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1 Introduction

1.1 Background

Our current information society builds upon the extensive application of information systems and technologies. Information technology (IT) nowadays, to some extent, has become or has the potential to become infrastructures of other industries, e.g. IT enabled services (ITES), which enable the business by improving the quality of service, are wildly used as the ground of call center, electronic publishing or medical transcription (Bhasin, 2000). However, it is not saying that IT is capable to change everything. Specifically, the procedures IT facilitated, the problems IT solved and processes IT reengineered, are all about to make things effective and efficient.

Proliferation of IT brought innovation into our focus. Innovation has been defined as '*creation and implementation of new processes, products, services and methods of delivery which result in significant improvements in the efficiency, effectiveness, or quality of outcomes*' (Mulgan & Albury 2003, cite in ANAO, 2009, p.1). IT enabled innovation, is the application of *new processes, products, services and methods of delivery,* depended IT to generate better performance. The value added by IT innovation has continually enhanced traditional service or products in various contexts. The focus of this research will be on the context of public sector and on the evaluation of value added by IT innovation.

By consideration of innovation's intangible and diverse nature, the traditional IT investment evaluation methods and/or techniques like Net Present Value (NPV) and Payback Rule are no longer helpful for measuring the value adding of this part. The evaluation of innovation is difficult, complicated and multiple considerations are required. Meanwhile, for the reason of innovation in the public sector playing a significant role to social well-being, research in this field, explore and develop an evaluation framework for measuring it could be considered as a meaningful and valuable task. As the other IT-enabled innovations usually emerge as E-terms like email, e-publication and e-learning, the IT innovation in health care has been defined as eHealth.

Ehealth has a long history both in Sweden and internationals. Internationally, Sweden is at the forefront of using IT support in the healthcare area (Jerlvall & Pehrsson, 2010). Sweden has strived to create health care information systems for years. The Swedish healthcare system makes intensive effort to use efficient resources and adapt care to citizen's needs. For example, the national projects as part of National Strategy for eHealth (Government Communication 2005/06:139) have been developed and adopted since 2006. EHealth has been considered as '*one important element in the creation of modern, safe and accessible health and social care* (Centre for eHealth in Sweden, 2010, p. 1).' County councils in Sweden have been using IT support for developing and improving performance and providing high quality services for health and social care. As Centre for eHealth in Sweden claimed, Sweden has a solid foundation for their efforts of eHealth (Centre for eHealth in Sweden, 2010).

Investments in eHealth require enormous financial and nonfinancial input, which makes investment a crucial decision to take. The implementation of eHealth application will change the health care sector from tiny upgrades of medical device or treatment programs to a redesign of the totally work process, rebuilt organizational cultures or communication channels. A genetic evaluation framework, which could guide stakeholders to identify issues of relevance for health and social care, is needed throughout the implementation period (Vimarlund & Koch, 2011). Specifically, in the pre-implementation period, it could be

used to convince stakeholders and top management when negotiation of purchasing eHealth products or services. Then it also contributes to set up a strategy of customizing by reference to key effects and indicators. During the implementation, as a formative assessment method, the genetic evaluation framework helps to compare the intended outputs with actual outputs, the comparison generate feedbacks for modifying and improving the ongoing implementation processes and adjust the strategy timely. For the post-implementation period, evaluation is necessary for knowledge accumulation, which will contribute to the relevant research and future's projects.

1.2 Case Background

The study of this thesis will be carried out in Jönköping County Council, Sweden. Jönköping County Council got international reputation on its high quality performance of health care system. As a part of Swedish healthcare system, Jönköping County Council with a typical function of Swedish county council on health care and act as an outstanding model to other Swedish county councils and internationals Jönköping County Council （2012）. Since National Strategy for eHealth was implemented in 2006, Swedish County Councils are using IT support for developing and improving performance and providing better services to citizens. An infrastructure was built in 2009 for further development of the eHealth strategy and solutions and by performing a series of management projects e.g. NPÖ (National Patient Summary), SITHS (Secure IT in Health) and NEF (National Format for ePrescriptions). Visible benefits from national services began to show in Swedish County Council from 2010 (Ministry of Health and Social Affairs, 2010). In terms of the overall environment and long-term high-standard performance in health care area, the authors of this thesis believed that Jönköping County Council could be a reasonable research setting for conducting research in eHealth evaluation. We continue to describe the Swedish healthcare system and the National Strategy for eHealth.

1.2.1 Swedish healthcare system

Swedish healthcare system is a taxpayer-funded and largely decentralized system that performs well in comparison with other countries at a similar level of development (Swedish Institute, 2012). In 1979, Sweden was among the first countries that recognized the limits of hospital care and made a national commitment to primary care and preventive services (Glenngärd et al., 2005 cited in Baker et al., 2008). The Swedish healthcare system nowadays has an outstanding reputation worldwide for meeting high quality services and medical outcomes at a limited and acceptable cost levels (Swedish Institute, 2012).

In the Swedish health care system, central government, county councils and municipalities share the responsibility of public health care. The role of the central government is establishing principles and guidelines for care and setting the political agenda for health and medical care. The authorities and responsibility for providing public health care are decentralized to the county councils and, in some cases, municipal governments (Swedish Institute, 2012). There are 21 county councils in Sweden, around 90% of the Swedish county councils' tasks and over 70% of their resources are focused on health care, but they are also involved in other areas, such as culture, infrastructure and public transportation (Baker et al., 2008).

1.2.2 Jönköping County Council

Jönköping County Council located in the southern of Sweden with the population of 337, 013 in 2011(Statistic Sweden, 2011). They manage 51 primary care centers and three hospitals with 10 000 employees (Jönköping County Council, 2012). They plan and allocate re-

sources to meet the need of citizen, they own and operate their health care facilities and employ physicians and other staff (Baker et al., 2008). For the last decade, Jönköping County Council was well known for its outstanding performance in health care. Jönköping has been cited as "a model of the healthcare system transformation that ranks among the best in the world" and example of "innovation, strong and stable performance and social values on Swedish health care". They have achieves the "*best overall ranking in Sweden for efficiency, timeliness, safety, patient centeredness and effectiveness*" (Davies, 2008, pp146).

1.3 Problems

The study of the problem area is well informed by previous research. The increasing importance of eHealth evaluation has been pointed out by plenty of authors and has been shown in several systematic literature reviews (Rahimi et al., 2009; Warren et al., 2009; Cotea, 2010; Hardiker & Grant, 2009). To evaluate IT investment in general, to identify, measure, and manage IT benefits is considered the most important and difficult tasks for any IT manager. As described by Schniederjans et al. (2004, p. 57) *'a performance measurement system evaluates the effects of IT and may be used to justify an initial IT investment and later to access its impact after implementation and use.*' An effective measurement program also allows the organization to monitor costs, make good decisions with respect to the allocation of IT resources and to develop improvement strategies (Schniederjans et al., 2004).

However, due to the intangible nature of certain IT effects, the evaluation of IT-based systems applied in healthcare is difficult. As Vimarlund and Koch (2011) point out, there is no generic model that can be applied in health and social care to demonstrate the contribution of IT to innovation and change. This finding is also supported by Warren et al. (2009). In their systematic review of 100 articles and other 27 systematic reviews of eHealth that were published from year 2003 to 2009, 16 different kinds of named evaluation framework has been identified, along with several other unnamed frameworks. The demand for such models still exists. According to a recent review of eHealth conducted by Black et al. (2011), relative to the number of eHealth implementations that have taken place, the number of evaluation is comparatively small. Moreover, published primary research has been repeatedly found to be of poor quality - particularly with regards to outcome measurement and analysis.

Findings from reviewed articles also show that there are a limited number of articles studies the impact of IT in health care. As pointed out by Rahimi et al. (2009), despite the large number of studies included in the reviews, there are no studies that have been conducted to explore the impact of IT on the system as a whole, particularly no studies that look at the impact of IT on health efficiency or productivity. Challenges that are related to evaluation of IT applied in health care have been pointed out by Vimarlund & Koch (2011) in addition to difficulties in quantifying the output of the use of IT in healthcare, evaluation challenges in assessing the impact of IT also include isolating its impacts from others. It is difficult to find a clear relationship between IT, organizational improvements, quality of care and benefits realization. Therefore, their review suggests that there is an increasing need to share knowledge and find methods to evaluate the impact of investment, and in parallel with this, formulate indicators for success.

A recent study conducted by Vimarlund and Koch (2011) aims to develop a model an identify innovation effects and its consequences enabled by IT in health and social care. Their intention is to make such a model as a tool that identifies and classifies the outcomes of IT innovation investments at different organizational levels for different stakeholders. However, a common problem is that many of existing frameworks have not been tested at all.

According to Warren et al. (2009), results from reviewed articles showed that among 16 labeled and several other evaluation frameworks, only DeLone and McLean's IS Success Model (2009) has been rigorously tested over the last fifteen years and has been adapted to healthcare implementations. Several authors indicated that their framework was based on previous models/frameworks, which were relatively new and untested. Some have indicated that theirs model was built upon several rigorously tested existing models/frameworks but in non-health contexts and appraisal of them for potential use in evaluating of eHealth (Warren et al., 2009). Vimarlund and Koch's (2011) model was built upon four complementary literature reviews and four case studies. Even though this model has been iteratively developed over time since 2009, when the initial model was presented, it still remains untested. As concluded by Warren et al. (2009) there appears to be a drive to develop and test frameworks in line with the growing demand for eHealth initiatives and associated innovations and interventions. Hence the existing frameworks are ought to be tested and refined in order to establish their use and usefulness.

1.4 Purpose and Research Questions

This study aims to gain a deep understanding of IT investment evaluation. The evaluation is focused on the use and implementation of IT application in the healthcare sector and its impact to different stakeholders. Based on what have been discussed above, it is difficult to identify, measure, and manage IT benefits. However, it is important and necessary to predicate, monitor and evaluate IT benefits before, during and after its implementation. As stated by Vimarlund and Koch (2011, p. 13) *'investment in IT innovations in health and social care often occur in a complex and fast-moving socio-technical and economic arena.'* The generated evidence on the success of these initiatives cannot be shown without classifying and structuring the context of the evaluation, the level of innovation and the level of interaction IT enables. Hence Vimarlund and Koch (2011) developed an IT investment evaluation model that aims to identify the contributions that IT investments bring to health and social care organization. Their model is comprehensive as consideration is given to both external (i.e. impact on patients and society) and internal (i.e. inter- and intra-organizational effects) perspectives and to different organizational levels when trying to develop indicators to capture the effects and impact of IT innovation.

Vimarlund and Koch's (2011) evaluation model is newly developed and has not been rigorously tested over time. In this case, the validation can be conducted from three aspects: the model's comprehensiveness, practicality and applicability. The **comprehensiveness** of the model is regarding the innovation, innovation effects and indicators of effects that have been identified. As the advantage of Vimarlund and Koch's (2011) evaluation model is to create a comprehensive framework that would guide stakeholders to identify issues of relevance for health and social care, the validation is conducted to found out whether the reality is comprehensively covered by their model. By definition, **practicality** is the aspects of a situation that involve the actual doing or experience of something rather than theories or ideas. It would be meaningless if a model designed was not capable of being used in practice. Since the model has not been used and tested in practice, the question can be addressed here is 'Can Vimarlund and Koch's (2011) evaluation be practically applied to a multiplicity of evaluation situations in healthcare context? '. Moreover, the evaluation of eHealth is a complex phenomenon. The way in which the evaluation is conducted can be vary depends on, for instance, 'what', 'who', 'when' and 'how' to evaluate. There is also a wide range of evaluation models/frameworks used in eHealth. Types of data collection will depend on the situation of evaluation. This study is going to examine the **applicability** of the model in a multiplicity of evaluation situations. Having stated the applicability will bring

great significance to model. It will help the model adopter to make a sound of the model's applicability in a certain situation.

The purpose of this study is evaluative. It aims to validate Vimarlund & Koch's (2011) IT application evaluation model. The validation is conducted through applying the evaluation model to evaluate a system called EIAS (ERAS Interactive Audit System) for Jönköping County Council. EIAS is a system to support ERAS (Enhanced Recovery After Surgery) process. The detailed description of ERAS and EIAS can be found in Chapter 4. The model will be used as a guide to evaluate and identity impact that derive from the use and implementation of EIAS. The process of evaluation of the system is also a process of validation of the evaluation model. The outcomes of this thesis will provide understandings of evaluation frameworks, its usage and how it is applied to E-health. As stated by Vimarlund & Koch (2011, p. 13), '*the model is based on the assumption that change in an organization can create important effects that lead to benefits for the organization and its stakeholders.*' Hence, through this study we firstly aim to find out:

1) What are the possible contributions that EIAS brings to Jönköping County Council?

Afterwards based on the evaluation results and implications that derived during the evaluation process, conclusion will be drawn regarding the validity of Vimarlund & Koch (2011)'s IT application evaluation model and the question below will be answered.

2) How is the performance of Vimarlund and Koch's (2011) evaluation model in practical application, in terms of comprehensiveness, practicality and applicability?

1.5 Use of Previous Studies

This study is conducted based on Vimarlund & Koch (2011)'s IT investment evaluation model. Their model aims to identify the benefits that IT innovation can bring to the health care organization. The development of this model involves two important steps: a systematic literature view and interactive development of the model.

The literature review phase conducted based on four complementary reviews of articles that were published from 2000 to 2011. The authors of the reviews mainly focus on evaluate the articles in health informatics aiming to evaluate effects and impacts of IT innovation. As stated by Vimarlund and Koch (2011, p.3), their literature review dealt with the following topics:

- *"Current knowledge position in terms of reference, methods and models used for describing and assessing the value of IT investments and its subsequent benefits for the health and social care sector*
- *Methods and models to analyze and express the benefits of IT investments in health and social care for patients.*
- *Studies of how to evaluate major national IT investment in health and social care.*
- *Studies that discuss how to evaluate the value of IT and its relationship with national IT strategies"*

After the completion of the third complementary review in the end of 2009 and with the information accumulated from previous reviews, the initial model was presented (Vimarlund & Koch, 2011). The initial model was developed based on the discussion by the authors, and comments and suggestions of senior researchers in the area of health informatics who belonging to Swedish national eHealth network. The fourth search was conducted in May 2011 and aimed to evaluate new articles published from 2009 to 2011. Meanwhile, the initial model was iteratively developed and modified with the help of national authorities and practitioners in two workshops. In the end of 2010, the latest version of the model was

tested and validated at the national level with a number of case studies before it was published (Vimarlund & Koch, 2011).

As described by Vimarlund & Koch (2011, p.4) they aim to '*create a comprehensive framework that would guide stakeholders to identify issues of relevance for health and social care and that depend on the capacities and possibilities that IT gives in relationship with the innovation effects for organizations at different levels.*' To create such a model the following steps have been gone through (Vimarlund & Koch, 2011, p.4):

- *The steps in the model were further outlined considering different levels of innovations and the outcomes they should give to different stakeholders.*
- *Then expected innovation effects at each level were defined*
- *Finally a series of indicators were developed in parallel to express functional capacities of IT, degree of innovation and expected consequences.*

To present an overview structure of this model, the simplified version of Vimarlund and Koch's (2011) IT application evaluation model is shown below in *Table 1.1*. A more detailed explanation of this model is presented in Frame of reference (Chapter 3, section 3.4.) One example of IT innovation, innovation effects and indicators at each level is presented in the table. The full version of Vimarlund and Koch's (2011) model is presented in ***Appendix 1.***

Table 1.1 The Structure of Vimarlund & Koch (2011, p. 6)'s IT Application Evaluation Model

	Innovation	**Innovation effects**	**Indicators of the effects**
Micro level	Electronic information supply	Electronic registration of clinical effort and effect	Reduced number of double referrals
Intra- & Inter organizational level	IT –based organization coordination	Patient portal presents information about healthcare visits	Reduced number of steps for access to information
Virtual Network for personalized Services	Personalized e-services for increased patient empowerment	Digitally integrated information tools for follow-up and interaction with healthcare	The healthcare receiver makes notes/comments electronically

1.6 Perspective

This thesis is written from the managerial view that to evaluate the benefits derive from use and implementation of IT application in healthcare organizations. Modern views have taken a sociotechnical perspective that an organization is seen in terms of people and technologies which cooperate together to produce outcomes. This study is conducted to identify contributions that IT application can bring to individuals, organizations or the society from the managerial perspective. The findings of the study should be particularly useful in decision making on IT investments. As Vimarlund & Koch (2011, p. 13) describe it, *'the model shows how IT supports organizational development, new business opportunities, increased organization intelligence as well as the formation of new virtual networks and their outcomes, visualizing effects that in the absence of IT are not possible to achieve.*' With the support of such an analytical model, decision makers can make well informed decision about whether to invest in a new IT application and identify goals that are to be achieved. It can also be used by top managers to evaluate whether the pre-identified goals have been achieved and issues for improvements have been identified.

1.7 Delimitation

The IT evaluation model is only developed to be used in the area of health informatics. The innovation effects identified is related to different stakeholders in healthcare sectors and different healthcare organizations. Hence, this model is not capable to evaluate and identify contributions more than in healthcare contexts. The entire study is focused on the IT application evaluation model. However, the model that we aim to validate or improve is only focused on evaluation from a sociotechnical perspective. That means consideration is only given to the functional capacities of IT. Technical issues were not considered in this study. The focus is to identify the organizational and managerial contribution derived from individual level, intra- or international level or even the society, rather than evaluate e.g. usability or reliability of the system.

1.8 Interested Parties

Interested parties of this thesis might be ***Medical Professionals***. The thesis shows various innovations, effects and indicators which will help medical professionals to get to know about what improvement is expected to be made by adopting IT-applications. Furthermore, the evaluation model verified in this thesis and the evaluation method adopted by IT-application (EIAS) might provide a meaningful reference for evaluation of other information system which maybe of interested for ***Information System Professionals*** like project managers. In addition, the evaluation process and anticipated evaluation outcomes presented in the thesis might be of interest for ***Decision makers of IT investment***. It is vital for the decision maker to know how to conduct an evaluation of IS. Although the decision maker will do exactly the same thing the authors did, however, it is always beneficial to know more in order to make better choices when to perform IT investment evaluations.

1.9 Key Terminologies

Table 1.2 Key Terminologies

Concepts	Definitions
eHealth	EHealth is a new interdisciplinary concept integrating information technology, computer science and healthcare science. Information technology and computer science are used to create IT-based systems. The changes include management and control of medical processes, health organization administration and inter or intra organizational communication etc.
HIS	HIS is an abbreviation of Health information systems. '*HIS are information management systems which capture and display data related to the delivery of health care services.*' (Chinn, 2010) In a broad sense, according to Chinn (2010), HIS could be paper-based or electronic, they include clinical guidelines, medical terminology dictionaries and other clinical and business information database such as laboratory, pharmacy and diagnostic imaging etc. However, in this thesis, the authors intend to delimit their study of HIS to solely electronically based system.
Web-based Systems	Web-based systems refer to the applications and/or services that are resident on a server and accessible to information resources via a web browser application. By web technologies, the system is, accessible from anywhere in the world.
Formative Assessment	It is a range of formal and informal assessment procedures employed by teachers during the learning process in order to modify teaching and learning activities to improve student attainment (Crooks, 2001). It is commonly contrasted with summative assessment. Formative assessment is derived from education but extended to other areas. In this thesis, formative assessment refers to an evaluation approach. By formative assessment, feedback will be in real time for possible modification and improvement given.
Summative Assessment	Summative assessment refers to the assessment of learning at a particular time. It is commonly contrasted with formative assessment. Like formative assessment, summative assessment is derived from education but extended to other areas. In this thesis, summative assessment refers to an evaluation approach. By adopting summative assessment, assessment and feedback is given for a certain period of time.
Innovation	Innovation has been defined as "*creation and implementation of new processes, products, services and methods of delivery which result in significant improvements in the efficiency, effectiveness or quality of outcomes*" (Mulgan & Albury, 2003, cite in ANAO, 2009, p. 12). Innovations, unlike inventions, are changes based on something already existing rather than the creation of something new. Innovation could be regard on products (product innovation), processes (process innovation), organizational (organizational innovation) and communication (communication innovation) (Bloch, 2011).

ERAS	ERAS stands for Enhanced Recovery After Surgery. ERAS is a multi-modal perioperative care pathway which is designed to achieve early recovery for patients undergoing major surgery (ERAS Society, 2012).
EIAS	EIAS stands for ERAS Interactive Audit System. It is a data entry and analysis and report system developed by ERAS Society. All patient data relevant to ERAS Protocol must be entered and monitored in EIAS in order to realize full control and achieve "best practice" in perioperative care (ERAS Society, 2012).
Best Practice	Best Practice is a method or technique that has been proved superior to other methods or techniques. The result or outcome achieved by best practice is used as a benchmark (Wikipedia, 2012).

1.10 Summary of each chapter

Chapter 1. Introduction

The thesis begins with an introduction of innovation, eHealth and the importance of evaluation to guild readers to know the background knowledge for this research. Then the problems discussion is presented which leads to the description of the purpose and the research questions. Hence this is an evaluative research that aims to validate Vimarlund and Koch's (2011) evaluative model in terms of comprehensiveness, practicality and applicability.

Chapter 2. Methods

Methods, which have been chosen, are presented in Chapter 2. The method discussion starts with a description of research the purpose and research approach. The purpose of this study is evaluative and it is conducted by using adductive approach. Single case study will be adopted as the research strategy. In this study, qualitative data will be collected through semi-structured interview with key respondents. The data collected will be analyzed qualitatively with a narrative approach.

Chapter 3. Theoretical framework

By an extensive literature review, the authors present a conceptual framework in chapter 3. The contents of this chapter include key concepts like eHealth, innovation and evaluation, relevant theories derived from key concepts and the model adopted in the study. In order to show the research foundation, a concept map will be presented in the beginning of this chapter. Vimarlund and Koch's (2011) evaluative model is the core of this study. The practicality was validated based on the generic eHealth evaluation framework (***Section 3.3.3)*** and the applicability was validated based on the classification of the six generic types of IS (***section 3.6).*** As for the validation of the comprehensiveness of the evaluation model, it is done through the process of evaluation of EIAS, to see whether the reality is covered by the model.

Chapter 4. Case description

The case described in this chapter is as a part of the findings of this study. This chapter begins with a general introduction of Swedish healthcare system and Swedish national strategy for eHealth. Then it followed by description of the current situation of Jönköping County Council regarding their current information system and expectation of the new system. A general description of ERAS, EIAS and how EIAS supports of ERAS is presented.

- **Chapter 5. Findings**

The fourth chapter presents the empirical data collected from case studies including the findings from documentary and observation and findings from semi-structure interviews. The results that were presented are regarding the innovation effects and indicators identified by the EIAS adopters and the EIAS provider. The empirical findings in this chapter will provide data for subsequent analysis.

- **Chapter 6. Analysis**

The empirical findings are discussed, summarized and analyzed towards the concepts and models presented in chapter 3 on the purpose of giving answers to the research questions presented in chapter 1. The comprehensiveness, practicality and applicability of Vimarlund and Koch's (2011) evaluative model are examined based on findings.

- **Chapter 7. Conclusion and reflection**

The conclusion is a draw and reflections from the study will be presented in this chapter Conclusion is written based on the analysis. It is a high level concentrated summary of the study. Guided by Vimarlund & Koch's (2011) evaluation model, the innovations that have been brought into healthcare organization by EARS are *electronic information supply*, *internal integration of clinical information* and *possibilities to learn from the system*. The model has been validated in terms of comprehensiveness, practicality and applicability.The issue of the productivity paradox has been noticed as some effects are not immediate after introducing of IT. User-participation or not could be considered as an important condition for the validity of the evaluation guided by the evaluation model.

- **Chapter 8. Further study**

Finally some possible directions and research questions for further study is presented. Attention should be given on different actors in health and social care organization, when evaluate impact of an IT investment from socio-technical perspective. Moreover, Vimarlund & Koch's (2011) evaluation model is expected to be further developed by including tool/method that for measuring indicator of innovation effects. .

2 Methods

Having decided the research questions to answer and the research objectives, the next logic step is to consider how the research questions can be answered. Research method is about the different approaches that exist in the transformation process from questioning to answering (Saunders, Levis and Thornhill, 2007). Therefore, it is critical for any researcher to make decisions concerning choosing of research methods, as it underpins the success and credibility of the research.

2.1 Research Purpose

According to Robson (2002), research questions are generated based on research purpose(s) and conceptual frameworks (as showed in Figure 2.1). The conceptual framework is sometimes referred to as the theory about what is going on, or what is happening and why (Robson, 2002), and the research purpose helps to clear the study is trying to achieve. In order to be able to make better decisions of method, a more detailed classification of research purposes is studied. As state by Patton (2002), *'one can't judge the appropriateness of the methods in any study or the quality of the resulting findings without knowing the study's purpose, agreed-on users, and intended audiences.'*

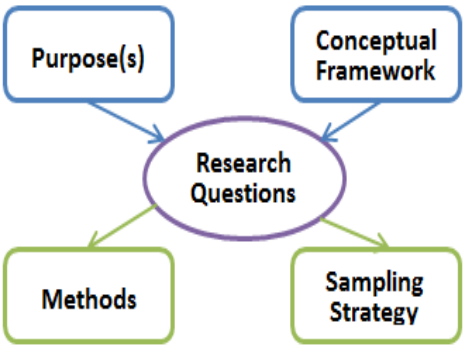

Figure 2.1 *Framework for research design (Robson, 2002)*

This is an evaluative research, but also encompassed an explorative and descriptive research. As mentioned in the previous chapter (***Section 1.4***), the purpose of this study is to validate Vimarlund & Koch's (2011) evaluation model in practical application, in terms of comprehensiveness, practicality and applicability. '*Evaluation research, quite broadly, can include any effort to judge or enhance human effectiveness through systematic data-based inquiry.*' (Patton, 2002, p. 4) According to Patton (2002), evaluation is the systematic collection of information about the activities, characteristics and outcomes of programs to make judgments, improve the effectiveness, and/or inform decisions about the future. It has been pointed out that there is a clear distinction between evaluation research and basic research. They are not only having difference audiences but their main objectives are different. As Jamieson (1984, p. 72, cited in Sliver & Pratt, 2006) describes *'the goal of the research report is the enhancement of understanding and knowledge via publication to the scientific community. The main goal of the evaluation report is to inform and/or influence decision maker.'* Patten (2002, p.4) also state that '*the knowledge and the theories that undergird knowledge, may subsequently inform action and evaluation.'* Moreover, according to Saunders et al., (2007) the classification of research purpose most often used in the research methods' literature is the threefold one of exploratory, descriptive and explanatory:

- An ***exploratory*** study is commonly used as a valuable means of finding out 'what is happening"; to seek new insights; to ask questions and to assess phenomena in a new light' (Robson, 2002, cited in Saunders et al., 2007).
- ***Descriptive*** research '*is to portray an accurate profile of persons, events or situation.'* (Robson, 2002, p. 59) It is necessary to have a clear picture of the phenomena on which you wish to collect data prior to the collection of the data (Saunders et al., 2007).

- ***Explanatory*** research is a study that establishes causal relationship between variables. The emphasis is on studying a situation or a problem in order to explain the relationships between variables.

The way in which research questions are asked will result in different kinds of studies and answers: exploratory, description and explanatory. Hence to think in line with the research questions and the research objectives of this study, *exploratory* and *descriptive* study will be conducted. As described by Saunders et al. (2007, p. 134), "*a descriptive research may be an extension of, or a forerunner to, a piece of exploratory research or a piece of explanatory research. It is necessary to have a clear picture of the phenomena on which you wish to collect data prior to the collection of data.*" This is an evaluative study since the main purpose of this study is to form a case, and from which the model can be tested, validated and improved. The first step is to describe the case and design the research settings. One cannot expect that there is a ready-made case out there, which covers all sufficient information and have addressed all key issues. Instead, the authors should identify an appropriate case, and to explore and describe relevant information that is inexplicitly clarified. Through the referral of the thesis supervisor Klas Gäre, a first contact was conducted with a surgeon (Niklas Zar) from Jönköping County Council. His explanation of a scenario of the hospital caught the authors' interest and we hence decided to form a case based on the current situation of this hospital, more specifically the ERAS process. The next step was to collect data through various means to portray an accurate profile of the situation, for instance, documentary analysis and semi-structured interview with key personnel. The authors aim to describe the current situation of ERAS, including a description of its current IT components. The work procedures of ERAS and expectations for future improvements will also be described. Therefore, this study will comply with the characteristics of descriptive research. The detailed description of case formulation and work procedures will be described in the following sections. The case formulated will provide a base for the authors to go further and draw conclusions based on collected data.

The exploratory research comes after the descriptive research in the sense that once a clearly formulated case an exploratory study can be conducted to explore the impact which a IT investment can bring into the healthcare organization. An important characteristic of the exploratory study is that the focus is initially broad and becomes progressively narrower as the research progresses (Saunders et al., 2007). According to Saunders et al. (2007), there are three principal ways of conducting exploratory research: 1) a search of the literature, 2) interviewing an 'expert' in the subject and 3) conducting focus group interviews. Those data collection methods mentioned all seem to be qualitative and open for various explanations. In this study, the model acts as a framework to guide the way to where the data is collected. However, due to the explorative nature of this study, during the data collection phase sufficient space will be left for the interviewees to express their views and opinions. Hence the validation of Vimarlund & Koch's (2011) evaluation model is done through the comparison of the effects present in the model and the explored effect through data collection and data analysis.

2.2 Research Approach

2.2.1 Induction, Deduction and Abduction Approach

In general, there are two kinds of research approaches have commonly been discussed and adopted: ***inductive*** and ***deductive (Figure 2.2)***. Deduction has its long history in research in the natural science, and it has been criticized by numerous scholars since the emergence of social science in the 20th century. Many would think of deduction as scientific research,

and it involves the development of a theory that is subjected to a rigorous test (Saunders et al., 2007). On the other hand, in the sense of social science, researcher holds another view of how to conduct research - induction. With an inductive approach, a theory will be built up from scratch based on data analyzed, where the data is collected through a variety of techniques. According to Saunders et al. (2007), the follower of induction mainly critics deduction because of its absence of interpretation of human behaviors and its tendency to construct a rigid methodology that does not permit alternative explanations of what is going on.

In fact, the impression that there are strict divisions between deductive and inductive approaches is proven to be wrong in practice by many researchers. As discussed by Saunders et al. (2007, p. 119): *'Not only is it perfectly possible to combine deduction and induction within the same piece of research, but also in our experience; it is often advantageous to do so.'* The combination of induction and deduction sometimes can be called ***abduction***. Within this study, abduction is interpreted as an iterative process of induction and deduction. It typically starts with incompleteness in evidence, explanation of a topic and yields an accumulated result in the end through an iterative process. As shown in ***Figure 2.3***, it may, for instance, start with an evaluation in terms of its validity, just like deduction. However, the process of validation may iteratively involve hypothesis formulation, hypothesis testing, and reformulation and retest etc. Therefore, it can be argued that given certain constrains on, e.g., time, resources and risk one are willing to take, the abductive approach has the 'golden middle path' between these two approaches and is relatively more capable to contribute to a robust conclusion.

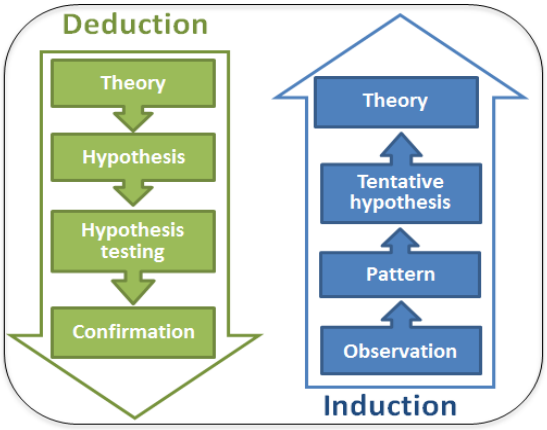

Figure 2.2 *Deductions and Induction*

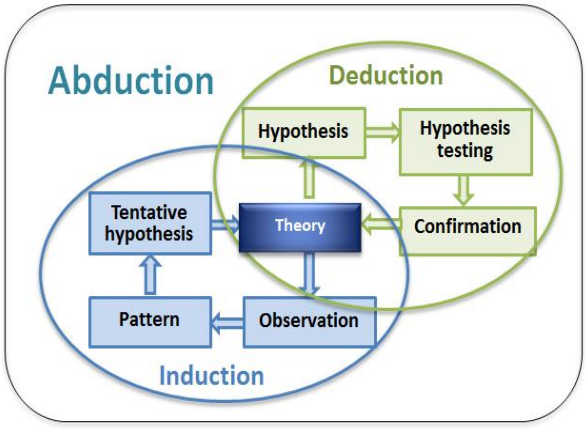

Figure 2.3 *Abduction, Deduction and Induction*

The choice of research approach is highly dependent on the nature of the research questions (Section 2.1), and it is important for the researcher to form a research strategy. As Easterby-Smith et al. (2002, cited in Saunders et al., 2007) suggest, the choice of research approach will enable the researcher to take a more informed decision about the research design. It helps to guide the overall configuration of a study, in order to provide good answers to the research questions. The authors also point out that it will be helpful in making choices about research strategies properly, e.g. if an inductive approach is more appropriate than an deductive approach when one is interested in studying why something is happening rather than to describe what is happening. Finally, it is argued that knowledge of different research traditions enables the researcher to adapt their research design to cater for constraints. For instance, with a deductive approach, the development of theory and formulation of hypotheses shall be highly based on sufficient prior knowledge and researchers' understanding of such a topic. As discussed by Saunders et al. (2007, p.119): *'the extent to which*

you are clear about the theory at the beginning of your research raises an important question concerning the design of your research project'.

This study is conducted with an abduction approach that combines both induction and deduction. As for the deductive side of the study, it aims to test Vimarlund & Koch's (2011) evaluation model through a case study. As mentioned previously, Vimarlund & Koch's (2011) model is built upon four case studies where this study can be considered as the fifth one. The result could either confirm what have been identified in the original model or identify issues that should be investigated in the future study. With a deductive approach, studies are normally started with hypothesis formulation. However, in this study, hypotheses are not explicitly formed. The initial assumption can be that the findings will be consistent with Vimarlund & Koch's (2011) original model. Vimarlund & Koch's (2011) model is still in its developing phases. As described earlier, their model was built upon a literature review and verified by four cases. From a long-term perspective, the model is expected to be validated with more cases in order to enhance its generalizability. As for the inductive side of this study, a semi-structured data collection technique will be adopted (***Section 2.5.4***). During the interview, the questions will be asked open for any answers, in case new effects and indicators are identified. Those issues are expected to be tested deductively in future studying. Therefore, in the long run this study uses an iterative process of deductive and induction – the abduction.

2.3 Research Choices

2.3.1 Qualitative Vs. Quantitative

The terms *qualitative* and *quantitative* are widely used in research to distinguish both data collection techniques and data analysis approaches. *Quantitative* is predominantly used as a synonym for any data collection technique (such as a questionnaire) or data analysis procedure (such as graphs or statistics) that generates or uses numerical data (Saunders et al. 2007). In contrast, *qualitative* is used predominantly as a synonym for any data collection technique (such as an interview) or data analysis procedure (such as categorizing data) that generates or uses non-numerical data (Saunders et al., 2007). The data required to answer the research questions is highly dependent on the choice of research approach as discussed in the previous section (***Section 2.2.1***). Having a clear view of which kind of data is needed to answer particular research question enables the researcher to make proper decision about research strategies, choice of data collection techniques and data analysis procedures. The classification of research choices is presented in ***Figure 2.4***. As claimed by Saunders et al. (2007), individual quantitative and qualitative techniques and procedures do not exist in isolation, and the way in which you choose to combine quantitative and qualitative techniques and procedures are your *research choice.*

Within the boundary of this study, *multi-methods* have been chosen. As described by Tashakkori and Teddie (2003, cited in Saunders et al. 2007), the term *multi- method* refers to those combinations where more than one data collection technique is used with associated analysis techniques, but this is restricted within either a quantitative or qualitative world view. As mentioned in previous section (***Section 2.1***), the main purpose of this study is evaluative and it is often related to qualitative data collection, e.g. documentary analysis and interview. Hence the multi-methods study will be used to collect qualitative data and to analyze these data by qualitative procedures (detailed description of data collection and data analysis will be made in the following sections (***Section 2.5***)). Tashakkori and Teddie (2003, cited in Saunders et al. 2007) have commented that the multiple methods are useful if they

provide better opportunities to answer research questions and where they allow a better evaluation of the extent to which the research findings can be trusted and inferences made from them.

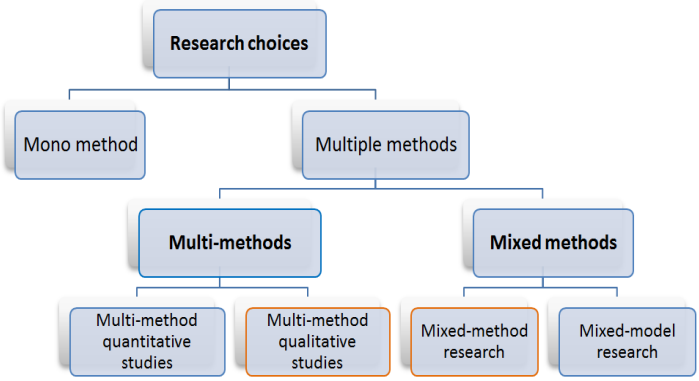

Figure 2.4 *Classification of research choice (Saunders et al. 2007)*

Drawing on these characteristics, *mixed-method research* can be chosen in this study. *Mixed-method* uses quantitative and qualitative data collection techniques, and an analysis procedure either at the same time (parallel) or one after the other (sequential), but does not combine them (Saunders et al. 2007). As discussed in 2.2.1, this study is conducted with an abductive approach that the knowledge accumulation is along with the iterative process of deduction and induction research. Hence, different research choices have to be made at each stage of this study. In this study, the authors aim to identify a list of all possible effects that EIAS may bring to health care organization. One of the outcomes of this research is to provide input for developing a questionnaire for collecting quantitative data in future study. In order to insure that the most important issues have been addressed, interviews, for example, may be conducted at an exploratory stage. By analyzing the qualitative data, generated key issues are used for developing the questionnaire in order to collect descriptive or explanatory data, which then becomes a starting-point of the deduction process.

2.4 Research Strategy

The choice of an appropriate research strategy enables the researcher to answer a particular question in order to meet research objectives. Some commonly used research strategies are: survey, case study, action research and grounded theory. Each strategy is used for different research purposes, as discussed earlier, exploratory, descriptive and explanatory research. When choosing the research strategy for different research approaches, some of these are clearly applied to inductive approach and others to deductive. As suggested by Saunders et al. (2007), the choice of research strategy will be guided by the research question(s) and objectives, the extent of existing knowledge, the amount of time and other resources that are available, as well as the researcher's own philosophical underpinnings. In short, the choice of strategy should largely depend on the problem under study and its circumstances. Moreover, it has been noted that research strategies should not be thought of as being mutually exclusive, e.g. a survey strategy is used a part of a case study (Saunders et al. 2007). The strategies that will be used in this study are introduced subsequently in this section.

2.4.1 Case study

Case study is defined *'as an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are using.'* (Yin, 1994, p.23) The case study strategy is particularly interesting if one wish to gain a rich understanding of the context of the research and the

processes being enacted (Morris & Wood, 1991, cited in Saunders et al. 2007). Within a case study, different types of data (quantitative data & qualitative data) can be collected through various data collection techniques (interview, questionnaire etc.) and used to answer different research questions ('why' as well as 'how' and 'what'). The use of data from multiple sources are called triangulation, which refers to the use of different data collection techniques within one study in order to ensure that the data are telling you what you think they are telling you (Saunders et al., 2007).

However, due to an 'unscientific' feel it has, case study strategy is one among other research strategies that have been most criticized. Critics of the case study method believe that the study of a small number of cases can offer no ground for establishing reliability or generality of findings, and that the intense exposure to study of the case biases the findings (Barnes, 2005). Researchers holding the view that social science is about generalizing, and argue that one cannot generalize from a single case study. Others comment that case studies are subjective, and allow too much scope for the researcher's own interpretations (Flyvbjerg, 2006). Hence, there is a saying that case study research is as useful only as an exploratory tool.

Yet researchers continue to use the case study research method with success in carefully planned and crafted studies of real-life situations, issues, and problems (Barnes, 2005). Some researchers hold a different view of its generalizability and credibility. As elaborated by Flyvbjerg (2006), generalization is one of the scientific tasks that are carried out by researchers, which is the most important precondition for science. The term 'science' means literally to gain knowledge. Flyvbjerg (2006) argue that formal generalization is only one of many ways by which people gain and accumulate knowledge. That knowledge cannot be formally generalized does not mean that it cannot enter into the collective process of knowledge accumulation in a given field or a society.

Given the problem under study and its circumstances, and taking the criticism into account, case study is still considered as an appropriate research strategy for this study. According to Yin (2003, cited in Saunders et al., 2007) case strategy can be further distinguished into two sub-strategies based upon two discrete dimensions: *single case vs. multiple cases* and *holistic case vs. embedded case*. A single and embedded case has been formed in this study. As an IT innovation – EIAS (ERAS Interactive Audit System) has been selected and will be evaluated by the model. The findings will be used either to validate or make improvement of it. Since the study will only focus on an individual unit within an organization, hence it is holistic. The detailed description of formulation of case will be introduced in *case formulation (**Chapter 4***). One may criticize that this study has an inability of generalization as it is conducted on the basis of an individual case. Consequently it will have no contribution to the scientific development unless it represents a critical case or, an extreme or unique case. It is true that there is no uniqueness of this case. However, under certain resource and time constrain, and take into consideration of the research goals and purposes, it can be considered as a proper case to be selected. On the other hand, this study does not aim to generalize based on this case; instead, the intention is to make the results transferable to, for instance hypotheses, further questions or future implications. As discussed previously, the initial model was validated and improved based on four case studies. The completion of this study will make it the fifth case that increases the generalizability of the model. The qualitative data collected is analyzed in order to build propositions that will be further validated deductively by quantitative data.

2.5 Data Collection

2.5.1 Primary Data vs. Secondary Data

Data is the source of answers to the research questions, and it is crucial to bear in mind which data is going to be collected in the study. In the previous section (***section 2.3.1***), the qualitative and quantitative data has been discussed. Generally speaking, they are distinguished by whether the data is numeric (quantitative data) or non-numeric (qualitative data). The data can also be classified as primary and secondary data based on when the data is collected and for what purpose. *Secondary data* refer to data that have been collected in the past (before this research) for some other purpose, whereas *primary data* refers to data that observed or collected first hand by the researcher for that purpose. In this study, both primary and secondary data will be used.

Secondary Data
Secondary data can be either quantitative or qualitative, and can be raw data or compiled data. It can provide a valuable source from which to answer particular research questions. Compared to primary data, secondary may have several advantages, as listed by Saunders et al. (2007) for instance: fewer resource requirements, unobtrusive, can result in unforeseen discoveries and permanence of data etc. Hence due to various kinds of limitation, when first considering how to answer the research questions, the authors considered initially the possibility of reanalyzing the secondary data. However, one challenge might be to ascertain whether the data needed is available. As stated by Saunders et al. (2007), for many research projects it is unlikely that the data you require is available as secondary data.

Saunders et al. (2007) provide a classification of secondary data that builds upon many other different researchers' work, and captures the full variety of data. During this study, searching, finding and locating secondary data sources was done simultaneously with the literature review process. According to Saunders et al.'s (2007) classification, documentary secondary data will mainly be selected and analyzed to answer the research questions. Documentary can be, for example, organization's database, organization's websites, journals and newspapers etc. In this case, documentaries are mainly from ERAS's official website, published articles and journals concerning ERAS/EIAS and organizations' Power Point presentation of ERAS/EIAS etc.

Primary Data
In this study, primary data are used coupled with secondary data. When required data are unavailable or inaccessible as secondary data, primary data will be collected. For instance, in this case, a detailed description of EIAS is required for the authors to understand the system, as the main purpose of this study is to identify the contribution that an IT investment can bring to a healthcare organization. However, as ERAS Society is a newly founded company such documents are under development. Alternatively, several interviews will be conducted with domain experts of ERAS. The data collected will be analyzed to outline features and profiles of EIAS, and to explore its IT functionalities. As discussed earlier, the primary data collected in this study is mainly qualitative and will be collected through semi-structured interviews with different people from different organizations. The discussion of the choice of data collection method will be presented in the following sections.

2.5.2 Data sources

Important Abbreviation

As those organizations will be frequently referred in the remaining chapters in this thesis, the following abbreviation is introduced for simplification.

- **P** for Provider of EIAS - *Encare®*
- **A1** for Adopter of EIAS 1- *Danderyds Sjukhus*
- **A2** for Adopter of EIAS 2 - *Örebro University Hospital*

Länssjukhuset Ryhoy (Jönköping County Council)

The County Councils first responsibility is to provide health care, medical treatment and dental service for the residents of the county from birth to the end of their lives. It is the fifth largest county in Sweden measured by the number of residents. It is responsible for 333 000 residents in 13 municipalities (Jönköping County Council, 2012).

(P) ERAS society (Encare®, provider of ERAS)

The ERAS Society is a non-profit international organization which was officially founded in Stockholm, Sweden 2010. *'The mission of the society is to develop perioperative care and to improve recovery through research, audit education and implementation of evidence-based practice.'* (ERAS Society, 2012)

(A1) Danderyds Sjukhus (Stockholm County Council)

Stockholm County Council is responsible for all publicly-financed healthcare and public transport in Stockholm County. It is one of Europe's largest healthcare providers, offering everything from telephone advice about self-care to advanced specialist care at university hospitals. The County Council has overall responsibility for caring for the county's inhabitants, and must meet the targets of the Swedish Health and Medical Services Act, i.e. good health and care on equal terms for the entire population. Knowledge of the county's inhabitants, such as age and health, forms the basis for planning this care.(Stockholm County Council, 2010)

(A2) Örebro University Hospital (USÖ)

USÖ is a wellness and healthcare center that is growing dramatically. It is a university hospital and it offers modern and accessible healthcare on the best scientific foundation. Together with the hospitals in Lindesberg and Karlskoga, they offer specialized somatic care to the county's 280,000 inhabitants, roughly 190,000 of who get their care at USÖ. The work is based on high-quality nursing, diagnostics, and treatment, and on meeting each and every patient in a positive and personal way (Örebro University Hospital, 2010).

2.5.3 Data collection overview

Table 2.1 Data collection overview

Reference Group	Occupation	Data collection Outline	Type & Time
Form the case (Potential Adopter of EIAS)			
Länssjukhuset Ryhoy (Jönköping County Council)			
1. **Niklas Zar**	Surgeon	- Situation Description - Identify needs for ERAS - Case formulation (Interview question see Appendix II)	Face to Face 52 mins
2. **Jenny Silfverhjelm**	Registered nurse Responsible for ERAS	- Current working process - Current IS - Expectation of ERAS (Interview question see Appendix III)	Face to Face 54 mins
ERAS/EIAS Investigation			
Documents Study			
- **ERAS Society website** - **Published articles** - **Company's internal documents**	---	- Gain preliminary understanding of EIAS - Outline the feature of EIAS - Contribute in designing of interview questions.	---
Observation of EIAS			
- **EIAS Interface**	---	- Gain preliminary understanding of EIAS and its IT capacity. - Contribute in designing of interview questions	---
(P) ERAS Society (Encare® the provider of ERAS)			
3. **Magnus Stasfing**	CEO of Encare®	- Descriptionon of ERAS - Its IT capacity - Identify innovation effects - Identify indicators of effects (Interview question see Appendix IV)	Telephone interview. 62 mins
Experienced adopter of EIAS			
(A1) Danderyds Sjukhus (Stockholm County Council)			
4. **Helena Hofström**	Nurse	- How ERAS works - Identify innovation effects - Identify indicators of effects (Interview question see Appendix IV)	Telephone interview. 44 mins
(A2) Örebro Hospital			
5. **Olle Ljungqvist**	Professor of Surgery and ERAS Expert	- Condensed discussion of key issues that have been discovered. (Interview question see Appendix IV)	Telephone interview. 25 mins

As shown is ***Figure 2.5*** below, a first introduction meeting was conducted at the early stage of this study. Through the interview with Niklas Zar, we found that Länssjukhuset Ryhoy was about to make a new IT investment and was interested to know what the new system could benefit to the hospital. Through this study, results will not only help the authors to deepen their knowledge about IT evaluation in the healthcare area, but also con-

tribute to providing input to decision making process concerning ERAS in Jönköping County Council. After the connection had been built, a second interview was conducted with Jenny Silfverhjelm - a registered nurse in Jönköping County Council who is also in responsible for ERAS and has deep knowledge in surgical care. Through the interview with Jenny Silfverhjelm, we expected go get enough information for the case formulation, e.g. their current IS/IT system and corresponding working procedures, the shortages of the old system and the expectation of the new system (EIAS). Prior to the collection of the empirical data through semi-structured interview with representatives from EIAS provider and EIAS adopter, a documentary study and observations of EIAS have been conducted. The documents are all articles relevant to ERAS and the observation is conducted based on all screenshot of EIAS provided by the ERAS society. Afterwards, the ERAS provider was expected to provide in-depth and comprehensive explanation of EIAS and to identify innovation effects and indicators based on his knowledge. The interviews with EIAS adopters were based on previously identified issues. We did not separate the findings derived from EIAS provider and EIAS adopters. As the interview process progressing, the list of identified innovation effects and indicators was refined and accumulated.

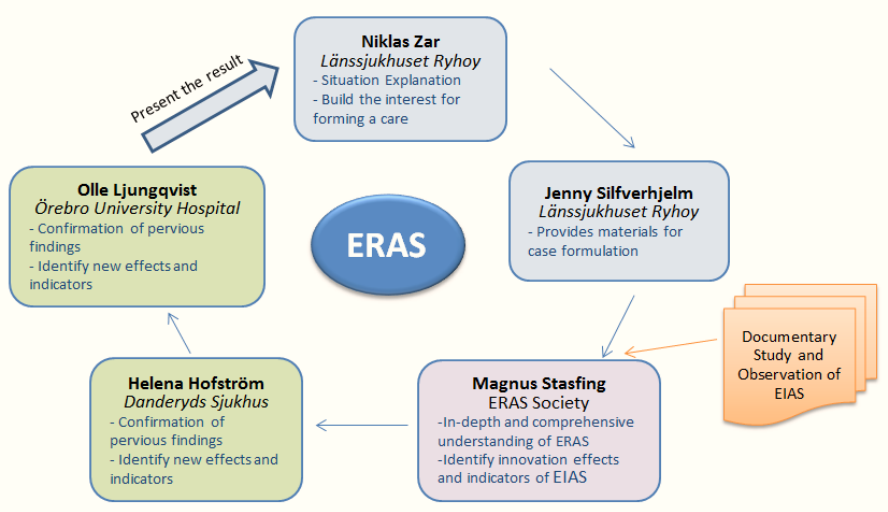

Figure 2.5 Process of the Case Study

2.5.4 Data collection techniques

2.5.4.1 Literature search

The literature search and review was conducted throughout the entire thesis project with different focus in different stages of the study. The focus was broad initially, and along with the research process progressing, it became more and more narrow. Jönköping University's searching tool – ***Primo*** was used as it gives access to the library collections and also include articles from other databases. ***Google scholar*** is another academic database search engine that has been used during this study. Google scholar ranks results with a combined ranking algorithm, weighing the full text of each article, the author, the publication in which the article appears, and how often the piece has been cited in other scholarly literature (Google Scholar, 2012). Internally, there were around 37,600 articles found written in the eHealth area. Later the articles were sorted according to publishing year, and we only considered articles that were published after the 2002. Those articles that have been most cited by other scholars were mostly considered. Furthermore, different combined key words were used to narrow down the searching range by filtering out irrelevant articles. Finally, remaining articles were read in its totality to identify whether they were within the

scope of this study. To this end, studies that are considered relevant to this study was n = 56. The keywords that were used for searching articles are shown in ***Table 2.2*** below. Those terms were also used in combination.

Table 2.2 Key words used for literature search

Key words	**Key words**
eHealth	Clinical informatics
eHealth accessment	Ehealth impact/effects
eHealth evaluation	Innovation evaluation
Evaluation model	Evaluation framework
Healthcare innovation	Innovation evaluation
Formative evaluation	Innovation in healthcare
Health informatics	Information system healthcare
Health information system	Evaluation framework
Healthcare informatics	Healthcare science
HIS	IS evaluation
Summative evaluation	IT innovation

2.5.4.2 Semi-structured interview

As part of a case study strategy, qualitative data will be collected in order to answer the research questions where interview is a favored means for collecting qualitative data. In simple words, interview is a purposeful discussion between one or more people of certain themes. According to Saunders et al., (2007), the research interview is a general term for several types of interviews and this fact is significant since the nature of any interview should be consistent with the research question(s). One typology that is commonly used is related to the level of formality and structure, whereby interviews may be categorized as one of, structured, semi-structured or unstructured or in-depth interviews (Saunders et al., 2007).

The choice of different types of interview has a close link to the research purpose. As discussed earlier, this research complied the characteristics of both descriptive and explorative research. At the stage of describing the current situation of ERAS in Jönköping County Council, interviewees were expected to provide comprehensive, reliable and comparable information that allowed the authors to outline the scene. While at the stage of exploring the impact of IT investment, the interviewees were expected to provide sufficient, reliable and comparable information to identify the indicators of the impact of IT investment. At both stages, the interviewees should be guided and inspired to cover all themes and aspects that the authors were interested in while at the same time also have the opportunity to talk freely about the topics. The collected data set should be rich and detailed, and provide the opportunity to gain data that the author may not have previously thought about before.

The *structured* interview is using a standardized procedure to collect qualitative data based on a predetermined list of questions, and later those qualitative data will be quantified and analyzed quantitatively. Whereas the *unstructured* interview is normally informal, and there is no predetermined list of questions prepared by interviewer. The interviewee is given the opportunity to talk freely about events, behavior and beliefs in relation to the topic area. Hence, the semi-structured interview is considered the most appropriate data collection method for this study. In *semi-structured interviews,* the researcher will have a list of themes and questions to be covered (Saunders et al., 2007). On one hand, semi-structured interviews contain open-ended question and the interviewee is encouraged to talk freely under

each theme to provide rich and detailed data set. On the other hand, the semi-structured interview gives the authors a better control while the interview is progressing. In reality, an interview is often conducted under certain time constrains. Before the interview, the authors prepare questions under each theme and plan for the amount of time allocate on each question. By doing so, the authors are able to ensure that all themes and questions have been covered, and key themes and questions have been given proper attention and focus.

2.6 Data Analysis

As quoted by Saunders et al. (2007, p. 478) *'a contrast can be drawn between the 'thin' abstraction and description that results from qualitative data collection and the 'thick' or 'through' abstraction or description associated with qualitative data.' (Dey, 1993; Robson, 2002; Box 13.1)* And '*qualitative data are characterized by their richness and fullness based on opportunities to explore a subject in as real a manner as is possible.'* (Robson, 2002, cited in Saunders et al., 2007, p. 478) As discussed previously, qualitative data was collected through semi-structured interview, and the way of which data was analyzed and interpreted is presented in this section.

2.6.1 Analysis Procedures and Interpretation of data

There are many qualitative research traditions or approaches, as a result there are also different strategies to deal with the data collected (Saunders et al, 2007). In order to explore and analyze the qualitative data in a systematic and rigorous way, there are certain common procedures to follow, regardless which analysis approach is adopted. As suggested by Saunders et al., (2007), one particular feature that is common to these analysis procedures involves organizing the mass of qualitative data is collected into meaningful and related parts or categories. The following four activities are suggested as shown in ***Figure 2.6***.

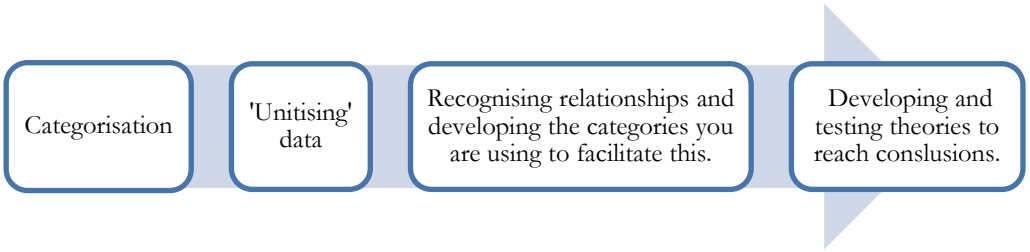

Figure 2.6 Four common activities for qualitative data analysis (Saunders et al., 2007).

Within the margin of the transcript, the qualitative data will be firstly classified into categories. Since the questions asked in the semi-structured interview were designed following the structure of Vimarlund & Koch's (2011) analytical model, the answers had already been categorized. Saunders et al., (2007) suggest that undertaking the 'unitizing data ' stage of the analytic process means that you are engaging in a selective process, guided by the purpose of your research, which has the effect of reducing and rearranging your data into a more manageable and comprehensible form. After this stage, words, sentences or paragraphs that are related to the effect of use and implementation of IT application will be highlighted. As the analysis process progress innovation, innovation effects and indicators will be identified through iterative rearranging of data and reorganizing categories. As discussed earlier, this study is conducted in the adductive approach. Hence, to more or less extent it has the deductive nature of hypothesis testing. The results gained will be used to validate of the model and differences, if any, will be used as input for developing of hypotheses to be used in further studies.

In this study, narrative analysis was considered the most appropriate for interpreting the data. As mentioned by Saunders et al. (2007), some approaches of analyzing qualitative data

may be highly formalized, whereas others rely much more on the research's interpretation. Approaches like narrative, are based on individual's accounts of their experiences and the ways in which they explain these through their subjective interpretations and relate them to constructions of the social world in which they live. Even though the findings through the semi-structured interviews were more or less structured and categorized, the content is linked closely. One of the aims of this study is to identify effects and their indicators of adoption of IT application. The findings that are rendered in the original sequence will ensure the logic of cause-effect relationship to be accurate. As a definition of narrative analysis given by Saunders et al, (2007) a narrative is an account of an experience that is told in a sequenced way, indicating a flow of related events that, taken together, are significant for the narrator and which convey meaning to the researcher. Hence, we believe that it plays a vital role for the interpretation of data.

2.7 Use of Vimarlund & Koch's (2011) Evaluation Model

In previous sections, the methods of how data are collected and analyzed in order to answer the research questions were introduced. Due to the fact that this study is conducted largely based on Vimarlund & Koch's (2011) evaluation model, a general description of how this model is used in this study is described in this section. In fact, the use of Vimarlund & Koch's (2011) evaluation model in this thesis is just like a guideline and it is hard to refer to where and when we utilize it since we have it throughout this study. We consider the model as a great pioneer and our thesis is the derivative. Specifically, at one hand, we tried to find a case and utilized the case to validate the comprehensiveness, applicability and practicability of this model. We believed it is necessary and contributed, it makes our study valuable due to the model is new built and only validated by prior four cases. On the other hand, we found that the model is capable of guiding our study during the entire thesis writing. During the process conducting this study, the deeper we dug, the more powerful we found the model is.

In order to better organize our study, we primarily divided our study into three phases, which are 1st Preliminary data collection phase, 2nd Data collection phase and 3rd Data analysis and interpretation phase. As mentioned previously, the purpose of this study is to validate their model in the practical application. Hence the model is of great importance and has been introduced and referred throughout our study. Below will introduce specifically how the model has been utilized in each phase and how we achieved the research outcome by guiding of the model.

As the beginning phase – Preliminary data collection, when we first got access to Vimarlund & Koch's (2011) evaluation model, we conducted a comprehensive and detailed study of the model. The structure of the model is clear and easy to understand, however the information included in the model are with large capacity. Prior to the interviews with the respondents, the IT capacities of EIAS have been studied through documents study and observation of EIAS user interface. Having the preliminary understanding of IT capacities of EIAS and contrast them to Vimarlund & Koch's (2011, p.5, Figure 1) three steps model *'From micro level to virtual networks',* the authors gained a preliminary judgment of at which level(s) EIAS may have impacts to the organization. In this phase, we only make judgments by our best knowledge and as considered the limited knowledge we have gained in this phase. We moved very carefully and conservatively to exclude the innovations list in the model in three level one by one, item by item. We referred to innovation effects and indicators in order to have good understanding of each innovation.

For example it can be clearly judged that EIAS has no impact on the *'virtual network for personalized services'* (Vimarlund & Koch, 2011, p.5) level as according to the documents reading EIAS has no functional capacity could support individualized services. But for the second level - inter- and intra-organizational level, there are no explicit evidence that EIAS has no effects on this area, so we remain the second level into the next phase. Thus, our preliminary judgment is EIAS have impact at the micro level and may have impact at the inter- and intra-organizational level, which is expected to be verified through empirical study of the interview result.

Vimarlund & Koch's (2011) evaluation model is an explicit and comprehensive instrument that identifies and classifies the contribution of IT application at different level for different stakeholders. The model has provided a long list of measureable examples of effects that IT application can bring to healthcare organization. Based on the understanding of functional capacities of EIAS and consult the list of *indicators that capture innovation and effects of IT-based application at the micro level (*Vimarlund & Koch 2011, p. 6-7, Table 1) and list of *indicators that capture innovation and effects of IT-based applications at the inter- and intra-organizational level* (Vimarlund & Koch, 2011, p. 8-9, Table 2), a preliminary analysis is conducted by comparison of listed indicators with the outcomes of EIAS documents study and observation. The principles of this phase are to conservatively eliminating of irrelevant indicators and their corresponding effects, and remain the indicators and their corresponding effects which are not for sure. Indicators are the items that can be directly excluded when they are irrelevant; Innovation effects can only be excluded when theirs corresponding indicators are all irrelevant; innovations can only be excluded when effects within the category are all irrelevant. The remaining innovation, innovation effects and its indicators are entitled to be further identified. The main purpose of the preliminary study is to reduce the list of the original Vimarlund & Koch's (2011) evaluation model. The outcome of this part is served as a valuable input for the design of interview questions for the next phase. Through the preliminary study, some obvious irrelevant innovation and innovation effects presented in Vimarlund & Koch's (2011) evaluation model has been filtered out. It helped to clear direction and focal points of the interview. For example, the indicators of '*Reduced number of double referrals*' (Vimarlund & Koch 2011, p. 6, Table 1) and '*More effective time allocation within the organization due to reduced telephone hours for booking/unbooking*' (Vimarlund & Koch 2011, p. 6, Table 1) are clearly irrelevant to EIAS's IT capacity due to the observation indicate that the EIAS has no functions related to referral and booking/unbooking. So we exclude the innovation effects '*Electronic registration of clinical effort and effect*' Vimarlund & Koch 2011, p. 6, Table 1) and '*Virtual booking/ unbooking of appointments*' Vimarlund & Koch 2011, p. 6, Table 1) where the indicators positioned, and the question related to those effects and indicators will not be asked during the interview.

Vimarlund & Koch's (2011) evaluation model is acting like a framework that also guide the data collection phase. As described earlier, a semi-structured interview is adopted in this study. In order to lead the respondents to systematically, accurately and comprehensively identify the possible benefits that EIAS can bring to the organization, the themes and the structure of the interviews are followed by the structure of Vimarlund & Koch's (2011, p.6, Table 1) evaluation model. The questions asked in the interviews are designed based on the innovation, innovation effects and indicators that have been identified in Vimarlund & Koch's (2011) evaluation model. During the interviews, innovation is identified based on IT capacity of EIAS. The respondents will be asked about the identified corresponding innovation effects and indicators. The respondent can either confirm or disprove an innovation effect. If an innovation effect is confirmed by respondent, he/she is asked to give examples of indicators of how the effect is captured. The respondents are also encouraged to identify uncovered effects and indicators that are not covered in the preliminary findings.

Moreover, during the discussion with the respondents, follow up questions will be asked and unexpected findings may be discovered. The listed indicators in Vimarlund & Koch's (2011, p.6, Table 1) evaluation model are also used as examples during the interviews to guide and inspire the respondents. One example of how the interview question is asked is shown as below:

One innovation, innovation effect and indicators are presented in Vimarlund & Koch's (2011, p.6, Table 1) evaluation model:

Innovation	***Innovation effects***	***Indicators of the effects***
Internal integration and co-ordination of administrative and clinical information	*Increased coordination and control of clinical information*	*Reduced time for coordination of healthcare efforts*

Corresponding interview question is designed as:

Does EIAS help to increase coordination and control of clinical information?

For example:

- *'Reduced costs for extra administrative work because of incorrect information'* (Vimarlund & Koch's (2011, p.6, Table 1)
- *'Reduced time for coordination of healthcare efforts'* (Vimarlund & Koch's (2011, p.7, Table 1)

The designed questions which are used to identify indicators that capture innovation and effects of EIAS are used during the interview with one EIAS provider and two EIAS adopters. During the process of organizing and interpreting data which collected from the interviews, findings are uniformly structured according to Vimarlund & Koch's (2011, p.6, Table 1) evaluation model, in order to make the findings comparable. In the analysis phase the evaluation results gained from different parties are compared, e.g.: EIAS provider and EIAS adopter. The purpose is to examine whether there exists different evaluation results corresponding to if actual users of the system are involved or not. From this point of view the authors of this study intend to verify the applicability of Vimarlund & Koch's (2011) evaluation model. Furthermore, all the identified benefits (from EIAS provider plus EIAS adopters) are compared with the evaluation result of current IS that support ERAS in Jönköping County Council, in order to have a list of possible benefits that the new system may bring to the organization. Finally, the findings are also compared with Vimarlund & Koch's (2011, p.6, Table 1) evaluation model, in order to validate its comprehensiveness that whether all the identified effects are covered by their model. If new indicator(s) is(are) identified then it is expected to be further validated in future study, and may be added to Vimarlund & Koch's (2011) original evaluation model to enhance its comprehensiveness.

2.8 Credibility of Research Findings

Attention has to be paid to the credibility of research findings throughout the entire research process. Simply speaking, to have high credibility of research findings is to reduce the possibility of getting the answer wrong through a rigorous research design. As described by Saunders et al. (2007), to ensure a high quality of research attention has to be paid to two particular emphases on research design, reliability and validity.

'Reliability refers to the extent to which your data collection techniques or analysis procedures will yield consistent findings.' (Easterby-Smith et al., 2002, p. 53, cited in Saunders et al., (2007, p. 149) In order to ensure the reliability of this study, every decision that was made related to the study was carefully considered and discussed by the authors. There were also strong arguments behind every research choice that was made. During the interview, a voice recorder was used to record the whole interview. The answers given by the respondent was repeated shortly by the interviewee. The double check with the respondent was done in order to ensure that the interviewer was interpreting the answer in the way that the respondent intends to express. We assume that under the same research settings and within the same period, similar conclusion will be derived.

According to Saunders et al. (2007), validity is concerned with whether the findings are really about what they appear to be about. Robson (2002) has charted the threats to the validity in terms of *history, testing, instrumentation, mortality, maturation* and *ambiguity about causal direction.* Among them, the mortality is a major threat to validity and shall be carefully handled. An agreement of conducting such study has been made with different respondents at an earlier stage of this research. In order to enhance the efficiency and effectiveness of the interview, the interview process was well structured and well prepared. Furthermore, in order to enhance the validity, a triangulation data collection strategy was adopted. That means that various kinds of data collection techniques were used within one case, for instance, semi-structured interview, observation and documentary study. Concerning the interpretation, as we mentioned earlier, we double checked every answer given by respondents to ensure the data was interpreted correctly by us.

3 Theoretical framework

By the extensive literature review, the authors present a conceptual framework in this chapter. The content of this chapter will include key concepts like eHealth, innovation and HIS, relevant theories derived from key concepts and the model adopted in this research. In order to show the research foundation, a conceptual map has been drawn in ***Figure 3.1***.

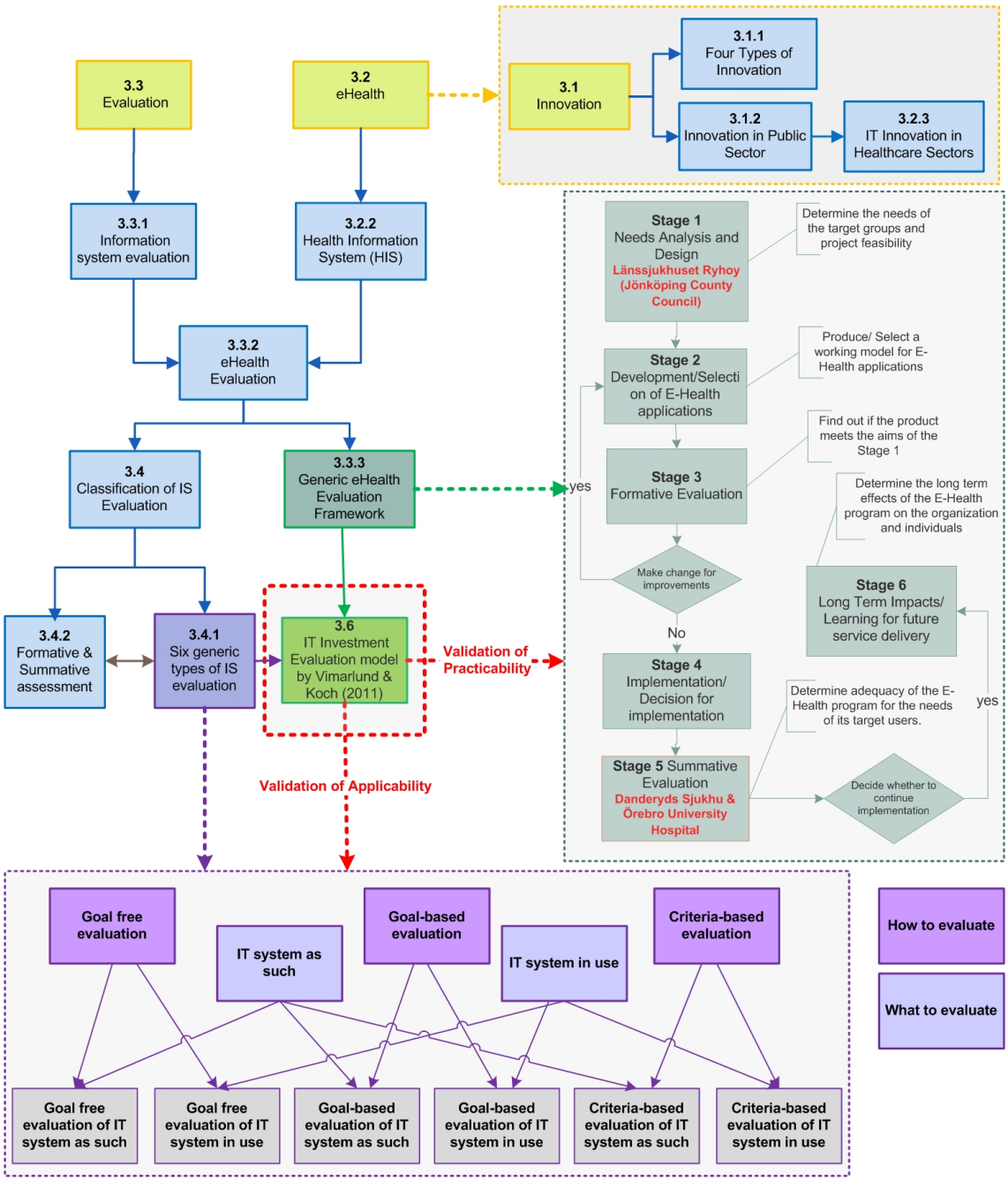

Figure 3.1 The concept map of this study

The focus of this study will be on evaluation of eHealth. This chapter will present a comprehensive conceptual framework which has been developed during this study. The content of this chapter includes,

- Definitions of key concepts within the research area such as eHealth, innovation and health information system (HIS);
- Relevant theories generated by the key concepts, for example, innovation in the public sector, IT innovation in the healthcare sector and eHealth evaluation;
- Some important factors that are considered when performing evaluation of eHealth, such as innovation input, output, effect and indicators;
- The introduction of the IT investment evaluation model in this thesis adapted to analysis of the case selected.

In order to present those ideas more explicitly, the authors drew a research map to display all the key concepts, relevant theories and key factors included in this study, as well as their relationships and possible interactions which will affect the outcome of the evaluation (see figure 3.1). Key concepts and theories presented in this section will give an overview to the reader.

3.1 Innovation

3.1.1 Four Types of Innovation

Innovation has attracted attention along with the evolution and proliferation of technology products, e.g., digital camera, smart phone and electronic paper. However, innovation actually has a broad meaning in research. According to Bloch (2011), an innovation is the implementation of a significant change in the way an organization operates or in the products it provides. The term 'innovation' appears in the previous studies often together with terms like 'improvement', 'evolving', 'enhance' and 'effective'. As discussed in the Copenhagen Manual (Bloch, 2011), innovation could be classified as product innovation, process innovation, organizational innovation and communication innovation, follows are brief introduction about those four types of innovations:

Product innovation is "*the introduction of a service or good that is new or significantly improved compared to existing services or goods in your organization*" (Bloch, 2011, pp14). This includes upgrading of key characteristics of the goods or service. Key characteristics could be better materials, which will improve the quality of the product, new component, which will add the use value, updated software, which will improve user experience, etc. For example, an upgrade of an operation system for a smart phone will make the smart phone a new product innovation by the update of the major feature, and in parallel make upgraded operation system itself a product innovation compare to the previous version of the operation system or old fashion operation system.

Process innovation is "*the implementation of a method for the production and provision of services and goods that is new or significantly improved compared to existing processes in your organization*" (Bloch, 2011, pp14). Process innovation is usually not visible to the customers, but brings significant benefit to the organization. It usually makes improvement by technology which will simplify or make progress on efficiencies of processes. The organization makes more profit by saving the cost of new processes rather than charging a higher price from the customer.

Organizational innovation is "*the implementation of a new method for organizing or managing work that differs significantly from existing methods in your organization*" (Bloch, 2011, p.14). It is

concerned with the perspective of organizational management, business practice, and intra- and inter-organizational processes. For example, organizational innovation could be the change of administration coordination or change the relationship for different actors having various management functions.

Communication innovation is "*the implementation of a new method of promoting the organization or its services and goods, or new methods to influence the behavior of individuals or others*" (Bloch, 2011, pp14). Communication innovation is interpreted as "marketing innovation", but in the public sector there is no "market" in the business meaning. However, promotion or champions for different stakeholders are needed. According to Bloch (2011), there are three types of communications innovations have been identified; new methods of promoting the organization or its products and services, new methods to influence the behavior of various users, and first time commercialization of goods or services.

The innovation that will be discussed in this thesis the IT-based applications. Innovations applied in health care are various and ubiquitous. Innovation brings enormous changes in health care organization not only by upgrading medical device or treatment programs but also by changing work processes, organizational management and/or communication channels.

3.1.2 Innovation in the public sector

Public sector and private sector differ essentially in ownership. Examples of public sector activities are social security, national defense, education and public health care which could be considered as state and government activities that mainly contribute to public welfare. Whereas the private sector is owned and run by private individuals or groups for pursuing profit in the market. Many people argue that the public and the private sector are radically different when it comes to innovation. Some of them believe that the private sector get more incentive and more innovative than the public sector, as they need to respond to market pressures and to stay competitive, whereas government agencies are relatively passive since they are not required to show a profit on their revenues (West & Lu, 2009). Other researchers state that the public sector is not a passive recipient of innovations from the private sector; it is the public sector that plays the role as influence to the private sector's capability to innovate. The reasons are mainly due to the close interaction between the two sectors in many domains and the role of facilitator of infrastructure for the private sector (Bloch, 2011). Take knowledge development and management through research and education as an example, it is generally supported by public education and research sectors, but the outcome obviously also benefit to the private sector innovative.

As the authors have mentioned above, the public sector work as a facilitator to the private sector in terms of being innovative. However, innovation in the public sector is mainly contributed to the quality and efficiency of the public well-being, improvement of economic performance and environmental protection. The changes brought by innovation of the public sector will eventually benefit to the quality of people's life. Take one of eHealth application – ePrescribing as an example, ePrescribing is a system in health care that use computing devices to enter, modify, review and communicate prescriptions in order to improve the quality of prescribing by avoiding medicines management errors and iatrogenic harm (Car et al, 2008).

3.1.3 IT innovation in healthcare sectors

Healthcare industry innovations have primarily concerned improvement of the quality of patient care, enhancing life expectancy, facilitating better diagnostic and treatment options,

as well as the efficiency and cost effectiveness of the healthcare system (Varkey, Horne and Bennet, 2008). Information technology as a powerful technology element has been explored and adopted in different industries and the benefits brought by IT have been well recognized.

According to Gupta (2008) '*there are four major ways in which Information Technology (IT) will revolutionize health care, more offshore services, integration of health information systems, drug safety monitoring on a global scale and more high quality information to doctors and patients.*'

Offshore service – offshore service refer to offshore outsourcing of diagnostic services, such as remote consultation by specialists (Omachonu & Einspruch, 2010). It enable advanced specialist to serve to areas with poor medical conditions and that are hard to reach. Offshore service is a feasible measure for making up for the regional differences in medical conditions. Take Teleradiology as an example, it is an approach to transmit X-rays result to doctors at the other site to enable clinical support (Gupta, 2008).

Integration of health information systems – The current situation is that health care center in different regions usually have their own systems, and even within the organization, the information in different system is not shared. The systems for various uses tend to build on their own rules, standards and have different encryption, which makes the system stand alone. The integration of health information systems is a vision to create of the medical record that can travel with the patient (Omachonu & Einspruch, 2010). The benefits brought by integration are mainly in convenience of patient and accessible data for research.

Drug safety monitoring on a global scale – Gupta (2008) point out that the need for an international database on drug safety has steadily increased for the reason that people travel all over the world. To date, the medication system in a different country is varying. People travel and take different medicines which sometime make their medication history a mystery. Unknown drug history and unknown drug safety information are significant risks for patients.

More high quality information sharing/exchanging to doctors and patients – According to Gupta (2008),the information exchange pathway could include publishing articles on online media, having speech on an open platform like wiki, as well as the exchanging of knowledge enabled by certain clinical information systems. The scale of knowledge sharing supported by information technology will be universally, and the interaction will be easier than before. It is worth noting that functions that enable knowledge exchange has been reorganized as a necessary module for many health information system, it could be either a simple message/note box for doctors or patients or a database contain patient record open for research use.

Along with the development of network and internet security, the impact and effect of IT in healthcare has been dramatically enlarged. IT innovation in health care develop from locally innovation in computerization of patient records, diagnosis, treatment, healthcare center procedures, to innovation that integration of different healthcare systems, communication and knowledge learning from each other between units. It is apparent that, in the near future, old fashion healthcare sectors will lose advantages in handling the clinical outcomes and become isolated while others are using advanced systems, which are enabling them to integrate with other systems or databases, and remotely use resources and sharing knowledge with each other.

3.1.4 Innovation Input, Output, Objective and Effects

To illustrate the state of innovation and its development process, IPO Model has been adopted in previous research. The IPO Model is an abbreviation of Input – Process - Output analysis model which is used as a functional model and conceptual schema to describe general systems. As showed in ***Figure 3.2,*** the original IPO Model defined the innovation process as a system starting from innovation input, by transforming innovation input by a process; innovation input is expected to eventually generate some innovation output; by the end of this process, the feedback in the entire system will be delivered and contribute to improvement in the beginning of the process. There is a small cycle embedded in the input to output cycle, which is the interaction between processing and storage. This cycle is a small learning loop. The processing will be stored every single round and the effect of the processing will be enlightened and enhanced when new round start.

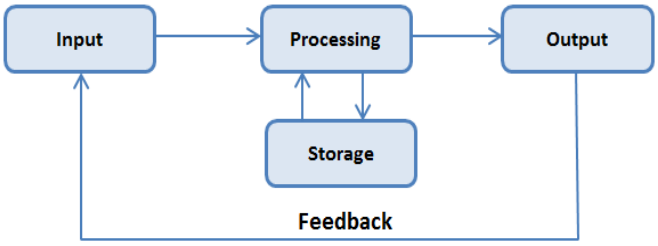

Figure 3.2 The original IPO model

In order to adopt the IPO model in the context of IT innovation evaluation and deepen the discussion, the original IPO model was adapted as in Figure 3.3.

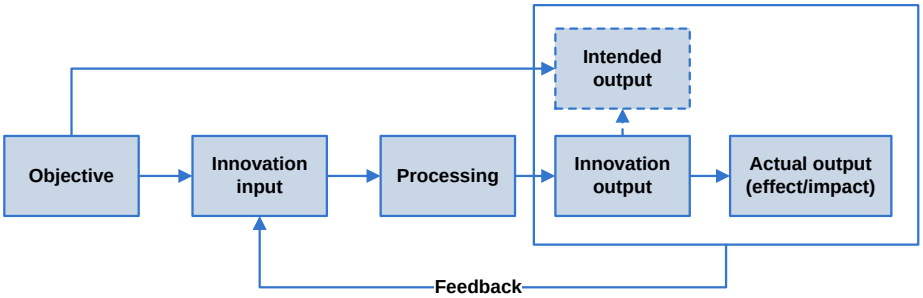

Figure 3.3 The adapted IPO model

Innovation input could be considered as the starting point for innovative activity. According to OSLO Manual, it is functional forms analysis related to problem-solving. In order to have a good startup to innovate, organization need to figure out whether there is an opportunity for changing/improving the situation or solving problems and how to arrive there. For the accomplishment of the objective, input is used for transforming those capabilities into a real innovation (European Commission, 2005).

Innovation output is the target of measuring. It could be marginal revenue from new product or service which is easy to be measured by accounting techniques. It could also be intangible and difficult to measure as the change of business processes, which contribute to smooth the communication within the organization, could be more tacit.

In order to illustrate the relationship between input and output, two fundamental concepts need to be introduced – 'objective' and 'effects'. Bloch (2011, p.21) has a comprehensive

and precise described the interaction of those factors for performing development of innovation:

"Objective and impacts of innovation are at opposite ends of the innovation process; objectives are at the beginning and shape how innovation processes are conducted, while effects are the actual outputs at the end of the process. However, they both concern the same aspects, thus making sense to consider them together (where objectives can be considered as measures of intended outputs)."

Adapting the IPO model according to Bloch's view, which is showed in ***Figure 3.3***, objective and input are on the left side of the process. Objective could be considered as the motivation or incentive to make input transform into processes while the output is separated into actual output (effects) and intended output, which are the consequences of the innovation.

It is noteworthy that the IPO model is more than a process that simply describes the flow of information. It is also considered as a learning loop. As Bloch (2011) argues, objectives could act as measures of intended outputs. Assume that there is a pre-implementation of an innovation project; the objectives should be used to check if intended outputs are consistent. Furthermore, when the process start to generate actual output, it is time to go back to confirm if the objectives/intended output has been realized as the actual output (effects) The feedback about whether intended output is able to reflect the objectives or whether objectives/intended output is corresponding to actual output are contributed to keep making progress of the innovation before, during or post implementation.

As discussed above, objective and effects are contributors of measuring innovation. The authors tend to believe that effects are more useful than objectives while measuring innovation. Unlike objectives, effects are in real, not only planned. However, effects might not easy to locate. Firstly, effects generated from innovations are also being affected by the IT productivity paradox (Vimarlund & Koch, 2011). Santos and Sussman (2000) argue that the IT productivity paradox refers that to each IT investment should contribute to enable an organization to be more efficient and or effective. Yet, frequently, few of the anticipated benefits are obtained within the projected time frame. Thus is believed to be due to that many IT investments require for reengineering of the processes and/or restructuring of the organization to acquire anticipated effects. Once organizations fail to adjust to meet the requirements of new resources, the expected effects will fail to be achieved. Moreover, as Bloch (2011) argues, some effects may require complicated analysis and evaluation to discern whether they have actually taken place. Even though there are barriers for measuring innovation by evaluating effects, if appropriate and systematic indicators are used, effects could act as the key factor when it comes to evaluation of innovation.

3.1.5 Indicators

The output of innovation activities is the effect of the introduction of the new resources which are provided by innovation. It could be new products, improved business processes, and changes of the organization culture or innovative method in the administration etc. Indicators are not included in the IPO Model. They could be the complementary or extended part of IPO Model, but when it comes to completing measurement of innovation, they are necessary. As discussed before, effects are the actual output, which are used to measure innovation. They refer to acquired results from innovation. Indicator measures to what degree effects enable the changes and to what extent value is added by innovation. A simple instance to interpret the general meaning of indicators is, an organizational attempt to use a computerized database to replace a manually paper-based database. One of the effects in

this case would be to enable an electronic searching engine for staff's information; To measure the effects, indicators would be reduced time for accessing the required information, high precision of returned information and avoiding manually information error occurrence during searching and archiving information. Unlike some other evaluation, innovation measuring in this thesis is focused on the non – quantifiable and non – financial perspective, thus, indicators identification is asked for multiple considerations.

3.2 eHealth

3.2.1 eHealth in general

As there has been a rapid development of information technology (IT) during decades, the e-terms began to emerge in different occasions in different use. For example, well-known e-terms are "e-mail", "e-commerce", "e-learning" etc. E-terms usually refer to IT enabled innovations, which facilitate traditional interaction activities by electronic way, thus in all of the e-terms, "e" stands for "electronic". The term, eHealth, like the other e-terms, are derived from the term "Health", the value adding is enabled electronically. The introduction of eHealth represented the promise of information and communication technologies to improve health and the health care system (Alvarez, 2002, cited in Oh, Rizo, Enkin, Jadad, 2005). "eHealth" usually appears in publications as "eHealth", "e-Health", "electronic health", "health informatics", "electronic health care", "medical informatics", "biomedical informatics" etc.

As with most neologisms, the authors of this thesis found that it is difficult to locate a universally applied definition of eHealth. According to Oh et al. (2005), even though definitions of the term "eHealth" differ from each other in various ways, settings and contexts where it is used, it encompasses a set of disparate concepts, including *health, technology,* and *commerce*.

Health as a key factor in the definition of eHealth usually refers to the process of performing health care rather than a simple clinical outcome. For example, Grantmakers in Health (2002) define eHealth as "*use of ICT (information and communication technology), especially (but not only) the internet to enable health and health care.*" Health is not a common sense term as the absence of disease or infirmity; it is more closely referred to the process and/or functions in the health care area which aims to lead to a state of physical health for patients or public welfare. eHealth is expected to bring large changes to the process of health care. For example, in patient care, some eHealth tools are capable of providing a checklist of activities and save the medical outcome record electronically for each medical move. In this case, the change from paper-based processes proceeding to the computerized system will avoid missing out on patient care steps by providing alerts automatically.

Technology could be considered as a tool to enable process, function and service, and act as the embodiment of eHealth itself (Oh et al. 2005). "Technology" is developed for realizing the "health" in this case. The technology embodiment in eHealth could be a health website on the internet, a simple application for certain functions or services, a database of the clinical center and a hospital's information system etc. Technology make eHealth as a promising new arrival and the nature of technology makes eHealth as an IT product. Interventions of information technology in healthcare or other industries shared a common advantage which is making things effective and efficient. No matter how different specific details in various services, functions and processes, the reason why eHealth are developed to-

day are the strength brought by technology are outweighed to the risk brought by technology in average occasion.

Commerce is the value of where the technology brought and the human activity improved by technology. According to definition by Wysocki (2001), the value brought by e-Health refers to all forms of electronic healthcare delivered over the Internet, ranging from informational, educational and commercial 'product' to direct services offered by professionals, nonprofessionals, businesses or consumers themselves (Wysocki, 2001, cited in Oh et al, 2005). The value will include financial and nonfinancial benefits. Financial benefit apparently refer to the cost saving or other input saving like manpower input saving which will eventually lead to cost saving. Nonfinancial benefit refers to the improvement which is difficult to measure quantitatively, such as innovation effects where the finding of this evaluation is taking place. eHealth with commerce is expected to emphasized on deliver benefits or value adding to health care industry in various ways. For example, some decision making support modules of health information systems are capable of data collection and organization and provide support for decision making by intelligent analysis of the data. In this case, how much information error reduced by this module and to what extent the module improve the precise of decision making could be considered as the commerce value brought by the module. To what extent this change happens is the key concern of evaluation of commerce, as well as the objective of evaluation of eHealth.

General speaking, eHealth is the intersection of information technology, computer science and health care. IT applications, information systems, database or business intelligent modules are developed and adopted for supporting management and control in medical processes, health organization administration and communication. The objective of eHealth is various, either for making sure that the biomedical information is collected comprehensive and used effectively and efficiently, or improving the organizational management and communication. Benefits brought by eHealth in the clinical perspective are mainly focused on improvement of healthcare processes through improving the quality of management of biomedical data, by information systems for intelligent analysis and decision making. Benefits brought by eHealth in the organizational perspective are mainly improved the interaction among actors, and avoiding error by manual operation. For example, in order to monitor patients' recovery situation after surgery, surgeons and nurses need to have a comprehensive review of the record in different specialties. For example, a patient who is pregnant might have problems while and after having cardio surgery and integrated information about both fetus and patient is required for having preoperative and postoperative patient care. In this case, databases shared across all the specialties are the basis for the corporation within or between health care units. Someone might argue that information could be shared even in the paperwork era. However, when it comes to countrywide or international cooperation for a single patient or a case, databases could be considered as significant tools which contribute to providing records and share data in real time across different health care units in various locations.

3.2.2 Health information systems (HIS)

Health information systems (HIS) is an important concept which needs to be further classified in order to understand a study of eHealth. In a broad sense, health information systems are information management systems which capture and display data related to the delivery of health care services (Chinn, 2010). They could be paper-based or computers based, which includes clinical guidelines, medical terminology dictionaries, various diagnostic devices and other clinical and business information databases, such as laboratory, pharmacy and diagnostic imaging (Chinn, 2010). In this thesis, the authors intend to delimit re-

search of HIS to computer based. The relationship between HIS and eHealth is that HIS is generated by the development of eHealth, and the study of HIS is taken place in the field of eHealth.

For creating improvement of health care service, HIS could be considered as a promising IT involved approach which has been explored for a long time. HIS as information system are not omnipotent when it comes to contribution to health care. HIS is not capable of improving health care fundamentally, as IT contributes to other subjects. Changes brought by HIS are about its effectiveness and efficiency. A minor change in the beginning will bring a tremendous difference in the end that is called the Butterfly Effect. HIS are taking the effort from the minor changes by avoiding flaws caused by old-fashion or traditional inefficient processes to facilitate the overall reorganization of clinical process. In the history of development of HIS, HIS started from contributing to free up manpower. Now HIS actually play a significant role to bring health care into best practice.

To be specific, in what HIS is capable to deal with, for the patient record, HIS are making data comprehensive, mobilized and traceable. Even though paper based records are necessary for some reasons, HIS are more capable and essential. The ideal scenario is that all health care providers shared a database, like a national or worldwide identity system, the record of medical history are continuous and accessible in different locations. Secondly, because of the nature of IT, the patient record by HIS is allowed to validate by definition of rules, that will improve the accurate and integrity of the patient record. Thirdly, for the interaction between health care receiver and provider, according to previous literature, some HIS are able to provide reminders generate by the system easily and quickly for informing about the coming of the routine check or result of the laboratory. Sometimes systems automatically send messages to both patient and provider. Fourthly, for decision making support, for example, it is capable of notifying health care professionals of errors in patient care and coming up with a recommended clue for it. Furthermore, for health care compliance, statistic and analysis, HIS facilitate customized statistic and analysis dashboards which are fit for different requirements.

As discussed before, the contribution of HIS to health care is enlarging over time. A successful HIS, like other IT application adopted in health care, is supposed to improve the quality of work and the quality of patient care. According to the previous studies , the ideal HIS does not exist yet not only because HIS is a relatively new area, but also as the definition of "ideal" changes over time along with the development of both health care and information technology. Hence, there is no consistent argument of "ideal". "Ideal" in an underserved location, the optimal situation is limited by shortage of resources and equipment. Thus, the definition of an optimal situation varies with overall medical condition of certain health care setting. Furthermore, since the health care setting will change over time, the optimal situation will change along with it.

3.3 Evaluation

Evaluation is a term with a broad meaning and could be used in many scenarios. It could use to assess the value of some objectives – in this case, evaluation is monetary; it could also be used to examine the quality of a product or service – in this case, evaluation is probably a process or criterion. eHealth is an introduction of modern technology into the health care area. The modern technology here concerns web-based technology, software, database or other electronic media. By the introduction of modern technology, the merits and benefits of health care appear with its shortcomings and risks. As a new development area, eHealth grows rapidly. And also because it is new, evaluation of it become much more sig-

nificant for the reason that the evaluation result could contribute to know better of it and explore its uncertain benefits and risks and make progress for eHealth in technically or medically.

3.3.1 Information system evaluation

Information systems are implemented within an organization for the purpose of improving the effectiveness and efficiency of that organization (Silver et al, 1995). Drivers of investment in information system are mainly focused on the promise of quality improvement, capability of process efficiency and further development possibilities. By adopting information systems, more and more traditional industries have been changed. Information systems are capable to embed traditional processes into the new system and essentially improve work quality. However, the barriers of investment in information system are noteworthy, as well. Introduction of new things within an organization usually cause resistance at different levels among staff, which could be seen as another important barrier for applying IT application. However, the drivers of advanced technology are is generally stronger than the barriers. Thus new technology is able to replace the traditional ones gradually in the history of technology development.

Along with increased adoption of information systems in various industries for different use, the investment in information system is raising which imply that the evaluation of IS is significant and necessary. Evaluation of IS could contribute to make sense to cost and/or benefit. By identifying the cost and/or benefit for alternative investments, investors could find solid arguments for investment.

3.3.2 eHealth evaluation

Quynh (2007) pointed out that one of the first and most important questions in eHealth evaluation is to identify the targets of evaluation. According to Quynh (2007), the targets of evaluation in eHealth are mainly in user satisfaction, usability and accessibility issues and cost implications (cost effectiveness and/or cost benefit). Specifically, various users represent different interests and needs. For example, doctors as users ask for eHealth programs including comprehensive and up-to-date patient's information for making prescriptions. User evaluative feedback helps to determine the content of information and create knowledge about priority and quality of information (Quynh 2007). Usability and accessibility are important when developing an appropriate user interface for different target users (Gustafson & Wyatt, 2004; Wyatt & Liu, 2002 cited from Quynh 2007). For example, the interface of the website for local citizen's health care consultation will be very different with the education and/or research public website for professionals. Cost effectiveness and/or cost benefit is highly meaningful and valuable when making an investment decision and ROI (Return on Investment) analysis in post implementation period.

The evaluation model validated in this thesis focus on the innovation effects and its consequences enabled by IT, which means the point of concern is mainly in improvement of quality of processes rather than the cost effectiveness and/ or cost benefit. The benefit brought by innovation effects and its consequences could be identified and categorized into user satisfactory and usability and accessibility issues according to Quynh (2007). The evaluation of user satisfaction is mainly taking place in the individualized service/care, maintain the quality and exchange of information, inner/outer organizational coordination etc. The emphasis of the evaluation is on the value added of information provided accurately, timely and effectively which meet the need of different user groups. For evaluation of usability and accessibility issues, the model includes different concerns between the

health care providers (doctors, nurses, anesthetists, care workers and other medical staff), receivers (patients) and the interaction requirements between the providers and receivers, such as consideration of various knowledge background and interested by different target users; thus, there is an indicator for the possibility to personalize information on virtual networks. Personalized information provides maximized flexibility to different users for ensuring usability and accessibility.

3.3.3 Generic E-health evaluation Process

The generic E-health evaluation process, according to Quynh (2007), adapted from Phillips et al (2004) and LTDI (1998) has been adopted for this study. As shown in **Figure 3.4**, the **1st stage** of the process is **Needs Analysis and Design**; in order to determine the needs of the target groups and project feasibility. In this study, stage 1 was conducted by the interview of potential adopters of ERAS care system (Jönköping County Council). Through the initial interview with Niklas Zar and Jenny Silfverhjelm, responsible person of ERAS in Jönköping County Council, Needs Analysis and Design was conducted and needs were identified as - a new IT system is required to have a better support for ERAS protocol. That was the starting point of the study.

The **2nd stage** was **Development / Selection of E-Health applications**; for producing/selecting a working model for E-Health applications. In this study, stage 2 was referred to chosen information system - EIAS. However, the selection was made by suggestion of Jönköping County Council. They suggested this information system as they were looking for arguments weather the information system was worth investing in.

The **3rd stage** was **Formative Evaluation** for finding out if the product meets the aims of stage 1. By comparison of current the information system (MOA) with the new information system (EIAS) benefits that EIAS bring to Jönköping County Council turned out to response to the needs identified in the first stage. Vimarlund & Koch's (2011) evaluation model could be seen as a generic eHealth evaluation framework and was possible to use in this stage. The evaluation process conducted by the guided of this evaluation model is also a process of its validation of practicability.

As described above, we considered that Jönköping County Council was in the first three stages. The **4th stage Implementation/Decision for Implementation** of EIAS by Jönköping County Council is expected to be made in the near future.

The **5th stage Summative Evaluation was** conducted to determine the adequacy of the E-Health program for the needs of its target users. The evaluation conducted in this study was interviews with the adopters of ERAS care system. Among the hospital who adopted ERAS concepts, there are only two hospitals in Sweden which has implemented the ERAS care system. As early adopters, identification of effects that EIAS brings to the hospital can be drawn from experience of use of EIAS. Moreover, Vimarlund & Koch's (2011) evaluation model, a generic eHealth evaluation framework worked as a guide for questionnaires and interview design for data collection. The result from this stage was expected to provide reference for late or potential implementers, like Jönköping County Council. On the other hand, interviews with the two adopters of ERAS care system will also allow us to conduct a more practical and fact based discussion based on the effects and indicators which has been identified.

When it comes to the 6th stage **Long Term Impacts / Learning for future service delivery,** its aim is to determine the effects of the E-Health program on the organization and

individual level. The outcome is primary for providing research material for researcher and organization that care about the future's service delivery, such as application providers.

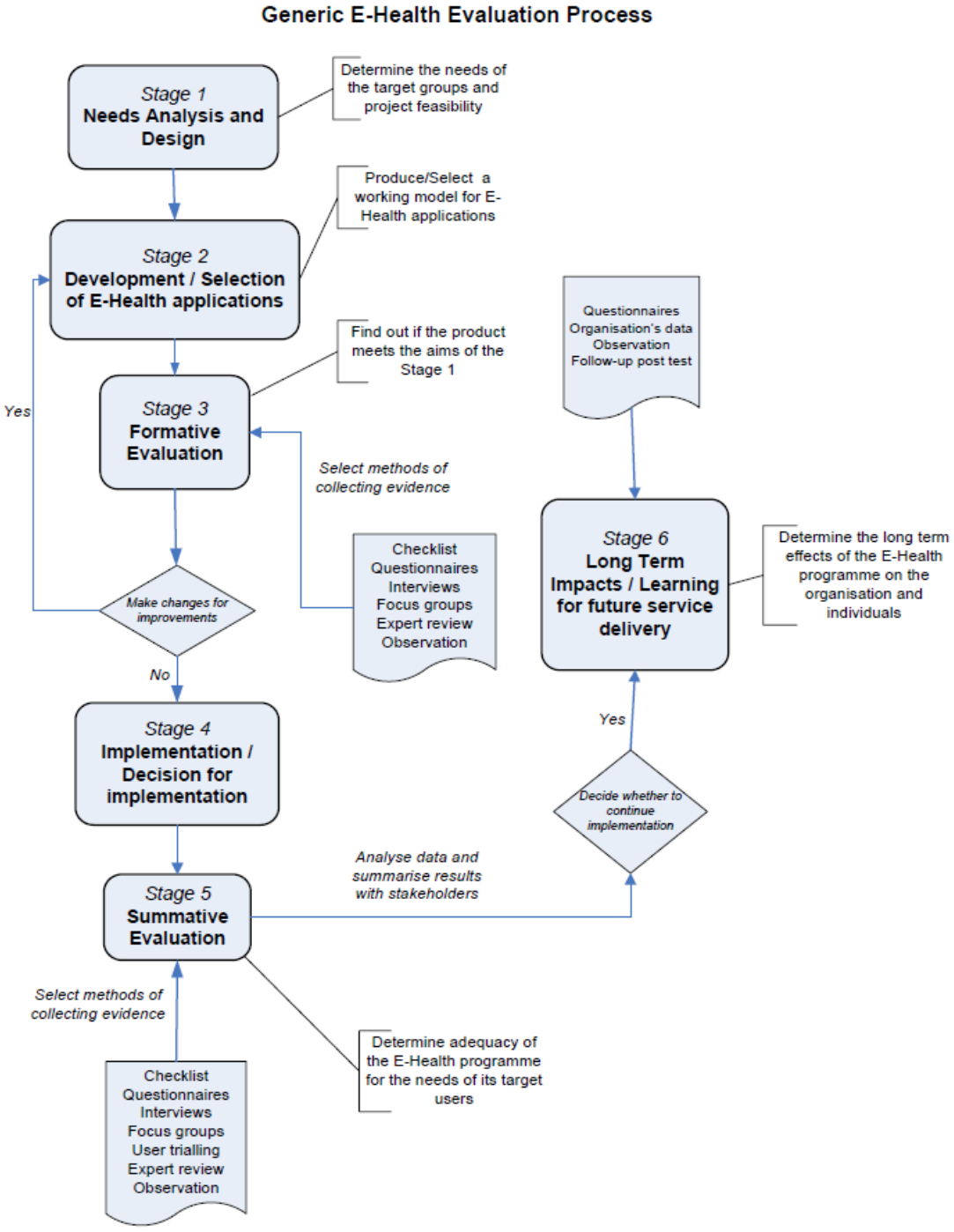

Figure 3.4 Generic E-health evaluation Process

3.4 Classification of IS evaluation

According to previous research, much of the literature on IS evaluation takes a formal-rational view of organizations, and see evaluation as a largely quantitative process of calculating on the cost of the preferred choice and evaluating the likely cost / benefit on the basis of clearly defined criteria. There is also an interpretative approach for evaluation which see IS as a dynamic socio-political process within multi-level social contexts (Walsham, 1993). As there is a large amount of research activity on evaluation approach, some approaches like responsive approach and preordinate approach have been found as approaches differed by different concern, which are responsive approach focus on the usefulness of the findings to the people and preordinate approach emphasis on the statement of goals, the use of objective tests and production of research-type reports (Stake, 1975, 1983).

There is no doubt that there is a large and growing literature in this area divided by various criteria. However, according to the literature review of this study, six generic types of information systems evaluation summarized by Cronholm and Goldkuhl (2003) has been seen as an objective and systematic evaluation classification and the research outcome have been accepted to the 10th European Conference on Information Technology Evaluation.

Six generic types of information system evaluation were derived from a literature review. According to Cronholm and Goldkuhl (2003), all the approaches including formal-rational, interpretative or criteria-based are different. To put it simply, all approaches are concerned about one question, which is "how the evaluator should act to conduct the evaluation?" . However, when performing evaluation, the approach selection is usually affected by many conditions, such as environment setting and resource limitation. Cronholm and Goldkuhl (2003) argue that the evaluation context is another key factor to affect the choice of evaluation approach. That is, for deciding on evaluation approach, consideration could be taken on the question "what to evaluate", as well. The six generic types of IS evaluation will be introduced in the following text.

3.4.1 Six Generic Types of IS Evaluation

As showed in ***Table 3.1*** below, six generic types of IS evaluation are concerned at two dimensions, which are "how to evaluate" and "what to evaluate". The combination of those two dimensions generate a matrix, and six elements derived from the matrix refer to six generic types of IS evaluations from type 1 to type 6. They are separately combination of each strategic concerning context of "what to evaluate" and "how to evaluate". As claimed by Cronholm and Goldkuhl (2003), those six generic types of evaluation are identified from a large amount of literature review and insights outcome of empirical findings in evaluation projects where they participated personally.

Table 3.1 The matrix of six generic types of information systems evaluation adapted from Cronholm and Goldkuhl (2003, p. 3)

What to evaluate / How to evaluate	IT-systems as such	IT-systems in use
Goal-based evaluation	Type 1	Type 2
Goal-free evaluation	Type 3	Type 4
Criteria-based evaluation	Type 5	Type 6

3.4.1.1 Strategic concerning "How to evaluate"

As listed in the column of "How to evaluate" in ***Table 3.1***, the strategy concerning "how to evaluate" could be divided into Goal-based evaluation, Goal-free evaluation and Criteria-based evaluation. The classification is based on the driver of the evaluation. The three types of evaluation are further explained in the following text.

✧ **Goal-based evaluation**

Goal-based evaluation could be understood literally, which means that some explicit goals from the organizational context act as drivers for the evaluation. In goal-based evaluation, the action of evaluation is finally to measure if the goal defined in the first phase is fulfilled by the IT application. The expected outcome is to what extent the goal has been fulfilled and if there is an improvement space for better fulfilling the predefined goal.

Cronholm and Goldkuhl (2003, pp2) further discuss that in goal-based evaluation, "*what is measured depends on the character of the goals and a quantitative approach as well as qualitative approach could be used.*" Overall speaking, according to Cronholm and Goldkuhl (2003), the common feature of qualitative and quantitative approaches is the concern about evaluation of if the goals are fulfilled (if question), and which goals that are fulfilled (which question). However, the differences between a quantitative and qualitative approach is that quantitative approach could be expressed in quantitative numbers, while qualitative approach could not. In addition, qualitative approaches are conducting judgment of goal realization situations by qualitative processes. It is descriptive. Besides answering the 'if' question and 'which' questions, qualitative approach could also contribute to answer the 'how' question – how the goals are fulfilled.

✧ **Goal-free evaluation**

On the contrary, goal-free evaluation means that there are no explicit goals to drive the evaluation. According to Walsham (1993), it is an interpretative, inductive and situation driven approach. The objective to conduct the evaluation is to achieve a deeper and more thorough understanding of the nature of what is to be evaluated and to further generate motivation and commitment (Hirschheim & Smithson, 1988, cited in Cronholm & Goldkuhl, 2003). Regarding how to conduct goal-free evaluation, Patton (1990) and Scriven (1972) summarized '*Goal-free evaluation is defined as gathering data on a broad array of actual effects and evaluating the importance of these effects in meeting demonstrated needs*' (Patton, 1990 & Scriven, 1972, cited in Cronholm & Goldkuhl, 2003, p.3). Cronholm and Goldkuhl (2003) state that the basic strategy of this approach is inductive evaluation that aim is to discover the quality of the object of study.

According to the previous study, to conduct goal-free evaluation, the evaluator should firstly gather data related to the outcome of the project, and at the same time make the effort to keep the evaluation process apart from any program goals, such as program brochures and proposals, and then make analysis from the data or evidence to generate knowledge. The only research object is the outcome of the project, the effects and affects that are bought by the project. Thus the evaluator need to stay objective, and the entire evaluation process should consistently by independent.

✧ **Criteria-based evaluation**

The keyword for this evaluation approach is "Criteria". Some explicit criteria are required in the criteria-based evaluation; the criteria are used as yardsticks to measure the study object. According to previous research, there are a lot of criteria-based evaluation approach is that has been developed for evaluation of existing data collections - checklists, heuristics, principles or quality ideals. Different criteria grounds contribute to various areas, for exam-

ple, according to Cronholm and Goldkuhl (2003), in the area of human-computer interaction, different checklists or heuristics could be seen as typical approaches. The criteria used in the evaluation are usually derived from one or more specific perspectives or theories and set focus on certain qualities that according to the perspective or theories which is important to evaluate (Cronholm & Goldkuhl, 2003).

In previous literature, criteria-based evaluation is usually compared with goal-based evaluation due to that they both have a solid ground. However, the differences between the two evaluation approaches are noteworthy. Goal-based evaluation is a goal driven evaluation, and due to the goal's organizational nature, the evaluation approach is strictly limited within a specific organizational context. Criteria-based evaluation is based on a general specification rather than a specific organizational context, thus criteria-based evaluation could be considered as a more generally applicable approach (Cronholm & Goldkuhl, 2003).

3.4.1.2 Strategic concerning "What to evaluate"

As listed in the row of "What to evaluate" in ***Table 3.1,*** the strategy concerning "What to evaluate" could be divided as "IT-systems as such" and "IT-systems in use". The classification is based on involvement of the users. Following is a brief introduction of both types of evaluation categories.

✧ **IT-systems as such**

There are no users allowed within the entire process of evaluation for "IT-system as such". In this situation, feedback from users will not be included. The only object of the evaluation is the IT-system itself, and the only participant is the evaluator. The data collection will be conducted on the IT-system and relevant documentation. The expected outcome of the evaluation on IT-system as such is primarily based on the evaluator's perception and understanding of how the IT-system will support the organization and to what extent and in what way the organization will be supported (Cronholm & Goldkuhl, 2003). In this case, the evaluator is required to make a thorough observation and deep investigation of the IT-system and eventually form a comprehensive understanding about the IT-system in various dimensions.

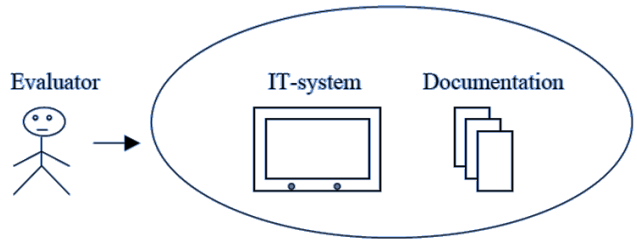

Figure 3.5 Two possible data source for IT-system as such (cited in Cronholm & Goldkuhl, 2003)

As showed in **Table 3.1,** the evaluation strategies concerning "How to evaluate" will take place in goal-based, goal-free and/or criteria-based approaches. For evaluating "IT-system as such", by choosing various strategies concerning "How to evaluate", three generic types of evaluation approach will be generated, which in sequence is labeled Type 1, Type 3, and Type 5.

✧ **IT-systems in use**

Unlike IT-systems as such, IT-systems in use has the focus on evaluating IT-system in a user situation. Thus, the feedback from users about experience and interaction with IT-system is considered as one of the important data sources. The participators of the evalua-

tion include evaluator and users. As stated in ***Figure 3.6***, besides of two possible data sources - relevant documentation and the IT-system itself, there are two extra possible data sources for IT-system in use; user perceptions and observations of interaction. The evaluator is able to choose to use any combination of the data sources in order to reach different levels of data quality (Cronholm & Goldkuhl, 2003). The way to involve users to data collection could be interviews about their perceptions and understanding of the IT-system's quality, and observations of users interacting with IT-systems (Cronholm & Goldkuhl, 2003).

User involvement makes the evaluation process more complex than the evaluation of IT-system as such. The data collection, in IT-system in use requires extra consideration for the evaluation question design- the evaluation question is supposed to guide the user to where the result is. On the other hand, the evaluation of IT-system in use is considered more difficult than the situation of IT-system as such due to the participation of users. More specifically, participating users with different knowledge backgrounds and attitudes toward the IT-system requires more from the evaluator, and cooperation and interaction between users and evaluator significantly affect the quality of evaluation. However, the advantages of IT-system in use are capable to provide a richer and more valuable overview of the IT-system with various requirements as a part of the evaluation outcome. More possible data sources will provide a broader range for the evaluator to conduct data collection and control the quality of data.

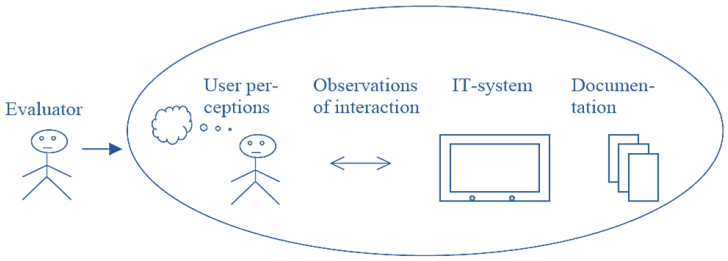

Figure 3.6 Four possible data sources for IT-system in use (cited from Cronholm & Goldkuhl, 2003)

When evaluating "IT-system in use", by choosing various strategies concerning "How to evaluate", three generic types of evaluation approaches will be generated which in sequence are labeled Type 2, Type 4, and Type 6.

3.4.1.3 Overview and characterization of six generic types of evaluation

According to the description of the matrix of six generic types of information systems evaluation, by the combination of the various options of "how to evaluate" and "what to evaluate" on the matrix, six generic types of information system evaluation approaches are generated. In the following description, "type 1" refers to goal-based evaluation of IT-systems as such; "type 2" refers to goal-based evaluation of IT-system in use; "type 3" refers to goal-free evaluation of IT-systems as such; "type 4" refers to goal-free evaluation of IT-system in use; "type 5" refers to criteria-based evaluation of IT-systems as such; "type 6" refers to criteria-based evaluation of IT-system in use. The classification of the different types of evaluation approaches according to their characteristics is introduced and summarized based on some general criteria from Cronholm (2004):

- **Main perspective**

The classification of main perspective for each information system evaluation mainly depends on the chosen strategy of "How to evaluate":

For goal-based evaluation, such as type 1 and type 2, the main perspective depends on the features of the goals no matter for which choice of "what to evaluate". That is, the evaluation is conducted according to the predefined goals; the aim of the evaluation is to measure if the goal defined in the first phase is fulfilled by the IT application.

For goal-free evaluation, such as type 3 and type 4, the main perspective is usually an open minded approach. Without explicit goals, the evaluation is performed depending on the evaluator's observations and perceptions of the qualities of the IT-system. It is an interpretative approach. The data collection emphasizes on a wide range of effects and matching of the effects and demonstrated needs (Patton, 1990; Scriven, 1972, cited in Cronholm, 2004).

For criteria-based evaluation, such as type 5 and type 6, the main perspective is depending on the characters of the criteria. For both kinds of evaluation objects, the evaluation is performed according to the predefined criteria which have been introduced briefly in the previous section. The objective of the evaluation is to enable the evaluator to decide if the quality of the IT-system meets the criteria used and to what degree and now it meets the criteria.

- **What to achieve knowledge about**

Regarding the knowledge expected to be achieved as the outcome of the evaluation, there can be various combination of the question "what to evaluate" and "how to evaluate".

For the goal-based evaluation type 1 and type 2, knowledge expected to be achieved from the evaluation could be summarized into questions. Firstly, has the IT-system contributed to the predefined business goals? This question could be considered as the first concern for both evaluation type1 and type 2. In goal-based evaluation, the goal act as the focus of evaluation, thus the final objective for the evaluation is measuring if the goal has been fulfilled. Secondly, the different participants of "what to evaluate" make the expected outcome different. For type 1 – goal-based evaluation of IT-systems as such, without participation of users, the evaluate consequences for the business are focus on the potential consequences and the presumed contribution of the IT-system; while the type 2 – goal-based evaluation of IT-system in use, is able to collect data from real users and obtain data for real benefit of the organization. Thus, the consequences of evaluation type 2 are an emphasis on to obtain actual consequences for business and real contributions from the IT-system.

Type 3 and type 4 are the goal-free evaluation approach combined with each "what to evaluate". Without the goal limitation, they are open minded and aiming to create a broader and deeper understanding of the IT-system. Compared to evaluation type 3, evaluation type 4 is more apt to create a deeper understanding and to obtain more evidence . Thus, evaluation type 3 is performed for gaining primary understanding of the IT-system and acts as an introductory evaluation for getting to know the IT-system and build a foundation for conducting a deeper evaluation. Evaluation Type 4, as a more complex evaluation type, with the involvement of the user, create a richer picture of IT-system and is capable to form a comprehensive measure for the position of IT-system in the business and effect on the organization.

Both criteria-based evaluation (type 5 and type 6) are mainly for achieving the knowledge of the quality of the IT-system based on certain criteria. Evaluation type 6, which are combined with IT-system in use will enable the collection of user's perception based on certain criteria for the IT-system. For success of the evaluation, the user is required to have a pre-

cise understanding of the criteria, or the evaluator should be in charge of providing guiding question to lead the user to the certain area and eventually achieve the knowledge from the user. The evaluation Type 5, without the participation of users, the process of the evaluation will be simpler, but the outcome of knowledge about IT-system will not be as deep and broad as in the evaluation type 6 does.

- **Data sources**

Table 3.2 presents data sources distributed across the six generic types of IS evaluation. The first column refers to data source category. The data source items listed on the second column has been classified into four data source categories which are IT-system, goal-based, in use and criteria based category.

Relating ***Table 3.2 to Table 3.3***, it is easy to find the rule of the data source distribution. Apparently, IT-system related information including IT-system itself and its documentation are common materials for all kinds of IS evaluation. Goal-based evaluation (type 1 and type 2) correspond to the goal based category. Thus the data sources of goal descriptions and requirement specifications are included in the data sources of Type 1 and type 2. The in use category could be divided into two groups. One is the common type users related, which include interaction between users and IT-system and users perceptions of IT-systems. Three evaluation types (type 2, type 4 and type 6) with a combination of IT-system in use shared these two data sources. The other group within the in use category includes data sources of observation of interactions and Users pre-knowledge (IT-maturity) are data sources of both Goal-free evaluation (Type 4) and Criteria-based evaluation (Type 6). The criteria-based category includes data sources of *descriptions of the criteria* according to different criteria (Type 5 and Type 6). As the key feature of the criteria-based evaluation, *descriptions of the criteria* will provide reference for conducting data collection.

Table 3.2 Data sources for six generic types of IS evaluation, adapted according to Cronholm & Goldkuhl (2003)

Data source category	Data sources	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6
IT-system	IT-system	●	●	●	●	●	●
	Descriptions of the IT-system	●	●	●	●	●	●
Goal based	Goal descriptions	●	●				
	Requirement specifications	●	●				
In use	Interaction between users and IT-system		●		●		●
	Users perceptions of IT-system		●		●		●
	Observation of interactions				●		●
	Users pre-knowledge (IT-maturity)				●		●
Criteria based	Descriptions of the criteria					●	●

Table 3.3 Feature of six generic type of IS evaluation adapted from Cronholm (2004)

	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6
Goal-based	●	●				
Goal-free			●	●		
Criteria-based					●	●
In use		▲		▲		▲
As such	▲		▲		▲	

- **When to choose each type**

Different evaluation approach as will be used in a different situation and meet various requirements. Specifically, type 1 with the combination of the goal-based evaluation and IT-system as such is adequate when a clearly focused evaluation is needed and when there are fewer resources at hand, and no users available (Cronholm 2004). For example, in the situation when the system implementation is just finished and there is no user available, type 1 will be chosen as a pre-implementation evaluation. Type 2 is still wanted when a clearly focused evaluation is required; however, with the participation of users, the resources at hand will be richer. The interaction between users and IT-system and observation of the interaction is required as resources for the evaluation.

Evaluations of type 3 and type 4 are done during different circumstances. The goal-free evaluation, evaluation type 3 and type 4 will be used when the IT-system are open for exploring and observation. Without the limitation of the evaluation goals, the objectives of the evaluations of type 3 and type 4 will focus on achieving a general understanding of the IT-system and the role of the evaluation is thus an introductory study of the IT-system (Cronholm, 2004). The other determinant for the occasion to conduct evaluation type 3 is the same as evaluation type 1 decided by the feature of IT-system as such, which is the occasion when there are fewer resources at hand, with no users available. Evaluation Type 4 is a case with a combination of goal-free evaluation and IT-system in use. The evaluation Type 4 tends to reach a comprehensive understanding of the IT-system; thus it used when a thorough evaluation is desired (Cronholm, 2004).

According to Cronholm (2004), with a combination of criteria-based evaluation and IT-system as such, evaluation Type 5 could be chosen when a focused evaluation according to the chosen criteria is wanted, or when there are fewer resources at hand. While evaluation type 6 with a combination of criteria-based evaluation and IT-system in use will be used when a thorough evaluation is desired with a chosen set of criteria and when there are more resources at hand.

- **How to perform the evaluation**

According to Cronholm (2004), there are some objects or subjects in the evaluation context within the business context - business process, business goals, system owners and IT-system etc. For each object or subject, there are one or more possible knowledge sources. The knowledge source could be defined as the information sources for an object or a subject. Knowledge sources could include IT-systems, other factors around the IT-system included in the business context such as business process and business goals, and user participation related knowledge sources like user's interaction with the system and user documents.

For each knowledge source, there are one or several gathering methods proposed by Cronholm (2004). The entire process of "how to perform the evaluation" could be interpreted as that in order to investigate objects or subjects, the evaluator need to identify the actor and locate corresponding knowledge sources for conducting the investigation, and then identify gathering methods regarding to each the knowledge source. For example, in order to investigate the object of business goals, the business manager is identified as the actor. By involvement of the business manager, key personnel and strategic documents will be identified and considered as knowledge sources. Gathering methods for each knowledge source is easily located. To gather data from key personnel, interview is considered as the main method while in order to understand strategic documents, reading is the gathering method. It is noteworthy that, for identifying the knowledge source of users, besides interview, observation is a powerful method. The observations will be targeted to user's attitudes towards the IT-system.

Table 3.4 Overview of evaluation object/subject, knowledge sources and gathering methods, adapted from Cronholm (2004)

Evaluation context	Actors	Object/Subject	Knowledge source	Gathering methods
Business context	IT-system itself	IT-system	IT-system	Observation Exploration
			IT-system documentation	Reading
	Business manager	Business process	Key personnel	Interview Observation
			Business documentation	Reading
		Business goals	Key personnel	Interview
			Strategic documents	Reading
	System owners	IT-system in use	The user's interaction with the system	Observation Interview
		Users	Users	Interview Observation
			User documents	Reading
Outside business context	/	Criteria	Criteria description	Reading
			The evaluation situation	Sensitivity, an open mind

3.4.2 Formative & Summative assessment

There is another commonly accepted classification of IT evaluation based on 'when' to evaluate: ***summative*** and ***formative*** evaluation. This kind of classification is focused on the situation where the evaluation takes place. Formative assessment is typically contrasted with summative assessment. By formative assessment, assessment is conducted during the learning process.as feedback given in a real time in order to modify and enhance learning and understanding (Crooks, 2001). By summative assessment, they conduct assessment and making a summative feedback after a particular period, e.g. at the end of the implementation stage, after a certain accounting period, or simply when a project is done. Formative assessment in the scenario of IT-projects is modifying and making improvement during the implementation process by giving feedback timely, while summative assessment given feedback after a particular period or after the implementation is finished.

Previous researches show that, for IT investment, formative assessment is more popular than the summative methods. Formative assessment collects feedback during the process of implementation which could be used to modify and enhance the process timely. By handling the feedback in real time, formative assessment could make implementers aware of the gap between the current and expected situation and thus be able to monitor the entire process. It directly contributes to the current project and lesson learned from the change processes also benefit to future's projects. Whereas summative assessment is for accumulation of knowledge which will contribute to the future's project.

3.5 Chosen types of evaluation for this thesis

By consideration of the case (EIAS) selected in this thesis, the evaluation types that have been chosen in sequence are type 3, type 4 and type 2 for conducting the evaluation, which are the combination of **"Goal-free evaluation of IT-system as such" + "Goal-free evaluation of IT-system in use" + "Goal-based evaluation of IT-system in use"**. This option is a typical combination with characteristics of both "IT-system as such + IT-system in use" and "Goal-free evaluation + Goal-based evaluation" which has been discussed in ***Section 3.3.7***.

Type 3 - **Goal-free evaluation of IT-system as such** could be seen as the simplest evaluation approach, which will enable to create a basic and thorough understanding of the IS. The evaluation objective of Type 3 is the IT-system (EIAS) itself. Without the limitation of goals and criteria, the main perspective of Type 3 is an open minded approach and objectives of the evaluation are set to gain primary understanding of the EIAS and to build a foundation for conducting deeper evaluation in the future. The data sources of the Type 3 evaluation is the EIAS system itself, related descriptive documentation of EIAS and interviews with ERAS care system providers (Encare®). Unlike the data sources of general type 3 evaluation defined in ***Table 3.4***, the knowledge source for IT-system (EIAS) itself include an extra interview with the system provider. EIAS is a very new information system. The secondary data that authors collected includes the information published online and other related documentations is very limited and not sufficient for performing the study (According to CEO of Encare®, an amount of official information about EIAS is still not ready for release, thus they are not available for research until the day authors started to conduct data collection (it is about May 2012)). In order to have an in-depth and comprehensive understanding of EIAS, the authors wished to interview someone who had a good knowledge about EIAS. Encare®, as ERAS care system provider, could be considered as professional for EIAS. The data gathering in this evaluation was observation and exploration of the IT-system itself (EIAS), reading the relevant system documentation and interviewing ERAS care system provider. This part of the evaluation outcome acted as an introductory understanding and input to the design of the interview questions in the further evaluation.

Type 4 - **Goal-free evaluation of IT-system in use** was interviews with adopters from Danderyds Sjukhus and Örebro University Hospital. Even though there are primary understanding through prior Type 3 evaluation, in the perspective of users and consideration of the reality situation of each health care sector, the application of EIAS could be vary with the context. Thus, authors conducted the interviews in an open-minded approach and tried to explore broader and deeper what EIAS actually contributed to and has capable of. The data source of Type 4 evaluation is user perceptions of the EIAS. Data gathering in this evaluation was interview with adopters who adopted EIAS around one year earlier. This

part of the evaluation is the main body of the study and the findings contributed to the comparative study with both MOA and the findings from the Type 3 evaluation.

The last evaluation in this study is Type 2 – **Goal-based evaluation of IT-system in use**. As a goal-based evaluation, the evaluation was driven by an explicit goal and closely connects to gain goal, which is *what is the change or improvement that EIAS is capable to make*. In order to have knowledge about the predefined goal, the authors conducted a comparative study between old ERAS system (MOA) and EIAS. From the comparison, the benefits brought by EIAS will be clearly located. Data sources of Type 2 evaluation are user perceptions of each system. The findings from both MOA and EIAS were based on interviews with users. This part of the evaluation is also a part of the main body of this study and the findings contributed to give a strong argument for Länssjukhuset Ryhoy for their potential investment in EIAS.

3.6 IT investment evaluation model

3.6.1 Overview of the IT investment evaluation model

Along with the proliferation of information system in various industries, the investment of IT is increasing and thus the evaluation of IS investment has become more and more significant. Evaluation of IS investments makes an effort to make clear sense of cost and/or benefit on different perspectives brought by IS project. By identifying the innovation input (cost, including financial cost and nonfinancial cost) and/or innovation output (benefit, including financial benefit and nonfinancial benefit) for the IS investment, investors and top management will be able to find solid arguments for investment and researchers and developer of IS could find research evidence to adjust the design or make a change for improving existing IS.

The most common evaluation of IS investment is the measurement of economic outcome, and the evaluation result is monetary. '*Evaluation methods and/or techniques like Net Present Value (NPV), Return on Investment (ROI) and Payback Rule could be adopted for accounting and economic requirement evaluation, and the expected result will be the cost-benefit related value of the investment of the IT application'* (Vimarlund & Koch, 2011, p.2).

However, there is another perspective of measuring the innovation benefits and effects without consideration of the economic and accounting aspects. Innovative effect brought by the IT application has a profound contribution for health and social care organization; the changes will extend from routine work processes to the culture on the organization level. The effects brought by innovation of IT applications will involve the users, accepters, work processes and organizational change. Investments in IT in health and social care organizations is usually aiming for improving overall productivity and performance of the organization, to enable new approaches of managing and organizing, or to establish or adopt new business models in order to achieve competitive advantage (Vimarlund & Koch, 2011).

By consideration of innovation's intangible and diverse nature, the traditional economic methods and/or techniques are no longer helpful for measuring the value adding of the innovation. Evaluation of innovation is difficult due to its complication and multiple considerations required. According to Vimarlund and Koch, (2011, p.2), "*there are today, no generic models that can be applied in the health and social care area to demonstrate the contribution of IT to innovation and change*", that is why IT investment evaluation model is developed.

The model presented by Vimarlund and Koch, (2011) are built upon a study of IT's role, which is to contribute to change processes, increase patient empowerment, individualize

care, exchange information, stimulate interaction between organizations and increase ability to provide high quality patient care. The knowledge generated by the model when performing the evaluation is expected to provide innovation input and identify issues which need to be included into consideration when identifying the project goals that large infrastructural IT investments are supposed to bring to an organization (Vimarlund & Koch, 2011). The goal of the development of the model was to build up a comprehensive framework that is able to provide a guild for the design of IT application and for evaluators and stakeholders to identify possible innovation output (effects) for health and social care.

3.6.2 Structure of the model

The model developed by Vimarlund and Koch (2011) will be introduced in the next section. The structure of the model (see as **Table 3.5**) includes three vertical columns with the elements of "innovation", "innovation effects" and "indicators of the effects".

Table 3.5 Structure of the model, cited from Vimarlund and Koch (2011)

Innovation	Innovation effects	Indicators of the effects
Electronic information supply	Electronic scheduling of appointments	More effective allocation of time for appointments

As discussed in the section 3.2.4 and 3.2.5, innovation effects are innovation output (actual output), which comes from innovation input and is located at the end of the process of the adapted IPO model as the outcome of the innovation. Innovation effects in the model act as the linkages which connect innovation and indicators of the effects for completing the measuring process. Vimarlund and Koch (2011) point out that given the consideration of the IT's role in eHealth, major innovation effects brought by IT are included functional capacity of IT and organizational and managerial outcomes on both the internal and external perspective. The indicators of the effects are aimed to capture the outcome of the innovation effects, for measuring to what extent the effects has been realized and to what degree the value added by these effects brought changes to the organization. The data collected from each indicator could be seen as the outcome of the evaluation.

3.6.3 Three levels

The model is divided into three levels: micro level, IT integration on intra- and inter organizational level and virtual networks level. Vimarlund and Koch (2011, p.1) pointed out: "*The novelty of the model is that it visualizes the opportunities an organization would have lost in the absence of IT, separating outcomes derived from the implementation and use of IT at the micro level, from outcomes derived at the inter and intra-organizational level and outcomes derived from the capacity to vertically and horizontally integrate stakeholder.*" The three levels are described in ***Figure 3.7.***

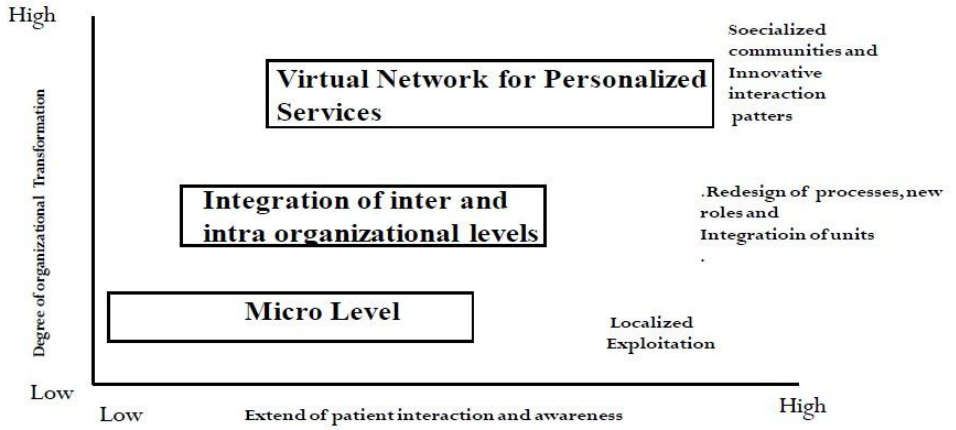

Figure 3.7 From micro level to virtual networks, cited from Vimarlund and Koch (2011)

- **The micro level: Information retrieval for healthcare providers and healthcare receivers.**

This level focus on the information retrieval which is enabled by IT based applications to support the internal communication of healthcare providers and/or communication between healthcare providers and receivers. Effective information management is the subject of this level and what the innovations identified in this level emphasis on. Indicators to measure the effect identified in this level are focused on the work effectiveness and efficiency, and to what degree IT based application contribute to reduce the error of manual handling of information. Anticipated consequences for this level are information sharing degree, workload reducing degree and improving resource allocated and effective decision making (Vimarlund & Koch, 2011).

- **IT integration on intra- and inter- organizational effect level;**

This level enables the IT application to create a combination of a modern and flexible information exchange with the entire chain of care empowering end-users in order to actively use innovative communication and interaction patterns (Vimarlund & Koch, 2011). The key feature of this level is that the innovations take place on the organizational level and contribute to enable the cooperation on intra and inter level. According to Vimarlund and Koch (2011), the benefits of the implementation and use of technological innovations at this level are related to establish new production models, improvement of productivity, and allowing real time communication for providers and receivers.

- **Virtual networks, individualized services for healthcare receivers and healthcare providers.**

This level focuses on a patient perspective. The healthcare receiver is an active actor and user who is updated on his own needs and preferences on the system, and will make an effort to influence the demand and supply of services at both the micro and the inter- and intra-organizational level (Vimarlund and Koch, 2011). Indicators of effects are the development of individualized services for activity involvement of the patient, encouraging a high level of awareness and empowerment, as well as a better knowledge of the patient's own health condition (Vimarlund & Koch, 2011).

3.7 Summary of theoretical framework

The theoretical framework is expected to build up a solid foundation for conducting the further study. Thus, the theories introduced in this chapter will play a significant role for

performing the collection and analysis of the data. The theoretical framework in this study was developed hierarchically. It starts with basic level and follows with extended levels (second level). In the following sections we will give brief introduction for each level in terms of the *Conceptual Map of this Study* on ***Figure 3.1***.

As shown in *the Conceptual Map of this Study* on ***Figure 3.1***, the theories selected in the study are originated from three concepts, which are *eHealth, Innovation* and *Evaluation*. We considered *eHealth, Innovation* and *Evaluation* as the basic level of the framework. These three concepts are the foundation where the other concepts come from.

By interaction and integration of concepts in basic level, extended level is generated and developed. Vimarlund & Koch's (2011) evaluation model is the core as the purpose of this study is to validate Vimarlund & Koch's (2011) evaluation model in terms of its comprehensiveness, practicality and applicability. In order to gain an in-depth and comprehensive understanding of the area of evaluation of innovation in eHealth, we detailed studied the area of innovation regarding, types of innovation, innovation in healthcare and innovation in public sectors. Moreover, we also focused on the study of evaluation, for example, the definition of evaluation, process of evaluation, types of evaluation and classification of evaluation. The validation of the practicality of Vimarlund & Koch's (2011) evaluation model was based on the generic eHealth evaluation framework which presented in ***Section 3.3.3***, while the validation of the model's applicability was based on the classification of the six generic types of IS evaluation which presented in ***section 3.6.*** As for the validation of the comprehensiveness of the evaluation model, it is done through the process of evaluation of EIAS, to see whether the reality is covered by the model.

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4 Case Description

The case described in this chapter is as a part of the findings of this study. As stated in the previous sections, the IT investment evaluation model developed by Vimarlund et al (2011) which aims to identify the contributions that IT investments bring to health and social care organization is a significant contribution to fill the gap between IT investment and its innovation effects and consequences enabled by IT. As pointed out by Vimarlund and Koch (2011, p.2), "*the knowledge generated is expected to provide input and identify issues that need to be considered when identifying the goals that larger infrastructural IT investments are supposed to bring and achieve in an organization*". The knowledge generated aimed to answer the following questions:

- To what degree the "input" and "identify issues" that described in the model could cover the user expectation and fit to the status of IT development,
- To what degree the model is integrity and validity, and
- Whether there is a space for further improvement of the model.

As an IT innovation EIAS (ERAS Interactive Audit System) has been selected and will be evaluated by the model. The case formulation begins with the interviews at Jonkoping county council who has adopted ERAS protocol since ten years and plans to take part in ERAS society in a near future.

4.1 Swedish healthcare system

The Swedish healthcare system is a taxpayer-funded and largely decentralized system with a well performs well in comparison with other countries at a similar level of development (Swedish institute, 2012). In the early 1970s, Sweden was among the first countries to recognize the limits of hospital care and to make a national commitment to primary care and preventive services (Glenngärd et al., 2005 cited in Baker et al., 2008). The Swedish healthcare system nowadays has an outstanding reputation worldwide for meeting high quality services and medical outcomes at a limited and acceptable cost level.

In the Swedish health care system, central government, county councils and municipalities share the responsibility of public health care. The role of the central government is to establish principles and guidelines for care and to set the political agenda for health and medical care. The authority and responsibility for providing public health care are decentralized to the county councils and, in some cases, municipal governments (Swedish institute, 2012). There are 21 county councils in Sweden. Around 90% of the Swedish county councils' routine work and over 70% of their resources are involved in health care, but they are also involved in other areas, such as culture, infrastructure and public transportation (Baker et al., 2008).

4.2 National Strategy for eHealth

The National Strategy for eHealth was introduced in Sweden in 2006. The national strategy for eHealth is about how to work together to reform and improve information management in health care, medical care and the social services for the benefit of individuals, staff and decision makers (Government Offices of Sweden, 2012). It is a strategy for accessible and secure information in health and social care (Government Offices of Sweden, 2012). It is a national wide activity for conducting and developing health care informatics which will lead to high quality health care and social services. ***Figure 4.1*** describes three main target

groups – individuals, health professionals and policy makers and corresponding improvement activity within the Swedish eHealth strategy.

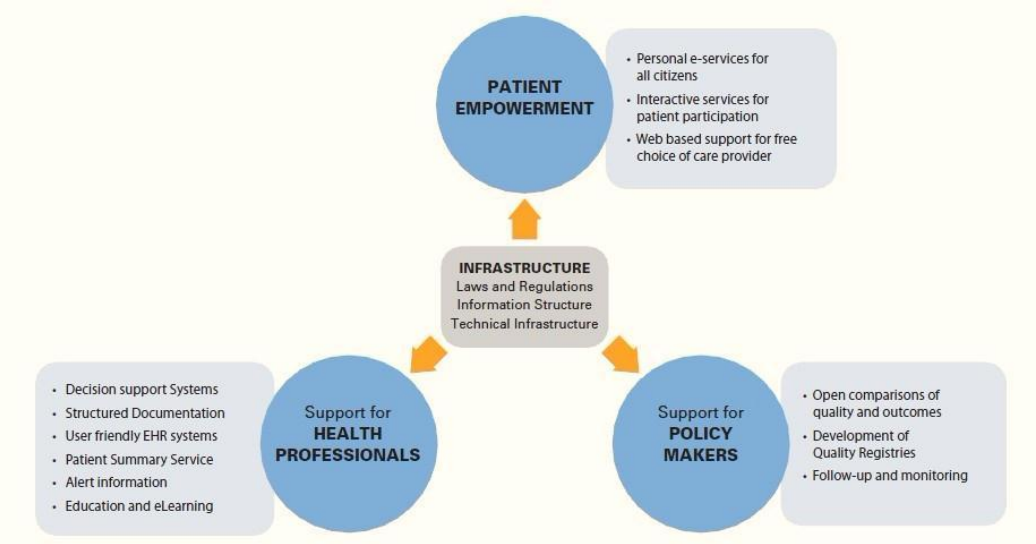

Figure 4.1 Swedish National Strategy for eHealth. (National Strategy for eHealth, 2010)

Swedish county councils and regions almost completed the activities planned under this strategy which is to build up an infrastructure including security measures, authorization solutions and communication standards for future development of secure and effective ICT solutions in 2009. Along with expansion of 1177.se, deployment of the National Patient Summary (NPÖ) in county councils, introduction of the Swedish Pharmaceutical Information Database and other development projects within the various action areas have been carried out gradually. The visible benefits from national eHealth strategy started to show since 2010 (National Strategy for eHealth, 2010).

4.3 Current situation of Jonkoping county council

Since National Strategy for eHealth (detailed information about *National Strategy for eHealth* could be found on the end of this section) was implemented in 2006, Swedish county councils are have used IT support for developing and improving performance and providing better services to citizens. They have built up an infrastructure (in 2009) for further development of the eHealth strategy and solutions and by performing a serie of management projects e.g. NPÖ (National Patient Summary), SITHS (Secure IT in Health) and NEF (National Format for ePrescriptions), visible beneficial effects of national services began to show in Swedish County Council in 2010 (National Strategy for eHealth, 2010).

Jönköping County Council is located in the southern of Sweden with a the population of 337,013 in 2011(Statistic Sweden, 2011). They manage 51 primary care centers and three hospitals with 10 000 employees (Jönköping County Council, 2012). For the last decade, Jönköping County Council has been well known for their outstanding performance in the health care. Jönköping has been cited as "*a model of the healthcare system transformation that ranks among the best in the world*" and an example of "*innovation, strong and stable performance and social values on Swedish health care*"; they have achieves the "*best overall ranking in Sweden for efficiency, timeliness, safety, patient centeredness and effectiveness*" (Baker, 2008, p.121).

For continuing the good performance and being a role model in health care and providing better patient care in the future, Jönköping County Council intend to adopt the new ERAS Care System provided by ERAS society. ERAS protocol is a patient-centered and evidence-based approach for improving surgery outcome. Use of ERAS protocol has proved to reduce the length of hospital stay by more than 30% and reduce the rate of postoperative complications by up to 50% (Varandhan et al., 2010). However, ERAS Study group found that "*there was a great discrepancy between the actual practices and what were already known to be best practice*" according to ERAS protocol (ERAS Society, 2012). In order to monitor and develop the change from tradition to best practice, ERAS society was founded in 2010 by ERAS Study group with the mission to '*develop perioperative care and to improve recovery through research, audit, education and implementation of evidence-based practice.'* (ERAS Society, 2012) ERAS society has developed the ERAS Care System consisting of the ERAS protocol, the ERAS Implementation Program, and ERAS Interactive Audit System (EIAS) (ERAS Society, 2012). By using ERAS Care System, clinical practice is expected to approach the best practice which is an important concern for Jonkoping county council. However, the implementation of ERAS Care system required large investment in both financial and nonfinancial aspects. Hence, strong arguments for this investment are needed.

The introduction of now ERAS is used in Jönköping county council was given by Niklas Zar, who is a surgeon in Jonkoping county council. According to Niklas Zar, so far, Jönköping county council has adopted ERAS protocol and used their own ERAS information system named MOA for about ten years. MOA is old fashioned with basic functions to support clinical practice by following ERAS protocol to some extent. However, by using the old system MOA, they are not capable to monitor and control the clinical data, and they are not able to analysis the data to see to what degree their clinical practices are complying to the protocol, i.e., to what extent their clinical practices approach the best practices. Their primary expectations are the data output from patient record and clinical practices will be enabled by advanced system functions to check whether or to what level the patient care practices after surgery are complying to the ERAS protocol.

4.4 ERAS Care System

ERAS Care System is developed by ERAS Society for standardizing the perioperative care system. The objective of ERAS Care System is to establish a systematic approach for hospitals or care centers to easily follow the ERAS pathway in order to achieve high standard compliance with the ERAS protocol and eventually bring benefits to patients. So far, ERAS Care System has been tested and implemented in about 40 leading hospitals throughout Europe (ERAS Society, 2012).

The ERAS Care System consists of three parts:

- **ERAS Protocol** – a serie of evidence-based protocol developed by the ERAS Society for improvement of clinical outcomes.
- **ERAS Implementation Program** – "*a change management program specifically developed for the perioperative team of surgical clinics performing major operations*" (ERAS Society, 2012).
- **ERAS Interactive Audit System** – a web-based software program designed to ensure compliance to the protocol by tight control of patient record and clinical process information step by step and monitoring of the results (ERAS Society, 2012).

In these three parts of ERAS Care System, ERAS Interactive Audit System (EIAS) is the selected IT innovation which will be evaluated by the model; ERAS protocol is the foundation of design of EIAS and from where EIAS will bring value, ERAS implementation program are more concerned on management of change such as training and time commitment. Thus is considered not directly relevant to the EIAS. Thus, the follows introductions of ERAS Protocol and EIAS are included as knowledge references.

4.4.1 ERAS Protocol

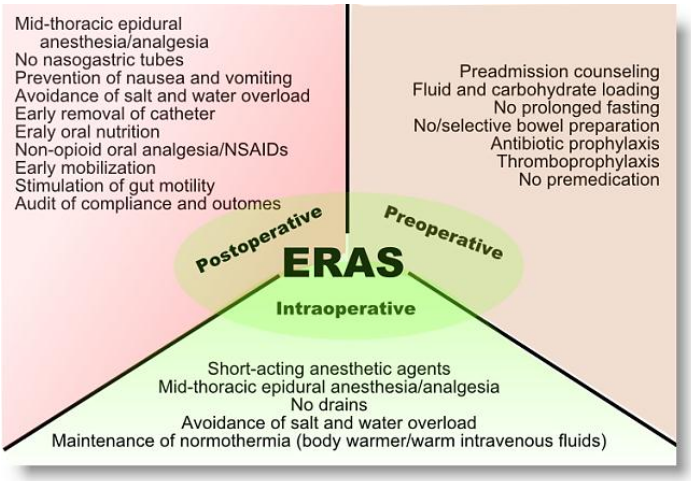

Figure 4.2 Overview of ERAS Protocol

ERAS stands for Enhanced Recovery after Surgery. In some studies, "fast-track recovery program" and "accelerated recovery program" also refer to the same program of ERAS. ERAS is a multimodal perioperative care pathway or protocol which is designed to achieve fast recovery by improving the quality of patient care, reducing complications and symptoms and shortening the length of hospital stay for patients undergoing major surgery (ERAS Society, 2012). Use of ERAS has been proved to effectively reduce the length of hospital stay by more than 30% and decrease rate of postoperative complications by up to 50% (Varandhan et al., 2010). Nowadays, ERAS are mainly used in colorectal surgery. The benefits brought by ERAS are widely recognized, and the use of ERAS in non-colorectal surgery is in progress.

ERAS pathway includes around 20 protocols for improving the quality of patient care and clinical outcomes (overview of ERAS protocols are listed in ***Figure 4.2***, detailed description is in ***Appendix V***). They are actually a series of guidelines for patient care in different stages from referral from primary care to the follow-up stage after the postoperative stage (***Appendix V)***. ERAS protocols have been explored and adopted for decades. The benefits are mainly in the perspectives of patients, staff, quality, local health community and productivity (Enhanced recovery partnership program, 2010).

4.4.2 ERAS Interactive Audit System (EIAS)

EIAS is a web-based software, which is used to enter patient data and monitor the patient information before, during and after a major surgery. The main goal for EIAS is to make sure that the ERAS protocol will be complied with every step for maximizing the benefit of patient care. ERAS society provides content support for EIAS.

EIAS consist of two modules, the registration module and the report analysis module.

- Registration module – This is where patient data and follow-up clinical process information. Uppsala Clinical Research Center (UCR Uppsala) provides technical support for this module.

UCR Uppsala is one on three quality registry center in Sweden. Main activities at the UCR Uppsala include the development and operation of National Quality Registries in health care, IT support for quality registries and clinical trials, analysis and quality control, and other responsibilities focused on developing and improving health care (SALAR, 2007). According to SALAR (2007), IT solutions that UCR Uppsala provides are web-based, and all components included in the system can be reached via each computer connected to the internet or Sjunet which facilitate EIAS's international nature. The registration module in EIAS is built on common platforms for data entry and data transmission as a database for further generating analysis reports in the report analysis module.

- Report analysis module – The purpose of the module is to get a quick overview about to what degree the clinical practice is complying to the protocol; in case there are deviations occurring in the reports, the system will enable users to find out the problems or errors in clinical practice quickly and precisely and thus enable users to adjust or improve the practice in time. EIAS is capable to play a crucial role in the daily decision making support and as a significant quality assurance tool (ERAS Society, 2012). The software QlikView provides technology support for this module.

QlikView is a new kind of business intelligence (BI) software developed by QlikTech International AB. "*The QlikView Business Discovery platform delivers true self-service BI that empowers business users by driving innovative decision-making*" (QlikView, 2012). QlikView works as a business intelligent module in EIAS to generate analysis report. It enables rapid uploading of all data, make sure it is possible to conduct cross comparisons of data to previous clinical record in the system by generating protocol compliance analysis reports.

5 Result

The results presented in this chapter are empirical data collected from case studies conducted in Sweden regarding to the innovation effect and impact brought by EIAS in IT perspective. As mentioned in chapter 2 ***(Section 2.5),*** the respondents can be categorized into three roles: potential adopters of ERAS care system (*Jönköping County Council*), ERAS care system provider (*Encare®*) and ERAS care system adopter (*Örebro University Hospital & Danderyds Sjukhus*). As illustrated in ***Figure 5.1*** below, the arrows indicate the sequence of the interviews. After the introduction meeting with Niklas Zar (*Interview 1*), an interest of investigating what changes (benefits) EIAS can bring to Länssjukhuset Ryhoy was evoked. The second interview was conducted with the responsible person of ERAS at Länssjukhuset Ryhoy, Jenny Silfverhjelm (*Interview 2*). Through the interview, their current information system that supported ERAS was studied and this is where the comparison with EIASwas built upon (***Section 5.1***). Prior to the interviews with ERAS care system's provider and adopter, a preliminary study of documents and observations of EIAS were conducted (***Section 5.2***). Afterwards, the ERAS care system's provider (*Interview 3*) and adopters (*Interview 4 &5*) were interviewed (***Section 5.3***). As the interviews progressed, lists of identified innovation effects and indicators were accumulated and refined.

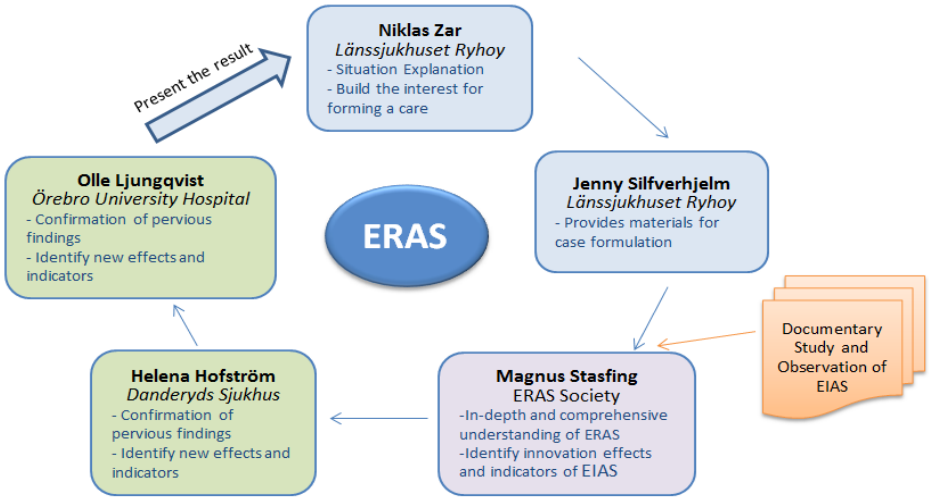

Figure 5.1 Process of case study (Same as ***Figure 2.5***)

- *Potential adopter of ERAS care system*

Through the initial interview with Niklas Zar, from Jönköping County Council, a need of a new IT system to support ERAS process was identified. Here is where the study starts (the case formulation is described in ***Chapter 4***). Another interview was then conducted with Jenny Silfverhjelm, the responsible person of ERAS in Jönköping County Council, to get a thorough understanding of how their current information system supports ERAS process. The study of current information system was made in order to compare the new information system (EIAS) with the old system and clarifying the benefits that EIAS could bring to Jönköping County Council.

- *ERAS care system provider*

The reason we interviewed the EIAS provider (CEO of Encare®) is that we considered him as the professional with the best knowledge about EIAS, and hence would provide the

most comprehensive and in-depth understanding for our data collection. For consideration of the role of provider, he is the most eligible person for delivering the original anticipation of what EIAS is capable of, and thus will make the comparative study (comparison anticipation of EIAS provider with actual benefit confirmed by EIAS adopter) possible and credible.

- *ERAS care system adopter.*

Through investigation, we found that compared to ERAS protocol, ERAS care system is rather a new thing which has been provided by Encare® since 2010. As mentioned earlier (***section 4.2***) the ERAS care system consists of three parts: ERAS protocol, ERAS implementation program and interactive audit system (EIAS). The concept of ERAS has been adopted by many hospitals in Sweden (Jönköping County Council is one of them), of which there are only two hospitals in Sweden that has implemented the ERAS care system. As an early adopter, identification of the impact that EIAS brings to the hospital can be drawn from experience of the actual use of EIAS. Moreover, as mentioned earlier, as the interview process progressed, the previously identified impacts were accumulated and refined. The interviews with the two adopters of ERAS care system also allowed us to conduct a more practical and fact based discussion based on the impact which had been previously identified.

5.1 Interview with Jönköping County Council

The results presented in this section are mainly about their current information system that supports ERAS process.

Q1: *Can you briefly introduce yourself please? E.g. what is your job title? How long have you been working with ERAS? What is your role in ERAS team?*

Länssjukhuset Ryhoy is a hospital belonging to Jönjöping County Council. The job title of our respondent Jenny Silfverhjelm is registered nurse. She is responsible for all work routines in connection to ERAS, including the development of the care for the patients that are included in ERAS (together with one of the surgeons, Nilkas Zar). Every nurse working in the ward is registered nurse. Jenny Silfverhjelm is the one among a few registered nurses who is specialized in patient care after surgery. She has been working with ERAS concept for around 10 years.

Q2: *When did the ERAS project start in Jönköping County Council?*

The concept of ERAS has been adopted by Länssjukhuset Ryhoy around 10 years ago.

> *"At first we have this early recovery that means early activities and early food intake. In 2005 or 2004 we were starting with ERAS protocol and at that time we don't have any database (to register all ERAS relevant information). "*

Q3: *How many members are there in the ERAS team?*

The whole ERAS team in Länssjukhuset Ryhoy is decentralized. They are contact nurses (responsible for the meeting and the first contact with patients), doctors, under nurses, anesthetists and register nurses among which there are three nurses with deep knowledge in surgical care. As described by Jenny Silfverhjelm:

> *"We are all over the hospital, but we try to connect with each other"*

Q4: *How is ERAS related information handled currently?*

In Länssjukhuset Ryhoy, patient related clinical activities are registered by using an electronic health record system called **Cosmic**. Those activities include, for instance: new patient registration, preadmission counseling, fluid and carbohydrate loading and bowel preparation etc. As for ERAS, another system called **MOA** is used for registering ERAS related information. MOA is a standalone system and has a local database for data storage. MOA is a system that lacks the ability of analysis as only binary data has been registered into MOA.

> *"In MOA, it is like a check list, you can write if the patients have a shower, you can write no, but you can write why not, something like that. In MOA, most of the things you do is to select 'yes' or 'no', and it should be all yes to follow the protocol."*

Q5: *Are you able to know how much you comply with the ERAS protocol with the current information system? Do you think it is important to know? Do you have any measurement to generate analysis report or something like that to audit and monitor the ERAS process?*

As discovered from pervious question, MOA is quite a basic system which facilitates ERAS by going through an online check list. Shortages of MOA have been identified:

> *"With this MOA we are not able to generate any analysis report. What we do today is that we follow the protocol. We take the data out to see "do we follow the protocol correctly?" That is the first level, what we have done. We just do the analysis on quite a surface level, not any deep analysis. We are not able to use the system to see what does this mean, what we do and what we can do more etc., not like with EIAS, you can compare with other hospitals and so on.*"

Q6*: Do you think to have access to other hospitals' patient information related to ERAS, and to analysis and compare those data with your hospital's data will have contribution in make improvement of your work?*

Through the interview, Jenny Silfverhjelm has expressed their interest in comparing ERAS relevant data cross hospital within Sweden or even outside of Sweden.

> *"There are differences between university hospitals and our hospitals. The most interesting part for us is to compare to equal hospitals within or even outside Sweden. "*

Q7: *Can you briefly introduce the ERAS process while with the focus on its interaction with MOA system and the information registration, retrieval and exchange between different people at each stage of ERAS?*

The purpose of asking this question was to understand the information registration, retrieval and exchange between different people at each stage of ERAS which was facilitated by the current information system MOA. Understanding of this process helps to identify effects and indicators of these effects of MOA to individuals (nurse, doctor and anesthetists etc.) or the hospital. The identified effects will be compared with contributions that EIAS can bring to individuals or the organization. However, from the previous questions, we discovered that MOA has a low level of integration with people or other systems. Its only functionality is to act as a check list to ensure that all ERAS protocol has been gone through once for a patient.

Q8: *What is your main expectation of the new support system of ERAS- the EIAS?*

As stated earlier, MOA is a standalone system that has no integration with other systems. Besides the journal system Cosmic, the surgical team has their own system as well. When it came to the expectation of the new system, Jenny Silfverhjelm said that:

> *"We think it is very important for us to see what the outcomes are. We need to know that we are doing the good work. And we do need a good system that works together with us all the time, because we have a lot of things to do with the patients. However, with the current system, we cannot do that. "*

Länssjukhuset Ryhoy seems to have expectations on EIAS's analytical functionality to enable a close monitoring of their clinical activities:

> *"Hopefully we will get more outcome, better data, more details. Then we can get better care of patients. We expect EIAS is able to show* ***"do we do what we are saying we do"****. We do a lot of things for patients and a small thing can have influence to the patient recovery, but we do not write them down in the database yet with MOA."*

As for the level of integration of EIAS with their current system and their daily work procedures EIAS is still expected to be a standalone system only registering ERAS relevant information, as described by Jenny Silfverhjelm:

> *"The implementation of EIAS system does not replace any current system that supports their normal working routines, for example, the* ***Cosmic*** *and* ***surgical system****. Those two systems have more rich information about a patient where EIAS only register ERAS relevant information for further comparison and analysis. With EIAS, we can, for example, compare patients within different groups with each other. We can also compare patient in this hospital with patient form other hospitals all over Sweden. EIAS will not help or be involved in the hospital's regular work routines. EIAS is just another check out program."*

5.2 Findings from documents study and observations

Prior to the collection of the empirical data through semi-structured interview with representatives from EIAS provider and EIAS adopter, a documentary study and observations of EIAS have been conducted. The documents are all articles relevant to ERAS and the observation is conducted based on all screenshot of EIAS provided by the ERAS society. Some examples of screenshots of EIAS interface is shown in ***Appendix VI.*** As guided by the model, innovation, innovation effects and its indicators have been preliminarily identified. The findings in this part will serve as a valuable input for the design of interview questions. Based on the documentary study and observations of EIAS, where the benefits of implementation and use of IT can be derived from can be identified, e.g. from the micro level, inter- or intra-organizational level or the capacity to integrate stakeholders. Through the investigation, some obvious irrelevant innovation and innovation effects can be filtered out. During the interviews, the respondents will be asked to confirm identified effects and indicators and some uncertain ones will be discussed with interviewees as well.

The outcomes of the preliminary study have a significant contribution to the design of interviews as well as during the interview. To summarize: 1). It helps to clear direction and focal points of the interview. 2). It can help to save time as time will only be spent on key issues and unknown areas. 3). It enables more interesting discussions that deepen under-

standings. 4).Having a pre-understanding of the situation, follow up questions can be asked and unexpected findings may be discovered. Therefore, based on the observation the following effects have been preliminarily identified, as shown in ***Table 5.1***. :

Table 5.1 Preliminary Identification of Innovation and Innovation Effects

Innovation	Innovation effects
Micro level	
Electronic information supply	Electronic registration of clinical effort and effect
	Electronic decision support when information is accessible in real time
	Web based simple service
Internal integration and coordination of administrative and clinical information	Increased coordination and control of clinical information
Logistic improvements	Shorter lead times for communication between different actors
Possibility to learn from each other (internal benchmarking)	Organizational learning through increased knowledge exchange
Inter- or Intra-organizational level	
Organizational intelligence	Intelligent systems for identification of best practice at intra-organizational level

Electronic information supply

- Electronic registration of clinical effort and effect

EIAS provides data entry for a complete set of data to be registered. It provides the possibility to register all ERAS relevant information for a patient's whole recovery journey: from the first day of admission to the hospital until the day of discharge and also including 30 days follow up. As observed, there are six forms for patient record registration: Registration, operation, POSSUM (stands for Physiological and Operative Severity Score for the enUmeration of Mortality and Morbidity), recovery, discharge and follow up.

- Electronic decision support when information is accessible in real time

As the name implies, EIAS is supposed to perform a close monitoring of the whole patient recovery journey by auditing whether the clinical activities is fully complied to the ERAS Protocol. It becomes a crucial support in the daily decision making process and an important quality assurance tool (ERAS society). Members of the ERAS group can have access to the EIAS system to check on patient record as frequently as needed. Consequently, this largely increases the possibility of discovering potential problems of patient treatment and then improvement can be made accordingly. As stated by the ERAS Society (2012), by continuous follow up, analysis, adjustments and improvements the perioperative team can not only ensure a high quality of care for the patient but also increase the understanding of the per-operative care process and thus the motivation of the staff involved is raised.

- Web based simple service

EIAS is an internet-based data entry and analysis system used to facilitate implementation and monitor compliance to the ERAS Protocol (implementation). UCR (Uppsala Clinical Research and Registry Center) is one of the centers of excellences in Sweden which started on July 1, 2001. UCR provides technical support for ERAS society that i.e., responsible for the development, operation and online analysis of ERAS registries. UCR's IT solutions are

completely Web-based, and all components in the system can be reached via each computer connected to the Internet or Sjunet (Sjunet connects the Swedish healthcare sector through a single private network for data communication) (UCR Uppsala, 2012). No local data storage is needed as all data that is relevant to ERAS Protocol will be stored in the UCR quality registry. The system is based on common platforms for data entry and data transmission. EIAS uses open source code and works with encrypted data via the Web server and applications server as well as with Java/JSP programming for web interface, MySQL as a relational database for entering data, and the SAS statistical program for analyses and report generation (UCR Uppsala, 2012.). The web-based simple service eliminates the needs for local system updates, regular maintenance, database management, data security and technical support for users etc. Less labor hours are demanded which leads to a more effective time allocation within the organization.

Internal integration and coordination of administrative and clinical information

- Increased coordination and control of clinical information

There are several different roles in an ERAS group, for instance ERAS group leader, ERAS nurse, surgeon and anesthetist. Those actors work cooperatively throughout the whole patient recovery journey including preoperative care, during operation and as well as postoperative care. As mentioned in the previous section (***Section 4.2***), so far ERAS contains around 20 evidenced based protocols to follow in order to achieve best practice. The extent to which the clinical practice complies with the ERAS protocol will largely influence the outcome of patient recovery. ERAS Protocol works as an instrument that guide the treatment process progress, where to a more or less extent an individual patient's care plan needs to be personalized. The care plan for each patient is normally made interactively between different ERAS group members. Hence it requires every ERAS member to be aware of 'why' doing something and 'what' has to be done by 'whom' and 'when' it should finish. By using such a common platform for data entry and retrieval, it enables integration of all clinical information at different stages of recovery. Consequently, such information result in faster coordination of health care efforts.

Logistical improvements

- Shorter lead times for communication between different actors

As discussed earlier, EIAS provides the possibility for entering full sets of data that concern patient recovering journey. The patient records from different stages of treatment have been integrated and centralized, and can be audited and monitored centrally. Normally patient's basic information, such as *weight, age* and *gender*, and the preoperative data, such as *preoperative body chemotherapy, pre-admission patient education given, and recent immunosuppressive treatment* etc. are recorded by the nurse, while surgery and anesthesia information are provided by the surgical team and anesthesia team. Without a common platform for data entry and retrieval, such as EIAS, the communication of data requires more administrative work and is more time consuming. Hence, the EIAS shortened the information communication flow between different actors.

Possibility to learn from each other (internal benchmarking)

- Organizational learning through increased knowledge exchange

As stated by ERAS Society (2012), '*EIAS is an analysis system used to facilitate implementation and monitor compliance to the ERAS Protocol. This tool is a quality and decision support system and ensures that compliance to the ERAS Protocol, once implemented, is upheld, and gives immediate feedback*

regarding any deviation from best practice.' It means that one significant characteristic of EIAS is to support ERAS process involving a 'learning while doing' process in which analysis reports are generated as frequently as needed and adjustment and improvement can be made timely and accurately. Patient recovery after surgery is a complex process, and the patient outcome can be affected by any part of the process. All patient data relevant to ERAS Protocols must be entered into EIAS system for comparison and analysis, and hence the result generated is reliable. EIAS not only helps to identify problem(s), but also provide frequent feedback that enables learning from experience and knowledge exchange within the ERAS team. As stated by ERAS Society (2012): *'adjust and improve based on known fact, no more guesswork'.*

Organizational intelligence

- Intelligent systems for identification of best practice at intra-organizational level

As internal benchmarking, EIAS also enable sharing and learning among different national hospitals within Sweden. As mentioned earlier, EIAS is a web-based system and no data is stored locally. Every ERAS center performing data entry uses a standardized platform and the same set of variables is used. That means that all ERAS relevant data collected form each hospital is using the same variables which allows comparison of patient outcome from different hospitals.

5.3 The general description of EIAS

5.3.1 History of EIAS

The ERAS Society is a non-profit international organization which was officially founded in 2010. Its originates from what was called the ERAS Study group *'assembled by Professor Ken Fearon, University of Edinburgh and Professor Olle Ljungqvis, Karolinska Institutet in 2001 to further develop ideas put forth in the 1990's by Professor Henrik Kehlet concerning the concept of multimodal surgical care.'* (ERAS Society, 2012)

The trigger that made the ERAS Study Group developed and broadened its scope from being a medical concept research group into a professional integrated clinical support organization in perioperative care is that, was a gap between traditional clinical practice and the concept of multimodal surgical care in the literature. They discovered that there were a variety of traditions in use in different units (ERAS Society, 2012). That is, there was a great discrepancy between the actual clinical practice and what was already known to be the best practice based on the existing literature. *'This prompted the group to examine the process of change from tradition to best-practice.'* (ERAS Society, 2012) The process of change from tradition to best practice could be considered as the beginning of the exploration of ERAS Care System and also the reason to establish ERAS Society formally in 2010 in Stockholm, Sweden. Nowadays, ERAS Society has been developed and strengthened by leading world experts of the surgeons and the development of ERAS Care System has attracted more and more attention from the medical profession.

As mentioned before, ERAS Care System consisted of three parts:

1) ERAS Protocol,
2) ERAS Implementation Program, and
3) ERAS Interactive Audit System (EIAS).

ERAS Protocol is an evidence-based clinical process for perioperative care which has been proved as best practice of patient care. As a selected IT innovation, EIAS is developed for easy monitoring and control of the process of change of the perioperative patient care in order to approach best practice.

"General speaking, the main goal and the purpose of EIAS are monitoring Enhanced Recovery after Surgery (ERAS). ERAS has been proven to effectively reduce the stress for patients who is going through major surgery by improving the quality of life by reducing the length of hospital stay and the number of complications."- Magnus Stafsing

5.3.2 Key indicators for patient care

Complications are one of the major risks for the patient who has been through major surgery. In medicine, complication has its formal definition - it is an unfavorable evolution of a disease, a health condition or a therapy (Wikipedia 2012). However, in this thesis, complication has a broader meaning. It is refers to any unfavorable symptom occurring to the patient who just went through major surgery and that require extra medication or care. Complications, to some extent, imply to the failure of surgery or failure of the perioperative patient care.

According to previous literature, ERAS Protocol has been proved of being capable of reducing postoperative complications by nearly 50%. The "complication" here is a major indicator to measure the quality of perioperative patient care. Therefore, it is expected that by compliance to the ERAS Protocol, the occurrence of complications will be reduced.

"Complications have been defined as anything happening after surgery that requires some sort of clinical practice to fix it. Complication rate is a key indicator for measuring patient stress. It is unusual that in major surgery, you have a rate of complications, which can be reduced for 50% by taking certain kind of measure and that is what ERAS Protocol does. "- Magnus Stafsing

5.3.3 Composition of EIAS

EIAS is a web-based IT innovation which is used to support implementation of ERAS Protocol. ERAS Protocol is an evidence-based clinical innovation, which has been recognized as an effective approach for improving patient care. In order to make sure that ERAS Protocol will be complied with clinical process and/or clinical practice in terms of ERAS Protocol are identified and embedded into EIAS. The entire process could be identified as having three steps:

First step ERAS Protocol transfer to certain practical clinical steps;
Second step EIAS content design. All practical clinical steps identified in the first step should be included in the content;
Third step Follow up of the steps included in EIAS to realize a high level of compliance to the ERAS Protocol.

The first two steps are for the period of developing the system which could be concerned by the ERAS care program developers. The third step is taking place on the realization of the medical effects, and the main actors of the third step are the nurses and surgeons. During the third step, the surgeons use ERAS Protocol by registering each step of clinical practice following the clinical practice included in the EIAS throughout the entire patient journey. EIAS with IT nature contribute to provide a simple and rapid pathway for complying

with the ERAS Protocol and eventually is expected to help in reaching best practice of clinical outcomes.

> *"The main purpose is to audit the clinical activity in compliance to the ERAS Protocol. EIAS is what we call the whole preoperative process, that is, to register in order to monitor everything that is done from the day that the patient is admitted to the hospital to the day the patient took free of his charge and then there is still 30 days follow-up as well." - Magnus Stafsing*

5.3.4 Strategic plan of EIAS

Besides directly supporting effect for ERAS Protocol, there is also a strategic goal of EIAS. By identifying the process changed according to ERAS Protocol and publishing the results in a user friendly system, medical innovation becomes an easy-followed process, which is expected to evoke interest from medical professionals. To be more specific, EIAS is a tool, which makes ERAS Protocol an easy accessible pathway to innovation with the ambition for more and more surgeons to adopt.

> *"The strategic plan of EIAS is to support performing ERAS Protocol for achieving anticipated clinical outcome, and to have more and more surgical centers adhere to and adopt ERAS over time*." - *Magnus Stafsing*

5.3.5 Why EIAS?

The data of patient care need to be monitored and controlled regularly, or it will fall back into the old routines. According to Manus Stafsing, they conducted a survey for the clinical centers that are going to start the training of ERAS implementation program on the questions as "to what degree do they follow and comply with ERAS?" The result showed that most nurses and surgeons at the centers believed that they complied with ERAS to a very large extent. However, the most of them did not. There are forty or fifty percent actual compliance, but users believed that it was at least 80 present compliance. The discrepancy between their perception and the real situation is what EIAS expected to contribute. Data entry, unique analysis and report provided by EIAS are for assurance to uphold compliance of protocol.

> *"I think history has proved that unless you have a good data entry into the analysis report system, it is very hard to uphold a high level of compliance to the ERAS Protocol. If you take hospitals, if they have not entered or monitored regularly, they will fall back into routines." - Magnus Stafsing*

5.4 Identifying Innovation effects and indicators of EIAS

5.4.1 Innovation: Electronic information supply

Important abbreviation

The following abbreviation is introduced for simplification.

- **P** for Provider of EIAS - *Encare®*
- **A1** for Adopter of EIAS 1- *Danderyds Sjukhus*
- **A2** for Adopter of EIAS 2 - *Örebro University Hospital* **P** for Provider of EIAS - *Encare®*
- **"✓"** indicates the interviewee agreed upon the identified effects or indicators

Electronic registration of clinical effort and effect

The first innovation that has been preliminarily identified through the document study and observations is electronic information supply. While interviewing with P, A1 and A2, the following question regarding this innovation have been asked.

Questions:

As we know that EIAS allows the electronic data entry of patient information and clinical information. Who performs the data entry tasks? Who are the users of this system? What benefits it can bring to those individuals?

Does EIAS capable of register all ERAS relevant clinical effort and effect? What are the benefits? Can you give us some examples?

The answers from the three interviewees are organized and presented as following. The identified innovation effects and indicators are presented in the table below and the key information where these effects and indicators were extracted from is presented.

Table 5.2 Effect: Electronic registration of clinical effort and effect

		P	A1	A2
Effect:	Electronic registration of clinical effort and effect	✓	✓	✓
Indicators:	*Reducing the risk of incorrect or missing treatment*	✓	✓	✓
	Better control over clinical activities	✓	✓	✓

As discussed earlier, EIAS is a web-based system that provides a standardized platform for data entry from different hospitals within Sweden. All ERAS relevant information should be collected and registered into EIAS system.

> *"The patient data is stored in a central storage in UCR Uppsala. Only the hospital itself can enter its own data. So it is very protective. In order to do research, it requires the approval of each hospital or center to release their data even though it is anonymous. " - Magnus Stafsing*

Since the ERAS process is covering the whole patient journey form the first day of entering into the hospital until the day of discharge, plus a 30 days follow up, different actors are involved, and various kinds of patient information need to be registered. All ERAS related information should be shared with ERAS members through the system.

> *"The users of the system should be the whole perioperative team including the staff that does the preoperative work such as reveiving the patient and give information about what they are going through. Everyone involved in the process has access to the patient information in that system." - Magnus Stafsing*

During the interview, it was found that even though EIAS provides data entry for all ERAS relevant information, the EIAS system is not involved in the normal working procedures. In other words, EIAS is a standalone system. Hence, there is a time lag between the data to be collected and the data are entered into EIAS. It can happen that patient data is entered into EIAS after the patient journey.

> *"Today, most of these (data entry) workers in most of the centers are still using papers no matter if they are using old fashion system or EIAS. They have a paper-based questionnaire that they fill in preoperatively, inter operatively and postoperatively. And then after a few hours, few days or few weeks, the nurse will enter this into system." - Magnus Stafsing*

Each hospital has its own plan to perform the data entry tasks. As discovered during the interview with *Danderyds Hospital*, they pointed out that time issue is the main reason they

could not enter the ERAS relevant patient data into the EIAS more frequently, as described by Helena Hofström:

> *"ERAS is a standalone system that is not integrated with any other system in the hospital. We need to spend extra time for data entry into EIAS. We only register all the ERAS related formation into the system twice a month. We do not have more time for that unfortunately."*

However, it has also been pointed out by the CEO of Encare® that real-time electronic information registration during the patient Journey is expected to be realized in the future. Such change is a more complicated in the hospital end than the supplier end (ERAS Society), as it requires changes in, for example, staff (nurse, surgeon, patient etc.), hardware, software and working procedures.

> *"Our mission is to have patient data entry and that everything happens on the patient's journey in real-time in electronic register like on iPad or something like that…", "…you would like to have this as electronic registration, but we are not there yet, because the hospitals cannot support this yet." - Magnus Stafsing*

Once the data have been entered into EIAS, a compliance check can be performed as frequently as needed. This is not possible to do by paper-based registration systems. EIAS is so a called an 'audit system' that closely monitor and control patient treatment.

> *"In order to uphold compliance and provide patients with the best treatment you need to control and monitor the process all the time. It is clear that in those centers where we successfully implemented EIAS, the length of stay has been reduced, the rate of complications has also been reduced, and thus life quality for the patient has been improved. So it is reducing the risk of incorrect or missing treatment in a long run and better control over clinical activities." - Magnus Stafsing*

Electronic decision support and quality assurance

Questions: *Does EIAS support decision making and quality assurance?*
If so could you please give us some examples?

The answers from the three interviewees are organized and presented in the following text. The identified innovation effects and indicators are presented in the table below and the key information where these effects and indicators were extracted from is described.

Table 5.3 Electronic decision support and quality assurance

		P	A1	A2
Effect:		✓	✓	✓
Indicators:	*Reduce the risk of incorrect and incomplete information*	✓		
	Reduce waiting time due to that the analysis report can be generated more frequently.	✓	✓	✓
	Increase the compliance to the ERAS Protocol	✓	✓	✓
	Problem(s) can be identified fast and accurately	✓	✓	✓

EIAS allows all patient data that is relevant to ERAS to be entered into the same database and possible to compare data across hospitals and centers. In order to ensure the comparability of the data, EIAS is able to control data quality in terms of data's correctness and integrity. One of the main purposes of EIAS is to have a close monitoring and control of clinical activities and provide on time feedback to healthcare provider to make adjustments and improvement frequently and accurately. However, as discovered earlier, EIAS is a

standalone system that is not integrated or connected with any other systems. The monitoring and analysis is only based on the data entered by the nurse manually. Hence, it is crucial that data entered is correct and complete.

> *"EIAS will reduce the risk of incorrect information. For example, in EIAS data entry registration module, if you try to register a patient's weight before the operation is 8 kilo, the system will resist and say this is not within the normal boundary, so with respect to what you enter the system can ensure that it is the correct information. It means that you will reach a much higher level of quality in terms of what you put in there. And in the same way, the system will avoid incomplete information as well."*

Helena Hofström from *Danderyds Hospital* on the other hand believed that the correctness and integrity of data is more dependent on the information available. As the data is entered by the nurse into EIAS, the integrity is simply controlled by the nurse. She pointed out on this issue that the correctness and completeness of information is crucial as the input of data will influence the results gained, for example, the compliance rate.

> *"We do not register incorrect information, if we miss any information, we never register it. But it will be a problem if we do not have that information. "*

> *"If we do not have that information, we will not get an accurate compliance rate. Missing information means that the compliance rate is reduced. So it is crucial for us to collect all patient information and register into EIAS.*

EIAS can be also defined as:

> *"A way to position ERAS interactive audit system (EIAS)…It is a decision making support system and a quality assurance system."*

ERAS Protocol is a recommendation. It supports best practice, which has proven to give the best result for the patient. As for how much complies with the ERAS Protocol, its a decision made individually by each hospital. As described by *Magnus Stafsing:*

> *"ERAS does not force any clinical expert like nurses, surgeons and anesthetists to follow the protocol, it is there up to the professional at the center to decide what they want to do."… "It is important to suggest that in order to reach good result you have to have at least about 75 to 80 percent compliance, there is much room for individual decision regarding individual patients. We have seen that if you reach about 75 to 80 percent compliance you reach very good result"*

Hence, it is obvious that even though 100% compliance to the ERAS Protocol is unnecessary and unrealistic, a high level (about 75-80 percent) of compliance is required.

> *"There must be a leader of the perioperative team, and we strongly recommend that they need to look at the performance in how they are doing on a regular basis".....I would not go as far as to say that you must have the system in order to do this, but it definitely helps, and the center that does not have a good system to back and monitor they will lose in terms of quality over time."*

The aim of the ERAS process is to reduce the patient's length of stay in hospital, to reduce the rate of complication after surgery and to improve the life quality of the patient. Studies show that a high level of compliance to the identified best practice will largely enhance patient outcomes (Lassen et al., 2009). Hence, a regular compliance check is necessary for the ERAS leader in order to make the right decision for the patient treatment.

"So in order to uphold your quality you need to constantly monitor how you are doing, and if you start to lose the level of compliance than you need to be able to find out what are we doing differently, what are we not doing as best practice. "

EIAS here act as an analysis and decision support tool that provides a full range of monitoring to ensure that the actual clinical activities maintain a high level of compliance to the best practice.

"The protocol asks you how to take care of patients. When they are admitted, it tells to what you should do the first day of the operation, the second day after the operation, etc. The benefit of using EIAS is to follow best practice, so it is a decision making support that helps you stick to best practice."

EIAS allows analysis reports to be generated as frequently as needed based on all ERAS relevant information stored in the quality registry. Through the analysis and comparison functions of EIAS, the compliance of actual practice to the best practice is easily showed. In case of an unsatisfying result, EIAS is also capable of providing great details of diagnosis for the decision making process.

"If it is going in the wrong way, then it is important for the team to find out why, and EIAS will give them the opportunity down to the extreme detail to see if anything is going wrong, where it is going wrong and if it has something to do with anesthesia, surgery or postoperative care."- Magnus Stafsing

"The work is conducted in a structured way. EIAS increases possibilities to discover potential problem. With the system, it is easier to identify the potential problems and risks. And it makes the ERAS member take care of the patients by following the ERAS care program (ERAS Protocol). The benefits are to have better control of clinical activities and to make improvements and to correct current treatments." - Helena Hofström

5.4.2 Innovation: Internal integration of clinical information

Questions:	*Is EIAS integrated with other systems within the organization? For example is the test result accessible in real time through the system, e.g. POSSUM scoring? Or are the test results manually entered into EIAS by the nurse?*
	Does it include any scheduling functions that determine which task has to be done by whom and when they should be finished?
	Does EIAS help to increase coordination and control of clinical information?
	Do you think EIAS enables more effective and efficient information sharing and communication between different actors? What are the benefits?

The answers from the three interviewees are organized and presented in the following text. The identified innovation effects and indicators are presented in table below and the key information where these effects and indicators were extracted from is presented respectively.

Table 5.4 Increased coordination and control of clinical information

		P	A1	A2
Effect:	Increased coordination and control of clinical information	✓	✓	✓
Indicators:	*Reduced time for coordination of healthcare efforts*	✓		
	Motivation of the staff involved is raised	✓	✓	✓
	Reduce cost for extra administration work	✓		

Any patient that is going through major surgery will need different staff of the hospital (nurses, surgeons and anesthetists etc.) to work in close coordination. The integration of all

ERAS relevant information largely enhances the coordination between different actors within the hospital, as in an example taken by Magnus Stafsing:

> *"It is probably more has to do with a combined team like A has to know what B is doing in order for C to do a great thing, and EIAS supports this"*

> *"Part of the purpose with ERAS and the system that support it is to make the perioperative team that includes surgeons, nurses, anesthetist, physiologist and dietetics work much more together as a team in order to get the protocol working and in order to improve the quality life of the patient."*

EIAS is a standalone system and could to some extent be regarded as a back-office support system. EIAS is not involved in the daily work of medical staff, but it extracts all ERAS relevant information from different units in the hospital, e.g. surgical team, nurse and anesthetists etc. At the same time, it supports their daily work with evidenced based best practice (ERAS Protocol) and performs compliance checks on a regular basis. The integration of information and periodic feedback allows every ERAS team member be better informed about the decision making process and better involved in the ERAS process. Moreover, decisions concerning improvements and adjustments of patient treatment can be made more easily and more targeted. As described by *Magnus Stafsing:*

> *"By continuous follow up, analysis, adjustments and improvements, the perioperative team can not only ensure a high quality of care for the patient but also increase the understanding of the perioperative care process and thus motivation of the staff involved is raised. EIAS becomes a crucial support in the daily decision making process and an important quality assurance tool."*

Helena Hofström also gives comments concerning the motivation of ERAS members:

> *"The registration of clinical effort and effect is to ensure the fully compliance to the evidenced-based best practice. We got happier and more satisfied patients, and also more satisfied staffs. Every member is more involved in ERAS process. Everyone knows what to do, when to do it and you can see the result of what they have done through the EIAS. And you know where you have to improve your work. "*

When it comes to reducing cost for extra administration work, one can look at this issue from two perspectives: long term and short term perspective. The standalone system requires extra work for the nurse to extract all ERAS relevant data from different units and put them into EIAS manuals. It is a time consuming job and brings extra cost for the hospital. This view is from the short term perspective. However, in the long run, if the goals of ERAS can be achieved with support from EIAS, e.g. shorter length of stay in hospital and reduced complication rate, considerable savings will bring to the hospital. As Magnus Stafsing said,

> *"On the one hand, initially you have to put in extra time to enter all the data from the patients. Eventually when you reach the compliance level about 75 or 80 percent, your will free up so much time that actually you are saving time, cost and administrative work.*

Magnus Stafsing further explains this by taking the rate of complications as an example:

> *"If you take the reduction in number of complications as an example, a complication could be intensive care, it could be re-operating the patient that is extremely expensive on input of resources. So if you can reduce the amount or rate of complications, you have some radical savings in terms of time and money."*

5.4.3 Innovation: Possibility to learn from the system

Questions: *Does EIAS enable organizational learning through knowledge exchange?*
If so could you please give us some examples?

The answers from the three interviewees are organized and presented in the following text. The identified innovation effects and indicators are presented in table below and the key information where these effects and indicators were extracted from is presented respectively.

Table 5.5 Enhanced learning through frequent and accurate feedback from the system

		P	A1	A2
Effects:	Enhanced learning through frequent and accurate feedback from the system	✓	✓	✓
Indicators:	*Increased possibility to knowledge exchange between different healthcare providers.*	✓	✓	✓

To summary up what has been discussed earlier, EIAS is a decision support and quality assurance system. Its main purpose is to ensure compliance to the ERAS Protocol. As described by Magnus Stafsing, when EIAS is once implemented and upheld, it will give immediate feedback regarding any deviation from best practice. With continuous audit of clinical activities and progress, learning is largely enhanced, and improvements can be maintained over time. As explained by Helena Hofström:

> *"EIAS enables knowledge exchange. We have exchanges among a lot of actors. In a team (ERAS team), we have surgeons, nurses, anesthetist, physiologist and dieticians. Through the system, they can see how they work. So there are a lot of possibilities to share experiences and thoughts among these people. For example, we have a once a month meeting with surgical wards, with anesthetist, with operation board. We exchange knowledge concerning treatments reflections and results etc." – Helena Hofström*

Moreover, the learning from the EIAS is sometimes indirectly enabled by ERAS society. As mentioned earlier EIAS is designed for the hospital to maintain a high compliance to ERAS Protocol. ERAS Protocol is best practice in perioperative care, which contains a number of measureable evidence based care elements that are crucial for the recovery and outcomes after major surgery. Encare® is a company who is managing ERAS society, where ERAS society is responsible for the development of different protocols. They have different experts with different expertise from different centers all over the world. Their research outcomes will directly be reflected in the updates of ERAS Protocols. Hence, the learning and improvements of the hospital is to some extent facilitated by the improvement of ERAS society. As Magnus Stafsing described,

> *"Today ERAS society consists of 30 plus members from 50 plus countries, and this is then refreshed in the EIAS system, because, Encare®, one of our tasks is to make sure that we adopt EIAS to the last findings and the last rules regarding the protocol. The ERAS society is an academic society. Their interest is to have the best protocol possible for all operating specialties, and thus they conduct the research all the time. "*

6 Analysis

6.1 Level of Innovation Effects

As discussed in theoretical framework chapter (***Section 3.2***), according to Copenhagen Manual (Bloch, 2011) innovations can be categorized as *product innovation, process innovation organizational innovation* and *communication innovation*. According to the findings, ERAS is a multimodal perioperative care pathway that brings significant improvements to the organization compare to the traditional pathway. EIAS is a web-based system that is designed to maximize the benefits of the ERAS by providing full control and auditing of all ERAS relevant information. Hence EIAS can be defined as a product innovation that is designed to support ERAS, whereas ERAS is a process innovation which aims to achieve shorter stay in hospital for the patients, lower complication rate and better life quality of patient.

The novelty of the IT investment evaluation model developed by Vimarlund & Koch (2111, p. 1) is that '*it visualizes the opportunities an organization would have lost in the absence of IT, separating outcomes derived from the implementation and use of IT at the* ***micro level,*** *from outcomes derived at the* ***inter and intro-organizational level*** *and* ***outcomes derived from the capacity to vertically and horizontally integrate stakeholders.*** We will call them *level 1, level 2* and *level 3* for simplification. As discussed in Chapter 3, the three levels are defined by the extent of patient awareness and the extent of organizational transformations as a consequence of integration between technology and actors (Vimarlund & Koch, 2011). Based on the results presented in Chapter 5 and the classification of the model, we can conclude that the outcomes from the implementation and use of EIAS are only derived from the first level (micro level).

At the first level, health and social care organizations focus on facilitating internal communication and stimulating a good information management for the local work team (Vimarlund & Koch, 2011). Normally, there is no possibility to interact or to exchange information with people in real-time by using IT applications at this level. EIAS is a decision support and quality assurance system that only works internally and with no interaction with the patient. As a standalone system, EIAS is not capable of substituting any system that is involved in hospital's daily work. It is a system that works in parallel with other systems and with a focus on all ERAS relevant information. In other words, EIAS has no or little influence to the way people work in the hospital. Hence, EIAS has both a low degree of organizational transformation and a low extent of patient interaction and awareness.

Healthcare organizations that implement or use of IT applications at this level is expecting benefits related to work-effectiveness. The main goals of the ERAS process are to reduce the length of patient stay in hospital and reduce the rate of complications after major surgery. In order for the ERAS program to be successfully implemented and the

satisfaction outcomes to be achieved, the effectiveness of clinical activities relate to patient treatments are crucial. EIAS is acting as an important tool to support ERAS process in terms of to ensure a reasonable compliance rate to the ERAS protocol and to monitor and control clinical activities. With the help of EIAS, ERAS has been shown to reduce hospital stay by around 30% and reduce postoperative complications by up to 50% (Vardhan et al., 2010).

As discovered during the interviews, EIAS can be regarded to integrate all EIAS users (hospitals) through its internet based data storage-quality registry. EIAS enables intra-organizational integration that integrates all ERAS relevant data nationally or even internationally. However, it still has not triggered any impact at the second level. Health and social care organizations at the second level are often '*developing less hierarchical alternatives for organizing work and changing the way individuals (practitioners and patients) interact with and within organizations'* (Vimarlund & Koch, 2011, p. 6). Moreover, at this level, the implementation and use of IT applications often trigger organizational structure change in order to fit the new and innovative process. Hence, according to the findings discussed in previous chapter, the integration of healthcare records enabled by EIAS does not bring EIAS to the second level in terms of either degree of organizational transformation and nor the extent of patient interaction and awareness.

The purpose of clarifying the outcomes derived from different levels can help the decision maker to identify relevant stakeholders and to anticipate the challenge he/she may encounter. As stated by Vimarlund & Koch (2011, p. 6) *'at this level, despite the fact that the changes are not revolutionary, there are, however, significant challenges for stakeholders'* (e.g. Jonkoping County Council) with regard to:

- *Inevitable increased costs due to technology costs,*
- *Unexpected changes in the organization and in work procedures*
- *The costs of running the old and new systems in parallel.*

6.2 Innovation effects and indicators of EIAS

6.2.1 IT as such versus IT in use (Type 3 V.s Type 4 evaluation)

Some obvious differences can be noticed when comparing the preliminary findings (**Table 5.1**) and interview with ERAS care system provider (Encare®) with the findings from the interviews with ERAS care system adopters. Part of the differences is due to the different kinds of evaluation type that are used. As described in ***Section 3.3.3***, there are six kinds of generic types for IT evaluation. The preliminary findings were gained by using type 3 evaluation (Goal-free evaluation to evaluate IT system as such) as there is no user involved and the focus of the evaluations is the capacities of the IT system. As discussed in ***section 3.3,*** evaluation type 3 is performed for gaining primary understanding of the IT-system and acts as an introductory evaluation for getting to know the IT-system and build a foundation for conducting a deeper evaluation. Whereas evaluation type 4 is used in order to gain more comprehensive and deeper understanding of EIAS as the user of

EIAS has been involved. Evaluation Type 4, as a more complex evaluation type, with the involvement of the user, enables the evaluator to reach a deeper understanding of IT-systems and to be capable of forming a comprehensive measure for the position of IT-system in the business and effect and affect for the organization.

The differences are mainly manifested in the use of EIAS and its link to other systems. Through comparison of the findings from evaluation type 3 and type 4, it has been found that there is a discrepancy between the actual practice and what was expected to be provided by EIAS. Through the interview with the adopters of EIAS, we discovered that the level of interaction with the system in their daily work was quite low. Patient data is not entered into the EIAS in real time. EIAS is used for monitoring and control of clinical activities and enables improvements and adjustments for a certain period of time, rather than for single patient. The frequency of use of EIAS to audit patient outcomes is different from hospital to hospital. For example, *Danderyds Sjukhus* performs data entry twice a month, whereas *Örebro University Hospital* performs it on every Tuesday. We consider that the discrepancy is mainly due to the reality of the hospital with limited resource and time to operate the system. The effects and impact of EIAS in this situation are focused on providing reference for periodically check and research use. It is expected that EIAS will be furnished with more input of resources in order to achieve real-time registrations in the future.

6.2.2 Innovation effects and indicators

The findings are organized, classified and summarized as showed in ***Table 6.1***. As described by Vimarlund & Koch (2011, p. 6) '*for IT investments at the first level, the focuses is on facilitating internal communication on the device and create a good information management for the medical team at the micro level.*' One characteristic of IT investments at this level is that it usually works as a substitute for or complement to existing work practices and to support the micro level with clinical information.

As discovered from the findings, EIAS is not involved in any existing work practices as a substitute, but it works as a complement to support decision making by providing timely and accurate analysis of clinical information. The effects identified are achieved by the digital use of data and the analysis functionality of EIAS. The focus of EIAS is on the secondary use of patient data, which allows cross checks against almost any variables stored in the quality registry. The periodical feedback provides valuable input for decision concerning adjustments and improvements of clinical activities. According to Vimarlund et. al. (2011), innovation effects at this level are mainly reflected in the following 4 aspects: *efficiency of operation, optimization of resources use, value-creation effects of healthcare organization and value -creating effects for local services and healthcare providers.*' EIAS mainly has effects on the value-creation for healthcare providers and the healthcare organization. The work effectiveness of health care providers are enhanced through the close monitoring by EIAS to maintain a high level of compliance rate to ERAS protocol. Even though the purpose of implementation of EIAS is not directly linked to economic returns, the outcomes of ERAS, for example, to have shorter length of stay in hospital and lower rate

of complication after major surgery will, however, to some extent bring considerable saving for the healthcare organization from long term perspective.

Table 6.1 Identified innovation, innovation effects and indicators of EIAS

Innovation	Innovation effects	Indicators of the effects	P	A1	A2
1.					
Electronic information supply	Electronic registration of clinical effort and effect	Reducing the risk of incorrect or missing treatment	✓	✓	✓
		Better control over clinical activities	✓	✓	✓
	Electronic decision support and quality assurance.	Reduce the risk of incorrect and incomplete information	✓		
		Reduce waiting time due to the analysis report can be generated more frequently.	✓	✓	✓
		Increase the compliance to the ERAS protocol	✓	✓	✓
		Problem(s) can be identified fast and accurately	✓	✓	✓
2.					
Internal integration of clinical information	Increased coordination and control of clinical information	Reduced time for coordination of healthcare efforts	✓		
		Motivation of the staff is raised	✓	✓	✓
		Reduce cost for extra administration work	✓		
3.					
Possibility to learn from the system	Enhanced learning through frequent and accurate feedback from the system	Increased possibility to knowledge exchange between different healthcare providers.	✓	✓	✓

6.3 MOA vs. EIAS

After the innovation and innovation effects of implementation and use of EIAS have been identified, a comparison of MOA and EIAS was conducted in order to clear the changes and benefits that EIAS could bring to the healthcare provider. As discovered from the interviews, MOA is a simple system that only works for supporting ERAS process in Jönköping County Council. Unlike EIAS, all data entered into MOA is stored locally. Both MOA and EIAS are standalone systems as there is no integration with other systems intra or inter-organizationally. Even though MOA has the same purpose as EIAS that to ensure compliance to the ERAS protocol, the richness of stored information is fairly low compared to EIAS. EIAS is able to register all ERAS relevant information in extreme detail, whereas MOA is mainly registering of binary data of whether all ERAS protocols have been followed. Instead of calling MOA a system, it is more close to an electronic questionnaire or an electronic checklist. MOA only helps the ERAS team to follow the ERAS protocols in a rather simple way that to answer each question by "yes" or "no", and it should be all yes to follow the ERAS protocols. Hence, there is limited information that MOA can provide to support decision making when unsatisfied patient recovery outcome appears. ***Table 6.2*** below shows a detailed comparison of EIAS and MOA.

Through comparison, EIAS shows absolute advantages over MOA. The ERAS protocol developed by ERAS society is evidenced based best practice. High level of compliance to ERAS protocol can bring remarkable improvements of patient recovery outcome. The biggest advantage of EIAS is its analysis function. As an audit system, it is able to monitor clinical activities through its analytical functionality that allows you to cross check almost any variables stored in the online database. It can provide extreme details to support decisions concerning improvements and adjustments of patient treatment. As pointed out by Jenny Silfverhjelm, staff have been asking themselves a question when adopting the concepts of ERAS – *'Do we do what we are saying we do?'* With the support of EIAS, the answer to that question can appear in any possible way.

Table 6.2 Comparison of EIAS and MOA

	EIAS	MOA
Innovation	**Innovation effects**	
Electronic information supply	Electronic registration of clinical effort and effect	- Simple electronic checklist - Main register of binary data "yes" or "no"
	Electronic decision support and quality assurance.	- Not capable of decision support - Checklist acting like a reminder to ensure there is no missing treatment based on ERAS protocol
Internal integration of clinical information	Increased coordination and control of clinical information	- Low level of integration of clinical information as data is mainly registered in binary form. - Low level of coordination through MOA
Possibility to learn from the system	Enhanced learning through frequent and accurate feedback from the system	- Learning from the system is quite limited as feedback from MOA is only a percentage of how much compliance to the ERAS protocol. No further detailed information is provided.
		-

6.4 Validation of Vimarlund & Koch's (2011) Model

6.4.1 Comprehensiveness

The validation of the comprehensiveness of the model is focused on the innovation, innovation effects and indicators of effects that have been initially identified. The authors are seeking to find out whether the reality is covered by Vimarlund & Koch's (2011) evaluation model. However, as we discussed earlier in this chapter (***Section 6.1***), the outcomes of the implementation and use of EIAS are derived from the micro level. Hence the contribution regarding the validation of comprehensiveness is only made on that level.

Through comparison of Vimarlund & Koch's (2011) evaluation model (***Appendix 1***) and what have been identified (***Table 6.1***) in this study, a new innovation effect has been identified concerning the learning within the healthcare organization. A major attractive feature of EIAS is its analytical functionality which is enabled by its embedded intelligent

system QlikView. The system is capable of making any cross-variable analysis of all patient data. The periodical feedback and indications of compliance of ERAS protocol enables all ERAS members to learn from the system, learn from the past or learn from mistakes, and then to make timely and accurately adjustments and improvements accordingly. Moreover, as shown in a systematic review of the impact of eHealth, intelligent systems (e.g. Supporting Clinical Decision Making (CPOE) or Computerized Decision Support System (CDSSs)) have been increasingly used in health care to support decision making (Black 2011). It is likely that such intelligent system may enhance the learning at the individual level. Hence, this newly discovered impact is expected to be validated by more cases and should be taken into consideration for further development of Vimarlund & Koch's (2011) evaluation model.

Table 6.3 New identified innovation effect

Innovation	Innovation effects	Indicators of the effects
Possibility to learn from the system	Enhanced learning through frequent and accurate feedback from the system	Increased possibility to knowledge exchange between different healthcare providers.

Furthermore, some minor differences have been noticed. The differences are mainly reflected in the indicators of innovation effects that have been identified. Our conclusion is that it is difficult to capture and cover all indicators of effect in the model, as indicators of innovation effects may vary from organization to organization. On the other hand to increase the level of detail may lose the flexibility and generalizability of the model.

6.4.2 Practicability

In this study, the practicability is examined through applying Vimarlund & Koch's (2011) evaluation model to an actual case- EIAS. As introduced in ***Section 3.6***, the model have been applied to two occasions: the formative evaluation for potential EIAS adopters to find out if EIAS meets the aims of the defined needs and project feasibility and the summative evaluation of two EIAS adopters to determine adequacy of EIAS for the needs of its user and determine the long term effects of EIAS on the organization and individuals. From the evaluator's perspective, we confirmed that based on the IT capacities of EIAS and possibilities that EIAS gives regarding innovation effects for organizations at micro level the model is a structured and comprehensive framework that provides adequate support to the respondents to identify issues of relevance for healthcare organization. Furthermore, another important indicator of practicability of Vimarlund & Koch's (2011) evaluation model is how valuable the evaluation result is to the healthcare organization. The practicability of Vimarlund & Koch's (2011) evaluation model can be further validated by considering the feedback from Jonkoping County Council concerning the evaluation outcomes derived through use of Vimarlund & Koch's (2011) evaluation model. As mentioned earlier, after completion of this thesis, the evaluation result will be presented to Jönköping County Council. A follow up meeting is expected to be held among key personnel in Jönköping County Council in order to get feedback on the evaluation results.

6.4.3 Applicability

As pointed out by Vimarlund and Koch (2011, p. 2), *"There is today, to our knowledge, no generic models that can be applied in the health and social care area to demonstrate the contribution of IT to innovation and change."* The purpose of the evaluation model is to fill the knowledge gap and create a generic tool for those willing to have knowledge about the contribution of IT to health care organization. The stakeholders could be different social groups with different purposes to perform the evaluation, in order to cater to different requirement. "Generic" could be seen as a keyword for this model. The applicability of Vimarlund & Koch's (2011) evaluation model is examined in the following aspects:

- **IS as such versus IS in use evaluation**

In **Section 6.2.1**, we have discussed the major differences of evaluation results derived from different evaluation types. As previously mentioned, the entire process of the preliminary study is without participation of users, while the subsequent empirical data collection conducted by semi-structure interviews are with the participation of EIAS users. Due to the absence of the EIAS users, the differences are mainly manifested in the perception of effects that EIAS brings to the healthcare. As showed in ***Table 6.2***, the EIAS provider (P) and the two EIAS adopters (A1 & A2) hold different opinions concerning the following three innovation effects that EIAS can possibly bring to their hospitals.

- Reduce the risk of incorrect and incomplete information (***Section 5.4.1***)
- Reduced time for coordination of healthcare efforts (***Section 5.4.2***)
- Reduce cost for extra administrative work (***Section 5.4.3***)

Coincidentally those three effects are only identified by EIAS providers when anticipating what EIAS is capable of and what possible effects it brings. The two EIAS adopters either don't consider it as an effect to the organization (*reduce the risk of incorrect and incomplete information* and *reduced time for coordination of healthcare efforts*) or haven't taken such issues into consideration (*reduce cost for extra administration work*). As discussed in ***Section 6.2.1***, one reason could be that there is a difference between how the system is expected to be used and how the system is actually used in reality. This difference is, however, consistent with what have been confirmed in Vimarlund & Koch's (2011, p. 4) study, as stated *'we confirm previous experiences that IT seems to be an experience good that first need to be used before its value is understood or perceived (Vimarlund et al., 1999).'* The evaluation model is considered and developed from the socio-technical perspective, 'People' is a crucial factor to the success of any IT implementation and adoption, and any negligence may lead to failures. Hence, user-participation or not could be considered as an important condition for the validity of the evaluation guided by the evaluation model. We considered that socio-technical perspective is concerned about the interaction between people and technology in workplaces. Thus the absence of users will lead to deviation of perception at different levels.

Moreover, as stated by Vimarlund & Koch (2011, p.4) *'some effects, after introducing any kind of IT, are not immediate and like in other sectors, healthcare also being affected by the productivity paradox.'* The ***Productivity paradox*** is, as noted by Brynjolfsson (1993) the apparent con-

tradiction between the remarkable advances in computer power and the relatively slow growth of productivity at the level of the whole economy, and individuals firms. Most of the positive effects of IT-based applications come to the organizations and even to individuals first after some years (Vimarlund & Koch, 2011). EIAS is a newly started up information system with a very short implementation history. Thus with the limited experience of the information system, the perception of the benefits brought by EIAS is not well recognized and some functions are probably blocked by ignorance. Even though the effect of *reduced cost for extra administrative work* is not recognized by either hospitals (A1 and A2) at current stage, in the long run, it might be. As explained by Magnus Stafsing (P), the standalone system requires extra work for the nurse to extract all ERAS relevant data from different units and put them into EIAS manuals. It is a time consuming job and brings extra cost for the hospital. This view is from a short term perspective. However, in the long run, if the goals of ERAS can be achieved with support from EIAS, e.g. shorter length of stay in hospital and reduced complication rate, considerable savings will bring to the hospital.

- **Summative and formative assessment**

By its generic character, the evaluation model is suitable to be adopted when conducting either formative or summative assessment. As discussed on chapter 3 (***section 3.4.2***), summative assessment is not a real time quick response assessment, as it is usually conducted after a period or when the project done. The evaluation model in the use of summative assessment will play a role as a reference of the innovation. Comprehensive information provided by the evaluation model on the aspect of innovation effects and indicators could act as a checklist for conducting summative evaluation at the end of the project, due to innovation and effects on the evaluation model is taking eye on the integrated IT application rather than a part or an accessory.

Formative assessment, on the contrary, is supposed to be conducted during the implementation process. The feedback collected in real time will contribute to make improvement of the process or IT application itself. In this study, with formative assessment, the indicators identified in the evaluation model will make an effort to measure the realization level of the effects. Assuming that there is a certain hypothesis about the realization level of the effects which could be described by collection data for each indicator, formative assessment in this scenario will enable real time monitoring and adjustment in case the result of the feedback regarding to the indicators is below the required level.

Regarding the case selected in this study, the ideal evaluation to our knowledge would be the combination of summative assessment and formative assessment in sequence. By consideration of the specific situation of EIAS and the way evaluation has been conducted, the interview with Helena Hofström from *Danderyds Sjukhus* could be seen as a summative assessment. *Danderyds Sjukhus* has six years' experience with ERAS protocol and two year experience with EIAS. The use of EIAS in *Danderyds Sjukhus* is mature enough to conduct a summative assessment. However, due to the limitation of resources and time, the evaluation performed by the authors was primary focused on the knowledge of the innovation effects. In the case the evaluation had been deepened with the outcome

and the data collection extended to actual output for each indicator, the completion of summative assessment could be seen as a pioneer evaluation for early implementation project. As claimed in the case description (***Chapter 4***), the objective of conducting this study was to find strong arguments for Jönköping County Council for their possible investment in EIAS in the near future. Thus, the result from the summative assessment in an earlier implementation organization (*Danderyds Sjukhus*) especially the outcome about the indicators, will contribute to provide standards and foundation knowledge for the subsequent evaluation. The evaluation followed by the summative assessment will be formative assessment. In our case, it is possible that *Jönköping County Council* and the summative assessment outcome and learned lesson from *Danderyds Sjukhus* will allow late implementers to follow the steps and adjust the implementation strategy when the expected innovation effects not appear, or the anticipated indicators are not fulfilled in time.

- **Goal-free and goal-based evaluation**

As discussed in ***Section 3.5***, chosen types of evaluation for this study were the combination of goal-free evaluation and goal-based evaluation. Goal-free evaluation has been conducted in the beginning of the evaluation process prior to the empirical data collection. The result presented is based on the observation of EIAS, document study and interviews with ERAS care system provider and adopters. Goal-based evaluation has been performed as a comparative study between old ERAS system (MOA) and EIAS with the explicit goal of "*what is the change or improvement that EIAS is capable to make"*.

For both types of evaluation – goal-free and goal-based, the evaluation model has with the role of preliminarily study guild. When performing goal-free evaluation, the knowledge about EIAS is very limited from both provider's perspective and adopter's perspective, and the evaluation model with clear three steps leading structure are contributing to the exploring experience with EIAS. The structure of the evaluation model could be seen as a flow from the first step "innovation" to "effects" and to the last step "indicator". In order to identify effects, innovation is supposed to be found first, and in order to have knowledge about realization level of indicators, the effects need to be located precisely. That is a closely logical process with a leading step that is easy to follow. The findings of this part of the evaluation served as a valuable input for the design of interview questions for the subsequent goal-based evaluation. With the predefined goal of EIAS, the subsequent evaluation, unlike goal-free evaluation, was not open-minded. It is performed more goal-oriented in the aspects of designing questions and discussions. For both evaluations, goal-free and goal-based, the evaluation model could be considered as a comprehensive framework for different stakeholders with different goals to find corresponding effects for their reference frames.

7 Conclusion and Reflection

7.1 Summary of Results

Q1. *What are the possible contributions that EIAS brings to Jönköping County Council?*

Due to the fact that EIAS has a low degree of organizational transformation and a low extent of patient interaction and awareness, the effects of using and implementing EIAS is at the micro level. The expected benefits at this level are related to work-effectiveness where challenges are related to inevitable increased costs due to technology investments. Through comparison, EIAS shows absolute advantages over MOA. The biggest advantage of EIAS is its analysis function. As an audit system, it is able to monitoring clinical activities through its analytical functionality that allows cross checking regarding any variables stored in the online database. It can provide information on extreme detail to support decisions concerning improvements and adjustments of patient treatment. The innovations that have been brought into the healthcare organization by EARS are *electronic information supply*, *internal integration of clinical information* and *possibilities to learn from the system*. Identified indicators are able to capture and reflect the effects at the micro level for value-creation for the healthcare provider and health care organization. The key findings concerning the possible contribution that EIAS brings to *Jönköping County Council* is summarized in Table 6.1.

Q2. *How is the performance of Vimarlund & Koch's (2011) evaluation model in practical application, in terms of comprehensiveness, practicality and applicability?*

The performance of Vimarlund & Koch's (2011) evaluation model is validated in terms of comprehensiveness, practicality and applicability. From the evaluators' perspective, the model is a structured and comprehensive framework that provides adequate support for identifying issues of relevance for healthcare organizations. As for applicability, it is a generic model to demonstrate the contribution of IT to innovation and change in health care. The model could be used in both formative and summative assessment and in goal-free as well as goal-based evaluation. Some inconsistencies have been shown in the evaluation results which derived from '*IT as such*' and '*IT in use'* evaluations. The evaluation model is considered and developed from the socio-technical perspective, 'people' is a crucial factor to the success of any IT implementation and adoption, and any negligence may lead to failure. We considered that socio-technical perspective is concerned about the interaction between people and technology in workplaces and thus the absence of users will lead to deviation of perception at different levels. Hence, user-participation or not could be considered as an important condition for the validity of the evaluation guided by the evaluation model. The issue of the productivity paradox has been noticed as some effects are not immediate after introducing of IT. Concerning the comprehensiveness, the model has been validated at its micro level that identified effects are consistent with what has been identified in the original model, but with minor differences. The differences are mainly reflected in the indicators of innovation effects that have been identi-

fied. Our conclusion is that it is difficult to capture and cover all indicators of effect in the model, as indicators of innovation effects may vary from organization to organization. To increase the level of detail may lose the flexibility and generalizability of the model. Moreover, an innovation effect, which regarded the enhanced learning that enabled by EIAS has been identified, but excluded in the original model. The Vimarlund & Koch's (2011) evaluation model can be improved by including this innovation effect after it has been validated by other cases in further studies.

7.1.1 Strengths of this study

- The theoretical foundation of this study

This study is built upon a series of in-depth and comprehensive literature reviews within the area of eHealth. The study of literatures covers all recent (less than 4 years old) systematic literature reviews which were conducted by other researchers concerning IS/IT evaluation in healthcare area. The problem has been clearly identified which clearly shows the reader which knowledge gap this study was expected to fill in. The presentation of theories iteratively brings the readers from a broad context (e.g. eHealth, IT investment evaluation) to a more specific interest area (e.g. IT investment evaluation in healthcare). The logical senses of the relationship of concepts and theories that have been deemed relevant/important to the problem have been demonstrated.

- The contribution to the new system

The case we have chosen in this study is ERAS Interactive Audit System (EIAS), which is a newly startuped up system with a very short implementation history. To the best of our knowledge, EIAS in Sweden are only implemented in two healthcare sectors so far (*Danderyds Sjukhus & Örbor university hospital*) and the benefits brought by EIAS are still underexplored. For ERAS practice, *'there is a big discrepancy between the best practice of ERAS and the real situation in most of current healthcare sectors.'* (ERAS Society, 2012) Consideration of the advantage of ERAS protocol for patient care, advanced IT application which will enable higher compliance to the protocol is required for those healthcare organizations for solving the discrepancy. Thus, this study will contribute to those who seek new approaches for ERAS practice and/or those who look for arguments for the investment of EIAS like Jönköping County Council.

- Multi-dimensional investigation of case study

In order to have a comprehensive study for the case (EIAS), we conducted the evaluation in different dimensions. We started the evaluation by documents reading and observations of the IT-system itself, and then we sought for perceptions of the system from interviewees. Interviews have been conducted with both providers and adopters, and the findings gained from the interview with provider and adopters are separately anticipations of what EIAS is capable of and real effects and impact of use of EIAS. Moreover, two comparative studies held between anticipation and reality situation of EIAS and between typical old system for ERAS (MOA) and EIAS provided comprehensive knowledge about what EIAS capable of.

7.1.2 Shortcomings of this study

- Methodology

This study is conducted from the managerial perspective which take a high level view of how EIAS is/will be implement(ed) and what contribution it can bring to the healthcare organization. However, differences between how ERAS provider claims EIAS is supposed to be used and how ERAS adopters use EIAS in practice has been noticed through the interviews. Moreover, during this study, only ERAS responsible people have been interviewed. We speculate that there might be different options among different stakeholders. As Vimarlund, Timpka & Hallberg (1999, cited in Vimarlund & Koch 2011) state, *'IT seems to be an experience good that first need to be used before its value is understood or perceived*. Hence more stakeholders should be involved into the study in order to strengthen the conclusions.

- Lack of complexity of this case

Through the process of case formulation, until all the innovation effects and indicators have been identified, we gained a rich understanding of ERAS and how it supported was by EIAS. However, in the later phase of the interviews, we realized that EIAS is a standalone system that does not integrate with any other system and is not integrated into any hospital's daily work routines. Its main purpose is decision support and quality assurance, which has relatively less direct contribution to the administrative gains. Due to its low level of interaction with different actors, its complexity is also relatively low. As the second purpose of this study was to validate Vimarlund & Koch's (2011) model, a more complex IT application would be more valuable in order to to cover more innovation areas of the model.

- Single Case study

Due to the fact that EIAS is a newly developed system, there is very limited information available about it. Thus it requires a relatively large amount of time and effort for the preparatory work. Although this is a valuable contribution made by this study, due to the time constrains we could not involve more cases into this study. The EIAS has been identified has having impact to the micro level. The other two levels (intra- and inter-organization level) are uncovered. In order to fully validate the model, more cases are required, which is expected to be done in further studies.

8 Further study

As we discussed in ***section 6.2***, more stakeholders of ERAS are expected to be involved into the study. The findings of this study can be used as a valuable input for design of interview/questionnaire questions for further investigations. As for continuing this study, the first step is to identify related stakeholders of EIAS in a healthcare organization. Qualitative data will be collected, and the same data analysis procedure can be adopted. Furthermore, as more stakeholders will be involved for interviewing, the collected qualitative data may be quantified and will be analyzed by using quantitative data analysis procedures. This is considered as a deductive approach of testing of a theory. The results will either validate our findings or improvements will be made as new evidence occurs. Moreover, in order for Vimarlund & Koch's (2011) model to be fully validated, more cases are expected to be involved into this study. The new cases will be targeted on the second and third level of the model, where the research setting can be copied from this study. Furthermore, the model presented by Vimarlund & Koch (2011) is a tool that identifies and classifies the outcomes of IT innovation investments at different organizational levels for different stakeholders. Unfortunately, the stakeholders in this model have not been explicitly identified and analyzed. From a socio-technical perspective, 'people' is a crucial factor to the success of any IT implementation and adoption, and any negligence may lead to failures, for example people's resistance of change or use of new IT. Hence, different actors should be taken into consideration on both formative and summative evaluation of IT investment. Moreover, even though a series of indicators were developed by Vimarlund & Koch (2011) to express functional capacities of IT, degree of innovation and expected consequences of IT innovation, there is no classifying of tools or methods presented to measure the identified indicators.

Through the literature review, we found that studies concerning the tool for IT application evaluation and actors identification have been conducted. Cusack & Poon (2009) has presented their third version of the *Agency for Healthcare Research and Quality (AHRQ) National Resource Center for Health Information Technology Evaluation Toolkit*. Similarly with this study, they have also realized the difficulties of predicting a project's impact to the healthcare organization and they have emphasized "how to evaluate" in their study. They present step by step instructions of different stages of evaluation and have provided a full list of measurements of IT application. Moreover, Vasiliki et al. (2006) in their study of *Identifying healthcare actors involved in the adoption of information system* have presented a model for healthcare actor's identification (see appendix VI). Through the static and dynamic steps, all individuals or organizations that affect or are affected by IS applications will be identified. Hence, the Vimarlund & Koch's (2011) model can be further developed by involving the actors and measurements tools. Future possible research questions are showed as below:

1) *Who will be the actors that will affect or affect by IT innovation in health and social care organization?*
2) *What methods/tools can be used to measure the indicators of innovation effect at different organizational levels for different stakeholders?*

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Appendix

Appendix I. Vimarlund & Koch (2011, p.6)'s IT evaluation model (Micro level)

Innovation	Innovation effects	Indicators of the effects
Electronic information supply	Electronic scheduling of appointments	Reduced number of missed contacts between different healthcare providers
		More effective allocation of time for appointments
	Electronic registration of clinical effort and effect	Reduced number of double referrals
	Electronic decision support when information is accessible in real time	Reduced waiting time due to real time access to information on test results
	Virtual booking/unbooking of appointments	More effective time allocation within the organization due to reduced telephone hours for booking/unbooking
	Web based simple services, e. g. prescription renewal and electronic birth registration	More effective time allocation within the core activity
		Reduced number of errors due to manual work/registration
Internal integration and coordination of administrative and clinical information	IT support for resource allocation and coordination of information	Reduced costs for double bookings due to lost information from referrals or as a consequence of the producing of double referrals
	control of clinical information	because of incorrect information
		Increased possibilities for optimal allocation of resources in planning
		Reduced time for coordination of healthcare efforts
Logistical improvements	Effective and fast access to information for joint planning and distribution of resources	Internal orders are followed-up and resources are managed out of need
		Proactive planning of resources and better decision support
	Shorter lead times for communication between different actors	Faster deliveries of test results, orders, etc
		Reduced time for administration of paper based healthcare records
Possibility to learn from each other (internal benchmarking)	Organizational learning through increased knowledge exchange	Increased possibility to knowledge exchange between different healthcare providers within the same unit
The individual (the IT-system user) controls the request for specific and simple services	Customization of simple services, flexibility and options	Increased use of IT-support for ordering of drugs, time booking and electronic birth registration
Patient safety	Control and confirmation of ordered services with reduction of incorrect registrations, mix-up or ordering.	Reduced number of incorrect prescriptions
		Reduced number of incorrect registration of infants
		Reduced risk of mix-up of healthcare receivers and thereby fewer incorrect registrations

Appendix II The introduction Interview

1st introduction Interview Questions

8th May 2012

1. **Which stage(s) are you in of ERAS implementation?**
   - Planning phase with activities and actors
   - Initial implementation
   - 'Basic' clinical process etc.

2. **Which kinds of IT investment have you made (or going to make)?**
   - IT/IS
   - Training (Education)
   - Others?

3. **What is your expectation of ERAS (ERAS goals)?**
   - Main goals and sub-goals

4. **Is there anything you think that particularly needs to be improved at current situation?**

5. **How do you consider/perceive the role of IT in ERAS process?**
   - Electronic data registry
   - Inter- or intra-organizational communication
   - Information exchange
   - Internal or external benchmarking
   - Others?

6. **The baseline measurements:**
   - How will success be measured?
   - How will you know you are making difference?

7. **What is the IT infrastructure? How are they interrelated? How are they used to support ERAS process? E.g.:**
   - ERAS Interactive Audit System (EIAS)
   - UCR (Quality registry)
   - Qlikview (Dashboard)

Appendix III Interview Template I

1. **Can you briefly introduce of yourself please?**
   - What is your job title?
   - How long have you been working with ERAS?
   - What is your role in ERAS team?

2. When did the ERAS project start in Jönköping County Council?

3. How many members are there in the ERAS team?

4. How does ERAS related information be handled currently?
   - Which kind of system are you using to support ERAS?
   - Dose all ERAS related information has been electronically registered?
   - How does ERAS related data be stored? In one place or in many places (Centralized or decentralized)?
   - How do you handle information registration and retrieval?

5. We learned that the more you comply with the ERAS protocol, the better outcome you will achieve.
   - Are you able to know how much you comply with the ERAS protocol with current information system?
   - Do you think it is important to know?
   - Do you have any measurement to generate analysis report or something like that to audit and monitor ERAS process?

6. Do you think to have access to other patient information relate to ERAS (patient from other hospital in Sweden) and to analysis and compare with your hospital will have contribution in make improvement of your work?

7. Can you briefly introduce the ERAS process while with the focus on the information registration, retrieval and exchange between different people at each stage of ERAS?
   - Patient registration (admission)
   - Operation
   - POSSUM scoring
   - Recovery
   - Follow up

8. What is your main expectation of new support system of ERAS- the EIAS?

Appendix IV Interview Template II

INTERNATIONELLA HANDELSHÖGSKOLAN
HÖGSKOLAN I JÖNKÖPING

Interview with _____

*Date:*_____

Interviewee: _____
Job Title: _____
Interview Format: Telephone
Duration: Approximately one hour
Interviewer: Jing Ma (Master student in Informatics, Jönköping University)

Table of content

Section 1. The General Description of EIAS

1. What are the goals of EIAS and the purpose of developing such system to support ERAS? Is there any strategic plan concerning EIAS?

2. The basic infrastructure of EIAS
   - What EIAS consists of?
   - How it works in relation with quality registry-UCR Uppsala, the Qlikview, and other communities/hospitals?

3. What are the main characteristics of EIAS? For example:
   - Web based interface
   - No local data assembly
   - Encrypted data transfer (https://)
   - Use of patient IDs optional
   - Administrated by coordinators (Country, center)
   - Local/research variables
   - UCR: Technical support
   - ERAS: Content support
4. What EIAS can do in general and why it is a perfect tool to support ERAS.

Section 2 Identify the Contribution of IT capacities of EIAS

General Descriptions of the Model

Vivian Vimarlund *(Professor in informatics, International Business School at Jönköping University and Linköping University)* and **Sabine Koch** *(Processor in Health Informatics at Karolinska Institute)* have developed a model to identify innovation effects and its consequences enabled by IT in health and social care.

The model is an instrument that identifies and classifies the contribution of IT investment at different levels and for different stakeholders. It is divided into three levels:

Level 1: The micro level: Information retrieval for healthcare providers and healthcare receivers.
Level 2: IT integration on intra- and inter organizational level.
Level 3: Virtual networks, individualized services for healthcare receivers and healthcare

In this section, we are going to ask you the following questions in order to identify the indicators to capture the effects and impact of the implementation and use of EIAS in order to support ERAS. You don't need to think too much about the model. We will guide you by asking you questions concerning each IT capacities of EIAS. You just need to tell us what you know and what you think of it. However, this section is quite open and it's not limit to what has been mentioned in the model. Moreover, our knowledge to the system is quite limited and not all IT capacities of EIAS have been identified. Therefore it will be much valuable if you could identify IT capacities, and their effects and impact that are not covered in our questions.

Level 1: Micro level: Information retrieval for healthcare provider and healthcare receivers

At this level, we mainly study the functional capacities of IT and its effects to individuals (Surgeon, Nurse, Patient, anesthetist etc.) Based on the investigation of screenshots of EIAS user interface (Appendix 1), the following IT capacities has been identified:

Electronic information registration and supply

1. As we know that the EIAS allows the electronic data entry of patient information and clinical information. Who performs data entry task? Who are the users of this system? What benefits it can bring to those individuals:
   - *Surgeon?*
   - *Nurse?*
   - *Anesthetist?*
   - *Others?*

2. Are the clinical effort and effect can be electronic registered? What are the benefits? Can you give us some examples please?
   For example:
   - Clinical effort of different individuals fully compliance to the evidence based practice.
   - Reduced the risk of incorrect or missing treatment.
   - Better control over clinical activities

3. Information security and integrity
   Do you think electronic information registration and supply will helps to:
   For example:
   - Reduce risk of incorrect information?
   - Avoid incomplete information?
   - What other?

4. Is EIAS integrated with other systems within the organization? For example does the test result is accessible in real time through the system? Or does the test result is manually entered into EIAS by nurse? E.g. POSSUM scoring.
   For example:
   - Reduced waiting time due to real time access to information on test results.

Internal integration and coordination of administrative and clinical information

5. Does it include any scheduling functions that determine which task has to be done by whom and when should be finished?

6. Does EIAS help to increase coordination and control of clinical information?
   For example:
   - Reduced costs for extra administrative work because of incorrect information
   - Reduced time for coordination of healthcare efforts

7. Do you think EIAS enables more effective and efficient information sharing and communication between different actors? What are the benefits?

   For example:

   - Shorter lead times for communication between different actors
   - Reduced time for administration of paper based healthcare records

Possibility to learn from each other (internal benchmarking)

8. Dose EIAS provide feedback to ERAS team of their clinical effort on a regular basis? What benefits could have?

   For example:

   - Increased possibilities to discover potential problems or hidden risk during ERAS process.

9. Does EIAS enable organizational learning through increased knowledge exchange?

   For example:

   - Increased possibility to knowledge exchange between different healthcare providers within the same unit

Patient safety

10. Does any EIAS functionality increase patient safety?

Level 2: IT integration on intra- and inter organizational level

At this level, we mainly study the functional capacities of IT and its effects on the inter- and intra-organizational level. Based on the investigation of screenshots of EIAS user interface (Appendix 1), the following IT capacities has been identified:

IT-based organizational coordination

11. Does EIAS enable any organizational coordination?

    For example:

    Integrate with lab report systems facilitates that tests can be taken within all healthcare organizations (hospitals) and results are accessible in the system. If so, what are the benefits?
    For example:

    - Reduced waiting time of registration and follow-up of information on results from different tests
    - Reduced transaction costs for making information accessible for all healthcare providers

12. Does it support for the development of new routines at inter-organizational level

    For example:

    - Pictures and opinions from different experts are presented and visualized in the system
    - Prioritization and reduction of time for the selection of treatment efforts and routines

13. Does it allow decision support for treatments, medication, etc.?

    For example:

- Particular prescription of drugs and its motivations are accessible for all actors in EHR

IT-based organizational cooperation

14. Does it allow Integration of IT solutions at intra- and inter-organizational level

    For example:

    - Connection between EIAS and quality register reduces costs at the organizational level
    - National warning signals in the EIAS

Organizational intelligence

15. Does EIAS provide the possibility for identification of best practices at inter- and intra-organizational level?

    For example:

    - Organizational learning leads to fewer mistakes and more secure administrative routines

Rationalization possibilities for increased patient safety

16. Does it enables Inter organizational integration that facilitates electronic control and follow-up

    For example:

    - Visualization of treatment strategies, efforts, interventions, e.g. individual care plan
    - Trustworthy healthcare receiver information of treatments and interventions

Level 3: Virtual networks, individualized services for healthcare receivers and healthcare providers

No IT capacity has been identified at this level.

Section 3 Detailed introduction of EIAS's IT functionality

If the time allows, in this section, we would like you to go through the screenshots of EIAS user interface with us and with the foucs on its IT funcationalities and what benefits and contribution it can bring to indivuduals and organization. This section is used as a complementarity of pervious sections to study the EIAS in a more logical and systematical way. If something were missed during the pervious section, it might be captured here. Please see Appendix 1

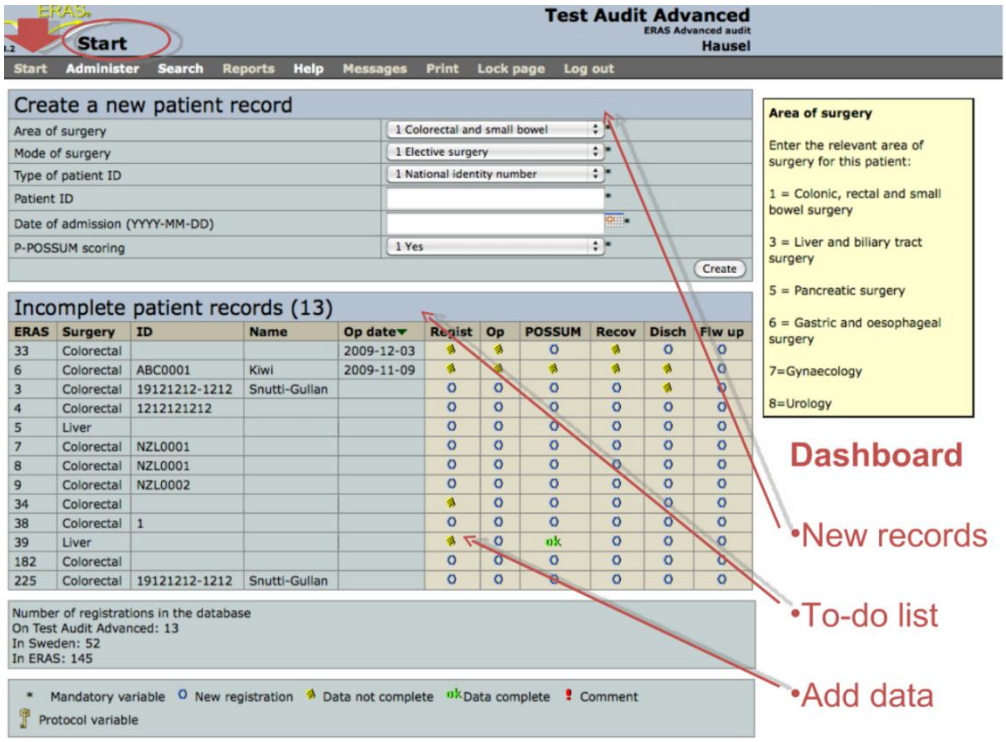
Appendix V ERAS Consensus Guidelines

Table. Consensus Guidelines

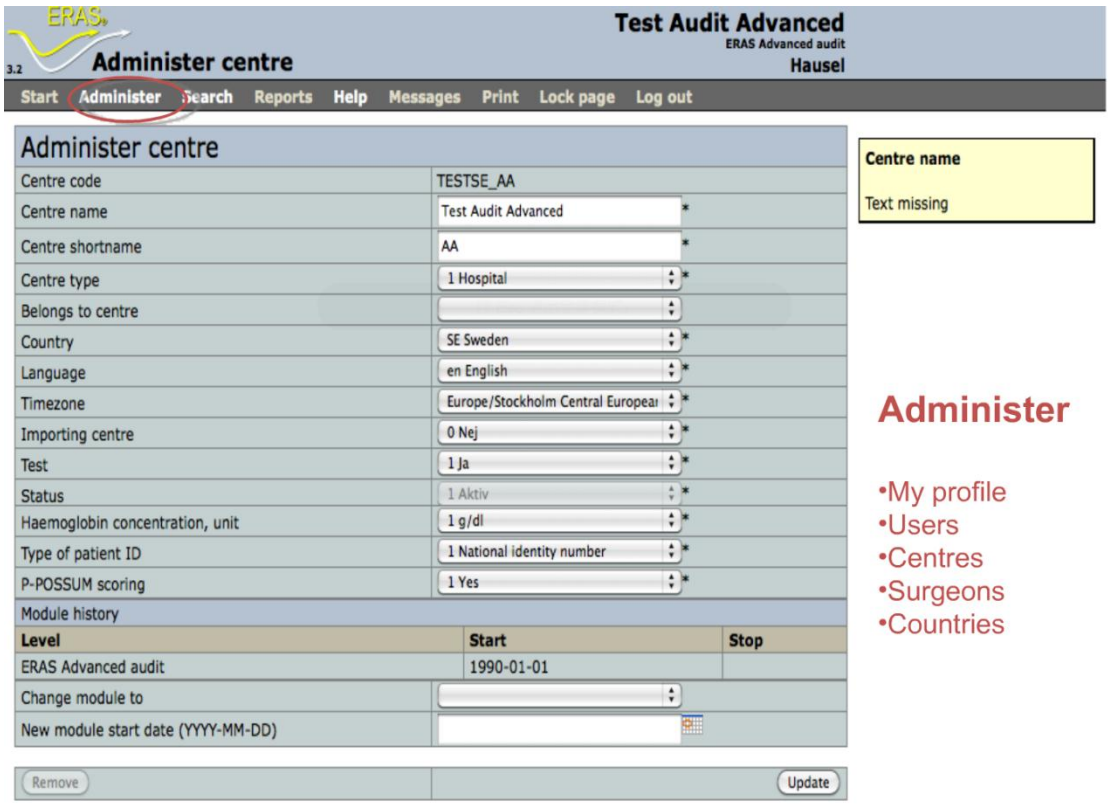
Item	Guideline
Preadmission information and counseling	Patients should receive oral and written preadmission information describing what will happen during hospitalization, what they should expect, and what their role is in the recovery process.
Preoperative bowel preparation	Patients undergoing elective colonic resection above the peritoneal reflection should not receive routine oral bowel preparation (grade A). Bowel preparation may be considered in patients scheduled for low rectal resection where a diverting stoma is planned.
Preoperative fasting and preoperative carbohydrate loading	The duration of preoperative fasting should be 2 hours for liquids and 6 hours for solids (grade A). Patients should receive carbohydrate loading preoperatively (grade A).
Preanesthetic medication	Patients should not receive medications known to cause long-term sedation, from midnight prior to surgery. Short-acting medications given to facilitate insertion of epidural catheter are acceptable (grade A).
Prophylaxis against thromboembolism	The preferred methods for prophylaxis in patients undergoing elective colorectal surgery are subcutaneous low-dose unfractionated heparin or subcutaneous low-molecular-weight heparin (grade A).
Antimicrobial prophylaxis	Patients undergoing colorectal resection should receive single-dose antibiotic prophylaxis against both anaerobes and aerobes about 1 hour before surgery (grade A).
Standard anesthetic protocol	Long-acting opioids should be avoided in patients undergoing anesthesia. Patients should receive a midthoracic epidural commenced preoperatively and containing local anesthetic in combination with a low-dose opioid (grade A).
Preventing and treating postoperative nausea and vomiting	Prevention of postoperative nausea and vomiting should be induced if ≥2 risk factors are present. Treatment should be immediate, with combinations of the drugs discussed.
Laparoscopy-assisted surgery	Laparoscopic colonic resection is recommended if the surgeon or department is proficient with the technique and prospectively validated outcomes show at least equivalence to open surgery (grade A).
Surgical incisions	A midline or transverse laparotomy incision of minimal length should be used for patients undergoing elective colorectal resection.
Nasogastric intubation	Nasogastric tubes should not be used routinely in the postoperative period (grade A). They should be inserted if ileus develops.
Preventing intraoperative hypothermia	Intraoperative maintenance of normothermia with an upper-body forced-air heating cover should be used routinely (grade A).
Perioperative fluid management	Intraoperative and postoperative fluid restriction in major colonic surgery with avoidance of hypovolemia is safe (grade A). When compared with excessive fluid regimens, normovolemic regimens in major colonic surgery lead to more favorable outcomes (grade A). Intraoperative goal-directed therapy (eg, with transesophageal Doppler monitoring) is superior to a non-protocol-based standard with respect to outcome (grade A) and should be considered on an individual basis.
Drainage of peritoneal cavity following colonic anastomosis	Drains are not indicated following routine colonic resection above the peritoneal reflection (grade A). Short-term (<24-hour) use of drains after low anterior resections may be advisable.
Urinary drainage	Suprapubic urinary drainage for pelvic surgery is recommended (grade A). For colonic surgery, both suprapubic and urethral techniques are appropriate.
Prevention of postoperative ileus	Midthoracic epidural analgesia and avoidance of fluid overload are recommended to prevent postoperative ileus (grade A). A laparoscopic approach is recommended if locally validated (grade A). A low-dose postoperative laxative such as magnesium oxide may also be considered.
Postoperative analgesia	Patients should receive continuous epidural midthoracic low-dose local anesthetic and opioid combinations (grade A) for approximately 48 hours following elective colonic surgery and approximately 96 hours following pelvic surgery. Acetaminophen (paracetamol) should be used as a baseline analgesic (4 g/d) throughout the postoperative course. For breakthrough pain, epidural boluses should be given while the epidural is running. Nonsteroidal anti-inflammatory drugs should be started at removal of the epidural.
Postoperative nutritional care	Patients should be encouraged to commence an oral diet at will after surgery (grade A). Oral nutritional supplements should be prescribed (approximately 200 mL, energy dense, 2-3 times daily) from the day of surgery until normal food intake is achieved. Continuation of oral nutritional supplements at home for several weeks is recommended for nutritionally depleted patients (grade A).
Early mobilization	Patients should be nursed in an environment that encourages independence and mobilization. A care plan that facilitates patients being out of bed for 2 hours on the day of surgery and 6 hours thereafter is recommended.
Audit	A systematic audit should be performed to allow direct comparison with other institutions.

Appendix VI Examples of EIAS Interface Screenshot

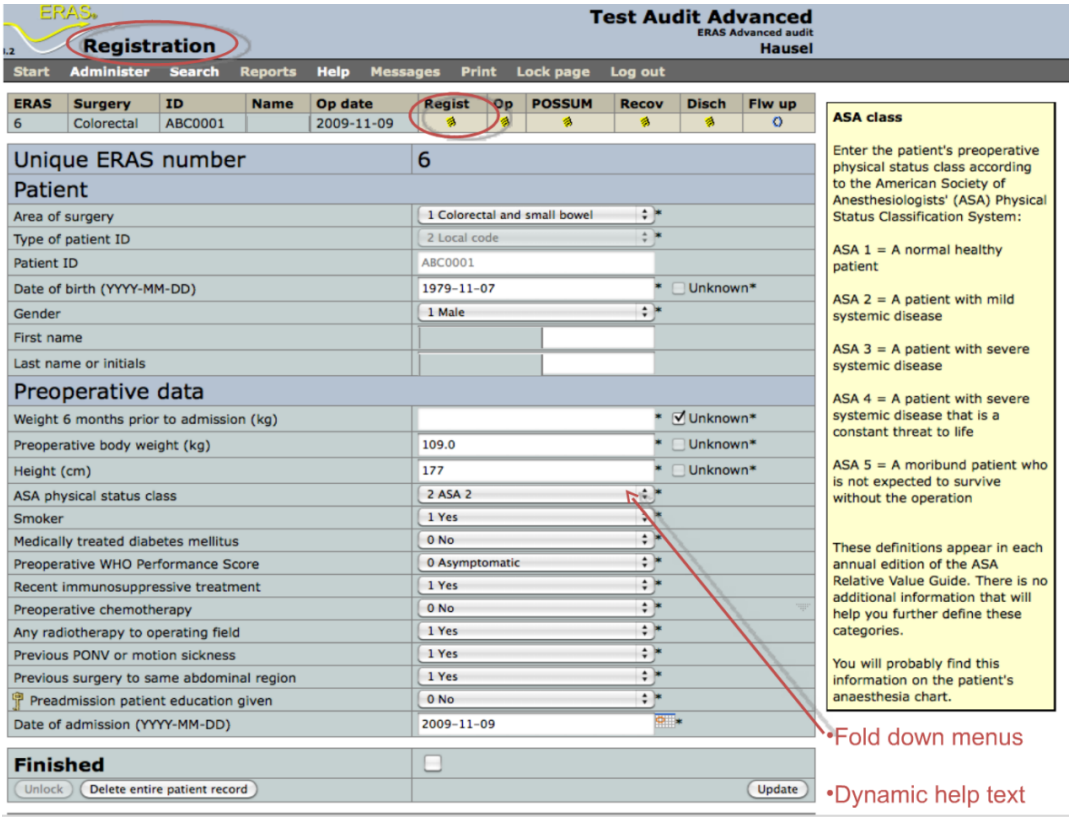
1. Start page of EIAS



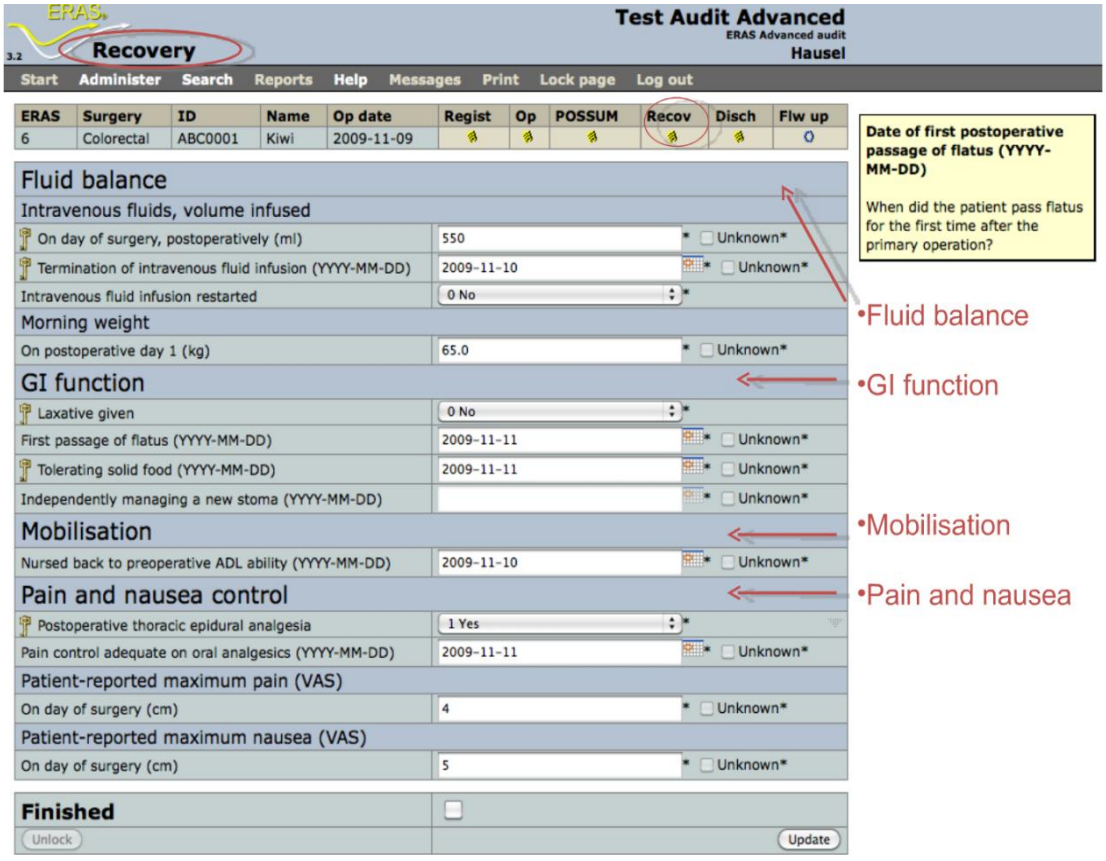
2. Administer's page



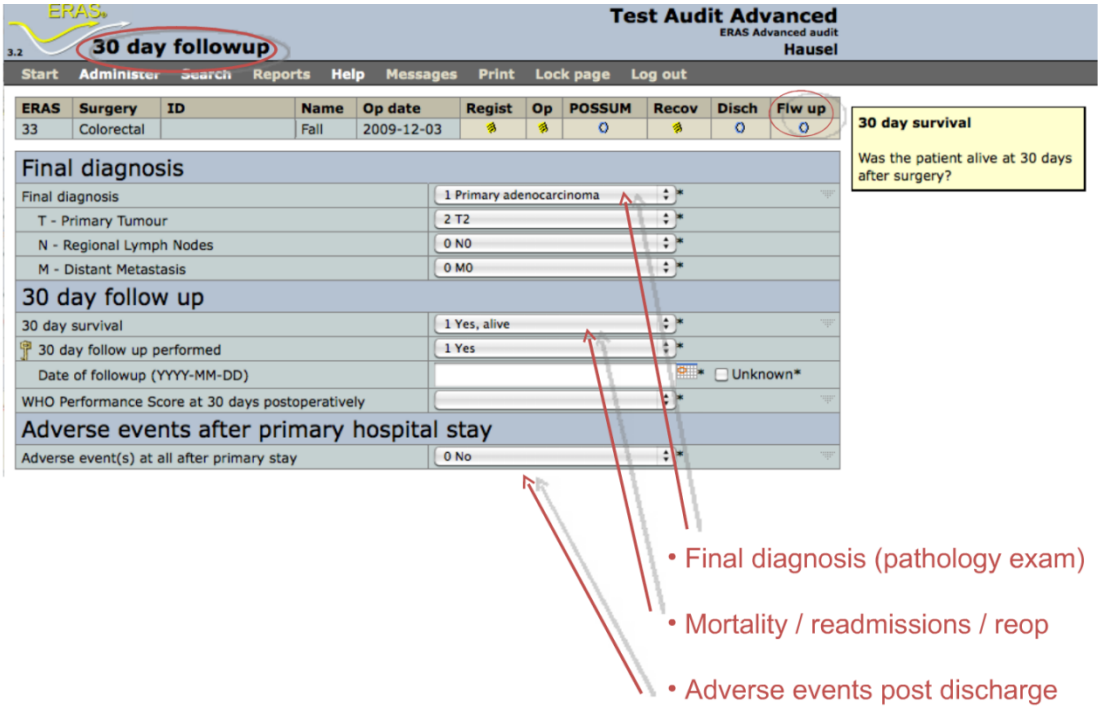
3. Patient registration page



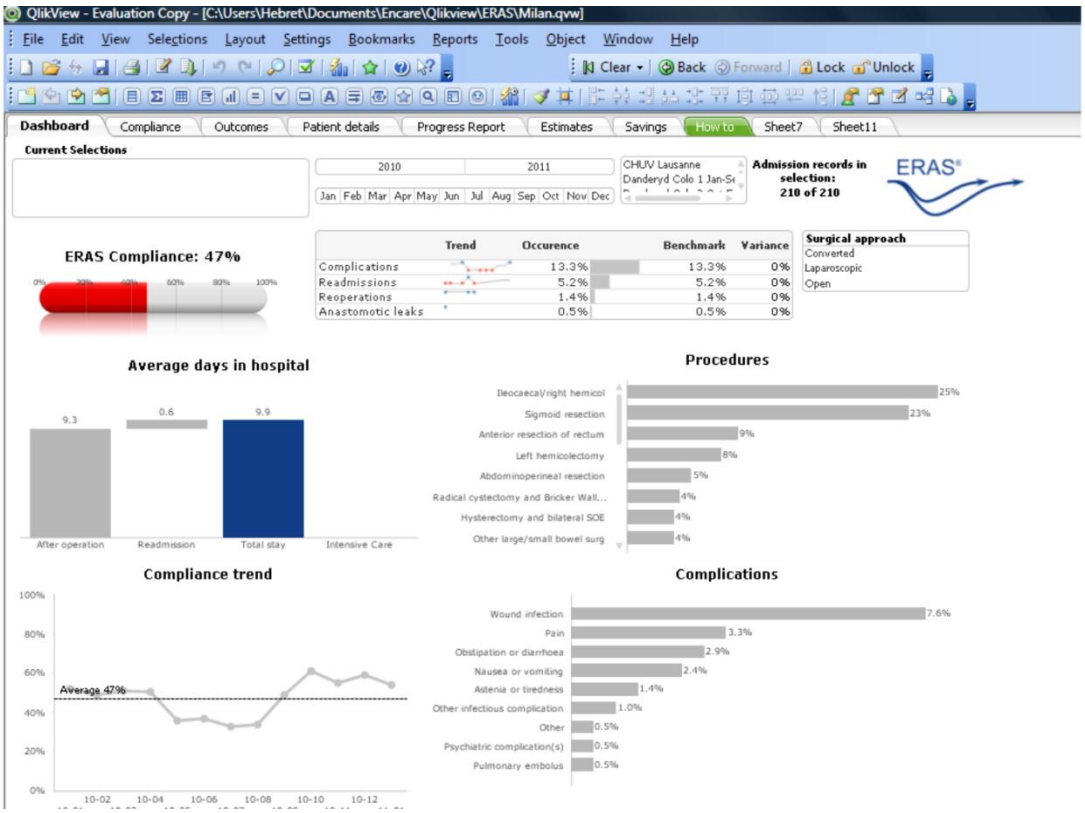
4. Patient recovery registration



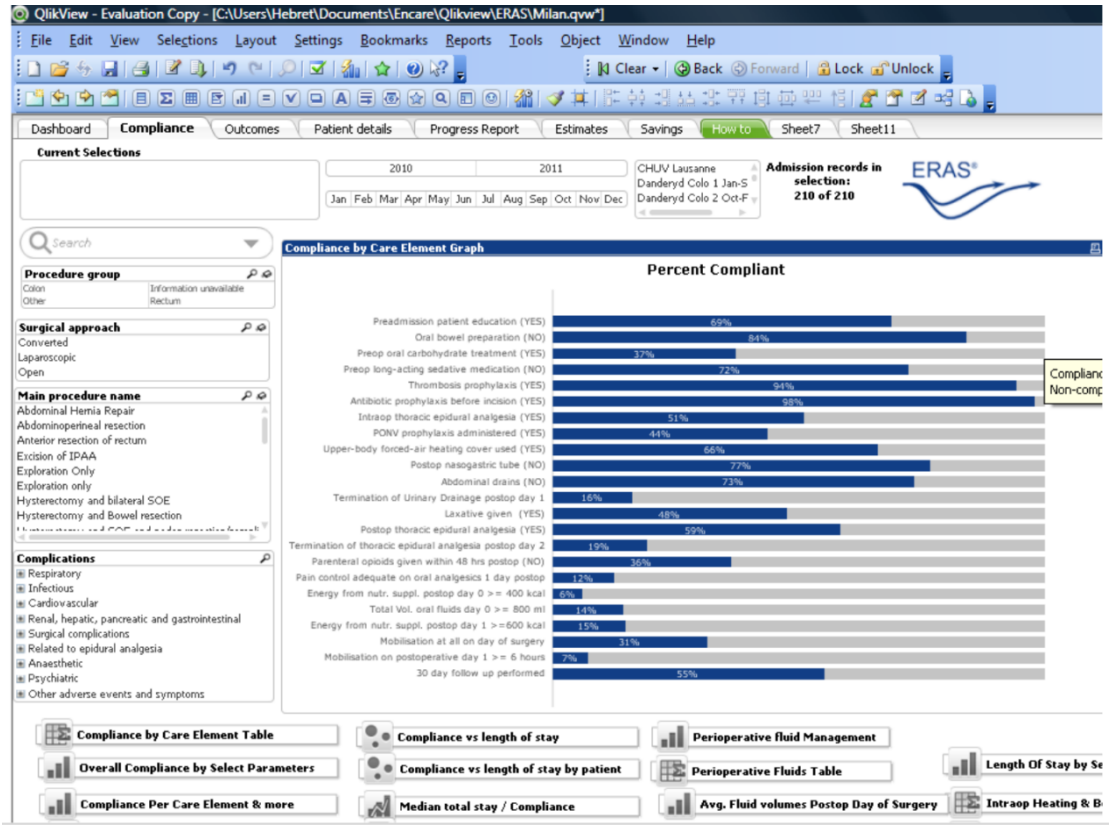
5. 30 days follow-up registration



6. Data analysis 1



7. Data analysis 2



Appendix VII Model for identifying healthcare actors

Table A.1 Methods for healthcare actor's identification

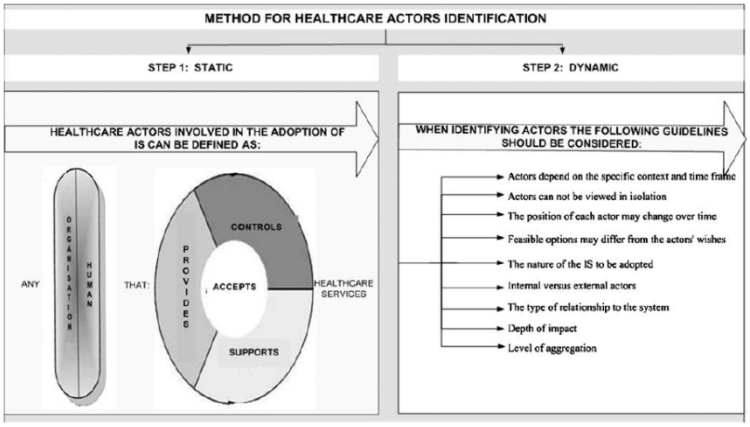


Figure 1 Proposed method (IGOHcaps) for healthcare actor's identification.

Table 1 Proposed guidelines for healthcare actors identification

Proposed guidelines for healthcare actors' identification	*Proposed by*	*Used in the healthcare area by:*
Principles		
G1: Actors depend on the specific context and time frame	Pouloudi & Whitley (1997)	Hu *et al.* (2000) Lapointe *et al.* (2002)
G2: Actors cannot be viewed in isolation		Hu *et al.* (2000)
G3: The position of each actor may change over time		Mantzana & Themistocleous (2004)
G4: Feasible options may differ from the actors' wishes		Mantzana & Themistocleous (2005)
Dimensions		
G5: The nature of the IS to be adopted	Lyytinen & Hirschheim (1987)	Menachemi *et al.* (2004)
G6: Internal *vs* external actors		Mantzana & Themistocleous (2005)
G7: The type of relationship to the system		Menachemi *et al.* (2004)
G8: Depth of impact		Menachemi *et al.* (2004)
G9: Level of aggregation		Lapointe *et al.* (2002) Gagnon *et al.* (2004)

Table 2 Proposed issues for investigation

Issue	*Description*
Human and Organisational	IS adoption in healthcare affects and is affected by human and organisational actors
Actors' Categorisation	Healthcare actors can be categorised into: (a) Acceptors, (b) Providers, (c) Supporters and (d) Controllers
Actors' Definition	The healthcare actors involved in the adoption of IS can be defined as: 'any human and/or organisation that accepts, provides, supports or controls healthcare services'
Mix Approach	The static and dynamic approaches can be combined to support the identification of healthcare actors
Guidelines	The guidelines presented in Table 1 support the actors' identification during the dynamic step