

UNIVERSITY OF OSLO
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**Recovery Unit: Work
coordination and its patient flow**

Master thesis
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Abstract

This thesis has two main objectives. First is to investigate the two research questions. Second objective is to find how information system can support the processes related to care delivery.

The setting is at Rikshospitalet – Radium HF, recovery unit. The approach used was an interpretive that was used where interactions between perioperative care (OR, wards, and recovery unit) were observed, and interviews performed later. The contextual design was utilized in gathering the data and the requirements. The analysis is performed using aspects from knowledge theories like the CSCW, BPR, and IIs.

In this thesis, a new functionality was considered and develop for the improvement of the existing Albert System - surgical planning. By adding new functionality of information, systems to allow the recovery unit to monitor and plan better the use of key resources such as beds and staff resources. In a long run these information would be made available to OR and the ward. This will improved the co-ordination between different professional groups within the departments of the perioperative care.

Keywords: Workflow, CSCW, Contextual design, Healthcare, Recovery unit

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List of Acronyms

RR-HF – Riskhospitalet-Radiumhospitalet – HF

PACU – Post-anesthesia Care Unit

RU – Recovery Unit

OR – Operating Room

DB – Database

.ASP – Active Server Pages

HTML – Hypertext Mark-up Language

IT – Information Technolgy

IS – Information System

GUI – Graphical User Interface

NAFREG2000 – Norway Anesthesia Registration System

PIMS – Patient Information Management System

CSAM – Clinical Systems All Merged

SVIPS –

KIR – Surgery

NKI – Brain Surgery

PLA – Plastic Surgery

ENT – Ear, Nose & Throat

OP2 – Operation department 2

OP3 – Operation department 3

TKA – Thorax Surgery

AT – Activity Theory

SDLC – Software Development Life Cycle

CI – Contextual Inquiry

1 INTRODUCTION

There are several reports in the literature on how to setup a recovery room services, and needed equipments, but less has been written about the pattern of patient flow through recovery rooms.

This paper illustrates and discusses the hospital work processes that is connected and need to be coordinated. The interest is on work processes in relation to the use and communication of information, and how information technology will managed or ease the work at Recovery unit¹ at Rikshospitalet – Radiumhospitalet HF². Glouberman and Mintzberg (2001a, 2001b) recognize how communication is crucial to collaboration and coordination in complex organization such as hospitals. The recovery unit is crucial to the surgical process because it is an extension of what happens in the operating room, and is part of the perioperative care³. Smooth operation procedure requires intermediate beds and nurses available to accomodate patients when the operation is done. The recovery room main activity is the patient treatment and care which is a complex task involving coordination of work processes, and communication that involves different people of diverse professions disciplines cooperating with each other to achieve the common goal which is the patient care. Though recovery unit depends largely on patient flow from OR and ward, this study is limited to the recovery unit needs.

1.1 Problem Area and Research Questions

This study focuses on management IT support rather than clinical aspects in order to provide insight of the work processes that center on the patient flow. During the fieldwork , the study focuses on the recovery unit work practices and the people performing the work. By using different methods the following questions are addressed:

- a) Identify and find solutions for patient flow bottlenecks;
- b) Identify possible solutions for the communication problems between medical personnel which interfere with the effective coordination of healthcare and;
- c) How IT-system can support the processes related to care delivery.

¹ The Recovery unit is sometimes referred as Post Anesthesia Care Unit (PACU).

² Rikshospitalet-Radiumhospitalet – HF. Rikshospitalet is the national hospital in Norway and was merged with Radium hospital.

³ Perioperative cares compose of units that handles pre-, trans-, and post-operative care.

1.2 Motivation for the research

The opportunity to study a complex organization like healthcare caught my interest. My previous work experience in different areas of industry prepared me to take this challenge.

My practical motivation in conducting this research is based on the interest of studying work processes which lead to the development of a new functionality of an existing system in a large and complex hospital in Norway. The expected contribution of this study is to create an IT -support system which increases the efficiency of the recovery unit at RR-HF.

1.3 Limitation of the Study

The addition of new functionality and implementation of the Albert System used in the surgical planning is produced in several versions. This thesis focuses only on Albert System's version for recovery unit needs where the data gathering was made and scoped. The functionalities of the Albert system used in surgical planning and scheduling will be presented in chapter 5.

The focus group of the research includes coordinators, nurses, the education nurse, administrative heads, the overall unit assistant and the secretary at recovery unit. After a series of interviews and observations, however, the education nurse, administrative heads, and the overall unit assistant were excluded because they were not using the Albert System. Despite this, their work processes were included in the description as part of the overall work processes at the recovery unit.

1.4 Organization of the thesis

This thesis is organized in eight chapters. Chapter 1 presents an introduction of the study, motivation of the study, problem areas, limitation of the study. Chapter 2 presents the various literature reviews, I locate this dissertation in relation to the IS research field by focusing on different conceptualizations of the relation between coordination-artifacts-and work practices. Chapter 3 introduces the research methods used during fieldwork. Chapter 4, 5, and 6 are the three empirical chapters. In Chapter 4 presents the research settings of the research, the context that the research has been carried out in terms of the location and the organizations function as a unit in a hospital's department. In chapter 5, I focus on the daily work practices and the sequence of activities taking place in the recovery unit, and the coordination of other department involved. Chapter 6 describes the overall development activities of Albert System

– surgical planning protocol new functionality for recovery unit. Chapter 7 presents the analysis chapter. Chapter 8 is the assessment discussion, conclusions, and recommendations of the study. It also concludes the summary of findings. Appendices contain copies of reviewed documents, tools for data collection, and necessary permissions for the study.

2 LITERATURE REVIEW AND THEORITICAL PERSPECTIVE

This case study is about the use of information technologies in medical practice. Thus, focus is mainly on technology, materials, and work practices. This chapter presents the theoretical framework to interpret the case. The interest is more in the details of understanding how actors coordinate and cooperate in their daily work. Various theoretical frameworks were selected, such as Computer-Supported Cooperative Work (CSCW), including the concepts of trajectories and articulation work, coordination, and borderline issues. The concept of Infrastructure in Information technologies is another perspective utilized, which links to technology to its context. The concept of Business Processing Reengineering (BPR) is used in terms of work practices in application to healthcare

2.1 Information Infrastructure (IIs)

Information Infrastructure is a framework for communications network that support high-level services for human communication and access to information, and can refer to a technical framework rather than to a public policy (U.S National Research Council, 22). The study of information infrastructure has emerged in Information Systems (IS) research and is seen as the “next generation” of information technology (Hanseth and Monteiro, 1997).

The term "infrastructure" has been used in relation to information technology to denote basic support systems like operating systems, file servers, communication protocols, printers, etc. (Ole Hanseth and Eric Monteiro, 1998). Ciborra (2002) uses the term infrastructure as “not just a sets of hardware and software but sets of the pre-existing institutional arrangements, cognitive frames, and imageries that actors bring to and routinely enact in, a situation of action” (pg. 70). Information Infrastructure is a shifting blend of configurations and capacities of technology, organization, and community (Baker et al, 2005a).

The concept of Information Infrastructures used in this thesis examines the role of the installed base on a broader trend of building more complex IT solutions. An alternative definition of an Information Infrastructure claims that they are larger and more complex systems, involving significant numbers of independent actors as developers, as well as users (Hanseth, 2000).

Nowadays, healthcare organizations use various applications of Information Technology (IT). This is also known as “medical informatics” or “healthcare information systems”. These information systems comprise electronic medical records, imaging systems, etc. Most of these systems are not just links with the basic support systems but of work practices, creating a distributed and large infrastructure.

There are several key aspects or characteristics to identify information infrastructure (IIs), namely: *open, shared, heterogeneous* and *evolving installed based*. One of the key aspects that characterize infrastructure is developed through extensions and improvements of installed based. This implies that infrastructure is considered, “as always already, they are never developed from scratch” (Hanseth and Monteiro, 1997). It is rather developed by interconnecting and interrelating to the existing components. New infrastructures must be designed in a way that can be linked to the old element or installed base. This applies the same with existing infrastructure that has to adapt as well to the new requirements that occur. As a result, the new requirement to be built carries heritage from and is affected by the existing installed based. These intertwined elements call for an ongoing process of balancing and arranging. A reminder of the need to be constantly aligning or (re)constructing is wrapped into the term “infrastructure” (Star and Bowker, 2002). This active form of information infrastructure serves as a reminder that infrastructure is not just a physical thing but also rather a set of dynamic arrangements, negotiations, and alignments that is “always ready”, undergoing constant maintenance and update (Star and Bowker, 2002; Star 2002; Karasti and Baker, 2004).

Depending on its size, degree of flexibility and degree of heterogeneity, the installed base can affect an infrastructure to move towards an inertial state. Monteiro and Hanseth (1995) state that the Information Infrastructure is the 'interwoven relationships between new organizational forms and their IT-based backbone'. Infrastructure is conceived as “something that emerges for people in practice, connected to activities and structures” and “it only becomes infrastructure in relation to organized practices” (Star, 1996). It is not a “substrate which carries information on it, or in it and the discontinuities of the infrastructure are not between the system and the person, or technology and organization, but between contexts” (Star, 1996).

In summary, healthcare processes are often defined by facility design, which is an architectural discipline rather than a discipline of production system design. Once hospital facilities are built, the processes they support are hardwired and difficult to change. Often, processes remain locked-in for decades due to the capital investment that is required to make changes. Perioperative systems design in today's Operating Room (OR) involves complex interactions with physical infrastructure, changing technology, and human factors.

2.2 Business Process Re-engineering (BPR) in Healthcare

Business processes are sequences and combinations of activities that deliver value to a customer (Coulson-Thomas, 1996). There are core business processes that can be identified, and enhancing these processes will lead to business improvement. In recent years, re-engineering business processes has been popular. There are many companies have been forced to re-engineer their processes to stay competitive, and deliver better services and products. Managers use process-re-engineering methods to discover the best processes for performing work, and these processes be re-engineered to optimize productivity (Weicher et al. 1995). The re-engineering concept has evolved from “radical change” to “contextual realism” (Caron et al. 1994, Earl 1995).

Hammer and Champy (1993) state that BPR refers to the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality and speed. This definition is one of the most cited and utilized in journal articles. Furthermore, Hammer (1993) defines the four keywords considered relevant: *fundamental*, *radical*, *dramatic*, and *process*. BPR is known as a form of organizational change. This organizational change perspective recognizes that business process re-engineering is not a monolithic concept but rather a continuum of approaches to process change (Kettinger et al. 1997). The faster the speed of change the more difficult and stressful it is to manage (Edwards and Walton, 1996). BPR is clear at least at the level of slogans in its objectives to “obliterate, don't automate work” (Michael Hammer, 1990).

BPR is a “blank sheet fresh start” approach to organizational development, adopting a cross-functional analysis of processes, in pursuit of ambitious and rapid improvements (Buchanan, 1997). Grounded upon Flood's (1996a, 1996b) four key dimensions of organization (process, design, culture and politics), a classification of four types of organizational change can be

suggested (Cao et al., 1999). This classification refers to a particular dimension of an organization. This gives rise to a key problem for BPR implementation, where organizational changes, it may argued, cannot be reduced to change in process, structure, culture, or politics. Consequently, any attempt to carry out change through isolated single efforts is likely to fail (Kanter et al., 1992).

Some healthcare organizations use re-engineering techniques to find out or review the processes involved within the organization, for inefficiency that can be take off from the system, and to identify work redundancy. Its emphasis is on streamlining of cross-functional processes to radically reduce time and cost, improve quality and service, increase revenue, and reduce risk. The benefits of re-inventing hospitals hold the tangible and realistic promise of radically reducing costs while dramatically increasing the quality of care provided (Harmon 1996). With most of the expenses tied to activities related to patient care, healthcare organizations can take advantage of BPR to improve managing labor, supplies, equipment, and facilities. With the increasing cost of health care, healthcare providers are starting to understand that BPR initiatives could provide a competitive advantage.

A case study at Surgical Directorate of Leicester General Hospital NHS Trust (LGH) by Dave Buchanan and Bob Wilson (1996) reveals that the re-engineering perspective did not deliver clear solutions. They identified BPR's weaknesses and strengths, but in their analysis, show that re-engineering was not necessary for the problem addressed. This is in contrast to the case study result made at Leicester Royal Infirmary (LRI) by Karen Newman (1997), where the benefits of re-engineering had a large impact. The enhancement in service quality derived from greater accuracy and speed, less re-working, and fewer mistakes and errors has led to an improvement in the cost base, higher patient satisfaction scores and improved employee satisfaction (Karen Newman, 1997). In order to apply BPR successfully, it has been suggested that either its usage needs to be restricted to those situations where process dominates, or a holistic view is needed which helps to deal adequately with changing situations where different types of organizational change are surfaced (Cao, G., Clarke, S., Lehane, B., 1999).

In summary, Business Process Reengineering focuses on changing existing business practices. The case of the recovery unit, where high-complex processes is involved. A hospital consists

of diverse occupational groups, which has traditionally enjoyed a high degree of autonomy over their work situation. In addition recovery unit processes in dealing with the patient has a knowledge-intensive type. The diagnostic, treatment and care work are based on an evolving knowledge base, interdependent. To the recovery unit work processes to new is not possible.

2.3 CSCW and Articulation of Work

CSCW can be described as a research and design field in search of understanding cooperative work, with the purpose of informing the design of computer based technologies for the support of cooperative work (Schmidt and Bannon 1992, p 11). He added that cooperative work are formed because of the limited capabilities of single human individuals, that is because the work could not be accomplished otherwise, or at least could not be accomplished as quickly, as efficiently, as well, etc., if it has to be done on individual basis. More specifically, cooperative work arrangements may emerge in response to different requirements and may thus serve different generic functions (Schmidt 1990).

Cooperative work is work, and most work is group. Nothing that we humans do is done outside of a social context and all our practices are therefore socially and culturally mediated (Huges, Randall, Shapiro 1991). Work is understood as cooperative when the involved actors are mutually interdependent in their work and therefore are required to cooperate in order to get the work done (Schmidt & Bannon 1992). The notion of interdependence is the key here. Cooperative work is articulated in the sense that actors involved in cooperative work must share, allocate, coordinate, mesh, interrelate etc. their distributed individual activities (Schmidt & Bannon 1992, p.14). Studies of interactions with the physical environment in collaborative work can provide insights into how people work together [11]. As demonstrated by studies on ways in which physical and perceptual properties of work environments are exploited [12–15], Strauss (1988, 1993) devised the terms “articulation work” and “articulation process” to describe the work within projects and to understand how a project’s participants get their work done. Articulation work is one constituent of an overall articulation process. It refers to “the specifics of putting together tasks, task sequences, task clusters - even aligning larger units such as lines of work and subprojects - in the service of work flow” (Strauss, 1988). Articulation process represents a more inclusive set of actions; it refers to “the overall process of putting all the work elements together and keeping them together” (ibid).

The theoretical nature and effects of articulation work are relevant to work practices and use of Information and Communications Technologies (ICT). Articulation work is “work that enables other work”: that which links people, processes, and technologies within organizations. Articulation work in organizations is common, but too often invisible from a managerial or budgetary perspective. We find, that as work becomes more complex (such as adding new work tasks and using new technologies), there is more articulation needed. These findings raise issues on assessing the costs of articulation on individuals, and arranging to accommodate explicit and implicit articulation in organizational work, particularly around the take-up and ongoing use of ICT-based systems. The notion of articulation work applies to technical and organizational arrangements but also to the coordination of cooperative work involving interdependencies (Schmidt and Bannon, 1992)

- *Artifacts at work*

In order to perform the articulation work persons engaged in cooperative activity will typically have to engage in communication in some way (Dix 1996, p.7). In addition, if they are engaged in cooperative work, there will typically be artifacts on which they are working, either in solid physical form or in digital form (Dix, 1996, p.8).

In recent years, CSCW researchers come to realize that the artifact in the work setting plays a crucial role in the coordination of cooperative work. One of the commonly used artifacts these days is the digital artifacts. It takes advantage of the capability for the support of collaborative work.

In addition to Dix's supply through concept. The mode of articulation work through the artifact has been described and conceptualized as interaction through the field of work by Schmidt (1997). Schmidt (1994) coins and employs the concept of “coordinative artifacts. In cooperative work settings characterized by complex task interdependencies, the articulation of the cooperative- and distributed activities requires specialized artifacts, which by employing of a pre-established coordinative protocol, are instrumental in reducing the complexity of articulation work, and in turn diminishes the need for ad hoc negotiation of the work process (Schmidt & Simone, 1996). A coordinative artifact can be thought of as constituted by two parts. On one hand a coordinative protocol of a social nature in the form of a set of agree-to-procedures and conventions that to competent members of the cooperative ensemble,

stipulates the responsibility of the different roles in the cooperative work group (Lars Rune Christensen, 2003). On the other hand, we have the persistent part of the artifact in which the protocol is imprinted (Schmidt & Simone, 1996 p.165).

Ethno methodologically informed studies demonstrated that material artifacts are the key in the understanding of coordinative practices (e.g. Harper & Hughes 1993; Harper, Hughes & Shapiro 1989; Harper, Hughes & Shapiro 1991). Other ethno methodologically informed studies pointed out how actors skillfully employ the affordances of the material work setting in order to articulate their cooperative efforts (Heath & Luff 1991; Heath & Luff 1992, Suchman 1993; Suchman & Trigg 1991).

In summary, Healthcare is full of examples of the articulation of individual activities. This articulation is often interceded by the physical environment containing work objects such that workflow is smooth and explicit coordination efforts are nominal. The physical environment also mediates information flow to maintain awareness of other people's activities and common status of the workplace. In terms of information technology, efforts toward shared and setting in information (both access and input) within physical work objects can further leverage IT in healthcare. The detailed studies using ethnographic methods should be carried out to understand how cognitive artifacts are used for safety and efficiency of healthcare delivery that fundamentally change collaborative work.

2.3.2 Common Information Space (CIS)

The concept of Common Information Space (CIS) provides an analytical framework for the description of specific work settings at the recovery unit at RR-HF.

CIS was originated by Schmidt and Bannon (1992), and was furthered explored by Bannon and Bødker (1997). CIS was discussed as an alternative mechanism to procedural or workflow-type arrangements to support cooperative work (Bannon & Schmidt 1989, 1991).

Cooperative work is not facilitated simply by the provisioning of a shared database, but" rather requires the active construction by the participants of a common information space where the meanings of the shared objects are debated and resolved, at least locally and temporarily (Schmidt and Bannon, p 22)

A work situation is not just about information, but also inter-communication between actors. Open communication accomplishes tasks, and agreements are needed to build some form of shared space among the actors. Such coordination requires articulation work, which designates “a set of activities required managing the distributed nature of cooperative work” (Schmidt, K. & Bannon, L. 1992, p18). The Concept of a CIS is not put forward as another loose abstraction, but rather as a potentially useful construct that may help in elucidating important aspects of cooperative work activity (Liam Bannon and Susanne Bødker, 1997). Reddy et al states that the heart of the CIS concept is the distinction between access and practical understanding. Schmidt and Bannon discuss the potential problem which actors face in interpreting information when either the information’s creator, the context of its creation, or politics of its use are unknown to the actors involved.

The term “common” was used to lessen the connotations associated with the word “sharing” – and indicates the transient and instrumental aspects of people having information “in common” (L. Bannon, 2000). This does not mean that the actors’ perspectives of the information are the same, but rather the information is simple enough to coordinate easily. Each actor has an opinion about the relevance of the information for him or her. Each has different work activities and different perspectives on the same information. The work of maintaining CIS requires the balancing and accommodation of different perspectives (Reddy, M., Dourish, P., and Pratt, W. 2001).

Key features identified in CIS’s include the seemingly dialectical nature of these spaces; the frequent need for additional effort in order to put, or use, information “in common”; the need for both closure and openness in representations; their simultaneous portability and immutability; etc.

L. Bannon and S. Bødker, (1997) identified many forms of CIS. They are in some cases constituted for people that are co-present in time and space, whereas in other situations they are distributed across time and space boundaries. The mechanism used to support “holding in common” the information varies accordingly (L. Bannon and S. Bødker, 1997). The nature of these CIS does vary depending on the work context. Hence, in a physically shared workspace for example, actors are able to cooperate with each other. This is “due to the common work

setting and exposure to the same work environment, both in production and reception of utterances and information, without having to resort to extended descriptions or elaborated codes, due to their understanding of the shared context within which they work” (L. Bannon and S. Bødker, 1997).

CIS involves local work practices and crosses group boundaries. The information artifacts at the heart of the space are the focus of heterogeneous workgroups and have characteristics of “boundary objects” (Star and Griesemer 1989). The work of Leigh Star and others on the concept of “boundary objects” is concerned with how communities develop means for sharing items in a common information space. Boundary objects are information artifacts flexible enough to fit local work practices but also stable enough to convey information across group boundaries, enabling them to act as coordinating mechanisms for interactions between diverse workgroups. (Reddy, M., Dourish, P., and Pratt, W. 2001). L. Bannon and S. Bødker (1997) use boundary objects as a lens for viewing CIS’s. They contend that, as with a boundary object, the dialectical nature of the CIS is an important characteristic.

Suchman, Goodwin & Goodwin () site an example of complex work coordination, namely an Airline operation room. In this example, the common information space is open and situated, with the participants able to make interpretations based on their shared physical context. This kind of work has ever-changing conditions, which may require changes to established procedures. They find many examples of complex human coordination patterns, where actors do not have time to package information in particular ways, and assume that others can interpret correct events due to massive shared context that exist in the work.

Bowker (1997) examines the medical record as “an organizational infrastructure.... [that] affords the interplay and coordination between divergent worlds”. She argues that the patient record is both a representation of the patient as well as a representation of the work being carried out on the patient. Different groups (e.g. physicians, nurse, administrators, etc.) use the record in their own local work context. To each group, the record has a localized meaning, but it also serves to coordinate the different activities of these groups. The patient record functions as a boundary object, spanning a number of different groups.

2.4 Software Process Framework

The documented collection of policies, processes, and procedures used by a development team or organization to practice software engineering is called its software development methodology (SDM) or system development life cycle (SDLC). System development life cycle models represent the entire process of formal, logical steps taken to develop a software product and their interrelationships in a graphical framework that can be easily understood and communicated. The motivation behind utilizing a software life cycle model is to provide project structure to manage ahead and to use process techniques to improve the quality of a software development effort. This is based on the theory that subject to continuous debate and supported by patient experience.

That by using a methodical approach to software development results in fewer defects and, as a result, ultimately provides shorter delivery times and better value.

All projects can be managed better when segmented into a hierarchy of chunks such as phases, stages, activities, tasks and steps. A software development lifecycle is comprised of four facets to manage the project: *Requirements* (What features will the product have?), *Design* (How will the product offer these features?), *Coding* (How will the features be coded and unit tested?), *Testing and packaging* (How will the products be tested and delivered to customers?)

The basic popular models that are adopted by many software development firms are: *System Development Life Cycle (SDLC) Model*; *Prototyping Model*; *Rapid Application Development Model*; *Component Assembly Model*; and *Iterative Model*. The waterfall model is one of the three most commonly cited lifecycle models. Others include the Spiral model and the Rapid Application Development (RAD) model, often referred to as the Prototyping model

The waterfall development model, which is attributed to Royce and was well documented by Boehm [1, 2], progresses from the analysis phase to the design phase, through to the coding and finally the testing phase. The waterfall provides an orderly sequence of development steps and helps ensure the adequacy of documentation and design reviews to ensure the quality, reliability, and maintainability of the developed software. While almost everyone these days disparages the "waterfall methodology" as being needlessly slow and cumbersome, it does illustrate a few sound principles of life cycle development. In a traditional Waterfall lifecycle model, (shown figure) the project plan organizes the four phases in a strict serial

order. A lot of time is spent up front to define and analyze requirements and to complete the design of the target system before a line of code is written. This model does not handle changes in requirements or design well. The waterfall approach has too much rework comes at the very end, as an annoying and often unplanned consequence of finding nasty bugs during final testing and integration. Even worse, when it is discovered that most of the cause of the "breakage" comes from errors in the design, which you attempt to palliate in implementation by building workarounds that lead to more breakage. The waterfall model made it easy on the manager and difficult for the engineering team. In addition, it creates an artificial separation between business analysts, architects, designers, and programmers, leading to the risk of miscommunication and divergence between the business objectives and vision of a software product and its implementation.

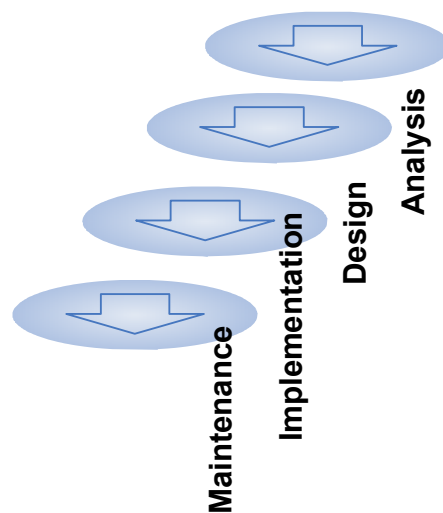


Figure: Waterfall model

In an iterative approach simply acknowledge up front that there will be rework, and initially a lot of rework: As the problems are discovered in the early architectural prototypes, it needs to be fixed. In order to build executable prototypes, stubs and scaffolding will have to be built that is to be replaced later by more mature and robust implementations. The project plan arranges the development into small releases, and mandates continuing integration of all coded components, incremental builds, and periodic validation of refined requirements and design. By doing so, it encourages a shared ownership of the product among business analysts, software architects, designer, programmers, and testers; this shared ownership reduces the risk of miscommunication and divergence. In a healthy iterative project, the

percentage of scrap or rework should diminish rapidly; the changes should be less widespread as the architecture stabilizes and the hard issues are being resolved. Projects are not easier to set up, to plan, or to control just because they are iterative. The project manager will actually have a more challenging task, especially during his or her first iterative project, and most certainly during the early iterations of that project, when risks are high and early failure possible. Iterative development is much more aligned with how software engineers work, but at some cost in management complexity. Given that most teams have a 5-to-1 (or higher) ratio of engineers to managers, this is a great tradeoff. Although iterative development is harder than traditional approaches the first time it is done. There is a real long-term payoff. When the entire team to understand and think iteratively, the method scales far better than traditional approaches. An alternative approach is the Iterative Development Life Cycle (sometimes referred to as the Spiral Life Cycle).

Below the diagram of the Iterative development Life Cycle in figure

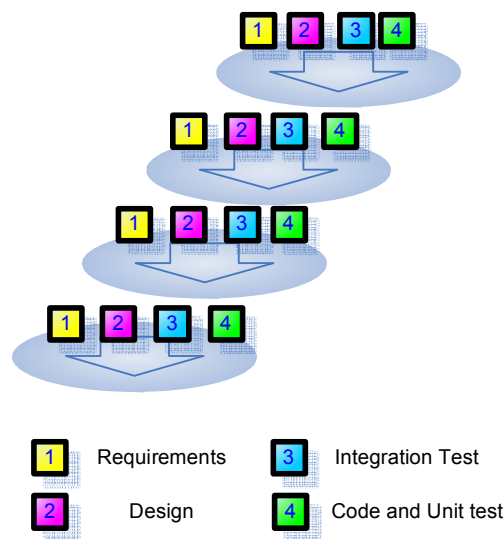


Figure: Iterative Development Model

The Iterative Life Cycle, analysis is done just the same as with the Waterfall method. The requirement is prioritized as high, medium, and low. The key steps in the process starts with a simple implementation of a subset of the software requirements and iteratively enhance the evolving sequence of versions until the full system is implemented. Design modification are made and new functional capabilities are added at each iteration.

Summary:

Life cycle steps are described in very general terms. Models are adaptable and their implementation details will vary among different organizations. Organizations may mix and match different life cycle models to develop a model more tailored to their products and capabilities.

All these different software development models have their own advantages and disadvantages. Nevertheless, in the contemporary commercial software development world, the fusion of all these methodologies is incorporated. Timing is very crucial in software development. If a delay happens in the development phase, the market could be taken over by the competitor. Also if a 'bug' filled product is launched in a short period of time (quicker than the competitors), it may affect the reputation of the company. So, there should be a tradeoff between the development time and the quality of the product. Customers don't expect a bug free product but they expect a user-friendly product. The SDLC models have evolved as new technology and new research have addressed weaknesses of older models. Ideas have been borrowed and adapted between the various models.

3 RESEARCH METHODOLOGY

This chapter introduces the epistemology, theoretical perspective, and methods. It also describes the sources of the data and documentation from fieldwork.

3.1. RESEARCH APPROACHES

The choice of research approach influences the way in which the researcher collects data (Myers, 1997). This research approach is based on a qualitative paradigm, with the underlying research epistemology category of an interpretive philosophy. The combined methods of case-study and contextual inquiry, are utilized as research methods. These research approaches are used to study the work processes in the recovery unit used to identify problems related to process bottlenecks, delays, information and management. The data was collected from the hospital information systems, through interviews with the recovery unit staff and by analysing material of the current system used in the surgical planning activities.

3.1.1. Qualitative research methods

There are two research paradigms one can use in choosing a research method: qualitative and quantitative. These two research methods represent fundamentally different inquiry paradigms. Researchers' actions are based on underlying assumptions of each paradigm. Thus, qualitative methods are appropriate in situations where the researcher has determined that quantitative measures cannot adequately describe or interpret a situation. The qualitative researcher attempts to make sense of, or provide an interpretation of, observed phenomena relative to meanings attributed to these phenomena by individuals involved in specific incidents or situations. Where quantitative researchers seek causal determination, prediction, and generalization of findings, qualitative researchers seek instead illumination and understanding, and use extrapolation to relate their findings to similar situations.

The particular design of a qualitative study depends on the purpose of the inquiry, what information will be most useful, and what information will have the most credibility. There are no strict criteria for sample size (Patton, 1990). "Qualitative research involves the user of qualitative data such as documents, participant observation, and interviews to understand and explain social events" (Patton, 1990). Relatively recently, the information systems(IS) research

community has responded to the call for more emphasis on qualitative research. As the focus of information systems research shifts from technological to managerial and organizational issues, qualitative research methods become increasingly useful (Myers, 1997). There is an increasing interest in the relationship between Information Systems (IS) and the organization as a whole (Myers and Avison 2002, p3). Lee (2001) provides further elucidation by suggesting that Information Systems research is more than the study of technology or behavior. Lee (2001) suggests that information systems researchers must deal, ‘... with the phenomena that emerge when the technological and the behavioral interact, much like different chemical elements reacting to one another when they form a compound’ (Lee, 2001).

Three categories of underlying research epistemology are suggested by Orlikowski and Baroudi (1991), and Chua (1986): *positivist, critical, and interpretive*. Orlikowski and Baroudi (1995) classify IS research as *positivist* if there is evidence of formal propositions, qualified measures of variables, hypothesis testing, and the drawing of inferences about a phenomenon from the sample to a stated population. Positivist research generally assumes that reality is objective and can be described by measurable properties. *Critical research*, on the other hand, focuses on the oppositions, conflicts and contradictions in contemporary society, and seeks to be emancipator. In other words, it helps to eliminate the causes of alienation and domination (Myers, 1997). Critical researchers also generally assume that social reality is historically constituted and that it is produced and reproduced by people. *Interpretive research* assumes that “reality is not given” (Myers, and Avison, 2002, p.65), but rather constructed and reinforced by social actors. Interpretive research begins with the assumption that access to reality is only through social construction such as language, shared meanings, and shared information.

Finally, qualitative research methods provides the researcher with flexibility by allowing the research participants to determine the response and to elaborate on their own comments. The techniques also allow the researcher to pose follow-up questions when necessary in the data gathering process.

3.1.2. Interpretative case study

The primary task of an interpretive study is to seek meaning in context - the subject matter must be set in its social and historical context so the reader can see how the current situation emerged (Klein and Myers, 1999). The most important characteristic between traditional research approaches and interpretive research are the underlying philosophical assumptions. Its research approach is inductive and concerned with discovering and interpreting social patterns (Fitzgerald et al. 1998; Klein et al. 1999; Lacity et al. 1994; Orlikowski & Baroudi 1991; Walsham, 1995). Interpretists believe that multiple realities exist as constructions of the mind. This approach to information systems is “aimed at producing an understanding of the context of the information system and the processes whereby the information system influences and is influenced by its context” (Walsham, 1993 p. 4-5). Klein and Myers state that “information system can be classified as interpretive if its assumed that our knowledge of reality is gained only through social constructions such as language, consciousness, shared meanings, documents, tools, and other artifacts” (1999 p. 69). Therefore, an interpretive approach in information system research attempts to understand information technologies through the work processes that people perform. Additionally, interpretivists argue that organizations are not static, and that the relationships between people, organizations, and technology are not fixed but constantly changing (Klein and Myers 1999). Furthermore, interpretive research methods do not pre-define dependent and independent variables, but focus on the complexity of human sense making as the situation emerges (Klein and Myers 1999).

There are two types of interpretive field studies, namely, in-depth case studies and ethnographies. The difference between the two interpretive field studies lies in the length of time that the researcher immerses in the social group studied and the emphasis on detailed observational evidence. Walsham would claim that, “the most appropriate method of conducting empirical research in the interpretive tradition is the in-depth case study” (1993 p. 14). Yin (1994) takes a more scientific approach to case studies, and is recognized and cited by many IS researchers. Yin defines a case study as “an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident” (1994 p. 13). Interpretive case studies, as opposed to other case studies, often rely on multiple sources of evidence. Yin

identifies six different sources of evidence relevant for data collection: documentation, archival records, interview and direct observation, participant-observation, and physical artifacts (Yin 1989).

Klein and Myers (1999) have proposed a set of principles for conducting and evaluating interpretive field studies in IS. The fundamental ideas of the principles are derived from philosophical writings that relate to the conduct and evaluation of interpretive research in the hermeneutic nature. Their most important conclusion is that, “While not all of the principles may apply in every situation; their systematic consideration is likely to improve the quality of future interpretive field research in information systems” (Klein and Myers 1999 p. 70)

In this research approach, the researchers’ role and knowledge develop throughout the research processes. The data gathered through observations, data collection, and interviews are interpreted through the actors’ knowledge and daily work. The interpretive approach has the potential to produce deep insight, helping to understand human thoughts and actions in a social and organizational context.

3.1.3. Contextual Design

In this research, Contextual Inquiry has also been applied as one of the research methods. This method helps to gain understanding of the department work processes through the contextual design work models. The inquiry is all about learning what users do and what they care about, observing actors performing real tasks in context of work practice and social environment. It also helps to better understand their task domain, work culture, and physical and social constraints of the workplace. Additionally, one of the objectives of the research is to address the requirements for the recovery room IT support system. This method is used in understanding the user needs in design the subfunction for the existing surgical planning system, namely the Albert system –Digital Protocol.

Contextual Inquiry is a field data-gathering technique. It studies a selection of individuals in-depth to arrive at an understanding work practices. It is a modified ethnographic technique designed to provide the detailed needs of the users. It is commonly used with a design method called Contextual Design (Holtzblatt and Beyer, 1998) to create new ways of doing work with computer applications, though it can be utilized also in any aspect of work. The

primary purpose of the Contextual Design is to create software specifically for corporations. This technique is rarely used in medical information. Additionally, this design method is mainly used in designing a system by getting involved with the users everyday work and learning what they need.

There are four principles of Contextual Inquiry namely, *context*, *partnership*, *interpretation*, and *focus*. The principle of *Context* tells the researcher to go to the customer's workplace and observe the work as it is unfolds (Whiteside and Wixon 1998). With context, the researcher gathers data through on-going experience and actual situations. Its goal is to get as close as possible to the ideal situation by being physically present and using real artifacts. With *Partnership*, the researcher and the actor collaborate in understanding the work (Holtzblatt and Beyers, 1998). Together they watch the work unfold and discuss how the work is structured. *Interpretation*, on the other hand, is a change of reasoning that turns facts into relevant action. It ensures that the work is understood correctly by both partners (Holtzblatt and Beyers, 1998). A good relationship between the actor and the researcher is essential to this understanding. Having *focus* allows the researcher to see more. It helps the researcher to keep the conversation on track without taking control entirely from the actor.

The Contextual Design process involves building work models to describe tasks that are being completed. Researchers use work models to capture data (Holtzblatt and Beyers, 1998). Work models provide a language for visualizing the work scheme. Data from this research was represented in each of five work models namely, Work flow model, Sequence model, Artifact model, Cultural Model and Physical Model. These paper models are formalized diagrams that depict a global picture of the work process. Each of these models has its own concepts and symbols representing one aspect of work for design. Work models are graphical languages that capture knowledge about work were used. Graphical models can communicate a lot, quickly, faster to parse, and understand than narratives. It extract and summarize information across one or more interviews into single representation. Different models provide different lenses with which to analyze work. No model will serve all needs. Additionally, models make work visible, give it concrete, and external representation

- *The Flow Model*

Displays how various nurses, doctors, administration personnel, and influences the patient flow and bed scheduling process. It documents the communication and coordination involved in the work. Individuals and well-defined groups are represented by circles. Information sources and sinks are drawn as rectangles. Labeled arrows between individuals and groups show the directionality and content of information flow.

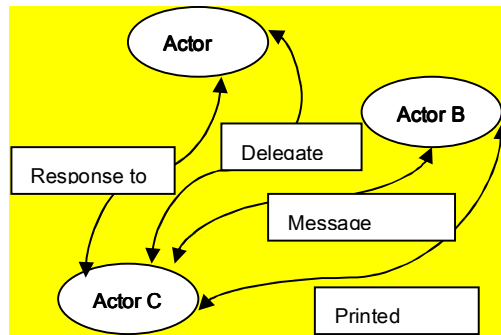


Figure 3: A sample flow model

- *The Sequence Model*

Display how the sequence of activities unfolds over time. Its goal in discovering actors strategies behind their action, what matters to them in organizing their work, and their intentions. It depicts the steps used to achieve the individual's work. Sequences within the model are anoted with the intent of the sequence as well as the trigger that initiated the sequence. The sequence model reveals the individual's strategy and intent.

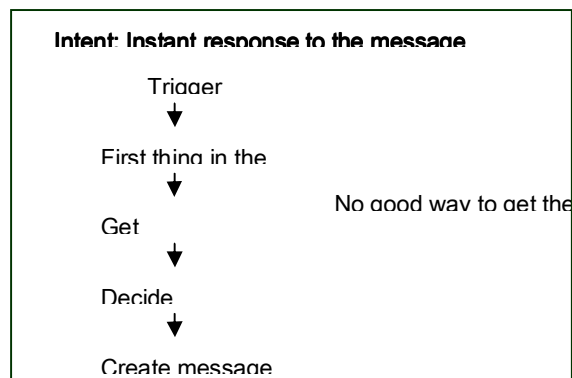


Figure 4: A sample sequence model

- *The Artifact Model*

Analyzed artefacts gathered during fieldwork includes drawings and copies of artefacts such as documentation, spreadsheets, forms where people create, use, and modify things while doing work. The model reveals the structure, usage, and intent of an object manipulated in the sequence mode or passed in the flow model.

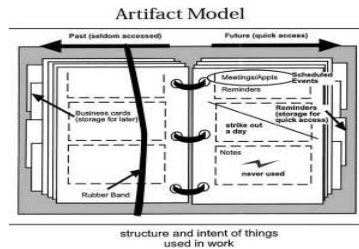


Figure 5: A sample artifact model

- *The Physical Model*

Captures the physical environments important elements matters for work and its constraints. It consist of drawing that describes the places, spaces, and its physical structures where the work is carried out, how is spaces used by the workers and the information how the people are group.

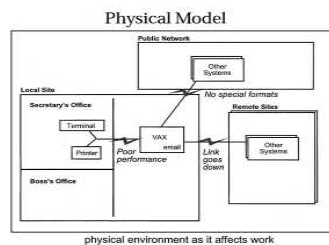


Figure 6: A sample physical model

- *The Cultural Model*

It provides diagrams in describing the cultural context. This approach aims to describe the person or group that influences others, which can include other workers, other work units, or environmental factors.

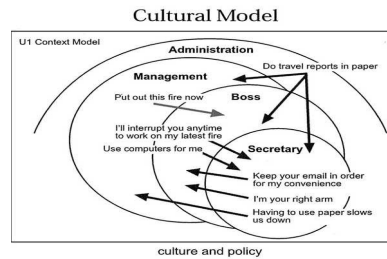


Figure 7: A sample cultural model

3.1.4. Conclusion

On a fieldwork case studies, drawing has been a powerful tool. The big picture had to be comprehended first. Everything within the context was dependent on each other in order to be able achieve the goal for capturing, understanding the details.

In this study, only the flow, sequence, artefact, and the physical model has been used. Culture model is a broader topic to be included, therefore it has not been utilized.

3.1.5. Discussion

It is crucial to take the contextual situation in order to fully understand the users' requirements. In further work, it would be worth trying to explore the potential of using video not only as documentation but also as a tool.

3.2 Methods and Sources of Data

This chapter describes the methods used in the case study conducted at Rikshospitalet-Radiumhospitalet – Medical Centre, recovery room. A series of interviews, data collection, and field observations were utilized in order to determine the patterns of work, collaboration, and organization.

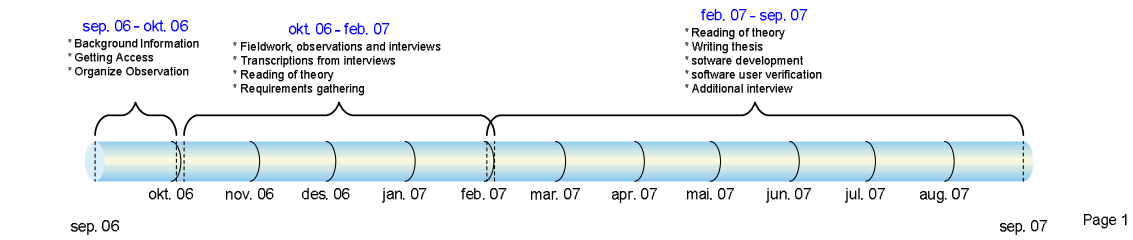


Figure 8: Overview master thesis phases

3.2.1 Data Collection

The fieldwork began in early March 2006 as part of the mandatory curriculum in the Master study program. This course focused on how to do research and conduct fieldwork on a chosen setting and topic. At the end of the semester, students were to produce a research proposal. I have chosen the health informatics as my field of interest. The university, together with its other cooperative institutions, has a group of PhD's, MA students and Professors whose main interest is health informatics. The group usually meets once or twice a week to discuss papers and assist fellow researchers. It is a good point of contact where researchers share information with one another. This is an advantage especially for new researchers.

My research proposal focused on data integration. There was a current datawarehousing project running whose aim was to have the hospital databases integrated. Due to the project's high profile and limited contact, it was very hard to get the information and schedule for the fieldwork. I therefore changed my research area of interest, yet still with health informatics and at the same hospital.

3.2.1.1 Access to the Field

I started the groundwork for my thesis fieldwork in September 2006. I scheduled a meeting with the hospital IT representative for a possible research area of interest. We have a half day brainstorming on the options available. Finally, I chose the recovery unit. Before the fieldwork started, a meeting was conducted between the IT hospital representative and the recovery unit administration representative. It took another week to get a hospital ID to access the unit and another month before I was able to start the fieldwork.

The first day of fieldwork was orientation and with a tour of the hospital and information about the dress code. The fieldwork was conducted twice a week from October to December 2006. The maximum number of hours per visit was five. I started at 10am or at 1pm. The assistant chief nurse was my main contact. She was responsible for scheduling my interviews with the nurses. She also managed my weekly fieldwork schedule. The first two weeks were mainly observation, taking notes, familiarization of the workplace, and learning the nurses' movement in their day-to-day work. Based on my understanding and observation, I formulated questions to discuss and issues to clarify. During the next week's fieldwork, the medical personnel answered the questions. The scheduling depended on the workload for that day since work in the recovery room is unpredictable. However, when we set time to discuss, it was often interrupted due to work demand. The medical personnel verified my interpretation of their answers during follow-up discussions. In this way, I was able to obtain verified information. Many terms used have no English equivalent or the interpretation has slightly different meaning. In effect, we mostly had long brainstorming sessions or called other nurses to translate. In parallel with observing and taking notes, I also used the time to establish contact with the nurses. It took at least 2-3 fieldwork days to meet the nurses due to their different shift schedules.

Aside from interviews, information was also shared by the nurses during breaks and in-between shifts. I also took advantage in getting information by asking questions when a nurse is not attending patient and when they use other systems in the hospital as part of their daily routine.

3.2.2 Input to data collection

The following list was used as input to the data collection:

Category	Comments
General description of situation	Describes the people, buildings, location, time of day, how long do they stay
People	Describes the people at the present location/situation representatives for the specified user group?
Tasks	Describes what do people do here, what is their focus here, personal or job tasks?
Communication	Describes how do people communicate, frequencies,
Tools	Describes what tools do people use (electronic

	and non-e) in the situation
Social info	Describes the social organization, groups, inter-group communication, what is main focus in the process of establishing social structures at the site,
Social info	Social organization, groups, inter-group communication, what is main focus in the process of establishing social structures at the site,

Table 1: Data collection inputs

3.2.3 Interview

Interviews expand ones understanding. The qualitative researcher's philosophy determines what is important, what is ethical, and the completeness and accuracy of the results (Rubin & Rubin, 1995). The researcher can mix different types of interviews, and interview techniques depend on what the researcher wants to know. Clarifications and follow-up inquiries are usually made through another set of interviews with more questions. It is import to establish "rapport and trust" (p.145). Patton (1990) identifies three basic types of qualitative interview techniques for research: *the informal conversational interview*, *the interview guide approach*, and *the standardized open-minded interview*. The *Informal conversational interview* takes place spontaneously- words, topics and questions are not predetermined. It is similar to a normal conversation, and sometimes the "interviewee" has no idea that an interview has occurred. The *Interview guide approach* is the most widely used method. It is an interview where the researcher has outlined which topics need to be covered and has prepared a set of questions. In this type of interview the data is comprehensive and systematic. The *standardized open-minded interview* is the most structured and efficient technique. It is very useful in reducing bias especially when there are many respondents involved. I decided to use all four types of interviews to compensate for my lack of previous experience in the healthcare field. In this way, the informants a chance to critically evaluate their current work procedures and prompted them to provide more information by posing investigative follow-up questions.

The interivews were conducted five rounds. Five key informers from the administrative personnel were interviewed: the chief nurse, the assistant chief nurse, the education nurse, the secretary, and the over-all unit assistant. In addition, several nurses in the recovery unit were interviewed. Interviews were usually done in the early morning or on meal breaks.

Each interview lasted from 1 to 1 ½ hours. The administration personnel had less flexible schedules, were usually busy most of the time and had no backups, making it difficult to find time to interview them. The *interview guide approach*, and the *standardized open-minded interview* were done after observation and after the first interview. These approaches were mostly used for the five administrative informants(write more why you use this approach only for administrative??). I recorded the interview with the secretary because of the systematic nature of her work. Most informants volunteered to be interviewed during their breaks instead of scheduling and interview meeting. Most of the interviews were done in a private meeting room. The first round of interviews, using the *informal conversational interview technique*, was informal and explanatory in nature and focused on developing a general understanding of organizational issues and basic work patterns. The second round, using the *the interview guide approach*, focused on identifying current information utilization practices, information sharing, documentation processes and communication practices. The third round, using the *standardized open-minded interview*, was used to follow up on the findings from the first two rounds, and to discuss issues in further detail.

In formulating interview questions, I used methods of contextual design. I started with the flow model of each actor as my guide in formulating questions. This helped me to understand what they were doing on a day to day basis - from their interactions with patients, with other nurses, with the administrative personnel, and with the doctors from the postoperative unit and the ward unit.

3.2.4 Observation

In addition to the interviews, observation was conducted. Observation method is the primary method of collecting data. It usually depends on the purpose of the study, its nature and epistemological starting point of the knowledge result by observational methods can be vary. One of the most common, subjective and demanding observation method is participant observation. Participant observation aims at scientific research through researcher's or observer's presence in social situation without their behaviour influenced by the presence of the researcher. The purpose is to understand what people's behaviour means to them. It requires joining or participating in with the people or situation you are observing. It requires months or years of work. The observer needs to be accepted as a part of the culture.

I spend approximately (60) hours carrying out the field observation with recovery unit to develop a detailed understanding of workers' day-to-day work activities. The start of the fieldwork, I started to get a general view that happens in the situation. Observing the way they do things around. How the actors move around on its day to day work, and the attitudes toward works. For example, how the nurse interacts with the patient, interacts with the doctor, interacts with other nurses, interacts outside the working area and how they use Information Technology as part of their work. This was done to identify interesting topics. The length of the observation varied from 3-7 hours. My observation was done at the Recovery unit on how they interact with other nurse and interact with from the Surgery department and the ward nurses department. Nurse daily work involves, report writing, taking care of the patient, negotiation outside the unit and interaction within its resources. The observation provides an understanding of the continually dynamic environment. The observation made to enable to understand several events and phenomena, which by then used as the basic base of formulating and exploring questions for interview. A total of 7 workers were observed.

3.2.5 Fieldwork Documentation

During interviews and/ or observation, I did a lot of notes taking. This helps record the activities being observed. This is used as record of sources in my research. It is used to keep track of my research, provide information in addition to what is found for further analysis. I also used it as a supply reference to support my research, statements or hypothesis. Tape recording was done aside from notes taking. The tape recording is not used intensively, I only had the chance to use it when I interview the secretary. It has less interruption and we were able to conduct the interview in a quiet room.

The fieldnotes from the observation and the audiotapes from the interviews were transcribed and analyzed to identify work, collaboration, and organization patterns that are relevant to system design. The forms that were collected during the round of interviews were analyzed to extract workflow information requirements. The data were analyzed in preparation for designing the add-ons functionality of the existing system. The data was analyzed using Contextual Design (Beyer, and Holtzblatt, 1998) and other analysis techniques. This is discussed further in section 3.1.3

3.2.6 Limitation

The time constraints in working with the master thesis and time constraints for the medical personnel limits other areas to be explored. A direct observation between OR team, ward and recovery unit nurses interaction could have been performed thoroughly, both in order to establish a more elaborative understanding between departments coordination. To be able to establish more profound and precise questions.

3.3 ETHICAL ISSUES

There were factors to be taken seriously among organizations where data about individuals are considered as valuables and should be treated with confidentiality. Ethical issues is the main concern when a hospital is a choosen field of research. Since delicate and important information about the patients were considered confindetial. A secrecy form was need to be signed before the field work study commence.

4. RESEARCH SETTING AND CONTEXT

4.1 CASE STUDY SETTINGS

4.1.1 Rikshospitalet

Rikshospitalet-Radiumhospitalet – HF in Oslo, Norway is the medical institution where the research held. It was established in 1826 and merge with Radiumhospitalet in 2005. It is part of “Southern Norway Regional Health Authority”, and is affiliated with the University of Oslo. It is a highly-specialized university hospital, with special assignments in research, and the development of new methods of treatment. It also plays an important part as a highly specialized hospital with advance and expert knowledge of the treatment of unusual diseases and complicated disorders. The hospital has more than 20 medical departments and 11 administrative departments. It has approximately 4,000 employees. Serving 7,000 rooms, 585 beds, 90 patient hotel beds, and 27 operation rooms. Performing 62,500 surgical operations and carrying out 225,000 consultations. About 30,000 calendar day admissions every year, about 20,000 patient gets daily treatment and about 160,000 polyclinic consultations are made.

4.1.2 Rikshospitalet-Radiumhospitalet - HF - IT Department

IT-department is an internal service department that delivers IT-solutions for Rikshospitalet-Radiumhospitalet Medical Centre. It is responsible for the IT-offers, and for buying, installations works and maintenance of the IT-services. The hospital has 1200 different programs and applications. Out of those, around 200 contains patient data. IT-support for all departments’ work practices in the hospital is autonomous. Some of the departments have their own IT-vendors to cater their specific requirements and needs.

The existing system that is the focus on this research is the Albert System. It is developed in-house by the IT department. Its’ functionality caters the hospitals’ surgical operation planning and scheduling. The functionality of the existing Albert system is limited to pre-operative and intra-operative usage.

4.1.3 Recovery unit

The fieldwork was held at Rikshospitalet – Radiumhospitalet - HF, Recovery Unit. The recovery unit is one of the four sub-units under Anesthesia and Intensive Care Department. The recovery room is also known as post-anesthesia care unit (PACU). Recovery room at Rikshospitalet – Radiumhospitalet - HF caters different type of patient operation cases. Recovery room is a space where a patient is taken after surgery to safely regain consciousness from anesthesia and receive appropriate post-operative care and is located in close proximity to the operating room. Patients, who have had surgery or diagnostic procedures requiring anesthesia, or sedation, are taken to the recovery room, where their vital signs (e.g., pulse, blood pressure, temperature, etc.) are monitored closely as the effects of anesthesia wear off. The patient maybe disoriented when he or she regains consciousness, and the recovery room nursing staff will work to ease their anxiety and make sure of their physical and emotional relief. The recovery room nurse will pay particular attention to the patient's respiration, or breathing, as the patient recovers from anesthesia. The amount of time a patient requires in the recovery room will vary by surgical, or diagnostic procedure, and the type of anesthesia used. As the patient recovers from anesthesia, the recovery room nurses assess their post-operative condition. Patients may have a different post-operative experience if they receive short-acting anesthetic drugs for their procedure. After the effects of anesthesia have worn-off completely, and the patient's condition is considered stable, the patient will return to their hospital room (for inpatient surgery), or discharged (for outpatient surgery). However, recovery care is sometimes provided in an intensive care unit (ICU). The ICU may be used because the physician wishes a complex case to be admitted directly into the ICU where that patient will be staying.

4.1.3.1 The Unit Services.

There are maximum of sixty patients are accommodated in the recovery unit everyday, although by rule as long as there are enough resources and beds, all patients will be accommodated. The patients that must stay overnight were transferred to an Intensive Care Unit (ICU) with 24-hour service. The recovery unit also receives follow-up day patient surgery. Patients are primarily from the Ear, Nose and Throat (ENT) department, Women's clinic, and Gynecology section. The recovery unit caters to patients from Operating rooms 1, 2, and 3 in the Intervention clinic and Gastroenterologist research unit.

4.1.3.2 The Unit Working Schedule.

The recovery unit nurses have a three-shift schedule everyday. First shift is from 7:30 am. to 11:00 am., and shift ends at 2:30 pm. Second shift starts at 11:00 AM, and ends at 6:00 PM. Third shift starts from 3:00 PM and ends at 10:00 PM. A maximum of 15 nurses works on daily-shift serving four rooms with six beds each. In addition to that is the day-surgery room consists of four beds. One nurse have the responsibility to receive and make followup on the patients until departure. The morning shift has seven nurses on duty. Two of the seven nurses on the morning shift start working at 7:30 AM. The remaining five nurses will start at 8:00 AM. In the midday shift, there are four nurses on duty, and five in the nightshift. The shifting schedule daily is planned for a twelve- week's cycle. The basis of the scheduling is through nurse schedule wishes. The administrative heads will then adjust and allocate them accordingly. Recovery unit use flexible staffing to maintain their target nurse-to-patient ratios, and flows through the day and evening. Last minute adjustments are made based on the timing of surgical procedures and the patients' expected arrivals in the recovery area. The recovery unit is open from 7:30 AM to 10:00 PM from Monday to Thursday. On Fridays, it opens from 8:00 AM to 7:00 PM. It is closed on Saturdays and Sundays.

4.1.3.3 The Organizational Structure

In the above organization chart shows the Anesthesia-Intensive Care department. The recovery unit belongs in this department. The other three sub-units are the Post-operative Intensive Care, Gynecology Intensive Care, and Children's Intensive care. These four units serve the whole hospital.

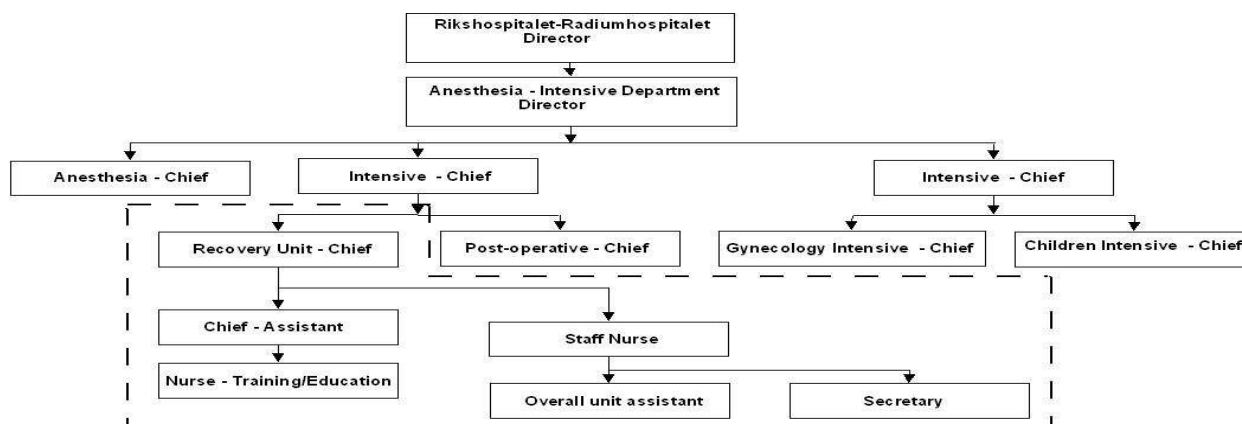


Figure 9: Anesthesia-Intensive Care Department

The recovery unit manages its own people, resources, and other administrative matters like training, personnel evaluations, budgeting, etc. The recovery unit has twenty-six personnel, in which twenty-four are nurses, whom three nurses are the administrative heads. The three administrative head nurses are the chief-nurse, the assistant chief-nurse, and the education nurse. The other two administrative personnel are the secretary and unit overall assistant. The chief-nurse oversees the whole unit. Her responsibilities are handling the administrative issues, and unit budgeting. The assistant to the chief-nurse assist the chief-nurse in different kinds of responsibilities like staff leave, hiring of new staff, staff work distribution, etc. The education nurse is responsible for education and research, her additional responsibilities includes the coordination of the administrative task. These three head nurses' works together ensuring that the unit meet the work standard, resolve issues, and functions in its daily activities. The staff nurses on the other hand are in charge of the patient-care area of treatment, and helps update the documentation of medical work procedures. For example, a step by step treatment to a special case patient. The overall unit assistant takes care of all units administrative mundane tasks. Her responsibilities are the management of inventory of the following: medicine, bed, bed sheets, nurse working clothes, blankets, beverages, and to other things that the unit needs. Making sure that its in the right number of stocks for daily use. The secretary take cares of the documents needs to be filed and encoded to the system.

4.4 Recovery Unit Issues and Measures

Based on the recovery unit 2006 overall assesement report, the following issues were identified and established measures to address the issues.

4.4.1 Issues

“We understand that there is a raising problem with “queue” meaning that the patients have to wait in the operation room before they can be transferred to recovery unit. That causes waiting time for the next patient on the operation program”. – Recovery unit 2006 report.

- We think that there might be different causes for the occurring of “queue” between
- 14:00 and 16:00
- Prolonged surgeries are often ended early in the afternoon.
- More patients are through with surgery at this time (we did not register number of
- patients done in this time period)

- The nurses at the posts do not have the possibility to pick up the patients. A change
- of shifts also takes place at the posts
- The working hours at a surgery unit are to a certain extent rounded off at 14-15
- We have a change of shifts. The evening shifts start at 14:30, and the mid shift first
- have to finish lunch from 14:30 to 15:00 before the evening shift takes over the
- Patients from the dayshift.

4.1.2 Measures

- Units delivering patients has to be disciplined not to report patients early “just to
- make sure”
- Units receiving patients from the recovery units have to contribute to their receiving
 - Patients.
- This way, the patient transfer at the recovery unit is not interrupted.
- The recovery unit has to organize ideally
 - Staff according to work load
 - Efficient completion of breaks/reports
 - Ideal cooperation between nurses and doctors
 - Ideal information to and cooperation with both the “delivering” and the “receiving” unit.

5 EMPIRICAL STUDY AND FINDINGS

This chapter will be the presentation of data drawn from the field-study that combined ethnographic observation, document analysis, and interview to study the recovery unit work processes. It starts by describing the overall workflow describing the activities in the recovery unit and other departments related to its function such as OR. The next section discusses the detailed work processes for each role performed in the recovery unit. The last section discusses the role of Information Systems used as a tool that is utilized for coordination and communication between the workers in their daily work processes.

5.1 Workflow Analysis

5.1.1 The PeriOperative flow/ Surgical care flow

Below is the illustrated diagram of the PeriOperative⁴ flow.

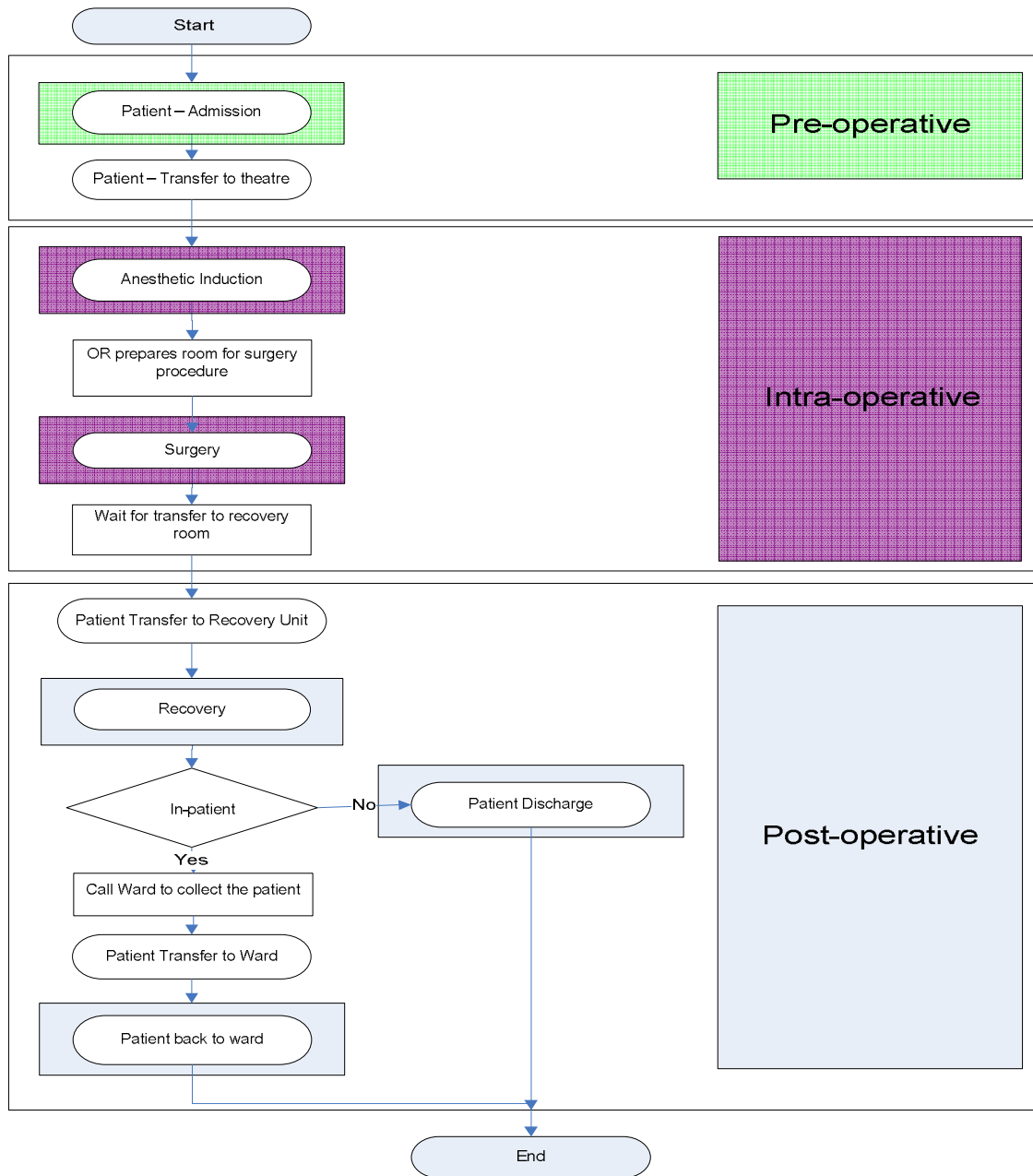


Figure 10: The PeriOperative flow

⁴ The perioperative period is the time surrounding a patient's surgical procedure; this commonly includes ward admission, anesthesia, surgery and recovery.

Post-operative recovery is a part of PeriOperative care and cannot be considered separately. PeriOperative is defined as the period of time extending from when the patient enters the hospital, clinic, or doctor's office for surgery until the time the patient is discharged. It includes three main activities: the *pre-operative*, *intra-operative*, and *post-operative* phases of the patient's surgical journey. The PeriOperative process often involves collaboration between medical personnel in different hospital departments.

The *Pre-operative* phase starts with the events in the *Patient Admission*, and is followed by *Transfer to the operation operating room*. *Patients admission* is where the patient is placed before the surgery starts. When the patient surgery day schedule starts, the patient will be *Transferred to the operating room*. Once the patient is transferred to the operating room, the intra-operative phase begins.

The *Intra-operative* phase starts with the *Anesthesia Induction*. Prior to the main surgery procedure, patients will go the *Anesthesia Induction* phase, which is the period from the first administration of anesthesia to the establishment of a depth of anesthesia adequate for surgery. Once the patient is ready, *Surgery* commence. Surgical procedure can be broadly categorized as either elective (planned) or emergency (unplanned). Once the surgery is done, the patient will *Wait for transfer to the recovery room*. Once the patient has left the OR the operating room can be cleaned and prepared for the next patient.

The *Post-operative phase* of a patient's journey starts when the *patient is transferred to recovery unit* from the operating room operating room. This transfer to recovery, or post anesthetic unit, may involve moving the patient to another bed or trolley. The preparation for each individual patient commences before the patient arrives. During the transfer, the anesthesiologist and a nurse from the intra-operative team accompanies the patient to the recovery unit. On arrival, the patient's care is transferred to the recovery room nurse. The recovery nurse assesses the patient immediately on arrival with a focus on breathing and circulation. Recovery room care aims to safeguard patients against trauma and effects of surgery and anesthesia. Patients are critically evaluated and stabilized post operatively, to prevent potential complications. Each patient's stay in the recovery room varies considerably, depending on the patient, type of anesthetic, surgical procedure and post-operative recovery. Guidelines state minimum criteria for the safe discharge of patients back to the ward after the recovery room and include an

evaluation of the patients' level of consciousness and body functions. The recovery room nurse must provide detailed information to the nurse who takes over responsibilities for the patients' care. In-patients are escorted back to the original ward when stabilized. Day-surgery patients are discharged from the hospital after the post-operative care. The recovery nurse will guide the patient logistic in sending the patient home.

- *Resources*

The general PeriOperative suite normally consists of an interview room, preparation rooms, and recovery beds. Personnel consists of healthcare aids, registered nurses, surgeons, and operating room teams. Health care aids complete pre-operative interviews, paperwork, cleaning, and some patient preparation. Registered nurses often assist in patient preparation, paperwork, physical examination, and drug administering. An operating room team is normally assigned to a surgeon or a certain operation type. Their responsibilities include preparing the surgical equipment, in-OR patient preparation, surgical assistance, and room clean-up.

5.1.2 **The Recovery Room overall processes**

Discussed here are general descriptions of recovery room activities. The description of this case contains both narrative and graphical representations which map the complex activities/trajectories, heterogenous actors, and information flow in the recovery unit. Illustrated below is how the trajectories of the OR and the ward must collaborate and coordinate. This graphical diagram is based on the general level using the macro perspective to illustrate interrelated activities.

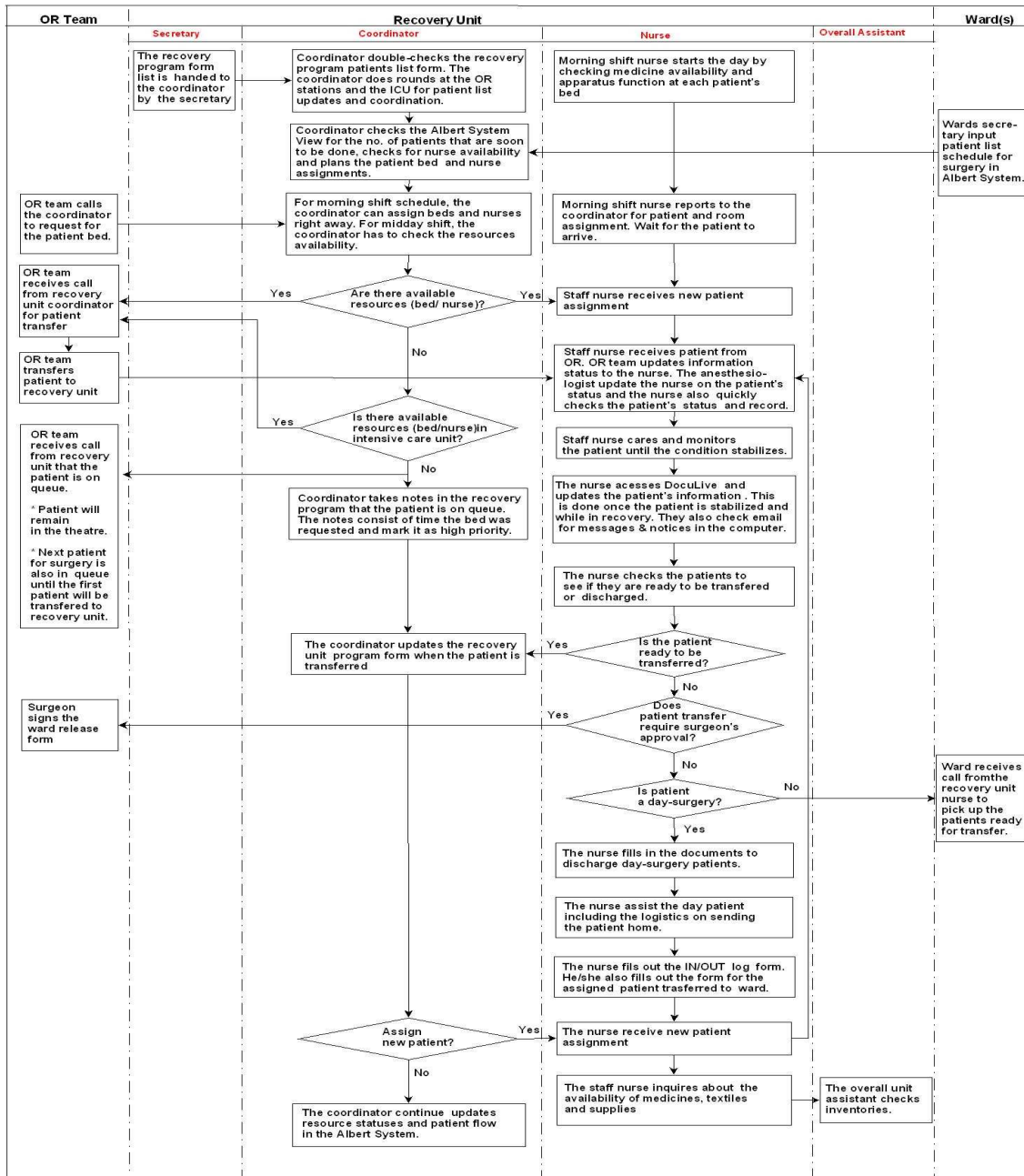


Figure 11: Overall Work Process

The recovery unit activities are monitored through the *recovery unit program*. The recovery program is a preformatted MS word document with information for patients who are scheduled for surgery. The preformatted form is shown in figure. The unit secretary shown in Figure collects the patient information from different departments' day before the surgery. The trigger of the days activity is when the *operating room team* notifies the *coordinator* by phone for a bed request. The first batch of patients can be accommodated without checking

availability of room beds and nurses. The first patient in surgery are *Day-patients*⁵. These only have one dedicated nurse, and this nurse resumes other activities once all day-patient are stabilizes. A buzzer is provided at each day-patients bed in case they need a special care. When *patients* arrive they are accompanied by anesthetic nurses and the surgeon. The anesthesiologist communicates with the recovery unit nurse on the patient status. On the side of the patient beds are documents (lab results, documents from the OR, etc.) shown in figure 1 from the operating room. These documents are passed on to the recovery nurses who then check the patient history.



Figure 12: Anesthesia & Intensive department registration form

During midday shift there are many bed requests from the OR. The *coordinator* checks resource availability for each request. In some cases, when all beds and nurses are occupied, patients can be transferred to the intensive care unit (ICU). When there are no available beds or nurses in either unit, the *coordinator* informs the *OR team* that the patient is on queue. The queued patients stay at the operating rooms causing delays for the next patients to be operated. The *coordinator* calls the *OR team* as soon as there is an available bed or nurse. The *coordinator* takes charge of the daily patient flow from the operating rooms to the recovery room shown in figure 1 for coordinator detailed responsibility.

⁵ Day patients are patients admitted and discharged from the hospital on the same day, i.e. do not occupy a bed at midnight.

5.1.3 *The recovery unit lay-out*

In this section displays the physical layout plan for the recovery unit described the arrangement of the room, the positioning of the beds, the artifacts, the information system, and difficulties may arose because of these physical properties.

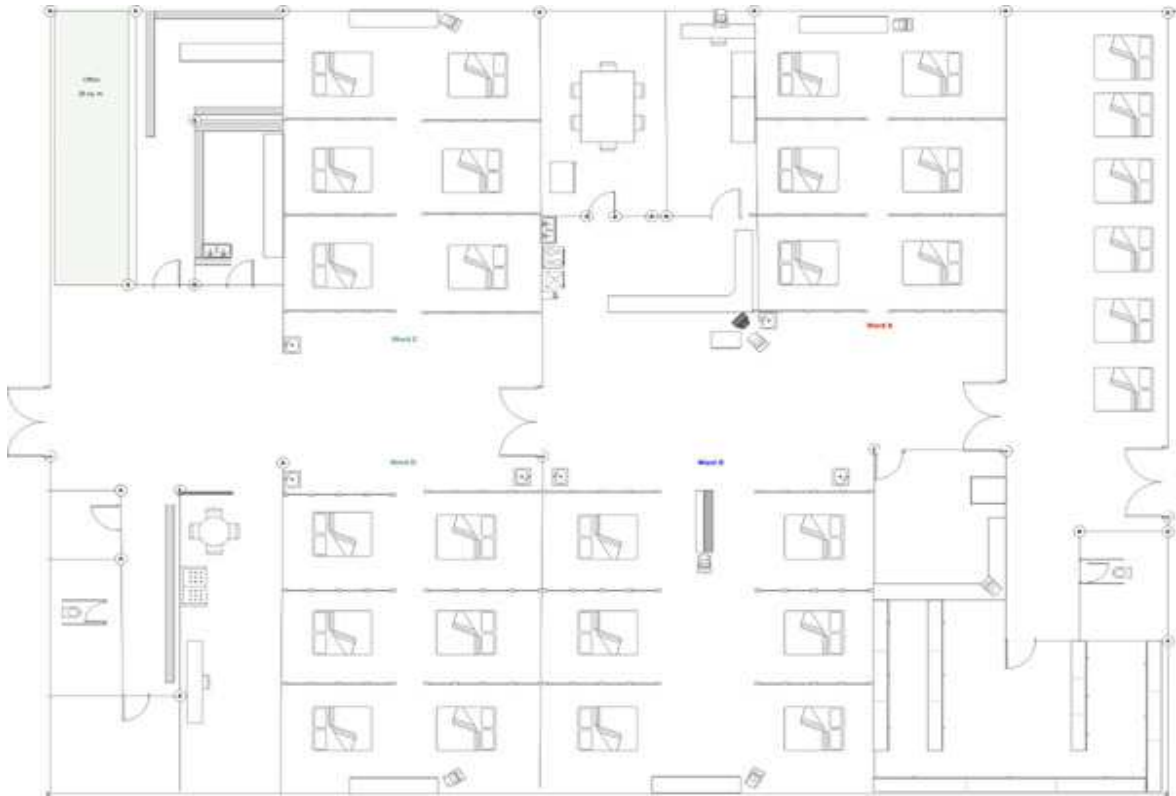


Figure 13: Recovery unit floor plan

- *Places that work occurs, shown in plan view and annotated*
- *Physical structures that define the space, shown as geometric shapes*
- *Hardware, software, and tools that are present, shown visually as appropriate and annotated*
- *Artifacts, shown visually as appropriate and annotated*

The recovery unit has five rooms for patients, and has approximately twenty-nine beds. All rooms are a partitioned space consists of six beds, shared by many patients, and one is specially allocated for the children patients. The *Day surgery patient room* is a separate room. An extra bed is located in one of the meeting room in the recovery unit to maximize the space,

and to accommodate more patients. Shown in Figure below is the one of the five rooms in the recovery unit at RR-HF



Figure 14: Recovery unit form

The coordinator who manages the recovery unit activities is stationed in the in reception area in between room A and B. The coordinator needs a constant updates and coordination with the nurses on status of patients and patient's assignment. This layout poses difficulties and time consuming, where the coordinator will be physically locate the nurses to check their status on order for the coordinator to update the recovery unit program form. Shown in figure is the space where the medicine cabinet, computers, wards telephone directory, textiles, and other necessary things for the patient's care while in recovery unit. In figure is shown one space partitioned of one room ready to receive patient.



Figure 15: Recovery unit medicine, textile, information



Figure 16: Recovery unit room space

The next section describes the recovery unit medical personnel and their work processes. It is also presented in a graph illustrates the work flows.

ENT (ear, nose, throat), General surgery and Pediatrics. The following flow chart in figure below describes the work performed in the recovery unit to prepare this form.

5.2.1 The process of collating the data for the recovery unit patients and their activities.

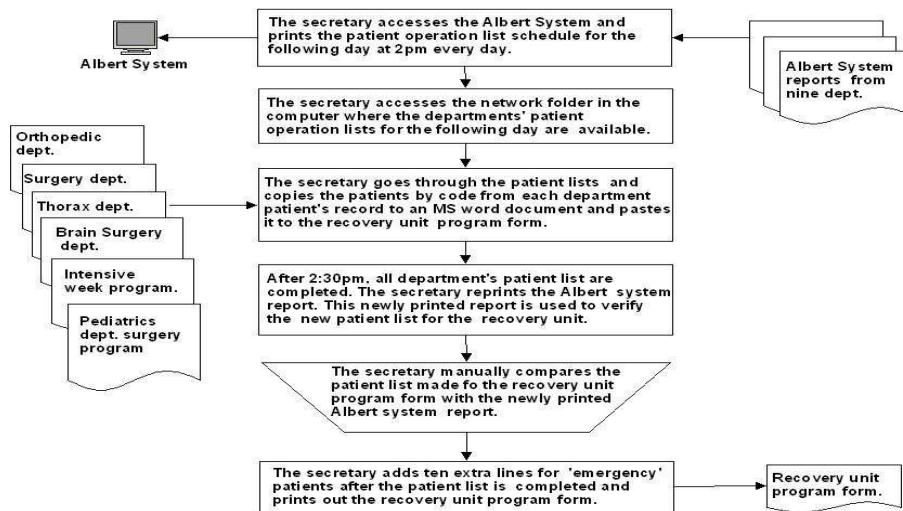


Figure 17: Secretary – collating information for the recovery unit patient list

Four of the departments mentioned above have no access to the Albert System. Therefore, the secretary needs to access the patient records through the MS Word documents in the network folder. The nine departments' patient list form has no standardized format. Each of the departments' patients is detailed by different naming conventions and codes. The secretary checks each department's patient record lists individually and adds records from the recovery unit patient list by category types. This is the main document where planning and scheduling activities are listed and updated.

All department	Age	Under 18	Children
All department	PO code	N	Night
All department	Status code	MRT/CT	Local/MR
All department	PO code	D	Day Surgery
All department	No codes		In Patient

Table 2: Ward patient codes

The next section describes how the recovery unit program form is utilized. It is also presented in a graph that illustrates how the recovery unit program is used and run by the coordinator.

5.2.2 Coordinator work processes

Coordinator run the recovery unit daily activities. It function like air traffic controllers to ensure that the patients move seamlessly through recovery unit process. They coordinate activities in conjunction with other hospital units, such as wards and the OR units. Coordinator most important skills is communication and coordination.

All nurses in the recovery unit can function as coordinator. The *coordinator* assigns shifts and rooms for nurses based on the planned nurse 12-week shift schedule. The coordinator must remember updates for each nurse’s assignment and estimate when nurses will be available for the next patient. The *coordinator* runs the unit’s patient flow throughout the day shown in Figure with the various people he/she needs to coordinate.

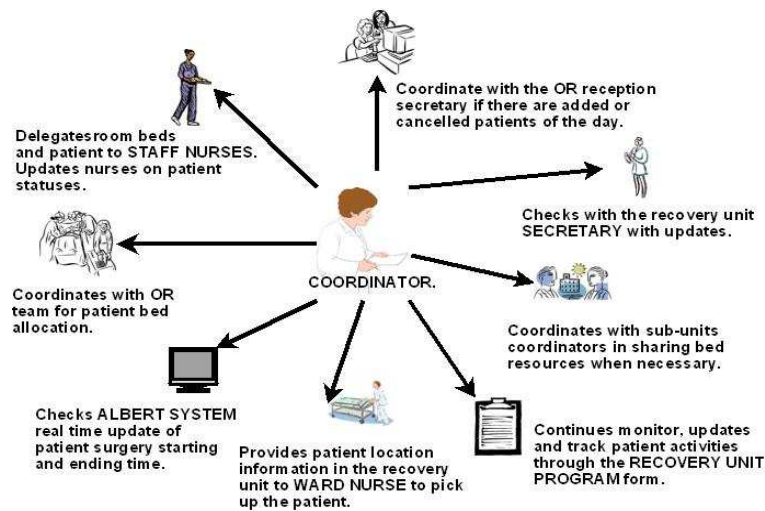


Figure 18: Recovery Unit Coordinator

5.2.3 The process in updating / tracking activities in the recovery unit

Below is a graphical representation of the updating of patient flow based on color coding.

Recovery unit program													
Date: 241006				Day: Tuesday									
A. Am shift: Annie B Md. Shift: John Doe Night Shift: Jennifer Grady			B. Notes are written when the patient is on queue			C. Updated patient status through color-coding			D.				
Room/Place	Assigned Nurse	Priority	Department	Name	B-#	Operation	In Time	Out Time	Tlf #				
				DAY SURGERY:									
X		3	NK1	Lily Gan	310155	1124	Stomach						
			MRI	John Doe	090931	OSL	Head						
A1	Sif Ole	2	GYN	Tatianna Lailey	010141	PC-OS	Cyst	12:00					
O			MRI	John Ga	090931	OSL	Head						
O			MRI	Ding Go	090931	OSL	Head						

Legends:

Patient on operation	Incoming patient / patient in recovery unit	Operation done	Patient no longer in the recovery unit
Operation is cancelled			

X = this sign is marked once the patient is in the recovery unit.

O = this sign is marked when patient operation is on-going.

The coordinator uses the Albert System to view the OR in on-going surgery activities. The Albert system's patient update is based on a color-coded updating procedure in order to identify the patient's status on the screen list. It updates every 3 minutes on the screen. The coordinator updates the recovery unit program form manually. The recovery unit program manual updating procedure is synchronized with the Albert system updating progress. The coordinator uses a highlighter pen of different colors to highlight the patient list in the recovery unit program form. These colors did not correspond all with the Albert System's

color standard. There are some color are of the same meaning with the Albert System color-coding shown in figure.



Figure 19: Albert System's color-coding standard

- Red = Not started
- Yellow = Cancelled operation
- Beige = On-going operation
- Green – Operation done

Emergency patients can be spotted in the Albert System by checking the “Emergency row” columns with a value of “O” and the color red. The coordinator then manually adds the emergency patient’s name and information under the emergency category in the recovery unit form. When there is no available nurse to care for the patient, the coordinator will write a note in the room/place column on a patient that is marked as on queue. The note contains the time the OR called for bed request, and the person calling. Once there is an available nurse or bed, the coordinator will call the OR and inform that the patient can now be transferred to the recovery unit. The coordinator then marks the patient’s detail in form as yellow.

The updating of nurse assignments is also needs to be done. When nurses are sick and cannot work, the coordinator must adjust the shift. Most of the nurses that cannot work for the day usually notify in early of the day. This gives the coordinator time to call for a substitute non-shift nurse. If none are available, they must manage with the nurses present. The time of transfer and discharge to/from the recovery room is also updated. At the end of working day at the recovery unit, the form will be kept as a document on file. This data will not be encoded into any system.

The next section is a discussion of the discharging procedure for patients where mandatory forms need to be filled out after the patients are discharged home (for day-surgery patient) or transferred to the wards (for in-patient).

5.2.4 Discharging of patient from the recovery unit

The recovery unit does not have a computerized system where nurses can register or enter patient data in discharging the patient, this must be done manually. Nurses must fill out two documents: *Patients Summary Discharge list*, and the *Anesthesia & Intensive Department Registration form*. Filling out these forms is a mandatory that is part of the nurse's routine.

5.2.4.1 The patients summary discharge list

The *Patients Summary Discharge list* is an internal documentation for the recovery unit. This form is placed on a shelf near the reception area shown in figure.



Figure 20: Anesthesia & Intensive department registration form filling out area

The nurses attach the patient's bar-coded ID sticker and fill in the following information: name, time transferred to recovery unit, discharged time, patient type (Day patient, Elective – Adult/Children or First AidAdult/Children), and original ward. The patients summary list sheet is placed in a folder that contains only the forms of discharged patients. Below is a sample view of a form.




No	In Time	Out Time	Name	EDA PNB	PCA	Dept./Day surgery	Yes/No	Postop# Stamp
1	9:00	11:00	John Doe	EDA		Neurosurgery	Yes	
2	11:00	3:00	Snoopy Dog	PCA		GYN	Yes	
3	10:00	4:30 (3C)	San Tana	PNB		PLA	Yes	

Figure 21: IN / OUT log form

5.2.4.2 The Anesthesia and Intensive department registration form

The Anesthesia and Intensive department's sub-units use the *Anesthesia & Intensive Department Registration form*. This form contains detailed information about the patients in recovery. The sample form is shown in figure. The information that recovery units need to fill out is the following:

- *Patient's name*
- *Operation/ incident*
- *Time in/ out*
- *Date arrived in the unit*
- *Post/ department*
- *Place*
- *Patient type*
- *In-patient reason code (Planned surgery or emergency)*
- *Discharge to (ward, other intensive care, home, dead, local hospital, overseas hospital)*
- *Status (better, unaffected, deteriorated, dead)*
- *Doctors signature, Date and Time.*

Figure 22: Anesthesia & Intensive department registration front form

The back page of the form contains the explanation of the codes, and guidelines for filling out the form shown in figure. These forms are completed and collated by the secretary and will be incoded in the computer system called NAFREG2000.

Figure 23: Anesthesia & Intensive department registration back form

5.2.5 Secretary collecting recovery unit documents processes.

Below is the graphical illustration on how the secretary collates and input the data to computer systems.

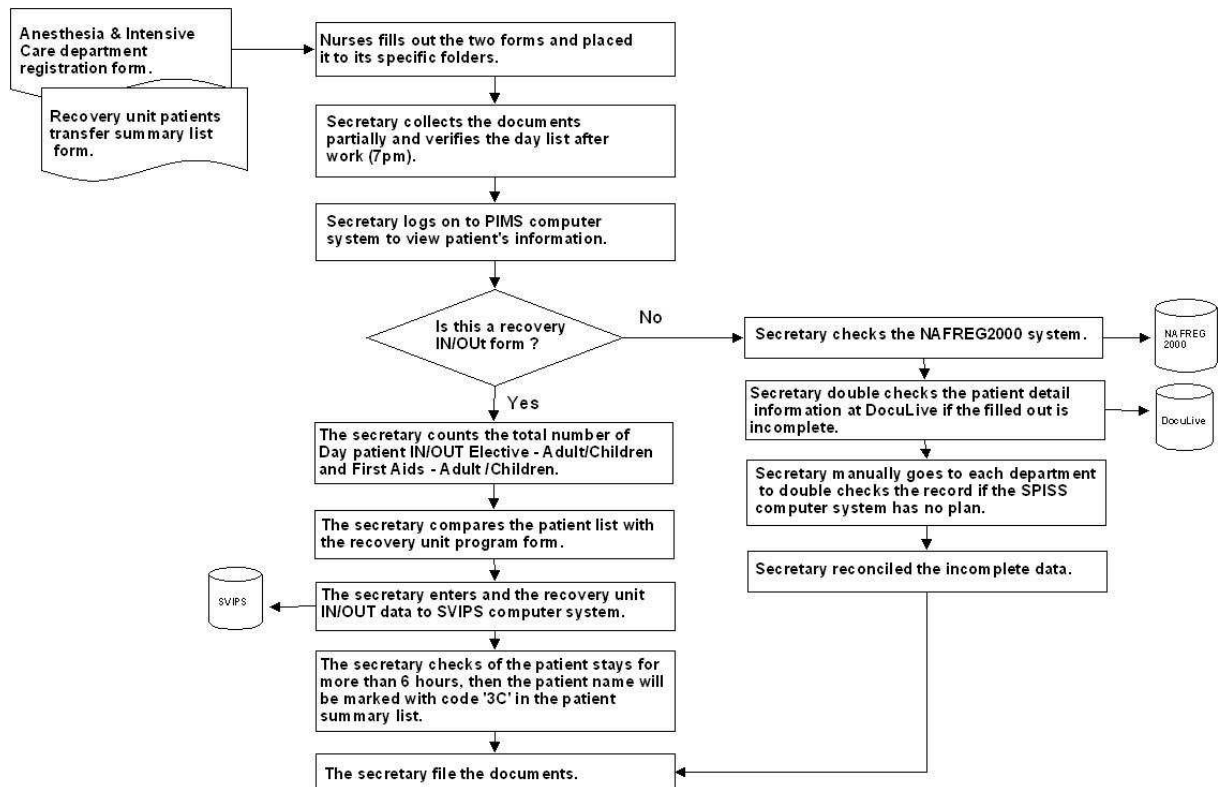


Figure 24: Secretary collating recovery unit documents processes.

Late in the day, the secretary starts collecting parts of the records and begins encoding the data into the system NAFREG2000. This collected data is verified, corrected and completed by the secretary before encoding on the system. The process of solving discrepancies in the manual form involves checking the record in the computer system like PIMS. If the data or information cannot be located in the computer system the secretary goes to anesthesia department records and backtracks the activities to be able to complete the necessary data. These cases occur when nurses neglect to fill out the forms completely.

The next document to be encoded and verified is the document produced daily in the recovery unit. This is the recovery unit patient summary list. The number of patients is verified through the Albert System. The secretary categorizes the types of patients and summarizes the total counts of each type. Once verified, the secretary also checks the number of hours the patient stayed. For patients staying six hours or more are marked with code "3C". This means that the patient is tagged as a case for review. The complete verified forms are filled.

The next section describes the education nurse and overall unit assistant roles and responsibilities in the recovery unit.

5.2.6 The education nurse

Below is the graphical illustration of the work performed by the education nurse.

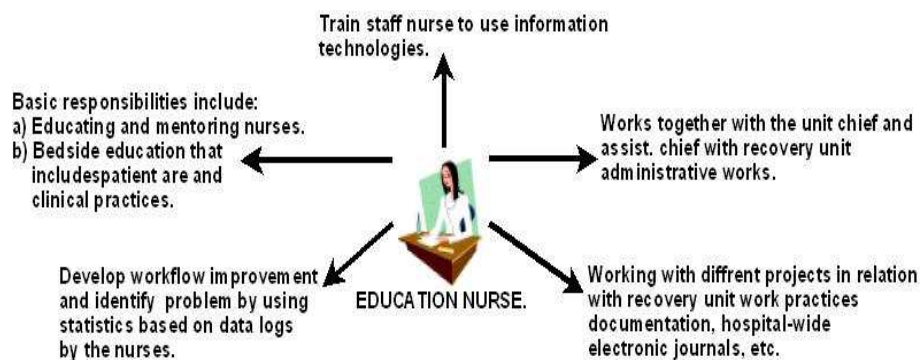


Figure 25: The Education/ Training Nurse

The *education nurse* main focus is to support the needs of the nurses with constant upgrade of skills and knowledge. Nurses are the first point of contact with health care. Nurses will need a constant upgrades of new skills and knowledge that prepares him/her for such work and provides a sound foundation for advanced practice. Health care and nursing practice will continue to evolve and adapt to new health care needs and new ways of delivering services but quality must remain the constant within nurse education and nursing practice.

Working with different internal projects

- *MetaVision Project*

A hospital-wide project whose goal is to make all the necessary documents for the entire hospital available on an electronic format and accessible on the intranet. This includes journals, downloadable forms, internal electronic bulletins and training schedules. The MetaVision project is lead by the *education nurse* and teamed with other administrative heads.

- IC (*Internal Control - Quality handbook*)

The current document for manual procedures in handling patients is filed in a folder which nurses can refer to for further guidelines. These step-by-step guidelines are updated by the recovery nurses and approved by a surgeon. This project is currently managed and lead by the *education nurse* teamed with other voluntary nurses. Updates of new procedures are disseminated through verbal communication. The existing internal control manual is not updated regularly.

The *education nurse* is also drafting a project for improving workflow. This is done by measuring statistics based on nurses logged data. This task is useful in developing a system for the future.

The next section describes the overall unit assistant roles and responsibilities in the recovery unit.

5.2.7 The Overall Unit Assistant

Below is the graphical illustration of the work performed by the overall unit assistant.

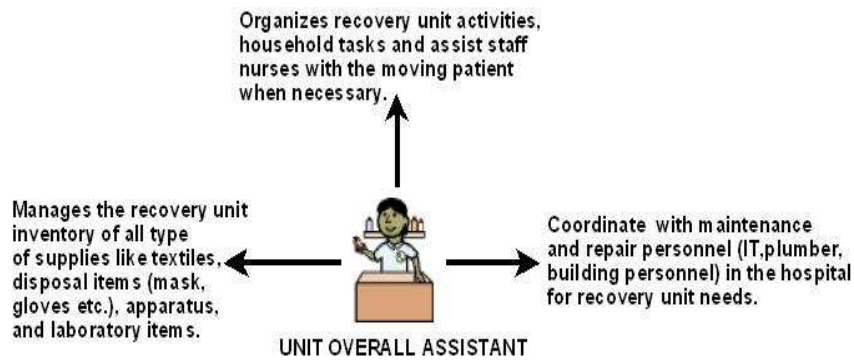


Figure 26: The Overall Unit Assistant

The *unit overall assistant* manages the recovery unit inventory, including all types of supplies and maintenance. Inventory management is not included in the scope of this study. The discussion is limited to an overview of how the *overall unit assistant* manages the inventory.

The overall unit assistant's work is planned from Monday till Friday according to what needs to be done. He/she uses a personal notebook to write reminders, lists of tasks, names of

persons and contact numbers to follow-up. Most nurses who look for supplies ask the overall unit assistant for information. She makes sure that the daily supplies of textiles, food, beverages, apparatus, equipments, disposal items, and medicine are available and is working properly to ensure the smooth day-to-day nurses tasks in caring the patient while in the recovery unit.

In the next section describes a brief introduction of the existing IT support system and the Albert system digital protocol - surgical planning system.

5.3 The Role of the Information System in the Recovery unit

5.3.1 The existing IT support system

Personnel in the recovery unit utilize a number of different information technologies. The information technologies available to personnel vary across the disciplines. There are different communication technologies such as office phones, voice mail, pagers and computers. Each staff member has his or her own email with updated information access. There are two computers in each six recovery rooms. All hospital personnel have access to computer terminals allowing them to access patient information. The following systems are used: DocuLive, PIMS, NAFREG, Inventory System for Ordering beverages, SVIPS, MS Office, Personal and Clinical Portal, IRS and Albert Sytem.

- *DocuLive* - is an electronic patient journal. Doculive will replace the paper-based journal though paper is still in used.
- *PIMS* – is patient administration system. Every patient that come to RR -HF is registered in the system.
- *SVIPS* – is a system used to document nurses and staffing level activities and workload.
- *NAFREG* – is a registration system database for intensive care patients.
- *IRS* – is for administrative system that holds information of each employee's salary, vacations, and other employee personal information.
- *CSAM* – is a portal system. It stands for Clinical Systems All Merged. CSAM will be a portal for the systems use at RR-HF. Currently, information about the patients is registered in many different systems. The users is therefore forced to

log in on all the different systems to retrieve the information that they are interested in. With CSAM, all the information will be available through one system. The information will continue to be in the different systems, but will be retrieved and displayed through the portal. More programs will also be developed, and compatibility with CSAM that will replace some of the systems that are used today.

This table presents the summary list of systems used in the recovery unit, and the corresponding personnel using it.

	Secretary	Coordinator	Staff Nurse	Unit Overall Assistant	Administrative Heads
DocuLive			Update and view patient's history while in recovery unit		
PIMS					
ALBERT SYSTEM	Print reports of the list of patients for surgery	View patient's surgery real-time updates			
SVIPS	Verifies and adds patient information				
NAFREG	Verify and add patient additional information				
Ordering System				Order food and beverages	
Personal Portal					Add/Edit/View personnel information
IRS	View personal information	View personal information	View personal information	View personal information	Add/Edit personnel salary, holiday &, etc
MS Office	Write, update, delete, view reports and documents.	Write, update, delete, view reports and documents.	Write, update, delete, view reports and documents.	Write, update, delete, view reports and documents.	Write, update, delete, view reports and documents.
Clinical Portal			View patient information		View patient information

Table 3: IT-systems

The next section gives the overview of the Albert System – digital protocol background, basic functionality as the dedicated system that supports the surgical progressive care cycle at RR-HF

5.4 The Albert System - Digital Protocol

5.4.1 History and Background

In 2002, the previous department chief for Operation department 2 (OP2) together with Jan Helge Wergeland from the IT department saw the need for the operation protocol. The Albert system was then developed. The system was designed for planning and protocol functionality, and was tested with surgical operation personnel for approximately two years. This was a basis of identifying user requirements for future use.

The system is named came up after the first test data after a childhood comic hero “Albert Åberg”. The IT department at RR-HF developed the Albert system in-house. Operation department 2 (OP2) and Operation department 3 (OP3) have contributed to the development of today’s Albert System. The system has about 400 users and splits to three surgical unit, three clinics, and the recovery unit. The department chief at surgical operation department 3 (OP3), Marit Sverstad, says

“In the middle of the hectic day, it is good to be able to trust that input data is available and correct at all time”. - RR-HF, Albert system internal bulletin (2002)

5.4.1.1 Project resource and user group

The project has only one resource from the IT department who functions as developer, deployment manager, and user trainer. The Albert system users are the following: *the patient coordinator, nurses in each department, anesthesia personnel, doctors, surgeons, and recovery unit coordinators*. These groups of users also serve as the testers and help identify possible functionalities that Albert System can offer.

5.4.1.2 More secure data

Sverstad believes that the accuracy of the registered data has increased by almost 99.9% after the Albert system was put into use, mostly due to the user friendliness of the system. The system is easy to fill out and the operation plan for each department is available for the people who needed them. The analysis and reporting module is a good tool with regard to resource planning and reporting of activities. Albert has not yet reached its full potential.

There is still a need to develop the system further so that the whole planning stage will be computerized.

5.4.2 Chronological development

Below is a chronological list of the Albert system's history.

- The first version of the Albert system was developed in the fall of 2002. It
- was put use to January 2003. The system was introduced in one department
- and it took a long time before it was accepted, and the user to get used in
- encoding the data to the database.
- In January 1 of 2004, the operational Surgery and Orthopedic department that
- consist of about 200 surgeons and nurses started to utilize the Albert system.
- In March 3 of 2005, the surgical operation 3 started. The user group is
- consisting of 200 surgeons and nurses started to utilized the Albert system.
- In January 2007, the Albert system was implemented in nine departments
- namely, the Neurosurgery, Thorax, Gastro surgery, Gynecology, Ears Nose &
- Throat (ENT), Plastic surgery, Anesthesia, Orthopedics, and Pediatrics
- surgery.
- In May 1st of 2007, the surgical operation 1 and the day surgery department
- that consist of about 200 surgeons and nurses started to utilize the Albert system,
- and is deployed in full functionality was also deployed at the Radium hospital

5.5 The Albert System Basic Functionality

The purpose of the Albert system, Digital Operation Protocol is to schedule patient surgery for nine departments of RR-HF. The Albert system is a web-based program that is used for planning and registering patients for surgery.

The modules of functionalities are:

- *Operation Plan for Doctors*
- *Day / Operation program*
- *Operation Procedure*
- *Statistics and Analysis module*
- *Recovery module*

The main Albert system screen shown in figure where the user can logon using different roles from different departments.

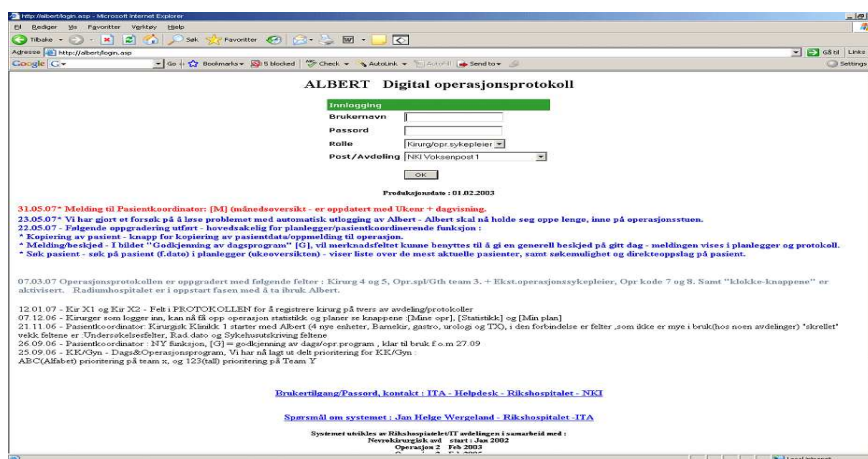


Figure 27: The Albert System - main screen.

The Albert system log in composed of different role of different departments shown in figure 28. Each department and role differs in access rights in the system. Within the main screen also includes the notices and messages to the Albert system users on the changes done of the system shown in figure.



Figure 28: The Albert System – log on screen.

31.05.07* Melding til Pasientkoordinator: [M] (søknadsoversikt - er oppdatert med Uken + dagstising).

23.05.07* Vi har gjort et forsøk på å løse problemet med automatisk utlogging av Albert - Albert skal nå holde seg oppa lenge, inne på operasjonsstuen.

22.05.07 - Følgende oppgradering utført - hovedsakelig for planlegger/pasientkoordinerende funksjon:

- * Kopiering av pasient - knapp for kopiering av pasientdata/oppmelding til operasjon.
- * Meldingsbeskjed - I bildet "Godkjenning av dagsprogram" [G], vil merknadsfeltet kunne benyttes til å gi en generell beskjed på gitt dag - meldingen vises i planlegger og protokoll.
- * Søk pasient - søk på pasient (f.dat) i planlegger (ukeoversikten) - viser liste over de mest aktuelle pasienter, samt søkemulighet og direkteoppslag på pasient.

07.03.07 Operasjonsprotokollen er oppgradert med følgende felter: Kirurg 4 og 5, Opr.spjGth team 3. + Ekst.operasjonsykepleier, Opr kode 7 og 8. Samt "klukk-knappen" er aktivisert. Radiushospitalet er i oppstart fasen med å ta i bruk Albert.

12.01.07 - Kir X1 og Kir X2 - Felt i PROTOKOLLEN for å registrere kirurg på tross av avdeling/protokoller

07.12.06 - Kirurger som logger inn, kan nå få opp operasjon statistikk og planer se knappene [Mine opr], [Statistikk] og [Mm plan]

21.11.06 - Pasientkoordinatør, Kirurgisk Kirukk 1 starter med Albert (4 nye enheter, Barnekir, gastro, urologi og TJC), i den forbindelse er filter, som ikke er nye i bruk (hos noen avdelinger) "ikkeEr" vekk feltene er "Undersøkelisefelter, Rad dato og Sykehusnummer felkene

26.09.06 - Pasientkoordinatør: NY funksjon, [G] = godkjenning av dags/opr program, klar til bruk f o m 27.09

25.09.06 - KK/Oyn - Dags&Operasjonsprogram, Vi har nå lagt ut delt prioritering for KK/Oyn

ABC(Alfabet) prioritering på team x. og 123(tall) prioritering på Team Y

Figure 29: The Albert System – log on screen notices.

The system has a calendar layout screen, in which information is filtered by dates and the information is displayed by weeks shown in figure. Each day of the week includes a list of patient names. Detailed patient information about check-in is displayed by clicking the patient name. Each department has its own security rights and controlled information.

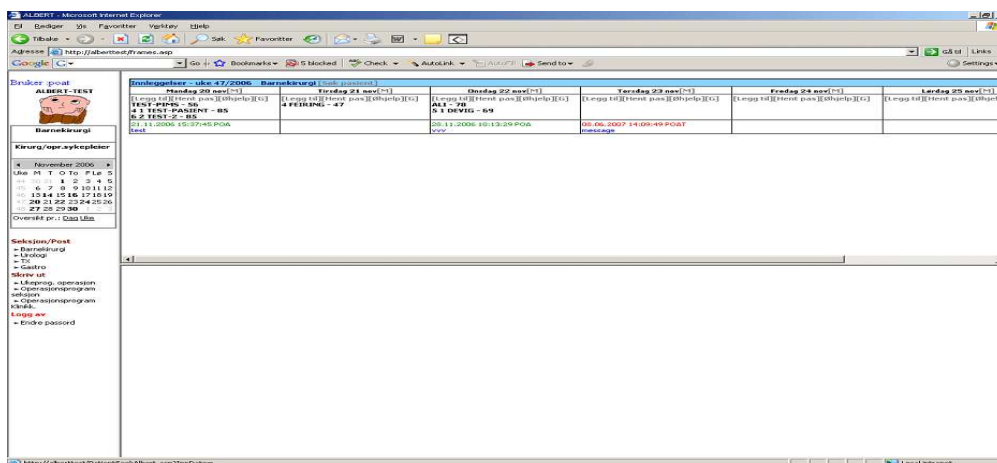


Figure 30: The Albert System - Week Screen.

The information displayed is tailored to the needs of every department. Information shared for all departments includes the following:

- Patient Name
- Patient ID
- Birthdate
- Admission date
- Operation procedure
- Surgeon name
- Pre-operation examination

The menu shown in figure is where the user can choose different functions. The user can choose months and days where the patient list is displayed. The other functions includes the different type of reports and which patient list view from different department is also included.



Figure 31: The Albert System - Calendar View

5.5.1 Where does the data in Albert System come from?

Patient surgery planning starts when reception receives the recommendation letter from the doctor for a patient that is schedule for an operation. The patient information includes the name of the regular doctor as registered in PIMS. If the patient is new, detailed personal information is collected at the National Registry (A Norwegian population census, where all persons living in Norway are registered). Once registered, the patient is listed in the queue, and is organized by category of operation. Once the operation date is decided upon, a letter is sent to the patient informing him/her of this date and other practical information. Once the list of patients is completed, a daily meeting is conducted by each department to come up with a short list for next days' surgery.

Each department plans its own surgery schedule for the next day. This is done at 2pm the day before the surgery takes place. Once the patient list is finalized, the department secretary enters this list in the Albert System. The patients' detailed information is taken from PIMS. Emergency patients are also registered in PIMS. The Albert System automatically adds the emergency patient as "emergency – for operation". Alternatively, the department secretary enters the emergency patient data. Below is the screen for patient registration in the Albert

System. Shown in figure is the screen where each secretary department input the patient's information schedule for surgery

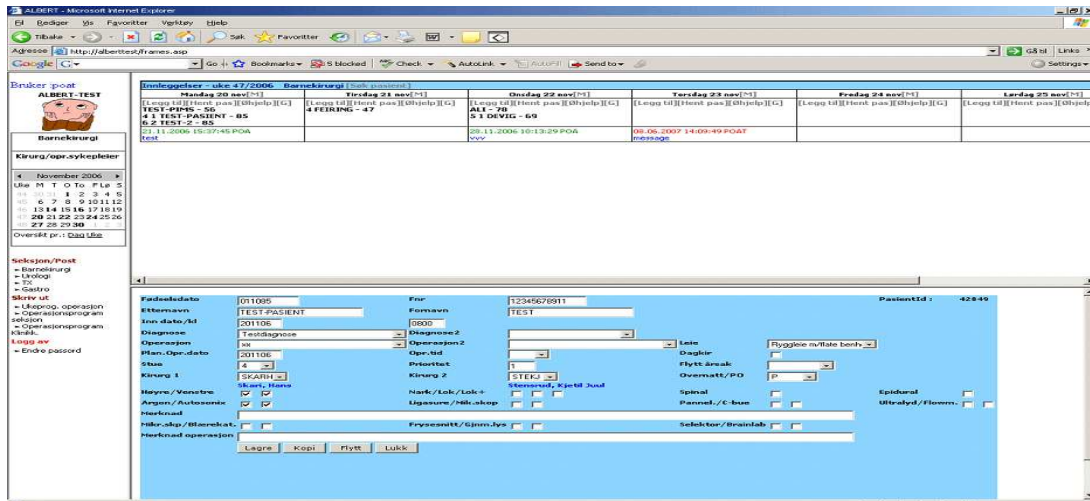


Figure 32: The Albert System - Add Screen.

Surgeons register operation information in the Albert system's "history module" upon completion of the surgery. This information is saved for documentation, reporting, and statistics. Statistics, such as average operation time and the length of various operations, can be retrieved from the system. The system is only connected with PIMS (patient information management system) which registers patient data, and operation queues. The sample reports shown in figure that list the total number of patients operated by each department per month.

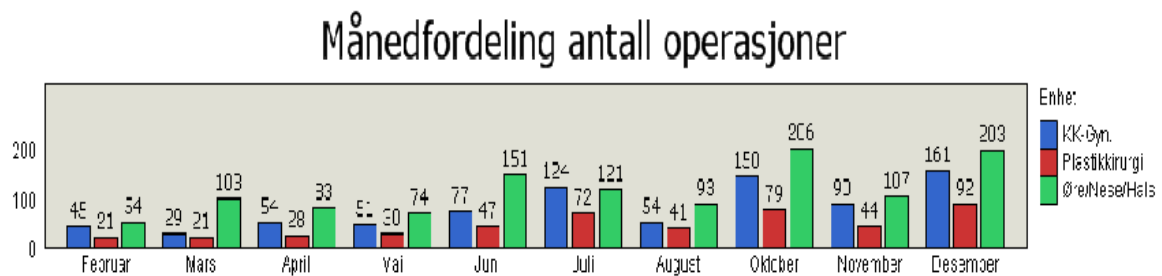


Figure 33: The Albert System – Surgical Patient Monthly report.

5.6 System Description and Architecture

The system is developed in a three-level architecture. The highest level is a *ASP/HTML* user interface level that presents information to, and collects information from, the user. At the next level, a *Java* program translates this information. The database used is the *MS SQL server 2000 enterprise* database. The reporting used is the Q-Likview program to cater the reporting and analysis functions.

The Albert System's Architecture shown in Figure.

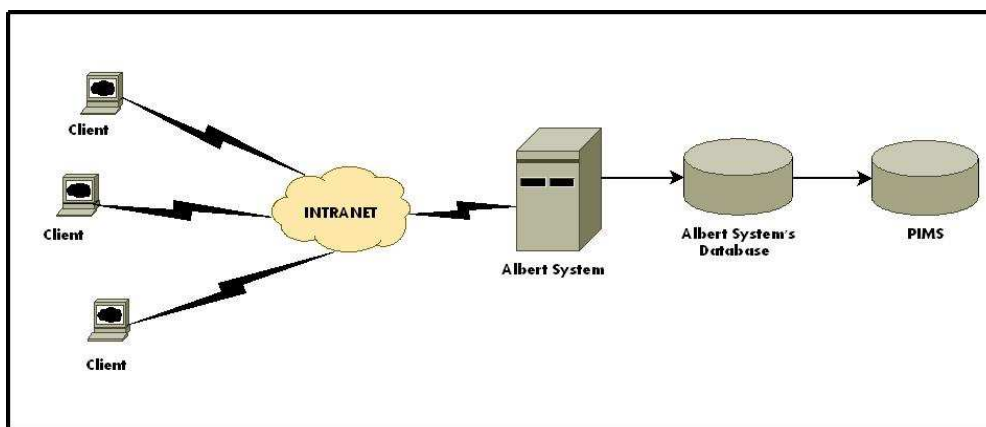


Figure 34 :Albert System's Architecture

The next chapter describes the new added Albert System – digital protocol new functionality done mainly for recovery unit.

6 DESIGN AND DEVELOPMENT OF NEW FUNCTIONALITY

This chapter identifies the requirements and constraints that the system developed, reasons for its development, its scope, and references to the development context (e.g., reference to the problem statement, references to existing systems). This additional functionality is designed for Albert System – Digital Protocol enhancements. The chapter is divided into five parts. The first section discusses the Albert System’s current functionality in the recovery unit. The second section discusses the user requirements and information gathering. The third section discusses the analysis and design phase. The fourth section discusses the coding phase. The fifth section discusses the prototyping and iterative implementation of the enhancement of the Albert System.

6.1 Objectives and scope of the system

This study focuses on the recovery unit. One of the necessary activity in the recovery unit is to designate the beds and nurses to patients after surgery. In the current scenario, the bed allocation is done manually through an artifact called the recovery unit program, and is still not included in the existing Albert system. The purpose of the system is to reduce the patient flow bottlenecks in the recovery unit and thus accommodate more patients. The discussion of the new functionality is mainly the recovery unit requirements added in the Albert system, and the work done from requirements analysis to initial implementation of the new function to the existing Albert system. The software development goal in this study is to build and deploy an iterative development method for adding new functionality to the existing Albert system.

6.1.1 The Implication of software development

There are potential difficulties of integrating changes in a particular phase of Albert system – digital protocol design. Hence, the new added functionality to the systems must be considered globally when changes are made to one phase; in particular, upstream and downstream issues must be addressed in an affective surgical system design. Surgical system processes and their vulnerabilities are widely distributed, and the design of improvements requires a multidisciplinary and holistic approach. Any planned change in the Albert systems must be considered in the context of the entire system, and timelines are a useful construct for this purpose.

6.1.2 The overall activities

Completing a feature of this project is a relative small task. For exact state reporting and keeping track of the software development project it is however important to mark the progress.

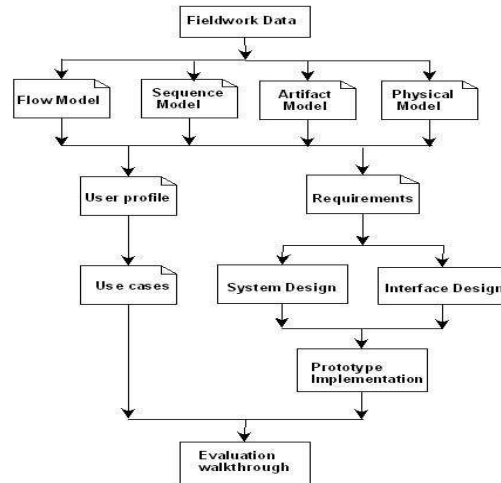


Figure 35 :Overall Activities Summary

The activities starts in gathering data through the fieldwork studies. During the fieldwork study period, a contextual inquiry and models were developed in order to understand the context of the setting through graphical presentation and with the connecting trajectories and work activities. Once the overall activities were understood, the area where the IT can be use to support the existing manual work., and how the IT be able to make the work better and efficient was done. The user profiles, use cases were made in order to identify users role and its specifics needs. Followed by the requirements gathering, system and interface design task which results a prototype. Finally is the evaluation walkthrough were the users or customer were able to see the overview of the new functionality.

6.2 The current system – Albert system

Rikshospitalet-Radiumhospitalet Medical Centre’s PeriOperative system (pre-, intra-, and postoperative) has not yet been able to assemble all of the available stages in one project, and many stages are missing altogether. Instead, today’s pre-, intra-, and postoperative environments are characterized by fragmented communications, lack of integration, bottlenecks, and staffing shortages. These factors contribute to an environment in which safety issues, frustration, and

The next section describes the process of how the new added functionality was constructed and the discussion of the software engineering cycle, from requirements analysis, design analysis to implementation.

6.3 Methods, Tools, and Techniques.

6.3.1 System and software requirements Definition

System requirements identify the requirements and global constraints that the system is designed. The requirements relate to all important stakeholders in the project such as the users, and who will develop the project.

6.3.3.1 Preparation

The requirements were gathered by observing and interviewing users. The first task was to observe and understand the users' current work processes as "as-is" scenarios, then develop visionary scenarios describing the functionality to be provided by the future system. The users validate the system description by reviewing the scenarios and testing small prototypes. As the definition of the system matures and stabilizes, the requirements specification - in the form of functional, use cases, and scenarios - reaches agreement and becomes finalized.

6.3.3.2 Project Requirements

The project level requirements mainly consist of the requirements related to the development of the project and those that affect the overall project. The requirements related to the development process have been covered in more detail in figure (life cycle plan)

The Albert system was built based on user requirements and needs. As per practice, the IT department Albert system's project manager based the system's new functionality on user requests. Gathering new requirements for each department is time-consuming, and due to lack of resources, most of the new functionality requests come from the Albert users.

Coordinators of the recovery units are users of the Albert system. The coordinators saw the advantages of adding recovery unit requirements. They compiled a wish list of recovery unit

needs which was delivered at the beginning of the fieldwork. Below is the list of requirements requested.

- Requested functionalities:
 - *Advance warning system of 15-20 minutes to notify the recovery unit when the patient operation is almost done.*
 - *Shared information so that the OR department knows where to locate the patients' bed and room number, based on the allocated bed space from the recovery unit.*
 - *A summary list of post-operative patients who have no bed assignment on a separate window.*
 - *Check nurses schedules and number of patients handled.*
 - *GUI (graphical user interface) display for a visual presentation of the ward, where the user can drag and drop patients information to a designated bed.*

- The doable requirements that were included in the project scope were:
 - *A summary of patient lists for bed assignments.*
 - *Room/ bed reservation and management*
 - *Shared information View with the OR team*
 - *A summary list of post-operative patient without room/ bed assignment.*
 - *Message to the OR team on the queue time on the waiting list patients.*

- Future enhancements
 - *Nurse scheduling*
 - *Nurses schedule and number of patients handled*
 - *Ward View*

Since the existing Albert system is considered a complex application, a process for gathering requirements has been utilized. This process consists of a group of repeatable procedures that utilize techniques to capture, document, communicate, and manage requirements. The formal process used were, the Contextual inquiry discussed in chapter 3 section: research methods and the requirements gathering process four basic steps: a) *Elicitation – Questions are raised,*

discussed, and considered, b) Validation – Analyze, and follow-up questions rose, c) Specification – Document and follow-up questions rose, d) Verification – Agreement is achieved.

6.3.3.4 The Graphical User Interface

The user interface allows viewing, updates, and enters pertinent information about the recovery unit. The user is presented with a calendar view selection of dates. Each date will direct the user to go down to the detail of information about the activities of that day shown in Figure.

The user clicked today's date in the calendar menu option and the system displays a week view list of patients and the bed reservation screen. The bed reservation screen has the following information:

- Room/ bed
- Color coding room/ bed patient status (green=out of recovery unit, gray=on queue, blue=in the recovery unit)

The user clicks a patient name under eg. Monday a new window is displayed shown in Figure 37. The system is now ready for the user to make a room/bed reservation.

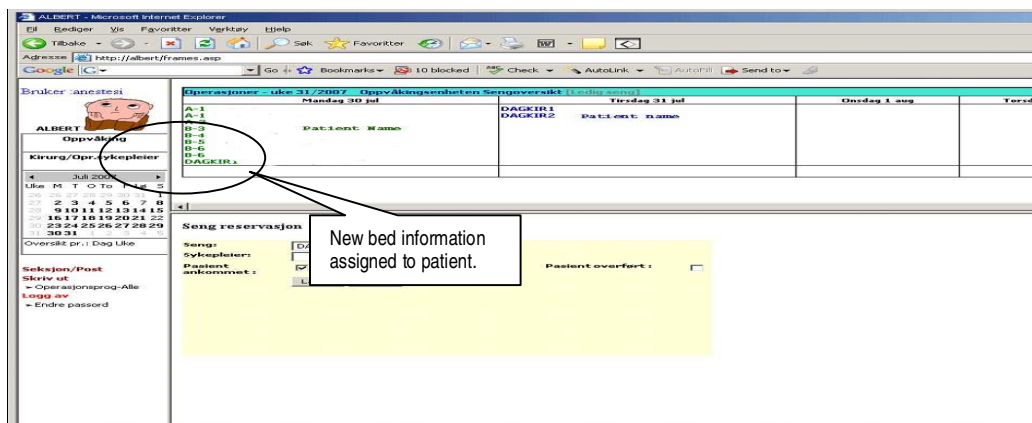


Figure 37 :Albert System – Recovery unit new View screen

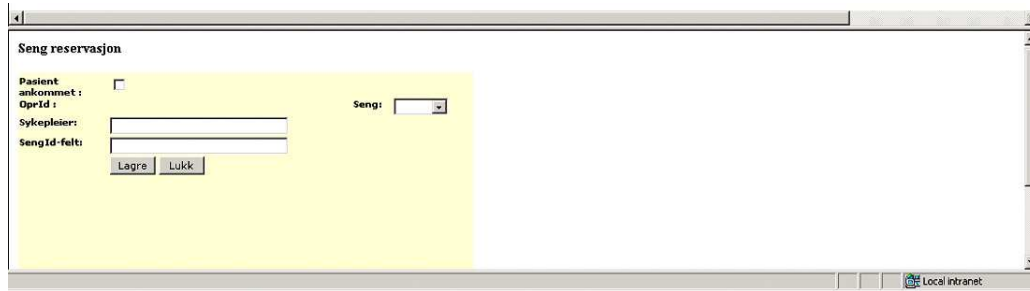


Figure 38: Albert System – Recovery unit bed reservation Add screen.

The bed reservation add screen has the following fields:

- *Incoming Patient – Patient for bed/ room reservation allocation.*
- *Patient transfer status – When patient is out of the recovery unit.*
- *Room/ bed – Room and bed assigned.*
- *Nurse name assigned – Nurse Name attending the patient.*

The user inputs the mandatory fields. The window has two option with cancel or save and closes once the option was chosen. Once the user clicks a patient name in the week-view screen, the detail-window will open shown in Figure 38. This detail-window lists all the patients' surgery activities. This includes the summary window patient that has done with the surgery but has no assigned room/beds from the recovery unit. This added filter function in the detail-window ease the user viewing all queued patients. The waiting list column has the following fields:

- *Department – Patient department e.g. General surgery, Day-surgery.*
- *Theatre – What theatre the patient is from.*
- *Time in/ out – The patient surgery start and end time.*
- *Name – name of the patient*
- *Diagnose*
- *Comments*
- *Waiting time*

The user click a patient in the waiting list column shown in Figure. The system display the *bed reservation - Add screen* shown in Figure. The user assigns a room/bed to a patient. The user saves and the *bed reservation - Add screen window is closed.* When the user goes back to the week-

view by clicking the go-back button in the window explorer. The week-view screen displays the patient list with room/bed assigned to it with color-coding statuses shown in Figure.

- Gray = On queue
- Blue = Patient in the recovery room
- Green = Patient is out from the recovery room

The patient color-coding will change to green once the user checked out the patient from the recovery unit.. The patient color-coding is automatic set to *gray* once the user is done with the surgery and no room/bed assigned.

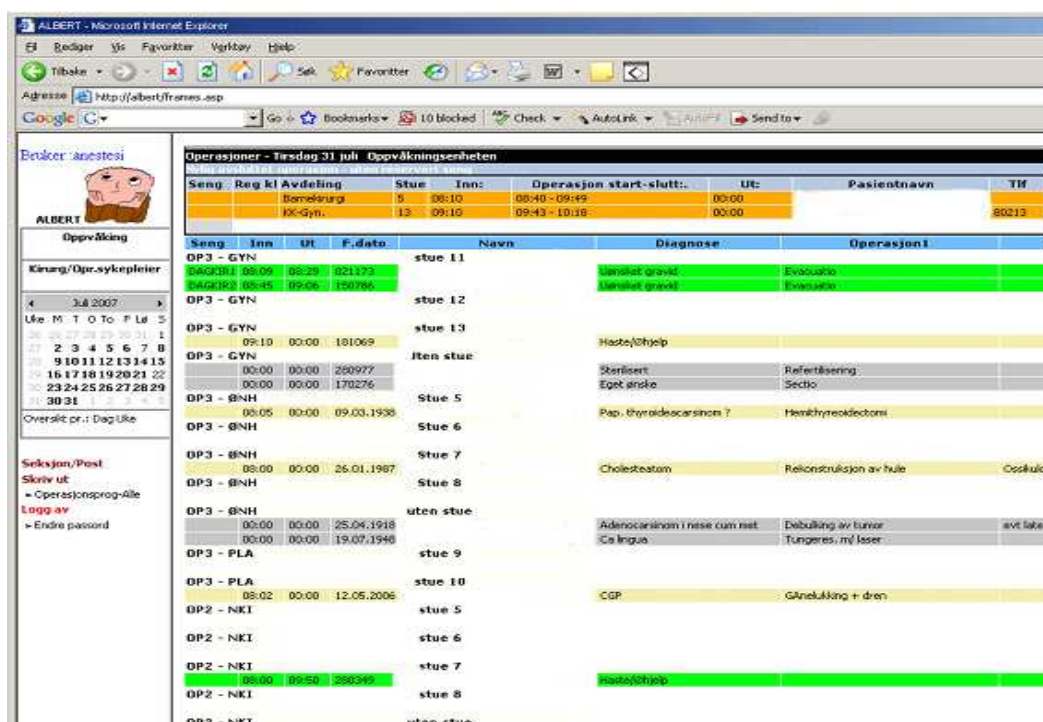


Figure 39 : Albert System – Recovery unit new View screen.

In the patient waiting list window shown in Figure 39 as the overview and Figure 40 as the detailed view. A message will be passed to the OR team shared window view on what is the approximate waiting time for each patients.

Operasjoner - Mandag 1 januar ANESTESI						
Avdeling	Stue	Fra kl.	Til kl.	Navn	Diagnose	Kommentar

Figure 40 : Albert System – Queue list view screen.

6.3.2 Constraints

Due to lack of resources, the project manager has to manage the new functionality based on priority, and has the final word on what should be included in the construction phase. The same procedure applies for the new requirements received and identified on the later phases.

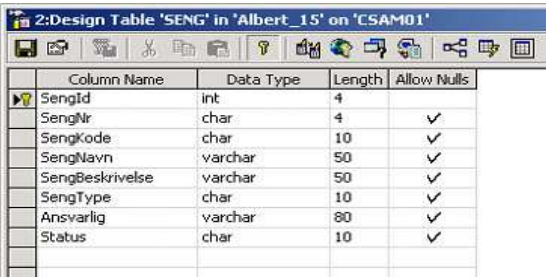
Once the basic requirements have been identified and collected, the next phase that the Design phase was started.

6.3.3 Software Design Analysis

Design Analysis is the phase that evaluates many potential solutions and choices to determine the most effective and efficient way to construct the solution. Even if in this relative small project where the requirements were simple, there is still a mental design process that occurs in between the understanding of requirements and beginning of construction. System models describe the scenarios, use cases, and data models for the system. This section contains a complete function specifications including the user interface of the system and navigational paths, representing the sequence of screens.

6.3.3.1 New Design Table

There were two new table added to the existing database to cater the new functionality. The two tables were the room/bed information and the room/bed reservation details. The Bed information table shown in Figure 41. The reservation detail information table shown in Figure 42 contains the information about the bed....



The screenshot shows a window titled "2:Design Table 'SENG' in 'Albert_15' on 'CSAM01'". It displays a table design grid with the following columns: Column Name, Data Type, Length, and Allow Nulls. The table structure is as follows:

Column Name	Data Type	Length	Allow Nulls
SengId	int	4	
SengNr	char	4	✓
SengKode	char	10	✓
SengNavn	varchar	50	✓
SengBeskrivelse	varchar	50	✓
SengType	char	10	✓
Ansvarlig	varchar	80	✓
Status	char	10	✓

Figure 41 : Bed information table

Column Name	Data Type	Length	Allow Nulls
SengId	int	4	
OprId	int	4	
ResdatoFra	datetime	8	✓
ResdatoTil	datetime	8	✓
Reservert	tinyint	1	✓
RegDato	datetime	8	✓
RegSignatur	char	10	✓
EndretDato	datetime	8	✓
EndretSign	char	10	✓
SengNr	varchar	10	✓
Sykepleier	varchar	50	✓

0

Figure 42 : Reservation detail information table

6.3.3.2 User oriented: Use Cases

Use cases are a popular way to express software requirements. They are popular because they are practical. A Use case bridges the gap between user needs and system functionality by directly stating the user intention and system response for each step in a particular interaction. Further information is still required, however, to detail each business function. Use Case Detail provides this information. No single use case specifies the entire requirements of the system. Each use case merely explains one particular interaction. An organized suite of use cases and other specification techniques is needed to fully specify software requirements.

The figure 43 below illustrates the use case summary scenario of the recovery unit bed management system.

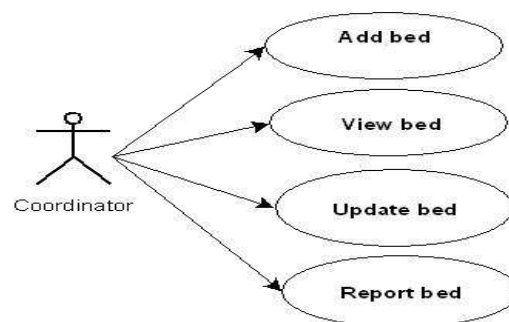


Figure 43: Coordinator Use case summary

Use Case detail	Assign patient's bed
Used by	Coordinator
Trigger	A patient is done with the surgical operation
Pre-Condition	The patient is registered in the system.
Post-Condition	Waiting bed information is updated (if necessary). Recovery bed information is updated. Operation room and ward information is updated. Wait list is updated (if the patient was on wait list and has been successfully scheduled an operation or is put to wait list during the scheduling of operation).
Normal Flow	<ol style="list-style-type: none"> 1. The system changes the color display on the patient's list screen. 2. The coordinator assigns patient room/bed. 3. The system checks for duplicate reservations. 4. The coordinator saves the reservation. 5. The system displays the room/bed assigned to the patient. 6. The system updates recovery bed information. 7. The system updates recovery bed report. 8. The system updates wait list report.
Variations	<p>User fails to provide all the information required by the system.</p> <ul style="list-style-type: none"> ○ System informs the user provides the user which information is missing and does save until all the information required be completed. <p>No recovery bed available.</p> <ul style="list-style-type: none"> ○ System informs user that there is no bed available.
Related Information	

Use Case detail	Update patient's bed
Used by	Coordinator
Trigger	The patient bed needs to be updated.
Pre-Condition	The patient is registered in the system.
Post-Condition	Waiting bed information is updated (if necessary). Recovery bed information is updated. Operation room and ward information is updated. Wait list is updated (if the patient was on wait list and has been successfully scheduled an operation or is put to wait list during the scheduling of operation).
Normal Flow	<ol style="list-style-type: none"> 1. The system displays the patient's list screen. 2. The coordinator checks the reservation checkbox, bed / room and reason for change. 3. The system checks for duplicate reservations. 4. The coordinator saves the reservation. 5. The system displays the updated bed/room assigned to the patient. 6. The system updates recovery bed information.
Variations	User fails to provide all the information required by the system. System informs the user provides the user which information is missing and does not move on until all the information required.
Related Information	Dates on which the operation should be done can be single dates or a period including start date and finish date.

Use Case detail	View patient's bed
Used by	Coordinator
Trigger	A patient is done with the surgical operation
Pre-Condition	The patient is registered in the system.
Post-Condition	Waiting bed information is updated (if necessary). Recovery bed information is updated. Operation room and ward information is updated. Wait list is updated (if the patient was on wait list and has been successfully scheduled an operation or is put to wait list during the scheduling of operation).
Normal Flow	<ol style="list-style-type: none"> 1. The coordinator clicks today's date and the system displays week patient's list screen. 2. The coordinator clicks the week day and the system displays all the patient's list on screen. 3. The coordinator clicks the bed summary list and the system displays the entire patient's list on screen.

6.3.4 Constructing and Obtaining Iterative Design Feedback

6.3.4.1 Coding

When the requirements phase was completed the development phase started. The development lasted for a week including testing. The allocated working hours is ten-person-hours during the week. Neither the resources⁶ worked full-time with the project. As mentioned previously, new requirements added during the development phase were re prioritized to avoid delays as per schedule.

6.3.4.2 Testing

Different kinds of basic testing with actual users as tester were conducted. The last four weeks of the project schedule was devoted to the testing and debugging errors. Fewer hours were allocated to complete the testing phase. The test phase was conducted on a test production environment where some of the sample data were copied from the production⁷. Even though the requirements are only a small portion, most of the main windows were impacted. The test started from logging on the system, adding new patients, editing, viewing, and generating reports. These test were to make sure that all was working as before, and the new added function was working well. The test was done in two cycles, and was validated by the same resources. This had benefits in terms of their familiarity with how the solution was supposed to work, and the advantage of being able to quickly go from testing to correction and then back to testing again. Most of the problems encountered were related to the new table see figure 41 and 42 added in the database.

6.3.4.3 Iterative design and functionality feedback

As redesigned work practices and system functions became available, methods were used to obtain iterative design feedback and adjust the design and functionality prior to implementation. The Chief assistant in the recovery unit reviewed the proposed system design and flows. These discussions occurred throughout the design lifecycle and provided a means for users to identify anticipated problems, and to improve the design based on that feedback.

⁶ Resources refer to the Albert System's project manager and the researcher/writer of this thesis.

6.3.5 Implementation

Implementation refers to the final process of moving the solution from development status to production status. Depending on the project, this process is often called deployment, go-live, rollout or installation. Though the newly added functionality implementation was small, communication to all Albert users⁸ had been circulated. Notices had been published to reinforce the messages to ensure that everyone was ready before implementation. Updates and information about roll-outs had been posted on the Albert system main page. This was a good way to sending messages, especially to the medical personnels where checking emails was the least of their priority.

The deployment was done in the 26th of June 2007 at the recovery unit. The coordinator had a quick run through to the new system's functionality. A two-hours system walkthrough has been done. The new functionality was now in used and is mainly for testing. Based on Albert System's overall procedure, changes and error report are still on going.

6.3.6 Evaluation

The users is using the system in paralle with the the manual system. The user continue to verify the new functions in placed and request for change when necessary.....

6.4 Additional Activities

Communication between the researcher and the Albert system's project manager during the project was made at least once a week. This is especially during the requirements and analysis, and development phase. There were many discussions made through emails. Those responsible for the project had freedom to make suggestions and were able to affect the outcome of the project. This freedom also implied responsibility towards the rest of the project members. A better technical solution, during brainstorming was always considered. There was always someone responsible for the code being produced, but all project members had the right to change another's code if necessary. Usually there was one person responsible for a certain component. The project manager did most of the database work.

⁷ There was no patient's information as test data were copied or moved to computer not owned by RR-HF. All test data and testing was done at RR-HF IT department's premises.

⁸ Albert System's user refers the department users the system. These include the wards whose patient is scheduled for operation, the OR, and the recovery unit.

6.5 Constraints

The initial plan was to build the new functionality to a newer software tool like .NET. Due to unavailability of outside resources and lack of advanced knowledge of project resources concerning the tool, the new tool was not used. It took more than two weeks to reach the decision to build the new functionality using the old software development tool. The advanced GUI based design requirements were not materialized because of software limitations.

7 ANALYSIS

The analysis in this chapter will help to meet the following three research questions previously presented in chapter 1. 1) Identify and find solutions for patient flow bottlenecks; 2) Identify possible solutions for the communication problems between medical personnel which interfere with the effective coordination of healthcare and 3) How IT-systems can support the processes related to care delivery.

7.1 Patient flow bottleneck problem

The number of factors cause bottlenecks in the patient flow at RR-HF:

- **Idle capacity due to a failure to synchronize complementary resources:** This problem wastes valuable nursing time. This is due to the pattern of the recovery unit that varies with the type of surgery performed. This happens inevitably as both nursing and medical personnel recognize the benefit to the most seriously ill patients of remaining under intensive observation in areas where immediate treatment can be carried out. The assignment of staff resources does not take into account planning for quieter and busier periods in order to increase efficiency.
- **Lack of proactive planning for the projected demand for beds:** This is frequently encountered at RR-HF recovery unit when managing the recovery unit patient flow. Variable inflow to the patient unit may also complicate matters, for example, occupancy of recovery unit beds varies greatly during the day, with peak utilization occurring during specific hours of the day. With maximum bed/nurse utilization bottlenecks are likely to occur. The RR-HF coordinator's responsibility is to plan beds/resources during the day doing their best to accommodate unavoidable delays and cancellations. This job is impeded by the deficiencies of the IT-support system.
- **Inefficient processes that require more work than necessary or repetition of work:** The scenario of communication between OR and recovery unit is made mostly by telephone. The lack of information shared by two departments causes the coordinator to be juggle with the tasks such as answering the phone while planning beds and assigning nurses to patients.

- **Staffing and transport factor:** The inability of ward nurses to pick up patients at the recover unit causes the most significant delay. This occurs when patients wait for placement in a hospital bed, often because ward nurses cannot pick up the patient at the exact time so that another patient bed from OR and staff allocation can be planned. Over half of delays are caused by personnel shortages or inefficiencies.

- **Inadequate communication from downstream to upstream departments:** The recovery unit is an extension of OR. The impending admission of a patient to the recovery unit when no vacant beds/nurses are available, triggers a chain reaction requiring that another patient be transferred to ICU or be placed on queue. Inadequate communication can also occur when the day surgery patients are not discharged home as planned.

Analysing the patterns and problems of workload in a recovery unit helps in this study to understand the requirements for IT-support.

7.2 Coordination, Communication and Possible Solutions

This section analyzes the highly cooperative activities surrounding the operation of a patient based on the scenario presented in chapter 5. The flow of patients from the original ward, to operating room, to recovery and back to the original ward can be successfully achieved with effective planning, scheduling, synchronization, and the coordination of the numerous actors involved. The next paragraph seeks to display the analysis of cooperative activities - conceptualizing, and thereby identifying different aspects and dynamics of cooperative work.

7.2.1 Artifacts as tools for coordination

At the RR-HF recovery unit, assignment coordination relies on the use of artifacts such as the recovery unit program for schedules and planning of resources in order to achieve the patient care. This artifact represents informations, assessments, plans, possibilities, and uncertainties. Without effective coordination, the synchronized flow of staff, and coordination with OR department for patient transferred to recovery unit, is chaotic. The artifact which represents the recovery unit program form is used to mediate collective work and is shared to maintain an overview of the total activity. Even though the intention is to reduce uncertainty to the minimum that is possible for a coordinator to manage on the day of procedures, no day proceeds as it was planned. Cases are cancelled or delayed. Procedures are changed. Patients

get better, or become too ill to proceed with an operation. Emergency cases intrude. Some workers are late, while others call in sick. Some patients are late or do not arrive at all. Procedures take more time than expected. Complications occur. These and other events combine to create a complex, uncertain, high-pressure environment for those who must plan the schedule, then manage the recovery unit for the day.

Artifacts such as the recovery unit program form are one of the foci of the study. The program offers a way to study the recovery unit work practices between and among cases, to sort out what does and does not matter, and to learn how things are done in different places. The recovery unit program form artifacts that are created or changed by those who coordinate work are very helpful in this study.

The deep observation and recovery unit program form analysis in this research extend the work and the translation into descriptions and diagrammatic representations. This was used as one of the basis to support in creating the computer-supported artifacts. The development of new functionality for recovery unit to the existing surgical and planning tool Albert System that is based on work domain characteristics. This has been very useful with assessment and for other needed functionalities that seek to use IT in healthcare information applications.

7.2.2 Information needs

Information is the framework around which organizations are planned and function to its day-to-day task. Access to patient information and records is one of the major requirements noted by all the clinical staff. At the recovery unit at RR-HF, the information needs of the nurses are the following:

- *Patient and Bed Assignment Information*

The nurse is assigned many patients during their shift in order to give care to the patient after surgery. There is a lack of easy accessibility of the information of knowing the bed and patient assignment creates a gap in maximizing their time. Instead, the coordinator is keeping their statuses. This often has taken a lot of time for each resource. The coordinator has to see them face to face or vice versa in order to allot assignment for a patient care. Locating the resources physically also cause difficulties and time consuming. Sometimes there is a (chasing scenario) that the coordinator has to look for the nurse or the nurse will look for the coordinator.

- *Inventory of Items Information*

Recovery unit orders has its cost center. The ordering of food and beverages, textiles, beds, disposal materials, medicines used in patient care; the maintenance of equipments, plumbing, IT-related problems and apparatus used and the used of items is billed within the unit. The lack of system to monitor inventory, to be able to order the estimated items used, to plan and see the statistics based on the usage history.

7.2.3 Communication practices

Communication practices are important for how the medical personnel use the information system, partly because information is often imparted informally and orally. The communication problem appeared to be between the ward nurses and theatre staff, in spite of the best intentions of both sides. Lack of interaction was mainly blamed on time constraints, conflict of schedules, and other communication breakdowns.

7.3 The challenges in exploitation and implementation of Albert system

7.3.1 The requirements and design analysis methods.

Using the method Contextual enquiry in understanding the work processes, and the users and their requirements was very useful activities. The five contextual model was used as a basis of mapping the data and information helps understand the users and their requirements with relatively little effort given as short period of time. Given the lack of domain knowledge on the part of researcher. By identifying appropriate users to get the most out of the information needs, and is identified specially those who will actually use your application, or are their tasks influences or play part of the enhanced application. The following basic information used as a guidelines are: The users (what sort of people are they?); their tasks (what exactly will they do with the system); and their values, concerns, and issues.

7.3.2 The Albert System

The Albert systems is dedicated to surgical planning. The use of the software as a planning and controlling tool requires further work. It must be defined which indices are calculated from the information provided. The definition of the process for each new set of system's user is needed for wider application of the software. Implementing all the capabilities of the

software functionalities for all different department user seems an unrealistic goal. Considering the different requirements and needs that is demanded or rather requested. A limited set of high-volume process was done as reasonable approach.

8 DISCUSSION AND CONCLUSION

8.1 Assessment

A recovery unit is part of the perioperative care and cannot be separated. It is made of tightly controlled teams of service providers such as specialized nurses, surgeons, and anesthesiologist. They perform complex procedures that routinely have significant consequences. Multiple hospital departments collaborate and coordinate to balance the demand for health care with resources such as care providers, equipment, and facilities. To plan and manage the balance, an anesthesiologist from OR team, nurses coordinator from recovery unit and wards predict resource availability, build consensus among team members, resolve disputes, plan resource allocation, assess and re-plan the balance between need and resources, speculate about future needs, create test solutions, anticipate resource requirements, bump procedures and store resources. These identified patterns and character of health care teamwork processes with regard to planning and decision-making, the resource allocation, and other information tools can be improved through the utilization of information technology.

At the RR-HF most of these information systems were internally developed, and is waiting to be analyzed and utilized. The existing surgical planning system (Albert system) is one of the information system that provides rich source of patient data awaiting to be utilized. It is a dynamic scheduling system provides sytem is cattered mainly for surgical planning of patient enrolment, surgical time monitoring, documentation and reporting, administrative data for each case including procedure, patient name and scheduling surgeon. This system is currently shared for view its information to recovery units and ward. During fieldwork, requirements gathering and data analysis has been conducted to further developed the new functionality for recovery unit. By sharing the bed information to OR and the ward. Eventually adding staff resource planning and staff patient assignment. This will ease the queue and constant phone calls, that will also help the coordinator ease its work load and plan better resources. The preparation for the next patient, until "bed control" is notified of its availability, and until the next patient is transported to the bed will be improved. Lastly, the shared data to the OR and the wards, communication will be better between the OR department and the ward as to the exact time patients will arrive and picked up.

There was a good work cooperation and coordination with the RR-HF IT department Albert system's project lead, the assistant head of the recovery unit department and with the data and information inputs by the researcher . The result was done as expected. Though, with the time frame schedule was not as what as planned, overall, the efforts that was combined altogether paid off such a good result.

8.2 Contextual Inquiry

A Contextual Inquiry important usage advantages was that an interviewer required only minimal training and there is no need of prior practical experience in CI. The combination of a highly structured data analysis process, and the interpretation of the data, makes CI a practical alternative to traditional ethnographic study. It can also be utilized for software design. The use of this method is practicable, and provided extremely valuable data for functional design. Although there were some considerable limitations:

- Time Intensiveness and Labor. The acquisition and analysis of this data was time-consuming. Large amounts of raw data were generated and required analysis. The time and labor costs of CI need to be weighed against the usefulness of the data collected. CI is best suited for domains where information needs assessments are limited, it is unclear how to best use technology and there are few examples to guide design.

- Healthcare work is often not interruptible and thus not easily amenable to standard CI methods. Although, the use of video recordings as substitute contextual references during CI interview has not been performed. This approach worked quite well in clinical settings like the recovery unit or other departments e.g. hospital emergency rooms, operating rooms and outpatient medical clinics. However, another important aspect researchers must consider is the access to Patient Information. The new HIPAA legislation on data collection of this kind of data Medicine means access to patient identifiers. Video/Audio-taping of CI interviews may only be possible where no patient identifiers are recorded or where patient's can be consented prior to incidental exposure of the researcher. These requirements may or may not extend to studies using CI with the purpose of Quality Assurance and improvement of supporting technologies and infrastructures.

Contextual Design is effective to study a perioperative care and yielded important insights that will be integrated into the design of user-centered perioperative care system. Though, there are identified several potential limitations of this technique. However, the technique can also be used in many other domains requiring user-centered design that will help create, and enhance current information technology. The development of new health information portals, laboratory information systems, etc. is one of the many examples.

8.3 Conclusion

It is clear that the work of the recovery unit medical personnel involves both practical and non-technical skills. The recovery unit is mostly dependent on its patient flow from the OR and to the wards. One important work processes characteristics of recovery unit is the allocation of attention planning and resource management. The automation of monitoring of patient flow and planning resource allocation would reduce the workload associated with these tasks but this has not been borne out yet. The implementation of the new functionality added to the Albert System is still on testing and still open for improvements.

Analysing the pattern of work processes in a recovery room has helped understand the IT support requirements for such care in terms of staffing and facilities. This will also benefit teamwork processes and thereby enhance patient safety. The goal of IT support for healthcare work processes to assist healthcare professionals reduce their work overload by having the information easy, accessible, shared, and improve the basis for their decisions based on the available information.

8.4 FUTURE WORKS

There are a number of reports in the literature on how to set up a recovery room service including the equipment needed, though only little has been written about the pattern of patient flow to ward and from OR. As well as its work processes and examining workload and its effects in recovery unit. Future work will seek to extend the study of the ward that is part of the PeriOperative care. This is in the interest of proposing and evaluating the effect of new approaches to the use of information and informatics in this complex high-risk environment like the PeriOperative care.

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APPENDIX
