Cost Modelling of Resources in the Personnel Life Cycle

A case study of the Swedish Air Force

Bachelor’s thesis within Informatics

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Abstract

Over the past few years, the Swedish Armed Forces (SAF) in similarity with forces in many other countries has been undergoing a major process of change. One of the major reforms is the government’s decision to replace the compulsory military service with a professional army. In order to manage this, SAF requires tools to evaluate the long-term consequences of different decisions regarding its manpower, such as different recruitment, training and educations policies, mission rehearsal, mission planning, and etc. These tools should, for instance, include information about different type of resources such as weapon systems and materials required for conducting training and missions, as they directly affect planning of courses, training sessions, etc. These resources have a total life cycle cost that besides the acquisition cost includes maintenance costs, cost for spare parts and cost of human resources which are required for training and deployment of the resource.

This thesis has been performed in collaboration with FOI (Swedish Defence Research Agency) in order to support development of a decision support simulation tool for assisting in the personnel planning process of the SAF. The main objective is to determine the connection between LCC (Life cycle cost) of personnel and LCC of system Hence, the study facilitates flow of information between the Human Resource Department at SAF and the Defence Material Administration (FMV) in order to base their decision making process on more accurate and complete information about resource costs related to different activities that are important to both organizations.

In this paper, the inductive approach is the chosen approach as appropriate theories are studied and used for making hypothesis in order to create a new model. Consequently the interpretive approach is deployed as it is associated with this reasoning style. Furthermore, the research purpose is exploratory as it is essential to identify the resources cost factors and the relations between them.

The research strategy is case study and the utilized technique for collecting primary data is interview. The secondary data is gathered by studying hard or digital copy of books, articles, journals, handbooks and dictionaries.

Hence, through a set of interviews, information about different activities regarding the education and operation phases of the fighter pilots at the Swedish Air Force has been collected. As a result a corresponding model consisting of resources employed in those
activities and their relation has been developed. The model is based on the Unified Enterprise Competence Modelling Language (UECML).

The contributions of this thesis are (1) Identification of the cost factors of personnel-related activities including courses, training sessions and missions, 2) Classification of cost factor elements in a number of classes, and 3) Illustrating the connections between the classes using UECML.
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1 Introduction

Managing human resources and planning different activities in an organization requires a clear understanding of different cost factors and resources which are possible bottlenecks in the personnel life cycle. “Many firms have moved ahead on the basis of this perceived need for more accurate cost estimates and have designed and implemented activity based costing systems”. (Schiff, 1991)

Identifying these resources is however not a trivial task. This is particularly true when organizations undergo major changes. Swedish Armed Forces (SAF) which consists of different types of military services such as Navy, Air Force and Army, has recently changed its policy of military service application from compulsory to voluntary. In 2010, SAF decided that the peacetime conscription should be ceased and replaced with contracted personnel, giving up a tradition that had started over a century ago (FOI, 2012, Website).

In order to manage this shift, SAF requires tools to evaluate the long-term consequences of different decisions regarding its manpower, such as different recruitment, training and educations policies, mission rehearsal, and mission planning. HuMaST (Human resource Management and Simulation Tool) is an on-going project at the Swedish Defence Research Agency (FOI), which aims at handling these issues. The project aims to investigate and survey the critical components of the personnel management and create understanding about SAF’s long-term requirements. “Companies attempted to forecast their human resource requirements in the medium to long term and then to analyze their ability to achieve the forecast levels. There was a very real need for appropriate analytical tools but few, if any, were available. Much effort was devoted to developing tools and techniques to assist managers with their planning”. (Parker & Caine, 1996)

HuMaST models and simulates the personnel organization of SAF. It enables a decision maker to upload a complete military organization using a database, set different policies such as the number, age and gender of recruits, number, period and length of courses and training sessions, required competency levels, etc. Given this data the decision maker can then run the simulation over a specific period of time, study how the organization evolves during that time and gather statistical data regarding different factors of interest. “Using simulation the impact of turnover on the rate and level of learning for hierarchies and teams is examined.” (Carley, 1992).

However, military organizations besides Human resources consist of other type of resources such as different weapon systems and materials required for conducting training and missions. These resources have a total life cycle cost that besides the acquisition cost includes maintenance costs, cost for spare parts and cost of human resources which are required for training and deployment of the resource. The organization responsible for calculating these costs is the Swedish Defence Material Administration (FMV).

Today there is a general problem as the existing modelling efforts either present a view of the life cycle cost of the systems (Asiedu & Gu, 1998, p. 883) or life cycle of personnel (Parker & Caine, 1996, p. 30-45), and there is no model that covers both. For this reason, these efforts do not explicitly consider relations between different cost factors related to system (material) and human resources presenting a knowledge gap that needs to be addressed (Petersen et al, 2010).

As a result, today HuMaST does not take into account the effect of using different resources in the recruitment process. In order to include this ability, a model regarding de-
ployment of resources in different stages of the recruitment process needs to be designed and integrated within HuMaST. This model needs to take into account the total life cycle cost of different material systems, including human resources required for education, training and deployment of those resources.

Therefore, this thesis aims to supplement the gap of information between FMV and HR department which can resolve some of the problems when making decisions in the planning processes. The main reason is that making decisions without considering all important elements leads to inappropriate output resulting in wasting money and time. Consequently the study presents a model which attempts to be a fundamental pattern for adding additional planning and cost calculation capabilities to the HuMaST simulation tool by investigating the education and operation cost factors of the fighter pilots in the Swedish Air Force. The thesis

In the initial part of my thesis, the identification of cost-making resource factors in education and operation phases such as courses, tutors (which are HR related cost factors), different systems such as, aircraft, simulators, etc. (which are FMV related cost factors) is done through interviews with experts.

In the second part of the thesis, these cost factors are presented and linked in a structured table, based on findings from interviews and meetings. Columns of the table denote the identified resources and the rows present different activities, such as courses, training sessions, exercises, etc. The empty boxes in the table are filled gradually during the course of the project. The UECML (Unified Enterprise Competence Modelling Language) model illustrates the result of what I found out and presents a quick outlook of pilot’s cost factors, which can support the decision making for new recruits, and the short and long term personnel planning of the Air Force.

1.1 Thesis Outline

This thesis is organized in the following order:

Chapter 1: This chapter gives an introduction to the whole project, the thesis objective and the thesis outline.

Chapter 2: This chapter introduces organizations involved in the study and describes the case scenario, the problem specification, the purpose of the thesis and the delimitations of the study.

Chapter 3: This chapter contains my literature review and the theoretical framework, which includes theories that are used as a basis for collecting data and structuring the final model.

Chapter 4: In this chapter, selected methods and techniques of data collection are presented.

Chapter 5: The designed model using UECML (Unified Enterprise Competence Modelling Language) and the steps in designing according to the model are illustrated and presented in this chapter.

Chapter 6: Finally, in chapter 6 conclusions are reported and future work is pinpointed.
2 Background

Absorbing new staff counts as a marketing power of a Human resource department (HR). Therefore, these departments have established methods for attracting more groups and managing them within their organizations. Positions at Swedish defence follow the same rules and policies as the other regular jobs in Sweden with respect to insurance and possibility of terminating ahead of time. Consequently, the responsibility of army to attract and keep their staff is not an easy task. It has to provide an attractive working environment with carrier opportunities and in which a person is able to affect its working situation.

Achieving this objective should be an obvious goal of an organization and something that leaders can base their strategies on. Hence, clear strategies regarding this aspect of the organization are required. To cover this mission, an exhaustive blueprint of the staff state from the point they join the army until they terminate their employment is considered as an essential requirement for HR.

Responsibilities of HR include activities such as, selecting, developing, training and managing the staff. However, in this thesis, Air Force (that is described more detailed in the following chapters), is interested to get a clear picture of how each pilot’s life cycle affects the material and non-material costs of the organization. Non-material resources (knowledge, know-how and social attitude) and material resources (instruments, machines, etc.) should combine in an efficient manner in order to respond to the need of an activity (Pepiot et al., p.132). For this purpose we need to identify what resources Fighter Pilots require during their employment and how these resources affect different phases of their life cycle. Another question is whether any model (which focuses on the human resources) can support planning a strategy for acquisition of the material and non-material resources for the recruiting process. Normally some of the resource cost factors which are part of the personnel (pilot) activities are being considered and taken into account by Swedish Defence Material Administration (FMV), but these cost elements are not considered in HR. Hence the cost alterations caused by recruiting new personnel are intangible for HR. This leads to management issues regarding SAF’s long-term requirements for planning and managing personnel. Generally, cost estimates assist managers to have efficient decisions on product line, human assets and price “Systematic biases in cost estimates may also lead to distortions in flexible budgeting systems, variance analyses, and responsibility-accounting systems” (Banker & Johnston, p.576). In the case of SAF these issues are related to uncertainty regarding available human and material resources which are required for conducting courses, training sessions, exercises and missions.

2.1 Presentation of Organizations

In this chapter, the organizations which are involved in this study are introduced to give an overview of their mission. FOI is the research institute where the thesis project has done there. The lack of communication between FMV and HR department is the motivation behind my thesis research, and different activities of the fighter pilots at the Air Force during their education and operation periods constitute my target case study.
2.1.1 Swedish Defence Research Institute (FOI)

Swedish Defence Research Institute (FOI) is an assignment-based authority under the Ministry of Defence. The organization employs around 970 people of who around 800 are research skilled employees with a range of different backgrounds, such as physicists, theorists, lawyers, social scientists, chemists, engineers, mathematicians, economists and IT technicians (2010). Hence, FOI is the largest research institute in Sweden. FOI’s vision is to be “In demand as a world leader in defence and security issues, thereby contributing to a safer and more secure world.” (FOI, 2012, website).

Major assignments of FOI are research, method and technology development analyses and studies in addition to studies for the use of defence and security. FOI is one of Europe’s leading research institutes in the areas of defence and security and is particularly successful when it comes to EU-financed projects (FOI, 2012, Website).

FOI offers its customers principal expertise in a great number of fields, such as security-policy studies in defence and security, IT security, evaluation of threats, systems for crisis leadership and executive, defence against and management of hazardous substances.

The Armed Forces (SAF) and the Swedish Defence Materiel Administration (FMV) are FOI’s major customers, and FOI also have some assignments from the civil industry.

FOI has many international customers, cooperation partners along with foreign establishments, research institutes and various. A number of the most significant are the European Defence Agency, EDA and NATO/PFP, and cooperation with the Nordic countries, USA, Canada and the Netherlands.

2.1.2 Swedish Defence Materiel Administration (FMV)

Swedish Defence Materiel Administration (FMV) is an independent civilian authority. Its main assignment from the Government is to supply products, services and systems to the Swedish Armed Forces, and their mission is to “create defence capability”.

The other main task of FMV is to look into existing products and services and offer cost-effective and creative solutions for material and method development. In addition to the main task, FMV has assignments from other agencies within the civil security segment (FMV, 2012, Website).

FMV collaborates with many other organizations nationally and internationally to deliver cost-efficient solutions to the Swedish Armed Forces (SAF) and other government agencies. To do so, FMV is required to perform life cycle cost analysis of different systems that are being purchased or planned to be.

2.1.3 Swedish Armed Forces (SAF)

The Swedish Armed Forces (Försvarsmakten) is a Swedish Government Agency (Mynighet) responsible for the operation of the armed forces of the Realm. The main responsibility of the agency is to train, arrange and to deploy military forces in addition to cross-border education and training and even train Army forces in the long-standing skills required to defend the Realm in the event of war. The Supreme Commander (Överbefälhavaren) is the head of the agency, and is the highest ranking officer on activity duty and in turn reports through the Minister of Defence to the Swedish Government. Since 1994, the
three military service divisions including the Army (Armén), the Air Force (Flygvapnet) and the Navy (Marinen) are constituent of SAF Agency (Forsvarsmakten, 2012, Website).

At the present the Swedish Armed Forces units are on deployment in Afghanistan (ISAF) and Kosovo. Furthermore, Sweden supplies as the lead nation for an EU Battle Group once every three years and contributes with armed observers in a variety of nations.

2.1.4 Human Resource Department at SAF

Army, naval and flying schools and centre units trains their response unit which are then deployed for the national and international mission. The Armed Force’s organization is constituted of an authoritative command, a training unit, schools and centres. The National Defence Training units also have swift response resources on standby situation in the form of guard forces, anti-terror units and security units.

The Human Resource department’s (HR) mission is to build up and implement HR plans and policies to recruit, extend and retain personnel to effectively support the SAF in all operations it is asked to execute including Fighter Pilots which are our target group in this paper (Forsvarsmakten, 2012, Website).

To take part in an officer training, one has to pass through a conscript training and take some theory-based training courses. Focusing on the officer’s activities, leadership, and competencies such as efficient deployment of the battle expertise, and leading and instructing other combatants are HR responsibilities. These competencies are trained at the Swedish Armed Forces' units, schools or centres and at the Swedish National Defence College.

2.1.5 The Swedish Air Force

The Swedish Air Force main tasks are to arrange and train Air combat, Command and control and Base units which must be capable of being deployed on both national and international scale and perform with land and naval units in order to compose the mission-oriented equipped units of the Swedish Armed Forces (Forsvarsmakten, 2012, Website).

Air Force combines both manpower and materiel facilities to create different specific units depending on the nature of the missions at hand. The Air combat units have to be prepared to take part in military operations beyond Sweden’s borders during missions, and in peacetime the Swedish Armed Forces must also be capable of being used in support of the civil community. The Swedish Air Force consists of Flight units comprising:

- Air combat units
- Transport aircraft units
- Helicopter units

And Base units and Command and Control units, comprising:

- Signals intelligence (SIGINT) units
- Air surveillance units
- Base and command units
2.1.6 Air Combat Training School

The Air Combat Training School was established on 1 January 2005. The LSS consists of three division includes Flying School, Command, Control and Air Surveillance School and the Aircrew Training School (Forsvaretmakten, 2012, Website).

LSS gives excellent facilities to its personnel and is known as the core centre for the development and training of the Swedish Air Force. The main assignments of LSS are related to preparedness of combatants. Besides the main task, the Air Combat Training School participates in the constant monitoring of Swedish airspace.

An important assignment of the Air Combat Training School is participating in the development of materiel, methods and units of the air warfare.

2.2 Case description

Estimating changes in buying new systems and materials is a basic forecasting concern, when anticipating changes in the Swedish Air Force economy. This enables the planning experts (decision makers) to forecast the requisite material schedules and thereby estimate whether any extra workforce (personnel) is needed in future, how to plan activities such as courses, exercises and missions for that workforce, and what additional resources are required to accomplish these activities (Coetsee, 1999, p. 205).

A key component of HR is predicting the number and type of people needed to meet organizational objectives. HR can consider new systems and any alteration in using materials to forecast staffing needs and whether the resulting costs are within the HR’s financial frame (Forsvaretmakten, 2012, Website). HR also has to recruit, train and maintain their personnel based on the available equipment, weapons, systems and other material resources to avoid facing the problem of lacking facilities for their personnel and inability of responding to their needs in short-term and long-term. Hence, HR planning process needs to take into account the rest of the organization’s strategic plans, especially FMV to be more accurate and precise.

FMV also needs to set policies regarding material and acquisition process by considering the personnel’s needs and abilities for example buying a new system requires an expert instructor to teach the army staff on how to use it (FMV, 2012, Website). The real time communication is required between different parts of the organization and it is problematic that there is little communication between HR and FMV, which raise issues when FMV does not anticipate the HR costs in their total personnel cost.

Furthermore when plans are changed, the effect of the changes must be estimated. For instance changes in the FMV’s strategic plans regarding material resources must be taken into account by HR and when HR makes changes in its policies, the effect of that should be considered by FMV while calculating the total cost of involved material resources.

The main focus of this essay is on interaction between HR and material acquisition sectors and finding out the intersection of those in order to improve their relations resulting in efficient cooperation between these two sectors and cost-effective utilization of resources.
2.3 Problem

Human resource department is responsible for planning education and career of their personnel to fulfil organizational needs by making sure that enough resources are available to them through different stages of their working life cycle. However there are some issues that have to be dealt with in order to accomplish this mission. One issue is that HR financial planning is not based on well-identified cost factor resources and the other issue is that there are some knowledge gaps between Human Resource (HR) department and FMV which potentially cause a number of problems for both departments in Air Force “Real-world business processes are resource-intensive. In work environments human resources usually multitask, both human and non-human resources are typically shared between tasks, and multiple resources are sometimes necessary to undertake a single task.” (Ouyang et al., 2010).

The first issue is due to HR lack of knowledge about the cost factors of each personnel during his/her life cycle in Air Force. As long as HR is not aware of different cost factor resources such as Instructors, Aircraft, Simulators, Facilities, etc. questions regarding for instance the number of instructors or systems (Aircrafts or Simulators) which are needed in a course, the number of students could be in one class or availability of required facilities for learning can’t be answered.

The other issue is that HR plans its strategy based on the current data and experiences gained during the last years and not based on defined a pattern or a model. The dilemma reveals itself when a new system (a weapon system or any other system used by military personnel) is proposed to the education department which creates ambiguity because of inadequate knowledge about the required resources, such as the required length of training, required number of instructors and their availability, etc. When I during my interviews with experts asked questions such as availability of skilled instructors for teaching new systems or the number of students which can utilize each tool in time, the answers were not precise.

For the FMV perspective the lack of information flow causes some other problems. As FMV receives no or little information from HR department, it does not consider HR related facts which are important in its decision making process. For instance activities planned by HR where systems are deployed affect those systems total life cycle cost and need to be taken into account by FMV.

This is particularly important when purchasing a new system. To decide on a system FMV evaluates and compares candidate systems and selects an appropriate one based on specific criteria, one of which is the total cost of that system. But if FMV does not consider an increasing cost effect of selected system caused by education activities it does not have the proper foundation for making its decision.

Hence, the knowledge gap is a problem that needs to be addressed. The existing modelling efforts do not define different cost factors related to LCC of personnel (e.g. the existing LCC models do not consider all cost factors of systems) nor show the explicit relations between cost factors related to non-material resources and human resources (Petersen et al, 2010).

In order to deal with this knowledge gap I employ different methods. To start with I decided to choose a descriptive method, and register and document the information through interviews and take advantage of existing theories via literature reviews. In order to identify the relationships between different cost factors and design a model that illustrates these re-
2.4 Purpose

The general purpose of this study is to investigate the following issues:

1. What connection there exists between LCC of personnel and LCC of system?
2. How can this connection be identified and expressed in terms of cost factors and their relations?
3. How can a model that illustrates the cost factors and their relations be developed?

Specifically in this case study I aim to build a model to fill the knowledge gap and create an information flow between HR and FMV. The “Model” shall illustrate the relation between the personnel life cycle (PLC) and deployed resources.

The objective is to assist the future decision making process in Human resource department overcoming the challenges regarding human resource policies in SAF via utilization of modelling and simulation. Human capital Management and Simulation Tool (HuMaST) is an existing simulation tool developed by FOI which aims to predict possible future states of SAF given different personnel policies.

By changing the numbers and increasing and decreasing the probability of each factor in the simulation tool it gives an observable diagram for comparing the personnel states in different years. Today however there is need for a model for calculating system acquisition costs which can be incorporated in the HuMaST simulation tool.

In short seen from the life cycle cost (LCC) perspective, the thesis shall high-light the cross-section between LCC of personnel (Personal Life Cycle) and LCC of system (FMV), identifying the cost factor resources (and their relations) which have effect on Air Force personnel planning.

2.5 Delimitations

Delimitations are about expectations of the research. There are three different types of delimitations in this study. First of all I mainly concentrate on part of the Army Forces, namely Air Force. Secondly, the focus is on the education and operation phases of PLC (Described in the theoretical framework), as the other phases have little or no relation to LCC of systems.

Finally, the HuMaST simulation tool is only concerned with the different cost factors and their impact on the personnel planning process, and does not take into account the competencies of the personnel. Hence competencies are not explicitly defined or modelled in the tool as they do not directly affect the personnel life cycle or the total cost of the personnel. And since the model that is being developed in this study will be deployed in HuMaST, I do not consider competence aspects of UECML here.

The ultimate goal of HuMaST is to contain models for predicting the future resource requirements and supporting establishment of new policies for the entire Swedish Armed Forces. However, SAF includes Army, Air force and Navy and since covering all these branches would require a much longer time than it fits within the time frame of this thesis.
we decided to focus on the Air Force. Air Force has already some of their education activities in the Defence Flight School, and since modelling from a known pattern can increase the speed and accuracy of the information, it seemed a logical choice. Later on FOI can extend this work by inclusion of Navy and Army.

Since SAF has just recently changed its policy of military service application from compulsory to voluntary there is little data (collected by HR) regarding soldiers. Hence it was decided to focus on pilots (specifically fighter pilots) as there is more historical data about their PLC.

From theoretical perspective, the life cycle of military personnel from the time they enter the SAF till they get retired includes acquisition phase, operation phase and settlement phase. However, this study focuses only on the education subdivision of the acquisition phase and the operation phase as these are the phases which have more impact on the LCC of systems and also in order to achieve FOI’s research goal considering my limited research time.

Applying UECML (unified enterprise competence modelling language) and not UML for presenting the Model has some advantages which are mentioned in detail in the coming sections, but in brief the main advantage with UECML is its focus on HR and Material and Non-Material resources. My effort is on illustrating the resources (and their relations) that cause competence advantage without actually considering competency, as (again) my project has to be align with FOI’s project mission.
3 Methodologies

3.1 Research design

Matching research questions to appropriate study designs is essential in each research. The frame of the research is considered as a research design and deals with research questions, the methods and techniques of collecting data and analysing that data. "Research design should be a reflective process operating through every stage of a project" (Hammersley & Atkinson, 1983, p. 28).

3.1.1 Reasoning style

Through this study, the attempt has not been to test or prove whether a theory is right or wrong, therefore the approach has not been deductive reasoning style. "Deductive reasoning is linked with the hypothesis testing approach to research. With deductive reasoning the argument moves from general principles to particular instance" (Williamson, 2002, p. 26).

Consequently, inductive reasoning style was the chosen approach in this study. Since selecting appropriate theories, keeping those in mind and taking advantage of them for making hypothesis in order to create a new model is inductive reasoning, I employed this method to gain the desired result. “Inductive reasoning begins with particular instances and concludes with general statements or principles. Inductive reasoning is associated with the hypothesis generating approach to research. Field work and observations occur initially and hypotheses as generated from the analysis of data collected” (Williamson, 2002, p. 27).

3.1.2 Research approach

The two major approaches are broadly labelled 'positivist' and 'interpretive'. The first term used is positivist where researchers attempt to apply research methods used in the natural sciences to the social sciences. Deductive reasoning is mainly associated with the scientific (positivist) approach to research. Interpretive approach is when researchers emphasis on the statements made by people (collecting qualitative data) as they interpret their world. Interpretive approaches are associated with inductive reasoning.

Research designs are mainly based on inductive reasoning. Researchers attempt to make sense of the situation, without imposing pre-existing expectations (Patton 1990, p. 44). Data are collected, analysed, and then “Researchers develop concepts, insights and understanding from patterns in the data” (Reneker 1993, p. 499).

3.1.3 Research purpose

There exists certain straightforward factual information (what, who, how many,) which can be measured at a particular point in time. Somehow questions may require the high level of control afforded by experiments. Qualitative methods are particularly appropriate for exploratory research and used for those researches which are supposed to explain some issues by answering to ‘why’ and ‘how’ questions.

Exploratory research “…is aimed at formulating more precise questions that future research can answer. It is used in the theory-building stage of research. Exploratory research frequently use qualitative research methods such as case studies and phenomenological studies” (Shanks, Rouse and Arnott 1993, p. 7), Hence Exploratory research is used to explore and investigate some issues by re-
sponding to ‘How’ questions. In my case study, exploring the resource cost factors was done by focusing on the research questions of “what are the cost factor resources of fighter pilot in Air Force?” and “How to model personnel costs resources for recruitment decisions?”

3.1.4 Research strategy

Strategies that can be employed here include: experiment, survey, case study, action research, grounded theory, ethnography, and archival research (Saunders et al., 2007).

In this thesis a single case study is used, mainly because the work focuses on one specific case (fighter pilots) in the Swedish Air Force for the exploratory research and provides the explanation of how the elements (resources and activities) affect each other. “Single case designs are usually appropriate where the case represents a critical case, where it is an extreme or unique case, where it is revelatory case, or where the research is exploratory” (Yin 1994, p.38-40).

3.1.5 Research method

The research method could be either single, multiple or mixed. This research adopted qualitative single method, which is well-suited to my goal of explaining interconnections between different cost-related elements in the form of a model. “Single-Case Research Designs provides a notable contrast to the quantitative methodology approach that pervades the biological and social sciences. While focusing on widely applicable methodologies for evaluating interventions—such as treatment, education, and psychotherapy using applied behaviour analysis—this revised edition also encompasses a broader range of research areas that use single-case designs demonstrating the pertinence of this methodology in various disciplines, from psychology and medicine to business and industry” (Kazdin, 1982).

This project have a qualitative approach as the desired research finding is a “Model” as opposed to the quantitative approach which requires statistics and figures type of results. Qualitative approach includes “data that approximates or characterizes but does not measure the attributes, characteristics, properties, etc. of a thing or phenomenon. Qualitative data describes whereas quantitative data defines.” (BusinessDictionary, 2012).

The compatible technique which is utilized to reach our purpose through qualitative approach is conducting interviews, which is one of the qualitative research techniques that is usually deployed in a case study “There are different research techniques for collecting qualitative data includes sampling questionnaires and interviews, focus groups, ethnographic techniques, Interview and one of the techniques which are frequently used in case studies is “interview”. (Williamson, 2002).

In qualitative research, analysing the data has done by transcribing, and based on theories categorizing and illustrating the data.

3.2 Data collection

In order to achieve the purpose of any research, and finding the answer of the research questions, it is necessary to gather relevant data. Thereafter it is possible to confirm the hypotheses, or provide answer(s) to the research question(s). This can be achieved by considering the collected data, to provide credibility to the result.

Furthermore, to become certain that there is a concrete ground for the research, it is crucial to clarify which type of data is required, ‘primary’, or ‘secondary’. Primary data is the data
directly collected from the source of the data, hence it is called primary. Secondary data on the other hand is the knowledge which is gathered from sources that refer to the original source, such as references in published books or papers. Besides, a variety of data collection techniques can be employed, such as questionnaires, interviews, and observations. Such techniques are utilized to collect essential information to achieve the purpose of the research (Saunders et al., 2007, p. 303).

In this thesis, I collected primary data through interview with eight persons in various positions which I describe in more detail in the Interview section. “Primary data are, data collected specially for the research project being undertaken; while secondary data are data were originally collected for some other purposes” (Saunders et al., 2007, p. 598). The type of interview which was suitable for gaining the desired result was semi-structure interview since this type in addition to a standard list of questions (Appendix II) allows the interviewers to ask the questions which come in mind during the interview sessions (Williamson, 2002, p. 242). Furthermore I took the advantages of using secondary data by studying hard or digital copies of books, articles, journals, handbooks and dictionaries.

### 3.3 Data analysis

“A general data analysis strategy is an important part of the case study design, as a major practical difficulty of case study evidence is dealing with amount and variety of data collected” (Yin, 1994, pp. 102-125).

In data analysis there are no strict rules which have to be followed. Instead qualitative researches suggest techniques to help ‘make sense of data’, and to interpret it”, such as transcribing and categorizing the data, playing with ideas, writing memos, conceptually organizing the categories, undertaking word searches, forming tentative theories, asking questions and checking hunches. **Transcribing the data** means typing the notes or interview tapes into a word processor, making the information more accessible and easy to analyze. **Categorizing the data** is to make sense of the data and is one of the most common techniques suggested. Glaser and Strauss (1967) indicate that researchers are likely to develop two types of categories: descriptive and explanatory. Descriptive categories are those which emerge because the respondents use them to talk about their own processes and behavior, while explanatory categories tend to be abstract concepts developed by researchers to explain processes and behavior.

**Conceptually organizing the categories** is something researches should do continually throughout the analysis. It involves thinking about the relationships between categories, the conceptual similarities and differences and representing the relationships pictorially (Williamson 2002, p. 296).

There are different research techniques for collecting qualitative data including sampling questionnaires and interviews, focus groups and ethnographic techniques. Interview is one of the techniques which are frequently used in case studies.

#### 3.3.1 Interview

Based on initial investigations and discussions with the people involved in the project, interview was determined as an appropriate technique for this research, since exploratory interviews were found to be very useful in the early stages of my research project.

As explained in the previous sections identifying resources (factors) which play an essential role in SAF’s decision making regarding personnel planning has been the focus of my the-
sis. Therefore, my goal was to gain knowledge about these resources from persons working with personnel planning, LCC, and modelling. Even pilots were an interesting target group for assisting me in mining the essential factors.

The types of participants who are involved in a study are always important in order to increase the probability of gaining the right information. As a result, eight interviews were planned and took place at FMV, SAF and FOI in the duration of 2 months. There were also a number of meetings with project leader, Farshad Moradi, and other project group members who were involved in the project. These meetings helped me to step by step move the project forward by providing the required resources and supporting me in identifying and selecting right interviewees and planning the interviews. Maria Hedvall and Malin Ivarsson were responsible persons to contact the interviewees and manage the interviews during this process. Below is the list of persons who I interviewed, followed by their positions and affiliations:

- John Medin Lieutenant Colonel, Pilot training, HQ Training & Procurement (Air Force)
- Jan Frisén Svetoft, Head of FLSC (Air Force Air Combat Simulation Centre), FOI
- Martin Caster Senior Scientist at FLSC, FOI
- Göran Berg Logistics Procurement Command, FMV
- Farshad Moradi, Head of the Modeling and Simulation Centre, FOI
- Ulf Schröder Deputy Head of Planning Dept, Personnel Staff, SAF
- Maria Axelsson Expert, Personnel Staff, SAF
- Farzad Kamrani Scientist working in the HuMaST project, FOI

From different types of interview including Structured, Unstructured, and Semi-structured I found Semi-structured as the most suitable type for my work. I used the method as the first step in the collection of primary data since it allows for flexibility in questioning and the follow up of interesting leads.

In order to prepare the interviewees I formulated a set up of questions that were emailed to them ahead of the interviews. The purpose of the questions was to provide me information regarding different activities during the PLC of pilots and resources required for performing them. As I needed to get a clear picture of how LCC of material is defined according to FMV, I also prepared questions regarding the material LCC. To help interviewees with their task, I provided information about the purpose of the study and my definition of activities and resources. The interview questions were divided in two sections covering both education and operation phases of the pilots PL, focusing on the activities conducted in each phase. Since I needed to gather information about both material and non-material resources I made a clear distinction about these different types. Based on the literature study I already had some idea about the type of resources that were required, such as fuel, flying operation labour, maintenance labour (Reddick, 1975). This information helped me to be better prepared for the interviews.

Questions that were asked during the interviews were besides the written questions (that were emailed to the interviewees ahead of the meetings (Appendix II), also included questions that came up in mind during interviews. With the permission of the interviewees their voice were recorded and the essential points were written. The advantage of conducting interviews was in giving me the opportunity to control the context of the interview to some
extent and ensuring that respondents would concentrate on the issues at hand, by repeating and illustrating the precise meaning of my questions.

3.3.2 Synthesize data

The interviews provided the data required for designing the model that would address the identified knowledge gap. I managed to sort out the existing activities in the education and operation phases of the pilot’s LCC and resources deployed in those activities. The different features of those resources were also pinpointed.

After recording the interviewees’ voice and registered the required information, it was time to arrange and categorize the collected data in a structured manner. Basically, the face-to-face interaction assisted me in the step by step establishment of the fundamental form through categorizing the gathered data in a table which result in creating a model.

The first step was designing a table that helped me to structure the data. This way I could also identify empty and full boxes which represented the collected and missing data. The first column in the table, as depicted in figure 4-1 is tagged “Process” and is composed of information based on LCC of personnel. The “Process” column consists of all activities planned and executed during the education and part of the operation phases of the fighter pilot PLC. The four consequent columns are settled based on extracted information about Human and Material cost resource attributes from interviews. The second column, “Activity”, presents different attributes used for defining an activity, such as the type of the activity, its duration and fee (Appendix IV). The following three columns include information about different resources required for performing each activity and are divided into three groups, Human Resource, Material Resource, and External Service. Each group consists of additional subgroups representing different types of resources. The required Human Resources are registered as Flight Teacher/Instructor and Personnel, and Material Resources as Aircraft, Simulator, live ammunition and Infrastructure cost. External services include Medical support, Cross-border Education Training, Control Centre and weather prediction. Each of these subgroups are either divided further or defined using a set of attributes. For instance the Simulator resource has type and number as attributes (for detailed information see (Appendix IV).
The boxes intersecting rows and columns are filled by Y or N sign which stands for yes or no, and indicate whether a resource is deployed in a process or not, i.e. presenting the existence or not existence of the association between the resource attributes and LCC of Personnel (education and operation phase). For instance not all activities deploy simulators or aircraft. Information gathered in columns and rows present the attributes in the designed UECML model.

<table>
<thead>
<tr>
<th>Process</th>
<th>Material</th>
<th>Resource</th>
</tr>
</thead>
<tbody>
<tr>
<td>BasicMilitaryEdu</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>ComplementaryMilitaryEdu</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>OfficerProgramme(1stAca)</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>FighterPilotProgram(2ndAca)</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>GBU/groundapp/flighttraining</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>CTU/groundapp/flighttraining</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>FighterPilotProgram(3rdAca)</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>CET/ConversionTraining</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>CRT/ConversionTraining</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>WorkExperience/Projects</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>InternationalCourses</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>HigherMilitaryEdu(Magister)</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>InternationalActivity</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>DailyPhysicalTraining</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>DailyExercises</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Mission courses&amp;Training</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Mission</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>1stSquadronActivities(high readiness)</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2ndSquadronActivities(becoming ready)</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>3rdSquadronActivities</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>4thSquadronActivities</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Headquarters Activities</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Flyflans-osel(take off, flying, landing)</td>
<td>Y</td>
<td>N</td>
</tr>
</tbody>
</table>
4 Theoretical framework

The basic concepts used for building the theoretical framework are HRP (Human Resource Planning), PLC (Personnel Life Cycle), LCC (Life Cycle Cost) and UECML. The theoretical framework presented here is employed for deciding what data to collect for the study and how to interpret the collected data and build our target model.

In this study, HR’s life cycle cost for the Fighter Pilots as the cost making entity is examined. Considering that the LCC of pilots has numerous phases, in order to limit the research area, the education phase and operation phase are the only phases investigated in this work in order to focus on the essential issues and address the existing information gap.

Designing the initial phases of the model requires identifying the most essential cost driver resources of PLC. Analysing PLC and LCC of deployed systems assists us to bring out the main cost drivers and reveals the relationship between those factors. For this purpose data is collected via associated expert interviews in the research area. Data is then modelled using the Unified Enterprise Competence Modelling language (UECML).

4.1 Human Resource Planning (HRP)

Human resource management key to success is sufficient supply of appropriately skilled people, which has led to the appearance of human resource planning (HRP) as a personnel management tool. ‘‘The impact of human resource management (HRM) policies and practices on firm performance is an important topic in the fields of human resource management, industrial relations, and industrial and organizational psychology” (Boudreau, 1991; Jones & Wright, 1992; Kleiner, 1990).

Human resource departments attempt to forecast their human resource requirements in the medium to long term and then analyse their ability to achieve the forecast levels. Consequently, most organizations feel the need to predict future human resource stages in order to forecast enrolment and training needs and to ensure that sufficient experienced people are rising through the ranks to fill vacancies at higher levels. ‘‘HRP is in essence a process of ensuring that the correct numbers of human resources were available at the right time at the right place’’ (Parker & Caine, 1996). For this purpose there is an actual need for appropriate analytical tools but few, if any, are available. Hence, much attempt is devoted to developing professional tools and techniques to assist HR managers with their strategy planning.

4.2 Personnel Life Cycle

The Personnel Life Cycle (PLC) is being defined and deployed by different Armed Forces in slightly different ways although they all mention the same process and activities that starts from the initial phase of identification of personnel needs until the individual leaves the organization. The personnel cycle that I deploy in my thesis is divided to a set of phases defined by the Canadian personnel cycle frame work and Swedish Air Force requirements (Canadian National Defence, 2002).

The major phases are depicted in figure 3-1 below and include, Identify HR Requirements, Recruiting and Selection, Development, Employment and Deployment, Transition. Each phase of the PLC is in turn comprised of a set of activities, not described here.
The framework that I come up with focuses on the Employment and Deployment phase which covers the Educational and Operational activities in order to fulfil the knowledge gaps that are recognized for our modelling purpose. The interview questions are asked based on this framework to gain the proper answers and collect data required for assisting us to complete our model.

Through interviews each answer is considered as a piece of knowledge in our modelling puzzle. By stepping forward and conducting more interviews we come closer to our goal of developing the final model. The assistance and cooperation of staff and the support of responsible individuals were another strong point for increasing the interview efficiency and the richness, reliability and validity of gained information.

Figure 4-1 Personnel Life Cycle as defined by the Canadian Defence adapted from CanadianNationalDefence

4.3 LCC

In this study, I took the advantage of the life-cycle costing technique to carry through an analysis of the costs for pilots over their whole personnel life cycle. In order to reduce the total cost of a product, system, an asset or human factors such as labour (Durairaj et al., 2002, p. 39).

A theoretical framework will be presented where the basic labour cost categories are examined. The framework is thereafter applied in a case study of pilots in the Swedish Air Force. In the following passage is discussed what LCC is and how it is deployed for fighter pilots in Swedish Air Forced.

“Life-cycle costing is a method of analysis used when quantifying the costs related to a production system or a product during its life cycle” (Dahlen et al., 1990, p. 462).
According to Dahlen & Bolmsjö (1996) the life cycle cost method can be broken down in the following steps:

1. Identify the basic cost categories connected with the production method.
2. Divide the basic categories into sub cost categories.
3. Define and quantify elements of costs.
4. Estimate the economic lifetime of the whole production system and its different parts.
5. Sum up the costs and relate these to the number of produced parts.

The usual LCC-graph for a system has a shape of a bathtub, as shown in figure 3-2 the curve in cost-time graph represents the probability of risk for system falling down. Usually in the initial phase of the chart, the slope is upwards because of high demanding cost of start-up, installation, selection and purchase. After managing and categorizing, the normal flow of job results in reduction of the costs and keeping it in a constant line in the graph. However during the final phases the systems repairs, distraction, rehabilitations, etc. create additional costs. (Dahlen & Bolmsjö, 1996)

These phases in the production systems are known as: the Acquisition phase, the Operation phase and the Disposal phase. Some authors however, divide the life cycle into four phases where an initial phase is added to the previous three.

LCC method is used as a foundation for a number of organization decisions. Life-cycle costing can present information about which input or other types of entries bring the lowest production costs and how to organize the most cost effective system chain. Additionally, LCC has been used to illustrate the total costs associated with the development, improvement, marketing, assembly and production of a product during its total life cycle (Asiedu & Gu, 1998, p. 883).

In view of the fact that the life cycle focus is directed on the investments in production, the costs for personnel are usually not considered as much. The personnel production development can be regarded as their knowledge and services they offer in limited times.
The main point of these thesis states personnel roles in changing the cost, therefore LCC is illustrated based on human investment and development as a kind of a system instead of machine production, focusing on development, reworks, training, education, instructor hours, etc. According to Ahmed (1995) different phases in the LCC of personnel related to the case study have been defined as follow:

- Acquisition phase/Recruitment and Education phase: The costs at the beginning of the cycle are high due to recruitment costs, introduction of the new worker, education costs, etc.
- Operation phase: After a while these extra costs should decrease and the personnel costs come closer to the average costs for wages and labour-related overhead.
- Disposal phase/Settlement phase: In this phase personnel end their contract for different reasons, such as retirement, changing job, medical reasons, etc.

4.4 The Unified Enterprise Modelling Language - UECML

UECML which is being utilized in this thesis is an extension of the UML language. In comparing with UML, the reason that this language is used and not just UML is because of the appropriate structure and illuminating factors that are demanded.

The focus of UECML as its name suggests is based on process and activities that create competence for the enterprise and identifying material and human resource factors of those activities (Tarasov et al. 2010). In our view, the information about material and non-material resources are HR’s essential knowledge requirements in order to support them for making enhanced and rational decisions about recruitment process in the Human resource department.

UECML models a set of core constructs such as processes, organization objects, resources, competence units and organization units, as shown in figure 3. Process includes activities or sub processes. Organization object can be any entity that supports an activity. Organization object class (OO) is divided into two sub-classes resource class and human resource class, which are composed of actors and teams (Pepiot et al., 2007). Another UECML fundamental is competence which can be at various aggregation levels from lowest to highest level. The lowest competence aggregation level is an individual. A unit is a collection of individuals. The combination of all competences in the highest competence aggregation level is referred to as a Collective unit (Petersen, Bach, and Svarlein, 2010).

Adding competence to an organization is the essential factor for improvement. The question is what competences are required in an organization and what we mean by Air Force competences.

The purpose of this work is however identifying resource factors and their relations to each other; therefore although “competence” is indirectly considered, it is not the main focus and hence not directly mentioned in my model.

Identifying cost driver elements and linking them requires a well-built and standard method for modelling. Consequently, UECML is considered as the right method and modelling language that responds to the identified requirements and can assist us to present the existing information gap and their relations.
5 Modelling Process

The nature of the problem seems ideally suited to the use of modelling as I need to describe the connection between LCC of personnel and LCC of material (system) in term of cost factors and their relations. “The strategy initiative was identified and defined as modelling to reach a change strategy in a long term business change initiative” (Karlsen, 2011, p.212).

5.1 LCC of Fighter Pilots

In the previous section I explained the different phases of personnel LCC and how the cost varies during different time periods. And as the focus of this thesis is on the cost factors for the personnel during their recruitment phase and partly operation phase, utilizing life cycle cost for interpreting Air Force personnel cost is found very useful. When observing the graph, increasing cost in the initial phases illustrates the high expenses while selecting and training new personnel.

After a while the costs decrease however to constant average personnel costs due to wages, salary and overheads. There are also some costs wasting situations such as personnel absenteeism or when personnel encounter work-related injuries.

It is therefore natural to divide the employment cycle in a similar way as the life cycle for a machine in a traditional LCC graph. The basic categories that the personnel costs, as depicted in figure 3-1, can be divided into are: employment costs, operation costs and work environmental costs. After identifying the major cost categories, the cost structure is broken down step by step according to the CBS (cost breakdown structure) model, see figure 5-1. The further subdivision of work environmental cost has been illustrated in Appendix I.

This research is focused on Employment cost of personnel which is the most important cost category seen from the PLC point of view. The employment costs can be quantified fairly easy by dividing them into Recruitment costs and Education costs sub categories. Recruitment costs start from the moment the company decides to hire until the selected employee is prepared to begin the employment. In figure 5-1, Education costs stand for costs for the internal and external education of new personnel and the required instructors. Additional costs consist of learning curves, controls, and reworks which determine the probable cost drivers. The aim to design this chart was to get some assumption about the further categorization of costs and related resources.
5.2 UECML

The main thrust of this approach was to identify and expose the human resource costs drivers. UECML was used in this work as the modelling language because of the following reasons:

- UECML is suitable for acting as the common language for modelling organizations
- The models developed in UECML are good platforms for communication between different actors in an organization and act as rhetoric devices for reaching common agreements about organizational issues (Pepiot et al., 2007).
- UECML models emphasize simplification. In fact, making the argument understandable through financial numbers and graphic representations, the management of human resources becomes more rational (Pepiot et al., 2007).

5.3 Design of a model

In order to structure the data in a standardized structure a modelling languages was needed. In this regard UECML was found to be an appropriate language. Visio was my selected software program as it allows for drawing various types of diagrams.
The Static diagram was my chosen diagram type for developing the model in a simple frame in order to be comprehensible and not complicated. This would permit future utilization without the need of additional comments to make it understandable. (Kazdin, 1982)

5.3.1 The developed general model

The Synthesize data section states how the table is developed based on the interviews to arrange the collected data. In this chapter, I discuss how to design the model based on the data boxes of the table. Consider (Appendix IV), there is one column which labelled “Process” in the table that is composed of the activities in the education and operation phases of pilot’s LCC. The process column is defined as a class and courses, projects, training sessions, and mission are considered as its attributes.

The consequent rows of the table are classes and attributes. The columns are organized in a tree structure, where resources which have similar type are grouped together. For instance “Infrastructure Cost”, “Aircraft”, “Simulator”, “Live Ammunition”, etc. belong to the class of “Material Resources”. Colours of the first few rows indicate different levels of the tree structure. The information boxes of the first row are presented in green colour as notice in (Appendix IV) and the orange information boxes are their sub classes followed by the purple boxes under each orange box as the attributes of that subclass. The lowest level in the UECMML diagram is presented by the blue boxes of the table.

As shown in figure 5-2 each high-level class and sub class is illustrated by a box which includes their attributes.

Each process is composed of activities and each activity is performed by an actor which is the same as human resources in this project and also each activity requires a number of material resources to be accomplished.

Therefore to not lose information about any resources and based on UECMML design, I begun with the processes and put them in a box. The activities in each process or course or training session have been not mentioned since it was unnecessary and not helpful to mention the type of each activity whether it is exercise, course, training or operation, so I put it in the box associated with activity (Karlsen, 2011, p. 216).

All resources that are required in the processes are linked to the activity box. These resources are divided into Material resources, Human resources and External services. The material resource box is composed of six attributes; Aircraft, Simulator, Facility, live ammunition, cloths and infrastructure cost.

There is a human resource box with Personnel and Flight teacher or Flight Instructor attributes in separate boxes that are linked to Activity box in order to illustrate the various types of actors who perform the activities.

There are some external costs for some special units in the Air Force. Consequently I consider those sections as a package or service which includes material and non-material resources that has apparently fixed price for organization. Therefore a class of external services is identified that is connected to the Weather prediction centre, Cross-border education and training, Control centre, and Medical support package.
5.3.2 The developed Specific model

In the general model, all the boxes based on their relations are linked but in a specific model I only focus on one process and its connected links and boxes. It is to show that not all boxes are relevant for all processes. Figure 5-3 illustrates the model for the “Fighter Pilot Program (2ndAca)” process and the two other developed specific model are also demonstrated in (Appendix V) and (Appendix VI). As can be seen the activity type is “course” and there is only one external service, namely “Medical Support”. The required material resources are also much less than the general model.
Figure 5-3 The specific model illustrating different type of resources deployed in the FighterPilotProgram

5.4 Analysis of the model

The limitation of the case study was to model relations that present the current situation (as-is) and not a desired process (to-be). The modelling is done based on the information gathered from the Air Force requirements.

The design of the model was influenced by a number of design principles which were the outcome of the meeting discussions and interviews. Design decisions are made for the model based on some decision principles.

The identified requirements are summarized as below:

- HR is concerned with the total cost of personnel during their educating and working periods.
- HR plans its courses and training sessions for short and long-term time stages.
- HR needs to consider availability of adequate facilities to assist all personnel during their PLC. For instance shortage of equipment affects planning of courses, training
sessions and missions, and overload of the equipments will increase the maintenance cost and time and decrease the availability.

- HR need to assure enough readiness of units for missions
- FMV is required to calculate LCC of purchased systems
- FMV is responsible for listing the detailed cost information of the new systems including HR related cost factors in the acquisition phase in order to compare new systems and purchase the affordable one.

Decision principles are deployed by the designer and affect its point of view when visualizing the issue at hand and creating a model. “The principles of design describe how the elements of design come together to create a design” (Levett, 1999).

Based the above requirements the following design decisions and principles were made for designing the model:

- To focus on the information that is required and used in the prospect simulation tool, namely education and operation phases of pilot’s LCC, and also highlight those activities that are most related to education and operation such as courses, training sessions, exercises, and missions.
- To cover all essential elements, except the limitations as discussed in delimitations, in order to explore all courses and training classes as activities even cross border courses and daily exercises, identify all material and non-material resources which are required by activities.
- To identify the type and required number of each resource, and the deployment time, for instance taking note of how many students can be in a class at the same time with enough facilities or how long it takes for a student to become an instructor.
- To calculate detailed costs of each person or system and their total costs in order to set them in the desired packages such as “Cost of each flight course” package.

When designing the model all the above principles are considered. The information that is gathered through interviews and literature study (and are incorporated in the model) are all focusing on the activities during the education and operation phases of the pilot’s LCC and include data about the material and non-material resources required in those activities. The attributes of the resources are also identified and denoted in the model, providing a means to eliminate the knowledge gap between LCC of pilots and the LCC of systems. However, the model only contains information about the Fighter Pilots and other types of pilot education are not considered here. Hence, the model is only the first for establishing a solid base for calculating the detailed costs of each personnel or system, more work is needed to design a complete model.

5.5 Evaluation

In this research, the validity and reliability of the data is considered as essential measurements. In order to ensure the validity the designed table and model were re-checked a number of times with interviewees (Appendix III) by the developed questions to assure that transferring of data from the original sources were done without any loss “Validity refers to the degree to which a study accurately reflects or assesses the specific concept that the researcher is attempting to measure.” (Howell et al., 2005, Website).
The developed model is reliable for the reason that even though the acquired information is gathered from different interviewees, there is no ambiguity in the collected data and similar data is gained and collected. “Reliability is the extent to which an experiment, test, or any measuring procedure yields the same result on repeated trials. Without the agreement of independent observers is able to replicate research procedures” (Howell et al., 2005, Website).

The model is checked and verified by the project leader during the project and also is discussed in various meetings with the experts. According to the discussions with the experts and the project team of HuMaST the model contains enough information about activities and required resources, and can be deployed in the HuMaST simulation tool.

In order to have a complete simulation, the PLC of other branches of SAF needs to be studied and modelled. This was however outside the scope of this thesis.
6 Conclusions

The purpose of this research has been identifying the connection between LCC of personnel and LCC of system, expressing it in terms of cost factors and their relations, and designing a model to illustrate these cost factors and their relations. The aim has been to define and address the knowledge gap that exists between the LCC of personnel and LCC of system.

For this purpose at the request of FOI a case study from the Swedish Air Force has been deployed. The study has resulted in a model which covers the education and (part of) the operation phases of the fighter pilots and contains information about different activities that pilots need to perform. For each activity the material (system) and human resources that are required are identified.

Furthermore, the study has been conducted from the perspective of the HR. Therefore HR LCC is utilized to illustrate various phases of the personnel flow through the organization. The HR LCC includes various phases from the time a person is subjected to recruitment till she/he leaves the organization. However, education and operation phases are the essential phases which are being focused on in this thesis since they are the joined phases in both HR LCC and Material LCC seen from the HR perspective. The objective of this part of study has been to cover the first question of the thesis, namely what connection exists there between LCC of personnel and LCC of system.

Possible expansion, contraction or diversification of an organization’s activities will obviously affect the demand for personnel and planning of different activities for developing their skills, such as courses, training sessions, mission rehearsals, etc. This can be estimated by finding out the effective connections between those activities and the required resources, for the purpose of analysis, modelling and simulating.

One of the objectives of this thesis has been development of a model to support HR when planning different activities for the personnel during their education and operation phases.

Thus, in order to answer to the second question, “how can this connection be identified and expressed in terms of cost factors and their relations”, interviews with experts based on associated theories and methods were conducted, identifying cost-making resource factors in education and operation phases such as courses, tutors, aircraft, simulators, facilities and etc. Most interviewees were from HR department as it was more essential for this study. However interviews with representatives from FMV were also conducted.

The interviews presented more challenge that it was initially anticipated. First of all it was difficult to find interviewees with good knowledge about the problem area, and those who were right for the task were very busy. Consequently, the interview process took much longer time than expected. In addition, finding the right set of questions in order to get the answers, that were required for building the model proved to be a difficult task. The main reason was that since there are no experts handling the issue I was addressing, I needed to gather information from different sources and put them together to create a complete picture.

In the second part of this thesis, the relations between different cost factors were illustrated and set in a structured table progressively through interviews and meetings. A UECML-based model is built using this table to cover the third question of this study: “How can a
model that illustrates the cost factors and their relations be developed?”. The model illustrates the result of interviews and presents a quick outlook of pilot’s cost factors to support the decision making for new recruits in the Air Force. UECML was used for this purpose after discussions with the project team at FOI and my supervisor at the university. Although it proved to be a proper language for the task we decided not to utilize the “Competence” aspect of the language, as it was not required by FOI and the HuMaST project.

The developed model has been validated through discussions with the experts and interviewees. However, the model needs additional work in order to be fully useful for FOI and the HuMaST project, as it only covers part of the Air Force and does not contain values for different resource types deployed by the identified activities.

6.1 Future work

There are still some steps which need to be taken to be able to utilize the designed model.

- The model indicates the elements and their relations however the values of elements as statistical information need to be completed. As shown in the table, the boxes filled with yes or no signs need to be filled with additional data, i.e. it is necessary to have exact values such as the number of students, the number of instructors and etc. There is also some information about the type of aircraft or the flight duration in each course, but additional support from FMV and SAF is needed in order to fill the boxes with data.

- In the general Model, the design principles are somehow considered in order to develop a ”general” model which can be deployed as a generic pattern for Navy and Army military services, but of course with different elements and details.

- In the specific models relations between elements were emphasized. However not all processes are covered in this thesis and further work is required to create the rest of the specific models.

- In next step the case study needs to be tested and deployed in the HuMaST simulation tool in order to prove its feasibility.
List of references


List of references


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Appendix I: The model showing LCC of personnel at SAF

The model illustrating LCC of personnel at SAF with further subdivision of work environmental cost.
 Appendix

Appendix II: The written questions that were emailed to the interviewees ahead of the meetings

Dear Madam/Sir,

Thank you very much for agreeing to participate in this study. This information sheet explains what the study is about and how we would like you to take part in it.

The purpose of this study is to start running a flow of information between Human resource department and material department (FMV) in order to support their decision making based on more accurate and precise information about each other. The lacks of information between these two departments leads us to collect and model data through number of interviews. It’s your kindness to assist us in this study for making future Armed Forces strategy planning efficiency.

Based on Life Cycle cost theory, we divided our questions into two sections. First, there are some questions around Pilot Education phase and in second section we would ask you to answer those questions related to personnel operation phase that can be composed of standby situation, the different Army positions, the missions, and etc. The text below is followed by some sample questions:

Education phase

- Which activities are done since a new personnel start education and training till he/she is prepared for Air Forced Army positions and missions?

- Which kind of courses do you have? Please tell us about the duration of courses, the number of instructor that is required, the equipment and facilities that are used, etc.?

Operation Phase

- Which kind of Positions are there in Air Forced Army and which activities are done in these positions?

- Could you please name the equipment, different weapon’s type, transportation facilities and other materials that are needed in each of those positions?

What is meant by Resources for us?

Whatever that produces benefits and has some cost for an organization as a source of supply is defined “Resource” that can be weapon’s material and systems, maintenance costs, cost for spare parts, Human cost, spending time which are required for training personnel and deployment of the processes in Armed Forced to achieve their goals.

What is important for us and how you can assist us?!

- Notifying the name of used and required cost- drivers resources( can be any type of human resources, material resources, logistic resources)
- Notifying the standards and common phrases while informing the key factors
- The name of different course types, duration, instructor types and their numbers(education phase)
Appendix

- The Standard name of different Air Forced Job positions and the missions (operation phase)
- The related documents in English in order to expand the discussed area

In order to elicit your views, we would like to come for an interview involved in the study at Jönköping University. If you agree to this, the interview will be audio recorded and will last approximately one hour.

Once again, we would like to thank you for agreeing to take part in this study. If you have any questions about the research at any stage, please do not hesitate to contact us.

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Appendix III: Email to interviewees to validate the designed table

Dear Mdm/Sir,

I come up with some questions in order to focus on the essential required information and do not take your time so much. It’s your kindness to answer these questions by looking at the table. To indicate the “Process” Column includes courses, training and mission boxes:
1. In which courses the students take the advantages of short-term rentals (Fortifikationsverket)?
2. In addition to those processes which utilize aircraft, is there any other processes that take the advantages of weather prediction center?
3. In which processes the students exchange abroad? (cross boarder education and training in the table)
4. Is it only CT and CRT which utilize simulators? Or are there any other processes which use simulators?
5. In addition to GFU, GTU, CRT, CR and also international activities that utilize aircraft, are there any other processes that flying aircraft is in their program?
6. There is an infrastructure cost for each class including many attributes such as locker, classroom and office. My question is if mission and squadron processes also use this attributes or not (locker, classroom, and office)? (In the other words is there any locker and classroom existing in a mission?)
7. Does mission include exercises in addition to operation?
8. What’s the difference between civilian and military staff? Which organization is responsible for them?
9. What’s the number of instructors in relation to the number of students in classes?
10. Does Squadron include training in their activities?

I labeled some processes by myself to name the activities which are done by students and pilots. I appreciate if you could check whether they are similar to reality or not and if not please edit it (Process column in the table):
- WorkExperience (Projects which is done by pilots)
- InternationalCourses (which is held in Sweden)
- DailyPhysicalTraining (exercise that each pilot or student is performed by trainers)
- DailyExercises (gym facility)
- 1stSquadronActivities (insatsförband, highest readiness)
- 2ndSquadornActivities (becoming ready)
- 3rdSquadornActivities
- HeadquarterActivities (the level of headquarter who leads the pilots and soldiers)
- Flygplansrörelse (take off, flying, landing),---- Is this process true or wrong?

If you think Process column needs more information and boxes please let me know. I appreciate your assistance in my thesis project. I look forward to your answer.

Best regards,
Mona Salmani
Appendix IV: Representation of the table containing “Process” column (educational and operational activities of fighter pilots at the Swedish Air Force) and required resources.
Appendix V: The specific model illustrating different type of resources deployed in the conversion readiness training
Appendix VI: The specific model illustrating different type of resources deployed in the mission