or actual results were gained from this step in excess of making sure that the information needed for the following step in the concept was available, and also that information aimed for different stakeholders was visible in the portfolio.

In addition, since the case study only intended to actually verify that the developed concept was feasible, the implementation of the basic information collection step, with the exception of excluding the maintenance-area and limiting the number of applications from approximately 200 to only 23 applications in the investigation, was considered valid and according to Scania R&D’s expectations, that is, the deviations from the concept did not affect the validity of the concept or investigation noticeably or more important negatively.

Regarding the application portfolio it is readily noticed that the design of it was greatly influenced by the Scania requirement that the information gathered when conducting APM had to be simple to administrate, requiring minimum workload etc. The portfolio, which is divided into many different information tabs to be completed by many different petitioners, has on purpose been designed this way, partly because it is interesting to maintain the entire picture of the applications and different aspects of them, but also to minimize the workload for R&D members that need to be involved in conducting APM. By doing so, everyone that need to complement and continuously update the portfolio with information will not have to reserve much of their time or become heavily work loaded in order to do so, since this task is distributed to many.

6.2 Qualities assessment

The following step, qualities assessment, which consisted of several surveys, provided the assessment of 23 applications. These assessments indicate that all 23 SPO’s, 16 ARD’s, and expert users of the applications who complemented the ARD’s answers, and users (not all users) of the applications answered the surveys. What is considered the weakest link here, is the fact that the response rate of users was very or rather low in some cases given that the actual number of users was much or at least somewhat higher. The weighting of the users answers and what these indicate in terms of business value and technical quality should therefore not considered representative or the absolute truth. Yet again, the idea of the case study was only to test the plausibility of the concept and moreover if it was feasible.
The purpose of the qualities assessment analysis is first and foremost to validate the questions asked in the surveys; whether these were understandable, seemed appropriate to ask, and if they needed some modification based on feedback and further analysis of the questions.

As stated before this thesis only deals with the technical quality aspects of the qualities assessment step in the APM Concept. The analysis of whether the business value questions are plausible or feasible is done in the thesis written by Camilla Palomeque.

**Technical Quality**

This part focuses on the analysis of the technical quality questions deemed problematic in the Case Study and the overall suitability of those questions. If considered necessary, changes of those questions are also proposed.

Overall, the whole concept using five different alternatives to each question as such, seemed to be viable from the input given from the respondents. However, it became evident that some alternatives to the questions needed to be reworked. This was due to a lack of understanding on how to answer the question among the respondents or due to the fact that almost every respondent used the same answer. A too frequent use of the same answer reduces the spread of the value for a particular attribute and thus also the spread of the possible locations of the applications on the technical quality axis, or to put it in another way, affects the transparency and the usefulness of the bubble chart as an analytical tool since the application becomes too lumped together. It also became evident that the questions regarding usability should be constructed in a way that would make them easier to analyze statistically. Lastly the question that examined if an application was a business or an infrastructure application seemed to be of little interest.

During the case study and the analysis of the bubble charts it turned out that the type of applications proposed in the question “What type of application do you consider the application to be?” only was of academic interest. The alternatives “infrastructure application” or “business application” were unsuitable when comparing different applications on the Application Chart as the graphical distinction between an infrastructure application and a business application did not give any interesting input to the analysis of the Application Chart. This was largely due to the lack of infrastructure applications as only three out of 23 applications were of infrastructure type. Instead it seemed that the ability to modify an application was of more interest as that ability greatly influenced the possibility to measure the maintainability factor, which in turn, affected the overall technical quality value and thus the placement of the application on the bubble chart. Three types of application types based on the maintainability factor were found interesting and consequently they also represents in the new question alternatives proposed. As those alternatives are clearly technical the respondent to the question has been changed to the application responsible designer (ARD).

- **Application type – How would you describe the application?**
  - It’s custom made (specifically for Scania)
  - It’s purchased but still modified to meet Scania’s needs
  - It’s purchased and considered a standard solution (commons)
Due to the fact that only two out of 23 understood or had the time to answer the security question “Does the application meet the classified security demands (e.g. on traceability, access control, encryption) for the information being sent?” the question obviously needed to be changed. When analyzing the result it became evident that the objective to summarize the quite complex security subject to a short and answerable question did not work in spite of the fact that Scania standards such as the information classification characteristic and Scania nomenclature were used. Instead of one question more questions that examines almost the same part but requires less analytical skill and less knowledge about what information the application send and receive is likely to cover the subject fairly good if constructed right.

As an alternative of using the complex information classification handling scheme that Scania used in their internal memos - a scheme which could be hard to translate into understandable goals for applications - a way forward could be to use the Scania definition of information security (consisting of availability, traceability, confidentiality and correctness) in combination with Johnson & Ekstedt’s system security attributes (confidentiality, integrity and availability) as a basis in order to construct new, more understandable questions. Scanias’s availability aspect is already represented by question two “Does the application meet the accessibility standard that was agreed upon (and is specified in the service level agreement)?” in the APM concept (even if it is arranged as an own technical quality goal according to the ISO/IEC Standard 9126).

Scania’s correctness attribute that refers to the trustworthiness of the information that is used or sent by the application is likely to depend on many things. First of all the accuracy of the data within the application is important, and that in turn, depends on the quality of the input, which is hard to measure. Good interoperability of course resolves this problem partly, but the fact that the input still must be correct makes this aspect very hard to measure. Having an application with good integrity lessens the risk of having correct data made incorrect as unauthorized users, which are likely to know less about both the data and how the a particular process connected to using that data works and therefore may manipulate the data, are less likely to be able to do so. The last important possibilities of having incorrect output from the application is if it was designed in that way that the accuracy of the application is bad or if an authorized user simply made a mistake; which of course could happen. But since accuracy and usability already is measured no special consideration for Scania’s correctness attribute is taken. Still, confidentiality and integrity and traceability need to be examined by the new security questions.

Traceability, which is both the ability to trace changes in the data and the ability to trace which user that makes changes to the data, could partly be considered a part of the integrity aspect presented by Johnson and Ekstedt, as integrity refers to the degree to which the system protects information from manipulation. A user that knows that his actions is likely to be traced is less likely to unauthorized manipulate data. However, traceability could also be considered to be a part of the confidentiality aspect as the possibility to trace what users’ access and not only what they change still exist. To include the traceability aspect in the integrity question may save space in the actual questionnaire but is also likely to make the questions seem more complex and harder to answer for the application responsible designer. To separate the traceability aspect with the other aspects is likely make the question alternatives clearer in the other questions, but of course it also affects how the security issue is measured if no weighting among the questions does take place. The fact that the traceability aspect is one of four foundations of UTI’s security definition is also a viable reason to make it a
separate question. Doing so, would also make it much easier to rearrange the questions and weight them for other purposes such as measuring security the Scania way instead of this complete assessment of an application from all business value and technical quality goals.

Thus instead of having one security question four is proposed.

The first question applies to confidentiality and alternatives proposed follows the scale of Scania’s security classification. The amounts of user’s that have access to this information and their roles within the company would be interesting but to measure that is considered too unpractical

- Are the users able to see information that the users do not need to perform their duties?
  - No
  - Yes, some users have access to internal information that they don’t need
  - Yes, some users have access to confidential information that they don’t need
  - Yes, some users have access to secret information that they don’t need

The second security question proposed follows the same format but evaluates the integrity aspect of the application. Instead of measuring the type of security classification the impact of the information is used. This is because changing information which appear insignificant to the competition may have a severe impact to the business if business processes stop or fail.

- Are the users able to change information that they don’t should or have reason to change?
  - No
  - Yes, but only information that does not impact the business processes or decisions to any great extent
  - Yes, and the information do impact the business processes and future decisions
  - Yes, the information impact important business processes or important decisions

The third security question proposed deals with traceability which essentially is about log ons, changes as well as if the user is able to view any content unnoticed or not, which all is important.

- Is it possible to track the users’ actions?
  - No
  - Yes, it is possible to track when the user logon to the application
  - Yes, it is possible to track any change the user does
  - Yes, it is possible to track what the user have accessed (looked at)
Lastly, the fourth security question proposed is about accessibility and it examines the protection from outside attacks. The alternatives are based on the ARD’s assumption of what is need.

- How well is the application being protected from attacks from outside of Scania or from people without a user name and password? (Human factors such as sharing the user name and password among people without permission is excluded)
  - Unprotected
  - Poorly protected (but still protected)
  - Sufficiently protected
  - More than sufficiently protected

The availability question’s “Does the application meet the accessibility standard that was agreed upon (and is specified in the service level agreement)?” alternatives that the application responsible designer chose from is likely to be benefited from a reconstruction since a few of the respondents did not understand the question.

The question did concern availability and as availability is normally measured as a percentage of the total uptime to the time the application is suppose to be running this of course would have been easiest. Just measuring the availability as a percentage of the total time running to the total time it was suppose to be running according to the service level agreement has its disadvantage though. The accessibility measurement’s impact on the total technical quality would be negligible if the functional values were aggregated. (E.g. if the recorded total time running was 80 % and the total time it was suppose to be run was 95 % the value could be calculated as

\[
\frac{80\%}{95\%} = 84\%
\]

which is about 2,5 out of 3 something that still would be considered a high value compared to the other factors as 2.5 is a quite high value compared to the average value of the technical goals presented in the case study.) And even with some heavy weighting attached to the availability goal in order to make up for the lack of spread between total uptime and to the time the application is suppose to be running, it would be problematic to use the measurement as the deviations from the acceptable availability measurement could potentially influence technical quality too much if sudden declines in availability would occur due to the heavy leverage.

A possible workaround to that issue would be to round of grade the scale when valuing the measured availability and thus to attach certain points to certain intervals at the percentage scale. The hard part of doing that is to decide what intervals to use as the intervals are suppose to be the same for all the applications. There is an advantage using the same intervals independent of the application evaluated as this could be done automatically using e.g. Excel. This is also proposed in this text as the availability percentage is suitable for being recorded in the application portfolio no matter what. Using the transformation table underneath the following conversion is suggested:
Table 12. Availability conversion table

- Does the application meet the accessibility standard that was agreed upon (and is specified in the service level agreement)?
  - No, far below (please specify)
  - No, just below (please specify)
  - Yes, (specify)
  - Yes, with margin (specify)

Also, the case study performed showed that the first interoperability question “Is the format of the information sent and received from the application standard at Scania?” was difficult to answer and that one of the alternatives to the question was not used at all. Thus, the question must be rephrased and the alternatives reworked to work as intended. This has also been done. The options are more straightforward and more clearly reconnects to the TBL in a better way now. The TBL works as the official standard at Scania and consequently it must be incorporated into the alternatives. The fact that the respondent still needs to know what TBL is and still need to be able to collect information about the application and their eventual alignment with the TBL is of course still problematic as it increases the amount of analysis that must be done in order to answer the question. However, no better alternative was found.

Another problem is that the de facto standard used at Scania among the personnel may be another one compared to the TBL. It would be positive if that unofficial standard would be reflected in the alternatives as well. That is partly solved by measuring how common the standard is at Scania or in that industry. Exactly how common the standard is at Scania may be difficult to answer but it would still be regarded as possible to have a general feel if it’s uncommon or common. Also, people that use special types of expert applications such as applications for cast simulations are likely to know for which functions that also uses those applications at Scania. The question could therefore be changed to this one:
- How standardized is the format of the data that application uses?
  - The format could be considered special for this application
  - The format is not supported by TBL but commonly used in the IT context industry wide
  - The format is supported by TBL but quite uncommon at Scania as only a few applications use it.
  - The format is both supported by TBL and commonly used at Scania

As the maintainability question “Does the application run on platforms which are not updated as the developer releases new stable versions?” had many respondents that did not know have to answer the question minor changes are suggested. The design of the question seems to have had quite low impact on the low response rate since the application responsible designers also found it difficult to fill in the Dependency Map, which is very interrelated to this question. Logically one needs to know what platforms that supports the application in order to be able to answer if relevant platforms for the applications are updated and not, and since the same respondents did not managed to do that, they of course had a difficult time to answer this question. The relative great proportion who knew how to answer this question compared to the proportion of respondents that filled in the Dependency Map could be explained if it could be assumed that some of the respondents knew how to fill in the Dependency Map but did not feel like doing it as it seemed to time consuming compared to this question.

But why use this question if the respondents do not have the time to answer it correctly in the first place? Why not replace it with other questions that are easier to answer? One reason for that is that the information about which platform that supports which applications is something that needs to be known and collected from somewhere anyway. It is a Scania requirement that, a request and something that are going to be implemented even if this method proposed by this thesis won’t. The Dependency Map is just a mean of doing that. The other reason is that this question, if enough information is known, summarizes what needs to be known in a good way which was discussed in the motivation for the question in the case study chapter. Still, small modifications to the question are suggested in order to separate the alternatives more from each other.

- Is/ Are the platform/s that supports the application of the latest stable version/s that is/ are available on the market?
  - No, or many platforms that support the application is very outdated
  - No, very few platforms that support the application are lagging behind one version wise but they could still be considered modern
  - Yes, all platforms that support the application are of the latest stable version

Furthermore the results from the case study lead to the belief that the problematic question “Does the application run on platforms which are not updated as the developer releases new stable versions?” was not enough to resolve the
platform issue since some respondents gave perfectly valid and sound answers but answers that still made it clear that the question above had its limitations. E.g. a lot of respondents used the fourth alternative - that the platforms were of the latest stable version - even though the programming language was completely outdated and a language which has not been updated since the beginning of the 90s. Of course the respondent could be right as the latest stable version probable was from the beginning of the 90s but that was not the intention of the question. To make up for that the question below is suggested to complement the earlier one:

- How does the age of the application affect the application's maintainability?
  - The application's age has affected the maintainability negatively as it is very difficult or very expensive to change migrate to more modern platforms and/or to fulfill change requests compared to more newer applications.
  - The application's age has affected the maintainability as it is harder to migrate to a more modern platform but not to such an extent that change requests becomes significantly harder to complete.
  - The application's age has not affected its maintainability significantly, but is likely to do so in the future.
  - Application of age has not affected the maintainability of the application and is not likely to do so in the future.

As stated before; concerning the Dependency Map itself, it is the thesis writer's opinion that the low amount of answers did not because of the construction of the dependency map; rather it was because of the high amount of information demanded. But as this information still needs to be collected anyway and as the low level of response of the Dependency Map did not seem to influence the overall response rate of the questionnaires, it is kept as it was initially constructed for now; at least before any Portfolio Governance have been implemented. Despite its shortcomings its serves as a tool to help the ARD to know how to answer the question about platform support. There may be better alternatives to collect the data but a better solution has not been found.

The next question of interest is the maintainability question “Does sufficient knowledge about the application and sufficient tools exist to maintain and further develop it if necessary?” as there existed an alternative which had not been picked at all. But it was hard to say if it was due to the applications chosen for the test (by chance) or if it was because of the construction of the question including the alternatives.

Instead another discussion arose; whether to make multiple questions of the question. It could be worth to separate the task of more regular maintenance of an application from the more demanding maintenance which occur when technical changes are made of an application. This logical as it these actions require different kinds of expertise and since the different expertise required are located at different units with different missions and different budgets at Scania. Both the regular maintenance and the ability to change the application are also vital in order to be able to maintain the demanded functionality which the application provides. Furthermore, the question about more regular maintenance could be said to be closer to the usability aspect of the application than the other one. As the usability questions are formulated now, they are essentially the view of the users and thus in a how the customer reflects it and demands. Adding the maintainability about the ability to perform regular maintenance would add the supply aspect as well. However, the issue is who to ask the question about
the regular maintenance to without involving too many stakeholders in the questionnaires. Is the application responsible designer that belongs to the unit (Infomate) that perform the technical changes and not the regular maintenance really the right role to ask this question and would asking another role make this method to complicated? Another problem with the regular maintenance question is that not all applications have a role that indulges in that type of help and administration activities. (Scania R&D, 2010)

However since it is possible that resources to redevelop the application exist but that sufficient tools do not exist the question needed to be changed. Therefore these two questions are suggested:

- **Do adequate skills and sufficient resources to further develop / change the application exist?**
  - Yes, the adequate skills and resources do not exist
  - The skills and resources exist to some extent
  - The skills are sufficient but not desired amount of resources
  - Yes, skills, resources and tools are all sufficient

- **Do adequate tools to develop / change the application exist?**
  - Yes, tools that are well suited for this particular task exist
  - Tools exist, but they are considered difficult or unpractical to work with
  - Some tools are available but some tools are missing
  - No, not at all

A new version of question “**How well documented (except user help) is the application? (The documentation applies to changes in the application, programming code, descriptions of the application’s structure but also both functional and non-functional requirements)**” is proposed as well since some users found it hard to answer the question, even though it may have dependent on the question itself and not the understanding and thus the formulation of the question or the alternatives. One of the alternatives was also never chosen by any of the respondents but as this alternative was that no application documentation existed at all it was hard to draw any conclusions from it. Especially since installation manuals could be counted as documentation if one examined how the question was formulated. This time the alternatives were rephrased to avoid such things. Instead having alternatives describing how good the documentation is, the alternatives describes how often one could find what you could demand from the documentation in the documentation.
How well documented (without user help) is the application? (This applies to changes in the application, programming code, descriptions of the application's structure but also both functional and non-functional requirements)

- You rarely find it you could demand in the documentation
- You sometimes find it you could demand in the documentation
- You often find that you could demand in the documentation
- You find what you could demand in the documentation

All of the usability questions and their alternatives tested in the case study worked fine when considering the users' opinions about them. The questions were understandable, easy to answer and gave interesting input on how to improve the usability in some cases as the questions sometimes referred to tools and expressions used at Scania in the alternatives. However, they lacked the possibility to make some kind of statistical use of them apart from getting to know the type value as the construction of the questions used ordinal data as alternatives. Compared to the other questions given to the ARD or the SPO where ordinal data was of little problem as deviations and averages are of non-interest when only one answers the question, the problem of not being able to calculate the standard deviation and the average and thus the confidence interval is huge when determining the usability from multiple user opinions.

When deciding between being able to propose suggestions to improve the usability based on the questionnaires more easily and the ability to actually measure the users' actual opinions about the applications in a more correct way the latter is considered more important, as a prerequisite to improve the usability is the ability to measure it correctly. Therefore, the questions given to the user to answer must be of interval data type.

The usability questions are thus changed into statements which are to be judged on an interval scale of zero to five where five is the best outcome (I strongly agree) a zero is the worst outcome (I strongly disagree). As this interval differs from the usual interval which is between zero and three, the values from the usability questions need to be multiplied with 3/5 in order to have the same weight as the other questions.

- It is easy for an experienced application user to use to carry out the tasks it is for.

- If necessary good support exist from what one could expect, (i.e. crib sheets, routines, available expert users, support)

- The application is easy to learn using available tools such as education, internal training courses, manuals, quick reference guides

Secondly the fact that the questions had a very high amount of respondents and that they seemed very understandable made it possible to add even more questions without imposing the users much additional work when they answer the questions. In fact, they may perceive the questionnaire as more serious if more than six questions whereof four were usability questions were asked to be filled in by the users. Hence more is also suggested in order to measure the usability more accurately.
The first question or statement to be judged that is suggested was done so to measure the error rate (Nielsen, 1993) of the user while using the application. This is also natural making errors is very frustrating. Of course error rate could be measured in many ways but this summarization was considered enough given the fact that the amount of questions shouldn’t be that long.

- **It is hard to make errors when performing normal tasks with the application**

The statement to be judged that is suggested was to include of memorability aspect (Nielsen, 1993). The ability to memorize how to use the system is important as it is annoying if one needs to learn the application all over again almost no matter how easy it is to learn. Of course it is less frustrating if the application is so simple that one could learn how to do things almost instantly but doing that would still make it take more time to perform the duties that you want to do by using the application compared to if you already knew how to do them. In that way, memorability is always interesting. Below is the new usability question that examines the memorability aspect of usability.

- **It is easy to remember how to solve the tasks using the application (without the help of manuals, quick reference guides and/or support)**

Experience from the survey also showed that some user wanted to be able to judge the attractiveness of the applications interface. Therefore a question about the interface is suggested which partly also examines the satisfaction of using the interface.

- **The application’s interface feels satisfactory for my need**
6.3 Overall assessment and recommendation

First and foremost, when analyzing the results from the overall assessment and recommendation step, it is absolutely important to underline the fact this step was not performed by those appointed in the APM Concept, the Application Council. Instead the BMM’s for each application were considered to be appropriate stand-ins for this assessment and their opinion has been said to not diverge significantly from the council’s evaluation if anything at all according to Scania R&D members. Since a BMM should possess the knowledge required of the applications and also the business, they maintain a good overview of the applications business value and technical quality and how these two factors would be reflected in the decision tree and what recommended directions Scania R&D should take. In addition, the purpose of performing the case study was yet again only to test if the concept was feasible.

The overall assessment and final recommendation followed the steps in the decision tree, starting with the evaluation of the BV and TQ results. The guidelines in the APM concept given to assess the BV and TQ results seemed helpful since there was no problem to determine the adequacy of these. The BV and TQ assessment corresponded each time to the BMM’s perceptions and expectations - high value meaning adequate, in most cases and vice versa, not necessarily a remarkable conclusion but important to highlight. If the results would have indicated anything else, a disagreement between the surveys and the BMM’s perceptions, then a review of the basic idea of the two separate steps qualities assessment and overall assessment and recommendation could have been necessary to perform. Even though the two steps are developed with the purpose of being independent of each other the results of the qualities assessment should be credible and transmittable to the following concept step as in, the management needs only to rely on the results and complement the assessment by determining whether they are adequate enough or not, not reconstruct the investigation and compare the different results and then determine the adequacy. A reconstruction of the investigation would probably have been necessary if the management disagreed on the results. What is reasonable to believe is that the similar perceptions of the applications should more or less apply throughout the company, whether it is from a user-perspective or a management-perspective.

In the following and penultimate step of the overall assessment and recommendation process, substitute applications, the application lifecycle and/or resources were discussed. For the substitute and/or resources assessment it was not required any deeper or further analysis in order to determine if they existed or not. Either there were known substitute applications or not, same for resources; either competence, people and financial resources was available or not. As for the application lifecycle both TBL standards and type of application needed to be considered. Both questions were nonetheless easily determined which indicates that the given guidelines and tools proved to be useful and most importantly reliable.

The final step in the decision-tree resulted in:

- **Application 19**: maintain
- **Application 21**: redevelop or replace
- **Application 23**: phase out (phase-out)
These results were all in line with the BMM’s expectations and perceptions proving that the overall assessment and recommendation process was perceived as reliable and definitely relevant for the APM concept. Also the decision-tree visualized the results satisfactory, however it must not be forgotten that the decision-tree, as shown, is a case-to-case assessment meaning that the tree is an aid not the absolute truth. All things considered the results seem logical based on the data collected and input given from the BMM’s, the overall assessment and recommendation process has thereby proven to fulfill its purpose, a recommended direction, which means not a definitive decision but rather a basis for a decision.

6.4 Validity and Reliability of the APM Concept Overall

Given that the concept of validity is defined as the measuring instruments’ ability to measure what it claimed to measure, the APM concept has also as shown, proved to measure what it claimed to measure. The concept has indeed given a recommended direction for how to proceed with the maintenance of applications in the portfolio, and thus facilitated for the management how to optimize the portfolio and its content. The validity of the concept overall has therefore been satisfied, even though segments of the concept, in particular some of the questions asked in the qualities assessment step and moreover the surveys have been debated and suggested to be modified, rephrased or in other cases even been complemented by additional questions. Moreover, the questions asked in the surveys have been developed and reviewed with different stakeholders at Scania R&D that in some way were involved in the outline of the investigation, but also with advisors. The surveys should therefore be considered valid for this thesis and are assumed to not give a distorted picture of the situation.

Summarizing the validity of the methodological approaches exercised in this investigation, these should be considered valid given that the established APM method actually satisfied Scania R&D’s requirements and that the perception from Scania R&D was that the scope had been fulfilled.

The reliability of each step of the concept has to some extent already been discussed in previous sub-chapters. Nevertheless, overall the concept has been affected by the limited and inconsistent knowledge of APM at Scania R&D. The impression, based on several interviews and meetings, is that APM at Scania varies between different departments, and the purpose of efficiently and continuously exercising APM has different meanings among different stakeholders and groups, not only between departments. There is also an unawareness of which applications to hold in a portfolio since it is perceived that not all applications used at Scania R&D are known or what they are used for. Neither is it fully established at Scania what the most important factors are to consider when evaluating a portfolio in order to optimize the use of it or even which applications to include in the portfolio. However, the information gathered from different areas involving personnel with widespread experience and different input to the subject solves this problem somewhat since it gives a fundamental and general opinion on what is needed in the management method and thus gives a better picture of the problem area and what aspects to investigate, in accordance with what the explorative and qualitative methods aim for. The concept has not been tested on other departments within Scania, only at R&D, but its assemblage and generic design allows the method to be suitable not only for R&D but elsewhere at Scania. Given these statements the reliability of the method as such, is acceptable.

Furthermore, most noticeable are the reliability weaknesses of the results given from the qualities assessment step in the concept, mainly the surveys focusing on the business value aspect and the formulation of questions.
asked and weighting of responses and answering alternatives. As it also appears, the respondents have affected some of the results of the surveys and therefore the authors have partially failed to formulate questions that generated reliable answers even though this problem was considered from the beginning when developing the surveys. It is evident that e.g. the future of applications is difficult to predict, and in a few cases it is therefore likely that answering alternatives have been interpreted differently depending on what seems logically a more accurate answer than another. Despite the limited outspokenness of interviewed individuals and uncertainty of survey-answers, the number of participants and the responses are considered to be adequate, and were changes or improvements have been considered necessary these have also been suggested. By rephrasing and re-addressing questions and also adding other questions before establishing the final APM method, this problem ought to be solved.

In addition the final step of the concept, overall assessment and recommendation, was as already pointed out not performed by the Application Council, and this fact has naturally also affected the reliability of the concept negatively. However, since the BMM’s of each application were considered appropriate stand-ins, the effect might not have been that severe. Even so, in order to assure that the reliability of the final step is high, the step must be tested again as recommended in 6.3 Overall Assessment and Recommendation.

Summarizing this chapter it has analyzed and discussed the concept that was developed for the case study and also debated the validity and reliability of the concept. In the following chapter the concept will be established as a definite Scania APM method.
7 ESTABLISHMENT OF THE SCANIA APM METHOD

The APM concept is revised and rephrased in this chapter providing a final method for implementation at Scania. The previous chapter discussed and highlighted potential issues of the developed concept, and suggested solutions and improvements for the concept. Based on previous chapters, this final one establishes the method and its content. This is followed by a discussion of the theoretical framework and how well it was suited to answer the purpose of this thesis which is to create a Scania APM method. In a concluding discussion the study's usefulness and a summary of this thesis are presented.

The following questions will be answered in this chapter in order to fulfil the objective of this thesis;

- Which applications are examined in the Scania APM method?
- What is the Scania APM method constituted of?
- Which factors are examined in the portfolio and how are these factors examined?
- How well does the theoretical framework suit the Scania APM method and how can the study be used for future purposes?

7.1 Final APM Method

The Scania APM concept has been refined, mainly from a practical standpoint as the method needs to be suitable for Scania's requirements. The final APM method is constituted of the following steps and sub-steps:
Firstly, it is determined whether the application should be included in the portfolio or not, then basic information about the application is collected. The next step involves collecting mostly qualitative information in order to assess important qualities of the application subjected to the assessment which is done under the same step. The last part constitutes of doing a general assessment of the application by using the results from the qualities assessment and weighting important attributes and facts against each other, and finally making a well-informed recommendation on the future maintenance of the application. When this is done, the management is able to make a judgment and decide the future of the application.

As could be depicted from Figure 58: The final Scania APM method, the main steps from the concept are essentially the same, even if some sub-processes clearly have been refined. This differentiation is mainly due to the fact that different stakeholders are responsible for fulfilling the sub-processes and as the sub-processes themselves deals with partly different assessments.

**Basic Information Collection**

The original idea of the basic information collection step will be maintained as described in the APM concept; however there are some further restrictions and additional operations that have been included based on the analysis in previous chapter, 6, ANALYSIS.

The main idea is still that applications that are used within Scania R&D and candidates for being included in the application portfolio have to support R&D business services represented by functional map, Figure 59, e.g. product design, verification, and maintenance. Naturally this distinction is a bit vague and therefore complicated to use at hand since different services have a need for different functions. This basic requirement has therefore been specified more in detail.
An application must provide functionality to at least one of the areas depicted in the functional map underneath.

**Figure 59: “Functional map” for R&D**

Because the functional map containing functional areas have been reworked by employees and managers at Scania R&D during several workshops to gain acceptance at Scania it is also ensured that the managers could be confident in that an application belonging to a functional area in the map really supports a service that Scania R&D strives to offer the company and, by extension, then also the customer.

Furthermore a second less theoretical criterion has also been added; the criteria that the application must be managed and administrated by a maintenance-group at Scania R&D and thus be assigned a BMM. This additional criterion is added due to the fact that it would be deemed to impractical to manage an application which no one has responsibility to manage.

To sum it up; those applications that do not fulfill both requirements, 1) to be part of the R&D functional map and 2) to be administered by Scania R&D, are not included in the R&D application portfolio.

**Qualities Assessment**

The second step Qualities Assessment is the part that has been most heavily revoked. First of all the step is now divided into three new different sub-processes which could all be performed independently, at the same time. In addition to the fact that this part contains the questions that are to be asked and answered to gain an insight of the particular qualities of the application assessed and that it is natural that the questions have been redesigned, the way the questions are answered and by whom has also been changed in order to suit Scania's needs and requirements since the concept first was presented. The fundamental concept of having the applications reviewed based on their business value and their technical quality has however not been changed.
Neither has the composition of the business value and technical quality been changed. The applications in the portfolio are still assessed based on:

![Diagram of BV: Business Value](image)

**Figure 33: Defining business value (BV)**

and

![Diagram of TQ: Technical Quality](image)

**Figure 34: Defining technical quality (TQ)**

The weighting of the answers given from the assessment follows the same format as in the APM concept, which is averaging the values at the same hierarchical level. BV is defined as the average value of criticality, strategic importance and functional value, which all are worth a third each. The questions that examine each attribute are also weighted equally at the goal level. TQ is defined as equally weighted max amount of security, availability, interoperability, maintainability and usability; hence each of these attributes could represent 20% of the TQ value at maximum. Consequently, if a goal that is investigated by four questions the maximum value for each question is 25% of the maximum value for that particular goal.
Instead of just doing a semi-qualitative study of the application (semi-qualitative since qualitative studies are difficult to judge, and qualitative answers are therefore forced to be quantified) using only questionnaires, the ways of determining the applications criticality and its strategic importance now is more qualitative. These decisions are now also taken by additional decision-makers than before, which lies more in accordance with the hierarchical structure at Scania. The amount of different types of respondents to the questionnaires has also been changed to a minimum in order to simplify the mailing and collection of the questionnaires. Therefore, the qualities assessment for the BV and TQ consists now of the following three steps; a Business Impact Analysis (BIA), a Future Impact Analysis (FIA) and Surveys.

Questions belonging to BIA and FIA will be asked to the Application Council and the SPO in order to retain different perspectives on the criticality and strategic importance of the applications.

Survey: TQ aspects

Here follows a short presentation of the final TQ questions used in the final APM method. The BV questions is available in appendix 1. In addition, the “do not know/ not relevant” metric is now divided in two.

As stated before, the technical quality is still considered to be a combination of interoperability, availability, security, usability and maintainability. A difference is that the usability questions addressed to the users have changed as they now reflect an interval scale more properly, which essentially gives the analyst more statistical tools to analyse the answers afterwards.

The questions sent to the role user are sent to sample of the population of users of the application.

The questions sent to the role application responsible designer (ARD) are only sent to the application responsible designer for that particular application (as it only exists one). His opinions are here taken as the true expert opinion (and therefore as a fact) for that application.

Underneath the final questions to the ARD is presented. The headings above the questions explains what attribute or what type of questions the questions underneath is associated with.

Application Type

- Application type: How would you describe the application?
  - It’s custom made (specifically for Scania)
  - It’s purchased but still modified to meet Scania’s needs
  - It’s purchased and considered a standard solution (commons)
  - Not relevant
  - Don’t know
Security

- Are the users able to see information that the users does not need to perform their duties?
  - No
  - Yes, some users have access to internal information that they don’t need
  - Yes, some users have access to confidential information that they don’t need
  - Yes, some user have access to secret information that they don’t need
  - Not relevant
  - Don’t know

- Are the users able to change information that they don’t should or have reason to change?
  - No
  - Yes, but only information that does not impact the business processes or decisions to any great extent
  - Yes, the information do impact the business processes and future decisions
  - Yes, the information impact important business processes or important decisions
  - Not relevant
  - Don’t know

- Is it possible to track the users’ actions?
  - No
  - Yes, it is possible to track when the user log on to the application
  - Yes, it is possible to track any changes the user does
  - Yes, it is possible to track what the user have accessed (looked at)
  - Not relevant
  - Don’t know

- How well is the application being protected from attacks from outside of Scania or from people without a user name and password? (Human factors such as sharing the user name and password among people without permission is excluded)
  - Unprotected
Availability

<table>
<thead>
<tr>
<th>Ratio</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 &lt; ratio &lt; 0.9</td>
<td>No, far below</td>
</tr>
<tr>
<td>0.9 &lt; ratio &lt; 1</td>
<td>No, just below</td>
</tr>
<tr>
<td>1 &lt; ratio &lt; 1.1</td>
<td>Yes</td>
</tr>
<tr>
<td>1.1 &lt; ratio</td>
<td>Yes, with margin</td>
</tr>
</tbody>
</table>

The box represents the ratio for how to interpret the deviation of the availability from the Service Level Agreement (SLA).

Table 1 - Availability conversion table

- Does the application meet the accessibility standard that was agreed upon (and is specified in the service level agreement)?
  - No, far below (please specify)
  - No, just below (please specify)
  - Yes, (specify)
  - Yes, with margin (specify)
  - Not relevant
  - Do not know

Interoperability

- How standardized is the format of the data that application uses?
  - The format could be considered special for this application
  - The format is not supported by TBL but commonly used in the IT context industry wide
  - The format is supported by TBL but quite uncommon at Scania as only a few applications use it.
The format is both supported by TBL and commonly used at Scania
Not relevant
Don’t know

- How well does the communication between this application and other applications, i.e. is the origin of data sent in compatible data formats and file are organized in a standard way so that information receiving application know how to read the information?
  - The communication cannot be said to work well as problems frequently occur
  - Sometimes problems occur, which influences the work
  - Sometimes problems occur, but it is unlikely to affect the work
  - The communication works well
  - Not relevant
  - Don’t know

Maintainability

- Are all platforms (e.g. programming languages, operating systems, hardware) that the application runs on standard at Scania in accordance the Technological Baseline and does tools exist to migrate the application from one platform to another?
  - At least one of the platforms are not standard. Porting tools does not exist
  - At least one of the platforms are not standard. Porting tools does exist.
  - The platforms are standard
  - The platforms are standard and porting tools exist.
  - Not relevant
  - Don’t know

- Is/ Are the platform(s) that supports the application of the latest stable version(s) that is/ are available on the market?
  - No, one or many platforms that support the application is very outdated
  - No, many platforms that support the application are lagging behind one version wise but they could still be considered modern
  - No, very few platforms that support the application are lagging behind one version wise but they could still be considered modern
Yes, all platforms that support the application are of the latest stable version

Not relevant

Do not know

- How does the age of the application affect the application's maintainability?
  - The application's age has affected the maintainability negatively as it is very difficult or very expensive to change/migrate to more modern platforms and/or to fulfill change requests compared to more newer applications.
  - The application's age has affected the maintainability as it is harder to migrate to a more modern platform but not to such an extent that change requests become significantly harder to complete.
  - The application's age has not affected its maintainability significantly, but is likely to do so in the future.
  - Application age has not affected the maintainability of the application and is not likely to do so in the future.
  - Not relevant
  - Do not know

- How many dependencies does this particular application have with other applications, application software and databases?
  - Many (more than 6)
  - Some (between 3 and 6)
  - Few (more than zero but less than 3)
  - None
  - Not relevant
  - Do not know

- Do adequate skills and sufficient resources to further develop/change the application exist?
  - No, the adequate skills and resources do not exist
  - The skills and resources exist to some extent
  - The skills are sufficient but not desired amount of resources
  - Yes, skills, resources and tools are all sufficient
Underneath is the questions asked to the users. These questions are made to be analyzed statistically as a lot of questions are asked.

**Usability**

The usability questions or statements are judged on an interval scale of zero to five where five is the best outcome (I strongly agree) a zero is the worst outcome (I strongly disagree).

- If necessary good support exist from what one could expect, (i.e. crib sheets, routines, available expert users, support)
- The application is easy to learn using available tools such as education, internal training courses, manuals, quick reference guides.

- It is hard to make errors when performing normal tasks with the application.

- It is easy to remember how to solve the tasks using the application (without the help of manuals, quick reference guides and/or support)?

- The application's interface is satisfactory for my needs.

**Overall Assessment and Recommendation**

Compared to the APM concept where this step is recommended to be performed by the Application Council, the method will also require collaboration with the BMM for each application since this is the person responsible for the application and has a wide knowledge of both the business and IT, and as the case study proved, the BMM had definitely the competence to perform this analysis.

Otherwise the initial idea is essentially kept. The aim of this assessment is still to get a recommendation for change if needed, either to maintain (and maybe roll-out the application), phase-out, redevelop or replace the application. The overall assessment and recommendation steps have not changed which could be seen in the figure below.

![Diagram](image)

**Figure 60:** Overall Assessment and Recommendation in the final APM method

The process of finding a recommended direction follows the structure of the decision-tree:
Figure 61: Decision-tree – how to reach a recommended direction

These are the guidelines for each step in figure 60:

1. Compile BV attributes
   - Are the results as expected? Why or why not?
   - Which BV attributes were given high or low scores? And why is that?

2. Decide if the BV is adequate
   Given the answers from 1, does the application have a high and adequate business value?
   - A critical application which supports important business processes of today normally has a high business value.
   - This is also true for an application which is expected to contribute greatly to future business goals or that benefit future industry competitiveness
Having a high functional value only may not be enough for a total high business value. Having a low functional value is however likely to mean a low business value. Performance problems may also have a significant effect on application users. If this is the case then the application is given a high business value since it is considered to be critical to the business, and will inhibit users and business activities if these occur.

If the application only has a small number of users or a small usage of the application occasionally may indicate low business value.

3. Decide which TQ attributes that are most relevant

Which technical quality attributes could be considered especially important given the business value attributes?

- Depending on what type of application the knowledge about the application and on how work with the application also becomes more or less important. How important is the usability aspect for this application?

- If the application is critical for the business but not expected to benefit future businesses, then availability becomes the most important aspect. Also the maintainability factor is important in order to minimize the cost and justify that it is more profitable to retain than disposing the application. If only a limited number of people understand how the application operates it may be difficult to solve problems that occur frequently and to many users. There is also an uncertainty factor to take into account if those persons are not available for some reason.

- An application with a high expected contribution to future business but is less critical today is likely to benefit from few dependencies with other systems as no decision on if to spread the application to a wide range of users is likely to have been taken. The easiness to phase-out or migrate the application as it could be both unsuccessful and successful in the future is therefore important.

- An application that is likely to be needed to adapt to new business processes often must have high maintainability in order to be able to do so without spending too much valuable resources.

- Applications that are considered to be valuable but not critical to business strategic success or critical for daily operations should only have a quality that is maintained in relation to the cost of failure as to keep the total cost of ownership low. The technical quality is often more important than the functional suitability and a way of keeping the total cost low could be to adjust the business activity to fit the application instead of doing the opposite.

4. Decide if the TQ is satisfactory

Given the answers from 3, a general assessment of the technical quality attributes must be done based on the achieved results and the known need and requirements for that particular application. Does the application need to improve its technical quality as one or more of the attributes do not reach up to a desired level nor can valuable resources be spent on more important improvements? To put it in another way, given resource restraints, is the applications technical quality good enough?
Apart from the weighting of the achieved results in 4, also three especially important factors must be taken into consideration before recommending what to do with the application.

1. Substitute

Is there any substitution (other similar application) that is likely to be better suited for the intended business process or function? If yes, then it might be an alternative to replace the application.

2. Application Lifecycle

Is the application lifecycle supported? Where in the lifecycle is the application found? What does this position imply for the management of the application? Will the application be supported during the whole application life cycle? If not, there is a need for improvement (redvelopment) or maybe the finding of a substitution (replacement), but it could also be that the application is found in the phase-out stage which obviously mean phasing-out the application.

3. Resources

What is capable of being done based on the resources available? Are there enough resources, financial as well as human, competence and skills to redevelop, maintain, replace or phase-out the application if needed? If not, it may be critical to educate the companies own employees, or to enlist the help of e.g. consultants.

5. Decide the recommended direction

When the adequacy of the business value and technical quality and the three scenarios has been reasoned through a recommendation can be reached and the applications' future direction be decided. This is also what the method aims for, to make the decision and optimize the utilization of applications in the portfolio.

7.2 Discussion about the theoretical framework

The theoretical framework has without doubt proved to be useful and given the APM method a stable and conformable foundation. The created APM method has more or less followed best practices claiming APM is mainly constituted of the steps: inventory, assessment, roadmaps and recommendations, and portfolio governance. However, these steps have been modified somewhat in this thesis and the APM method has consequently been decreased to only consist of three main steps: basic information collection (comparatively to the inventory step), overall assessment (corresponding the assessment step), and overall assessment and recommendations (essentially the roadmaps and recommendations step).

The scientific emphasis is particularly found in the qualities assessment step and the following overall assessment and recommendation step. In both cases the assessment is derived from the basic idea in Sommerville’s legacy theory; to analyze the business value and system quality. In this thesis system quality has been referred to as technical quality. These two aspects have been clarified, reviewed and compared to Scania R&D’s assumptions and interpretations of business value and technical quality. It is not obvious what business value and technical quality means, consequently in order to define these aspects the theories applied, e.g. Ward & Peppard (2002) on business value, together with theories from e.g. Wrenn (2005), Sommerville (2007) and
McFarlan (1987) has proven to be significant and valuable sources, and also corresponded to the interpretation of what business value is and includes from Scania R&D’s point of view. With that said, for the business value the theoretical framework has without doubt been useful and has reasonably explained and unraveled the complexity of business value as a concept. As for the TQ the main source have been Johnson & Ekstedt’s (2007) framework adapted to the stated definition of an application in this thesis, even if Vogelezang (2008), Nielsen (1993), Sommerville (2007) and Scania R&D have been valuable inputs too.

There have naturally been some drafting changes made for this thesis. The McFarlan matrix axles have been named criticality and strategic importance instead of value to the business of existing applications and the impact of IS/IT applications on future industry competitiveness as they are named in the theoretical framework, stating that the interpretation of the latter definitions actually describe and can be translated into criticality and strategic importance. These axles then explains the business value partly, the third business value aspect functional value has then been added to get a more comprehensive definition of business value.

Moreover, it is of course not possible to deviate from the fact that the theoretical framework is not entirely Scania adjusted even though many aspects of it are influenced by Scania requirements. The framework is thus a more general view on APM and best practices, but even so it has still been fully proved to be a good basis for further investigation and in particular the design of the Scania APM concept, and as a result also the final Scania APM method.

7.3 How the study can be used

This thesis has developed a very helpful tool for assessing an application portfolio at Scania. Likewise it helps the organization to;

- Review and overview the applications in the portfolio and applications that are potential targets to be included in the portfolio, as well as those that should be excluded.
- Optimize the use of applications in the portfolio, and the portfolio overall.
- For practical reasons; it is a framework/support for continuous operational work regarding the management of applications and getting control over the use of applications.

In the Scania APM method there are various techniques and models that are used which could also be utilized in future investigations in order to assess the portfolio and its content thoroughly and wisely.

- ALM aims to visualize the application lifecycle in order to determine what to do with the applications, how to manage them and identify legacy applications. It facilitates the assessment of the application lifecycle by graphically showing where on the graph it is found.
- The decision-tree facilitates the visualization of decision-making process regarding the applications. It is a good and accessible way for the traceability of decisions to be documented.
In the future it would also be interesting to be able to export and import the results given from an APM investigation into a large database, where all applications used at Scania are available, e.g. a database found on the intranet or maybe even SALT which is already exercised at Scania. SALT would then be complemented by the information gathered from the APM investigation, in particular information regarding applications that are developed in-house which currently is non-existing. The benefits of collecting the information in one place are many;

- All concerned stakeholders that are not physically located in Scania Södertälje will have access to the information gathered about different applications, not only commercial ones. Availability implies however, that it is also important to discuss who has the right to see what kind of information. Not all stakeholders will be interested in the same information or by all information. By enabling them to see certain parts of the database it would facilitate the usage of the database and assuring that confidential or restricted information does not end up in the wrong hands.

- Keeping the error-rate low since there will only be one database and not many e.g. excel-sheets to update and making sure of that they are also correctly updated.

- Enabling stakeholders to continuously review the current portfolio situation and also future expectations and plans about merging applications, stable applications and applications on their way to be phased-out (legacy).

The idea of gathering the data in one place could definitely be the topic in a follow-up thesis or further investigations at the department R&D at Scania.

7.4 Summary

The study has now established an Application Portfolio Management (APM) method which enables Scania R&D to control their applications in their portfolio, optimize the use of the portfolio and make well-informed decisions about applications lifecycles in order to efficiently manage their applications. Hence, the first objective of this thesis has been fulfilled. The Scania APM method consists of three main steps: basic information collection, qualities assessment and finally overall assessment and recommendation.

Each step has considered different aspects of information collection and assessments:

- **Basic information collection**: Which applications are included in the application portfolio and which type of information would be interesting to embrace and investigate in the portfolio?

Applications to be included in the Scania R&D portfolio have to be part of the R&D functional map and 2. Applications have to be managed and administered by Scania R&D.
Information to be included and continuously updated in the portfolio when conducting APM is found in the application inventory tab:

![APPLICATION INVENTORY](image)

**Figure 62**: The application portfolio - inventory tab

- **General**: description of functionality and usage, application version, available in language, supplier, manufacturer, application category, estimated lifetime.
- **Business**: supported business process, business process owner, business category.
- **Maintenance**: maintenance group, product responsible, ARD, BMM, SPO, expert user.
- **Assessment**: BV, TQ, date for last assessment
- **Security**: access control
- **Infrastructure**: status of infrastructure components, programming language, database type
- **Usage**: number of users
- **Licenses**: number of licenses, license type, costs
- **Operation**: operated by, SLA, availability demand
- **Cost**: maintenance, licenses, operations, total costs

- **Qualities assessment**: For a qualities assessment; which factors to consider and how can these factors be used to assess the application portfolio at Scania R&D? (The results from this assessment were and are of course also in the future implemented in the assessment tab in the application portfolio).

This thesis has highlighted the importance of business value and technical quality factors when assessing the applications in the portfolio;

- **Business value (BV)**: criticality, strategic importance and functional value.
- **Technical quality (TQ)**: interoperability, availability, security, usability and maintainability.

Given the BV and TQ rates these have also been implemented in the assessment tab in the portfolio.
- **Overall assessment and recommendation**: How to manage the applications given the results from the qualities assessment?

This step has the purpose of recommending how to manage the applications in the portfolio, if to phase out, redevelop, replace or maintain the applications in order to optimize the usage. With the help from different frameworks (e.g. ALM) and guidelines these recommendations have been possible to make and also to visualize in a decision-tree.

![Decision-tree](image)

**Figure 63**: Decision-tree – how to reach a recommended direction

Moreover, this thesis has also tested the plausibility of the proposed APM method, by first developing an APM concept, and then analyzing the results considering whether or not BV and TQ aspects were relevant and suitable for Scania R&D, and then modifying and improving where needed. Consequently the scope for this thesis has been fulfilled and related research questions answered.

The APM method is once again illustrated below:
Adequate business Value/system quality

Determine which applications should be included in the portfolio

Collect basic portfolio data

Perform BIA (Business Impact Analysis)

Perform FIA (Future Impact Analysis)

Surveys

Determine the future of analyzed applications in the portfolio

Adequate business Value/system quality

Phase out
Replace
Redevelop
Maintain

Application Portfolio Management Method

Basic Information Collection

Qualities Assessment

Overall Assessment & Recommendation
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APPENDIX 1

Business value questions in surveys including their metrics:

Criticality

- Are there any or several functions that the application supports and provide which the company cannot be without?
  - Do not know/not relevant
  - The function/s does not create any direct value for Scania
  - The function/s indirectly create customer value, but the business can after all do without this/these
  - The function/s does create added value for Scania customers
  - Without the function/s customer value will not be delivered to some of Scania's customers

- For how long will/ can Scania run properly if the functionality provided by the application/ applications is somehow lost, in order to keep contractual commitments, both internally and externally (today)?
  - Do not know/not relevant
  - The functionality is only needed on a long-term basis
  - The functionality is needed on a monthly basis
  - The functionality is needed on a weekly basis
  - The functionality is needed on a daily basis

- Is it possible to perform these functions manually or by using another available application for Scania? (At the expense of appointing or abolishing resources)
  - Do not know/not relevant
  - These functions can be performed manually or by using another application for a longer period and requires no further increased resources
  - For a limited time, the functions can be performed manually or by using another available application, it is not particularly resource demanding
  - For a limited time, functions can be performed manually or by using another available application, but it is resource demanding
  - No, the functions cannot be performed manually or by using another application

- Can a downtime influence decision-makers leadership opportunities? (Will it be more difficult to make decisions?)
  - Do not know/not relevant
  - No, the decision-makers will not inhibited to make decisions in any significant way
  - No, the decisions can still be taken even if these will not be based on a precise decision basis
  - Yes, but some decisions will be deferred, but it will not affect the company on a short-term as in the business functionality will be severely affected
Yes, policy makers will find it very difficult to make both decisions concerning current operations and long-term decisions regarding future operations.

- Can a downtime affect external stakeholders such as customers, suppliers and other public relations?
  - Do not know/not relevant
  - No, Scania is not affected at all
  - An erosion of confidence will not affect the stock market, retail or Scania's competitiveness significantly
  - Confidence in Scania will be damaged but can be repaired relatively quickly. The legal requirements are not extensive. Loss of competitiveness, but only in the short term
  - Yes, it will be a loss of competitiveness in terms of an erosion of confidence, which takes a long time to repair, or Scania will face important legal requirements

- Will a downtime affect the working environment?
  - Do not know/not relevant
  - No
  - Yes, the workload will increase, but it is a fact that will be accepted
  - Yes, the staff will find it very difficult or impossible to carry out duties imposed and the likelihood of outrage is imminent
  - Yes, the risk of personal injury exists

- What is the most acceptable downtime that will not seriously cause any negative business impact?
  - Do not know/not relevant
  - Downtime can be accepted more than a few days
  - More than a few days cannot be accepted
  - More than one day cannot be accepted
  - More than a few hours cannot be accepted

**Strategic Importance**

- Does the application support functions for increased competitiveness today?
  - Do not know/not relevant
  - No
  - Maybe
  - Yes, to some extent
  - Yes, definitely
How critical will the functions supported by the application be for future business activities with regard to stakeholders' confidence, customer impact, development, etc. in five years time?

- Do not know/not relevant
- Scania is not affected at all in the future if the application is not working properly
- Scania is not markedly affected by a stoppage in the future; backup is available
- The application is important for Scania in the future but not in terms of that the business would stall in case of a stoppage
- Scania is entirely dependent on the application in five years; a shutdown would stop operations, parts of the business and thus affect Scania externally

Will the functions supported by the application lead to increased competitiveness in the future, in five years time?

- Do not know/not relevant
- No
- Yes, in a near future (1 year)
- Yes, on a longer term, more than 1 year
- Yes, definitely, approximately or more than 5 years

Functional Value

Rate how well the application supports the business' intended functions.

- Do not know/not relevant
- Bad
- So-so
- Good
- Very good

Rate how well the application will support its future operation needs.

- Do not know/not relevant
- Bad
- So-so
- Good
- Very good

Is the information provided as output from the application adequately updated, relevant and accurate for its purpose?

- Do not know/not relevant
✓ Seldom
✓ Sometimes
✓ Often
✓ Always

- Under normal usage, do you consider the application to be fast enough to perform the functions/ tasks you use?
  ✓ Do not know/not relevant
  ✓ Seldom
  ✓ Sometimes
  ✓ Often
  ✓ Always

- Does it happen that the application is overloaded and slowed down if it is used more intensively than normal?
  ✓ Do not know/not relevant
  ✓ Often
  ✓ Sometimes
  ✓ Seldom
  ✓ Never
APPENDIX 2

Technical quality questions in surveys, including their metrics:

**Application Type**

- Application type – How would you describe the application?
  - It’s custom made (specifically for Scania)
  - It’s purchased but still modified to meet Scania’s needs
  - It’s purchased and considered a standard solution (common)
  - Not relevant
  - Don’t know

**Security**

- Are the users able to see information that the users do not need to perform their duties?
  - No
  - Yes, some users have access to internal information that they don’t need
  - Yes, some users have access to confidential information that they don’t need
  - Yes, some users have access to secret information that they don’t need
  - Not relevant
  - Don’t know

- Are the users able to change information that they don’t should or have reason to change?
  - No
  - Yes, but only information that does not impact the business processes or decisions to any great extent
  - Yes, and the information do impact the business processes and future decisions
  - Yes, the information impact important business processes or important decisions
  - Not relevant
  - Don’t know

- Is it possible to track the users’ actions?
  - No
  - Yes, it is possible to track when the user logon to the application
  - Yes, it is possible to track any changes the user does
  - Yes, it is possible to track what the user have accessed (looked at)
  - Not relevant
  - Don’t know
How well is the application being protected from attacks from outside of Scania or from people without a user name and password? (Human factors such as sharing the user name and password among people without permission is excluded.)

- Unprotected
- Poorly protected (but still protected)
- Sufficiently protected
- More than sufficiently protected
- Not relevant
- Don't know

Availability

<table>
<thead>
<tr>
<th>Ratio</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 &lt; ratio &lt; 0.9</td>
<td>No, far below</td>
</tr>
<tr>
<td>0.9 &lt; ratio &lt; 1</td>
<td>No, just below</td>
</tr>
<tr>
<td>1 &lt; ratio &lt; 1.1</td>
<td>Yes</td>
</tr>
<tr>
<td>1.1 &lt; ratio</td>
<td>Yes, with margin</td>
</tr>
</tbody>
</table>

The box represents the ratio for how to interpret the deviation of the availability from the Service Level Agreement (SLA).

Does the application meet the accessibility standard that was agreed upon (and is specified in the service level agreement)?

- No, far below (please specify)
- No, just below (please specify)
- Yes (please specify)
- Yes, with margin (please specify)
- Not relevant
- Don't know

Interoperability

- How standardized is the format of the data that application uses?

- The format could be considered special for this application
- The format is not supported by TBL but commonly used in the IT context industry wide
- The format is supported by TBL but quite uncommon at Scania as only a few applications use it.
- The format is both supported by TBL and commonly used at Scania
Maintainability

- **How well does the communication between this application and other applications, i.e. is the origin of data sent in compatible data formats and file are organized in a standard way so that information receiving application know how to read the information?**
  - The communication cannot be said to work well as problems frequently occur
  - Sometimes problems occur, which influences the work
  - Sometimes problems occur, but it is unlikely to affect the work
  - The communication works well
  - Not relevant
  - Don't know

Maintainability

- **Are all platforms (e.g. programming languages, operating systems, hardware) that the application runs on standard at Scania in accordance the Technology Baseline and does tools exist to migrate the application from one platform to another?**
  - At least one of the platforms are not standard. Porting tools does not exist
  - At least one of the platforms are not standard. Porting tools does exist.
  - The platforms are standard
  - The platforms are standard and porting tools exist.
  - Not relevant
  - Don't know

Maintainability

- **Is/ Are the platforms that supports the application of the latest stable version/s that is/ are available on the market?**
  - No, one or many platforms that support the application is very outdated
  - No, many platforms that support the application are lagging behind one version wise but they could still be considered modern
  - No, very few platforms that support the application are lagging behind one version wise but they could still be considered modern
  - Yes, all platforms that support the application are of the latest stable version
  - Not relevant
  - Don't know

Maintainability

- **How does the age of the application affect the application's maintainability?**
  - The application's age has affected the maintainability negatively as it is very difficult or very expensive to change/migrate to more modern platforms and/or to fulfill change requests compared to more newer applications.
✓ The application's age has affected the maintainability as it is harder to migrate to a more modern platform but not to such an extent that change requests become significantly harder to complete.

✓ The application's age has not affected its maintainability significantly, but is likely to do so in the future.

✓ Application of age has not affected the maintainability of the application and is not likely to do so in the future.

✓ Not relevant.

✓ Don't know.

• How many dependencies does this particular application have with other applications, application software and databases?

✓ Many (more than 6)

✓ Some (between 3 and 6)

✓ Few (more than zero but less than 3)

✓ None

✓ Not relevant.

✓ Don't know.

• Do adequate skills and sufficient resources to further develop/ change the application exist?

✓ No, the adequate skills and resources do not exist.

✓ The skills and resources exist to some extent.

✓ The skills are sufficient but not desired amount of resources.

✓ Yes, skills, resources and tools are all sufficient.

✓ Not relevant.

✓ Don't know.

• Do adequate tools to develop/ change the application exist?

✓ No, not at all.

✓ Some tools are available but some tools are missing.

✓ Tools exist, but they are considered difficult or unpractical to work with.

✓ Yes, tools that are well suited for this particular task exist.

✓ Not relevant.

✓ Don't know.
How well documented (without user help) is the application? (This applies to changes in the application, programming code, descriptions of the application's structure, but also both functional and non-functional requirements)

- You rarely find it you could demand in the documentation
- You sometimes find it you could demand in the documentation
- You often find that you could demand in the documentation
- You find what you could demand in the documentation
- Not relevant
- Do not know

Usability
Underneath is the questions asked to the users. These questions are made to be analyzed statistically as a lot of questions are asked.

The usability questions or statements are judged on an interval scale of zero to five where five is the best outcome (I strongly agree) a zero is the worst outcome (I strongly disagree).

- If necessary good support exist from what one could expect, (i.e. crib sheets, routines, available expert users, support)
- The application is easy to learn using available tools such as education, internal training courses, manuals, quick reference guides
- It is hard to make errors when performing normal tasks with the application
- It is easy to remember how to solve the tasks using the application (without the help of manuals, quick reference guides and/or support)?
- The application's interface feels satisfactory for my needs