Evidence Based Models for Evaluating Operating Room Performance

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This work has not previously been accepted in substance for any degree and is not concurrently submitted in candidature for any degree.

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ABSTRACT

The operating room (OR) within a hospital environment is one of the most expensive functional areas, yet the use of the OR also provides hospitals with an essential source of income. However, at present, there are variations on how to evaluate the performance of ORs, since there is no clear and full explanation of the concept and methods used for evaluation.

The overall aim of this thesis is to develop an evidence based Operating Room Assessment Framework (ORAF) to evaluate Operating Room performance with clear and complete guidelines that can be used by operating room managers, directors or any other medical professionals to evaluate operating room performance, determine OR planning and scheduling efficiency, OR workload and OR utilization. The resulting Operating Room Assessment Framework will assist targeted healthcare professionals in their quest to evaluate, monitor and improve overall Operating Room efficiency.

The OR management systems of eight tertiary and teaching hospitals in three countries (Japan, Canada and Saudi Arabia) have been examined from 2010 to 2012, which include more than 98,500 procedures.

The Operating Room Assessment Framework (ORAF) involves three important elements of Operating Room performance, namely: OR scheduling level, the type of OR workload, and OR utilization. These elements can simply be read to reach the end result, which includes three types of scheduling levels: under scheduling, ideal scheduling and over scheduling; five types of OR workload: OR total workload (the gross workload), OR actual workload, over workload, unnecessary workload and unexpected workload; and three types of OR utilization: underutilization, ideal utilization, and 100% utilization with over workload.

Through the validation process in different hospital contexts, the ORAF has proven its ability to perform satisfactorily, with accuracy, in line within the research's objectives.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1
INTRODUCTION

1.1: Background to the Study

Today, health systems play a greater and more significant role in people's lives than ever before, in both wealthy and poor countries (World Health Organization 2000). Health systems include all the establishments, organisations and resources that are devoted to patients' health (Belcon et al 2009); such systems also target promoting and maintaining the health of the population at large (Kirch 2008).

The prevention and treatment of disease are the positive roles of a health care system (Andersen & Taylor 2010). Surgery is one of the effective methods used in healthcare practice to achieve this goal. The American Cancer Society (2012) has pointed out that surgery can be employed to diagnose, treat, or even inhibit diseases in certain cases. Heisler (2009) defines surgery as the specialty of medicine that cures illnesses and disorders through cutting, eliminating or altering the body through an operative practice. Surgery is carried out by a surgeon- a physician with specialised training in operative procedures (Heisler 2009).

An operating room, operating theatre, surgery suite or a surgery centre is a room within a hospital where surgical and other operations are carried out. An Operating Room is the "heart" of any major surgical hospital (Harsoor and Bhaskar, 2007), and is popularly referred to as the 'OR' (Riley and Manias 2005). Operating theatres are so-called in the United Kingdom because they traditionally consisted of semi circular amphitheatres to allow students to observe the medical procedures.The Old Operating Theatre in London is one of the oldest, dating back to 1822 (Harsoor and Bhaskar, 2007).

The operating room is the most vital functional area in a surgical unit (Koneczny 2009). Its importance is further increased due to the invasive procedures that are carried out (Koneczny 2009). Considering the seriousness of this area, it is provided with professional staff and involves high-quality as well as expensive equipments, which makes it the most expensive part of a health care centre (Dexter et al 1999, Fei et al 2008). Conversely, the hospital generates a significant amount of revenue from utilizing the OR, making it a vital revenue source (Zekienock and Zambricki, 2001). For this reason, Watkins and his associates describe ORs as “the engines of a hospital” (Watkins et al 2011). To contain costs, optimally utilizing expensive resources is of great significance (Augusto et al 2010). Due to this, keeping ORs completely in use when staffed is suggested as one economic consideration (Tyler et al 2003). Nowadays, hospital authorities are increasingly focussing on the performance of their ORs, as this has a major impact on the financial viability of their hospitals (Strum et al 1997, Fei et al 2008, Guerriero and Guido 2011).

Efficiency is considered to be a key issue with regard to profitability in private organisations, and improved efficiency allows more operations to be performed at the same cost in non-profit organisations (Wright et al 2010). Also, Operating Room efficiency is a main determinant of hospital expense; maximising output while maintaining quality is therefore dominant in the maintenance of financial viability (Jacques and Higgins, 2004). Therefore, OR utilization has become a major factor in evaluating the performance of the OR (Viapianov and Ward 2000). Faiz and his colleagues state that utilization is now a key measure of performance for NHS operating theatre services (Faiz et al 2008).

With over 15 years experience spent in the field of surgical operating room practice and management, the researcher has noted that most Operating Room management systems differ in some aspects from one hospital to another. Each system depends on the needs of the individual hospital and the experience available, and in most cases strives to achieve the best performance in the Operating Room(s). Equally, Bramley-Harker and Macdonald (2007) emphasise that countries differ noticeably in their approach regarding healthcare systems. There are differences in how much is expended, how funding is planned, who delivers care, and where care is provided. It is also noted that there is a lack of clear guidelines or models to explain the relevant key concepts and methods for evaluating the performance of ORs in full. Most of the existing practices on this subject focus on economic aspects and discuss each point in this area separately; in addition, this is often presented in a purely statistical manner with an absence of illustrative cases. Hence, most medical practitioners tend to be confused as to the way to implement existing procedures aimed at evaluating OR performance (along with a lack of general consensus); therefore, the researcher argues that most OR evaluation underpinning concepts have not been applied successfully until now.

According to Wolper (2011), it is essential to consider both the external and the internal environments of hospitals to understand completely the progress of healthcare systems. Therefore, this whole study aims to explore the various Operating Room management systems of different hospitals in different countries on different continents, to investigate the similarities and differences between these systems, and to evaluate and validate the methods used for measuring the performance of the operating room. The aim is to develop clear and complete guidelines and an evidence-based model which can be used (in practice) to assist OR managers, directors or any other medical professionals, determine the performance of an OR. Targeted Performance areas are: OR planning, OR scheduling, OR workload, and OR utilization. The ultimate goal is to assist in the process of evaluating, monitoring and improving the overall Operating Room efficiency.

1.2: Scope of the research

This research focuses on measuring the performance of surgical operating rooms. The study will examine the current systems used to evaluate the performance of the operating room to ensure its validity, as well as investigate the non-medical factors influencing the evaluation process.

Variations currently exist in the techniques used for evaluating operating room performance. Also, there are variations concerning the concept of operating room utilization, with a lack of clear and full explanations of the concepts and methods used for evaluating their performance (Faiz et al 2008).

The Operating Room management systems in eight tertiary and teaching hospitals in three countries (Japan, Canada and Saudi Arabia) have been examined. Interviews, observations and documentation are the prime resources that have been used in order to gather information for this research during the extensive fieldwork. Semi-structured interviews have been conducted with the staff involved with surgical patients and surgical operation processes. To observe the process, the research follows the regular procedure for a surgical patient, starting from the surgical clinic, up to the performance of the surgery, and all the management data involved, such as the official reports, forms, and main statistical data from OR records and systems that have been documented.

The study did not require any changes to the original patient care that is provided to the surgical patients at any of the hospitals which participated in this study.

This study concentrates only on non-profit hospitals that are paid for by the government or by national health insurance; no private or profitable hospitals have been included. All the hospitals that have participated in this study are tertiary or teaching hospitals, meaning they are all on one level, and the study does not include secondary or general hospitals that provide a different level of service. Also, the study focuses only on planned elective procedures, which are scheduled for surgery during normal working days. This study excludes all procedures occurring on weekends or official holidays.

1.3: Aims and Objectives of the study

The overall aim of this thesis is to develop an evidence based Operating Room Assessment Framework to evaluate Operating Room performance with clear and complete guidelines that can be used by operating room managers, directors or any other medical professionals to evaluate operating room performance, determine OR planning and scheduling efficiency, OR workload and OR utilization. The resulting Operating Room Assessment Framework will assist targeted healthcare professionals in their quest to evaluate, monitor and improve overall Operating Room efficiency.

In order to achieve this aim, a number of objectives have been formulated and pursued, including:

- Compare and document various operating room management systems to be used as evidence of current operating room management systems practice.
- Intensively examine and investigate the similarities and differences between the Operating Room Management Systems within three renowned tertiary hospitals in three different countries on three different continents.
- Follow the regular procedure of the surgical patient in each hospital, from the surgical clinic up to performance of the surgery, to observe and document the process.
- Investigate and analyse the details of each system via fieldwork involving semi-structured interviews conducted with key staff involved with surgical patient processes.
- Gain access on the ground to the electronic or manual systems used to collect the surgical data, including how patient data is managed, what statistical method is used to evaluate Operating Room performance, and how exactly Operating Room performance is evaluated.
- Analyse operating room statistical data, and examine the annual reports of a large number of hospitals at the same level.
- Evaluate and validate the methods used for measuring the performance of the Operating Room in each hospital.

Through the accomplishment of the research objectives, a set of research outputs were obtained; they are as follows:

A complete and in detail study of three international Surgical Operating Room Management Systems from well established tertiary and teaching hospitals has been codified, in addition to research carried out at five other tertiary and teaching hospitals to find out the systems used to evaluate Operating Room performance in these hospitals. This clearly demonstrates a significant difference in the methods and techniques used to evaluate the performance of the Operating Room between the hospitals that participated in this study.

It has been noted during this study that there is a great deal of conflict concerning the definition and understanding of the most important statistical terms used to evaluate OR performance. In some cases, there is incorrect use of statistical terminology, or it has been employed in the wrong place. Therefore, the important terms used for OR performance evaluation have been improved, and a definition of relevant new terms introduced.

It has also been observed that all hospitals targeting assessing OR performance have used only the traditional OR utilization method, without clearly identifying the factors affecting it, while some systems simply compare the results that have been achieved with previous results, or for benchmarking with other organisations. Therefore, this study has been able to identify the primary statistical factors required for this process, which can be deducted from the OR records.

The following of the regular procedure for the surgical patient in each hospital, from the surgical clinic up to performance of the surgery, has enabled this study to determine the flow of the surgical patient in these hospitals, which has assisted in clarifying the differences and similarities between these systems.

Gaining access on the ground to surgical data has permitted this study to evaluate and validate the methods used for measuring the performance of the Operating Room in each hospital, which shows a weakness in most of these methods. This stresses the need to find new Operating Room Performance evaluation methods. In addition, the research has identified the primary statistical factors affecting the evaluation of Operating Rooms.

This study has developed an evidence based Operating Room Assessment Framework (ORAF) to evaluate Operating Room performance. It contains a fully developed practice-oriented mathematical model (ORAM), supported by illustrative figures and real world examples, as well as a visualisation metaphor model, namely ORRM, which can be used as a dashboard to enable the reader to interpret and convey holistic information about the performance of the Operating Room quickly and easily; thereby creating a decision making tool for the operating room management team.

This study has added new classifications for Operating Room assessment outcomes:

- The OR scheduling level has been classified into three new types of scheduling levels: under scheduling, ideal scheduling and over scheduling.
- The OR workload has been classified into five new types of OR workload: total OR workload (the gross workload); OR actual workload; over workload; unexpected workload; unnecessary workload.
- OR utilization has been classified into three new types: underutilization; ideal utilization, and 100% utilization with over workload.

The Operating Room Assessment Framework (ORAF), including illustrations and pre-validation of its contents, is concerned with real-world validation of the ORAF.

For the application of this principle, both developed models (ORAM and ORRM) have been tested on a new set of data obtained from King Faisal Specialist Hospital and Research Center (KFSH&RC) for the two main surgical suites, which contain 22 Operating Rooms, where 975 surgical procedures were conducted throughout 2,645 working hours in the month of October 2012.

Through the validation process, the ORAF has verified its ability to perform satisfactorily, with accuracy, and consistent within the research's objectives.

1.4: Rational and Research Question

The majority of Operating Room Management Systems differ from one hospital to another. Differences exist not only between each country, but even between hospitals within the same city or region. There are also considerable variations in the techniques used to evaluate Operating Room performance.

Furthermore, at present, there is a lack of clear guidelines or models to explain the relevant key concepts and methods for evaluating the performance of Operating Rooms in full. Most of the existing practices on this subject focus on economic aspects and discuss each point in this area in isolation; this is often presented in a purely statistical manner with an absence of illustrative cases, as argued earlier. This leaves scope for uncertainty and lack of general consensus as to how to implement existing procedures for evaluating Operating Room performance.

The thesis is driven by the following overarching research question:
Can a generic and adaptable operating room assessment framework be developed and implemented with a view to accurately determine operating room performance, including planning surgical activities, workload, and utilization?

1.5: Researcher's Background

The background of the researcher and his experience in the medical and management field is briefly presented in this section.

Abdulkarim Al-Ojaimi was born in Hail, Saudi Arabia in 1972. He is a PhD student specialising in operating room management systems and performance related issues. He is experienced in anaesthesiology, including in a managerial context, and has a track record in coordinating staff and services, and dealing with budgets and inventories.

EDUCATION:

Abdulkarim Al-Ojaimi is a doctoral student in the School of Engineering at Cardiff University in the UK, where the focus of his research involves an international study into the field of Operating Room Management Systems. Prior to this, he completed a Master of Science (MSc) in Healthcare Management, focussing on ‘Surgical Patient Flow at KFSH&RC’, in the Manchester Business School at the University of Manchester in the UK. Also in the U.K, he gained a Bachelor of Science (BSc) in Intra & Perioperative Practice from the School of Healthcare Studies at Cardiff University; an Advanced Professional Development Certificate in Preparation for Mentorship from the School of Health and Social Sciences at the University of Bolton, and a Bachelor of Arts (BA) in Health Studies from the School of Health and Social Sciences at the University of Bolton. Previous qualifications from his home country of Saudi Arabia are the Intermediate University Degree in Health Sciences in the field of Anaesthesia from the Intermediate College of Health Sciences in Arras, and a Diploma of Anaesthesia from Maddinah Munawarah Secondary Health Institute in Al Maddinah Al Munawarah.

WORK EXPERIENCE

Previous work experience includes Secretary General of Finance for the General Authority for Saudi clubs and schools in the United Kingdom and Ireland, and General Finance Manager of the Fourth International Saudi Scientific Conference (2010) at Manchester University in the UK. Abdulkarim Al-Ojaimi has had several supervisory roles in the field of anaesthesiology, including Supervisor of Anaesthesia Technology at King Faisal Specialist Hospital & Research Center (KFSH&RC) in Riyadh, Saudi Arabia, in addition to working as the Operation Room Quality Assurance Representative at the KFSH&RC.

Experience in an educational context includes supervising the Anaesthesia Technology Program for Training and Academic affairs at KFSH&RC, as well as being the Founder of the Program at KFSH&RC and the designer of the program’s curriculum. In addition, he has worked as Tutor of Anaesthesia and Surgical Procedure subjects in Training and Academic affairs and as Senior Anaesthesia Technologist & Education Coordinator in the Anaesthesia

Technology Dept at the KFSH&RC. Prior to this, his roles were Anaesthesia Technician at Anaesthesia Auxiliary, in the KFSH&RC, Riyadh, Saudi Arabia, and Cardiac Anaesthesia Technician at the Prince Sultan Cardiac Center, Riyadh Military Hospital, Saudi Arabia.

RELEVANT EXPERIENCE

Member of several medical, management and education committees at King Faisal Specialist Hospital and Research Centre, Riyadh, Saudi Arabia. He attended a number of national and international courses, conferences, symposiums and workshops on medical and management field.

1.6: Contribution to the Body of Knowledge

For over forty years, the scheduling of computer and manufacturing systems has been the focus of wide research. Scheduling theory can be applied to various areas, including agriculture, hospitals and transport, in addition to computers and manufacturing. The main concentration is on the effective allocation of one or more resources to activities over time (Chen et al 1998).

In the mid fifties, the initial scheduling algorithms were formulated. Since that time, there has been a rising interest in scheduling. Moreover, scheduling problems have been examined and classified with reference to their computational complexity (Brucker 2007).

The main objective of the schedule practice in the Surgical Suite is time management for elective cases, which ultimately increases the performance efficiency of the OR department (Persson & Perrson, 2010). There are numerous problems associated with the surgical scheduling process and it can be explained on the basis of planning horizon that staff member elect for. The overall process includes all the decisions, which are of concern to stakeholders. Several other responsibilities include allocation of time to patient, last minute adjustments, and the execution of the planned schedule

(May et al., 2011). The implementation of result tools is a real challenge for OR managers. The scheduling process is affected by all the staff members' availability, thus creating a considerable impact on the OR schedule (Van, Bredenhoff Hans, 2010).

These scheduling issues appear to be due to mismanagement in procedure selection, time allocated for it, and procedure sequence, within the given time slots. In addition to this, surgical scheduling is affected by bricks and mortar decisions, and staff scheduling to provide personnel support (Zonderland et al., 2010).

There are many types of scheduling algorithms which have been developed and used to resolve the scheduling issue in the past, such as Heuristic Methods, Shortest Paths algorithms, Linear Programming, Branch-and-Bound Algorithms and Genetic Algorithm (Brucker 2012).

To evaluate the level of performance, assessing planning and scheduling efficiency, and determining workload and utilization, are the most important concerns for any management organisation- not only for Surgical Operating Rooms, but also for all other productive sectors such as factories, airports and so on.

At present, there are variations in how to evaluate the performance of ORs, since there is no clear and full explanation of the concept and methods used for evaluation. Also, there are variations concerning the concept of utilization, with a lack of clear and full explanations of the concepts and methods used for evaluating performance.

The resulting Assessment Framework will assist all targeted healthcare professionals in their quest to evaluate, monitor and improve the overall efficiency of their departments and organisation; also, other sectors that involve the same nature of work may benefit from the application of this framework.

The main contributions of this research can be summarised as follows:

- Important terms used for OR performance evaluation have been improved, and a definition of relevant new terms introduced.
- The primary statistical factors affecting the evaluation of OR performance have been identified.
- An evidence based Operating Room Assessment Framework (ORAF) to evaluate Operating Room performance has been developed.
- A practice-oriented mathematical model (ORAM) has been developed supported by illustrative figures and real-world examples.
- Fifteen (15) factors have been derived through the use of the ORAM.
- A new visualisation metaphor (model) to analyse the newly derived factors has been developed.
- Through the use of ORAF, three important outcome elements of OR performance have been deduced, namely: OR scheduling level, the type of OR workload, and OR utilization.
- The OR scheduling level has been classified into three new types of scheduling levels: under scheduling, ideal scheduling and over scheduling.
- The OR workload has been classified into five new types of OR workload: total OR workload (the gross workload); OR actual workload; over workload; unexpected workload; unnecessary workload.
- OR utilization has been classified into three new types: underutilization; ideal utilization, and 100% utilization with over workload.
- This study provides a detailed account of three international Surgical Operating Room Management Systems from well-established tertiary hospitals, which can be used as reference for any hospital planning to start a new operating room service or just aiming to improve an existing one.

1.7: Structure of the Thesis

The thesis is structured into eight chapters. The following provides a brief summary of the content of each chapter:

Chapter 1: Provides the background to the study; scope of the research; aim and objectives of the study; the rationale of the research (hypothesis); brief information about the researcher's background; the contribution to the body of knowledge available, and the structure of the thesis.

Chapter 2: Reviews previous work and related studies that are relevant and important to this research. It addresses several issues in healthcare systems, and provides an overview of the Operating Room and Operating Room management systems and underpinning concepts.

Chapter 3: Presents the research design and methodology, including a detailed description of the case studies used in the research.

Chapter 4: Contains the data reporting. It is divided into three sub-sections dedicated to each selected hospital, and provides the interview reports for all services involved in the operating room management system, observations and statistical data.

Chapter 5: Contains the data analysis. It is divided into two main parts: the first part analyses the surgical patient flow, and the second presents a comparative analysis of the three surgical management systems.

Chapter 6: Introduces the Operating Room Assessment Framework (ORAF) developed for evaluating the operating room's performance, including its five logical connected phases to form ORAF, which are (a) the primary factors, (b) ORAM (the proposed model), (c) the derived factors, (d) ORRM (the second proposed model), and (e) the framework outcome which includes the three important outcome elements of the OR performance.

Chapter 7: This chapter contains the validation and dissection related to all the elements of the developed Operating Room Assessment Framework (ORAF). This model has been tested on a new set of data for various types of operating rooms and surgical suites at different periods of time to ensure its validity.

Chapter 8: This chapter summarises the entire thesis and suggests directions for further research based on the findings of the study. It discusses the overall findings from the thesis with conclusions and recommendations.

CHAPTER 2
LITERATURE REVIEW

2.1: Introduction

The overall driver of this thesis is to develop an evidence-based Operating Room Assessment Framework to evaluate Operating Room performance, with clear and complete guidelines that can be used by operating room management to evaluate operating room performance. Since the surgical management systems are integrated and associated with the healthcare systems in general, and are influenced by these system types and performance, this chapter presents a background and literature review related to operating rooms and related topics. This chapter focuses on the following areas:

- The Healthcare systems
- Overview of the hospitals
- The surgical procedure
- The Operating Room (Surgical Suite)
- Operating Room Management
- Surgical Patient Flow
- Operating Room Planning and Scheduling
- Operating Room Workload
- Operating Room Utilization

The following presents the details of these topics.

2.2: Healthcare Systems

2.2.1: Introduction to Healthcare Systems

It is possible to understand a system once we come to understand its components and the connections present between them. Understanding the reason behind their connections helps complete the understanding of the system. The difference between any other system and the health system lies in the purpose: a health system focuses primarily upon the health of people (Healthy Development 2007). The health system covers different aspects, including: offering home care for the sickly, medicines which can improve and cure an individual's condition and overall health, traditional medication, and other officially recognized health services such as giving professional and individual medical attention and counselling. A healthcare system involves a wide range of resources, institutions, and organisations working towards the improvement of people's health. It is worth noting that WHO reports do not include in the health system definition any measures whose prime focus wasn't on a health issue, even if their tertiary health-related aspects include community and individual health focuses.

Any society will gain benefits from healthy people as they will work towards the economic and social development of their society (Baswanthappa 2008). Any primary healthcare system has the primary goal of improving the quality of life for the people it deals with. According to the National Guidance for Healthcare System Preparedness (2012), the preparedness for any healthcare system depends on the community's healthcare system. The manner and ability within which the latter can respond and then recover from various incidents is what determines how prepared the overall healthcare system is. The kind of long and short term ramifications this has on medical and public health is staggering. It has been shown that by utilizing effective care techniques, institutions of all kinds (including clinics, nursing homes and hospitals) that provide health care services can help bring improvements in overall patient life quality. It was shown that clinicians can enable patients to take up healthy behaviours that can improve their overall health and avoid morbidity, even when they are facing any potential disease (Haggerty et al., 2010). The materials that are used to treat patients are generally referred to as commodities (Matcha, 2003).

Within this industry, there are different hospitals, all of them providing different kind and qualities of services. For any service to be successful, it is essential for the service quality to be optimal (Suki, Lian & Suki 2011). Researchers have steadily been collecting more and more evidence that supports the positive, health promoting effect that primary care has had on our societies. A study conducted by Starfield, Shi and Macinko (2005) showed that primary care helped in the prevention of death and illness, no matter if this care was supplied through primary care physicians, through another source of primary care or was the result of some other feature of primary care.

According to Kirch (2008), when we see health care systems as a field of research, it helps in maintaining and promoting the general population's health. Their actions and implementation depends on the kind of services that are being provided and the manner in which the health care system was organized. It cannot be doubted that their contribution to the health care system has not been significant. Any country that wanted to gain advantages from them had to redesign their reform strategies so that the institutional features and policies that lead to efficiency were included (OECD 2011). In recent years there has been resurgence in interest regarding health systems strengthening (HSS), even by the World Health Organization (WHO). HSS is being touted as an essential element for bettering worldwide health outcomes and achieving the Millennium Development Goals (Swanson et al., 2010).

There are three major responsibilities in health care: providing healthcare in such a way that state facilities, societal-based institutions or privately owned for-profit institutes can provide health care, regulating the state and private actors working in different institutes for provisional and financial purposes, and ensuring that health services are financed properly through private means, social insurance donations or taxation (Glennerster & Lieberman, 2011; Besley & Gouveia 1994). It has been stated by Karr (2011) that the phrase ‘standardized work’ has become equivalent to ‘best practices’ in healthcare. This kind of word play doesn’t so as much harm as it has led to benefits. When applying these kind of labels and their gradual acceptance by the public, the result is fairly positive. Generally speaking, when best care practices are used with consistency, that is when the finest and most favourable patient outcomes are achieved. This is under the best practices theory.

2.2.2: Developing of Healthcare Systems

To properly understand the way in which the healthcare systems work, the first thing that we need to study is the internal and external environments that hospitals work in (Wolper 2011). There was a drastic shift that occurred in the industry between the 60’s and 80’s. There was a sharp rise in the amount of systems along with a change in ownership patterns, resulting in over 250 systems working together by the time 1980 came along. Horizontally, oriented delivery systems saw a great rise in the same time period and their expansion led to the creation of a price-insensitive environment and cost-based payment method that encouraged growth within the system. Through medicare reimbursements, not only can costs be covered but a certain return can also be secured on investments. As a result, it is possible to buy an inefficient system operated in different locations and adapt / redeploy it with a low failure risk. By using issue stocks, it was made possible for investor-owned systems to move into the capital market and through them, underwrite their new acquisitions.

Not-for-profit systems do not have greater geographic distribution and are concentrated in fewer hospitals. On the other hand, their counterparts owned by the investors are more dispersive geographically and incorporated in some big systems (Wolper 2011). During the mid-80s, organizations started to undergo restructuring following the arrival of Prospective payment. Efforts for diversification centred upon development of a range of care facilities locally and regionally. The first stage was concerned with patient/outpatient care that was considered as the “core business.” Generally, to gain economies of scale, two or more hospitals associated, strengthened and merged their services. At the stage 2, the core hospital activities were divided into both forward and vertical integration activities like medical equipment companies and ownership of pharmacies. The third stage encompassed efforts to organize and regulate home healthcare agencies, satellite clinics, components of the continuum of care and physician primary care networks. In the fourth stage, acute inpatient care as the core business of primary care was replaced by disease prevention and/or health promotion.

The system aimed at acknowledging the risk regarding the health status of populations, who were provided with incentives, meant for maintaining the health of the population (Wolper 2011). Likewise, Collyer and White (2011) stress that in the current decades, both developed and developing health care sectors of many countries have been restructured on fundamental basis by two events: Novel interest in strategic investments in health products and services from the corporate sector, re-orientation of government policy for the privatization of institutions publicly funded. Some may take this remarkable change as bringing about the likelihood of increased patient ‘choice’ and increased efficiency.

On the contrary, it is agreed by World Health Organization (2000) that health systems in all countries, whether poor or rich, play a bigger and more significant role in people’s lives today than before. Some types of health systems will persist for as long as people take care of their health and treat diseases. Traditional practices have existed for thousands of years and also exist today along with modern medicine. These practises involve spiritual counselling and provide both preventive and curative care. For implementing them in public sector, it is recommended that quality improvement should discuss incentives that can be employed at high standards among providers that may not feel threatened like the private practitioners because of lack of business (Basu et al. 2012).

2.2.3: Roles and Functions of Healthcare Systems

Sturmberg (2011) stresses that an essential feature of any complex adaptive system is, most of the times, nested intricate relationship with other systems. The most significant relationships occur in the upper and lower layer. Therefore at a higher level, community, home and family environments largely influences the patient and his or her health and is directly related to it. On the other hand, at a lower level patient health is affected by the biological health potential and susceptibilities. All sectors of the health care system lead to the accomplishment of core clinical tasks to a lesser or greater extent. Hence, collectively, they are considered to be the functions of system although few of them may be fulfilled by a particular sector at a primary level. An annual report is produced by World Health Organisation that discusses a special topic of interest and the world Health Report 2000 is completely concerned with health systems (Skolnik 2008). There are three goals for every health system as per world Health report 2000. These are: good health; impartiality of financial contribution and responsiveness to the expectations of the population.

Responsiveness is regarded as the ability of the system to react to lawful expectations of potential users with respect to non-health enhancing aspects of care. In broader terminology, it can be defined as the way they are being treated and the environment, in which they are treated. This definition covers the ideology of Health Research and Educational Trust Health Services Research individual's experience of association with the health system (Robone, Rice & Smith 2011). One of the inherent goals of healthcare systems along with health outcomes and fairness of financial contributions has been given by Health system responsiveness (World Health Organisation 2000).

The prevention and treatment of diseases are the positive functions of health care system. On ideal basis, this establishes that the healthcare to entire population should be delivered to whole population irrespective of discrimination on the basis of race, ethnicity, social class, gender, age or any other characteristic (Andersen & Taylor 2010).

Health care, being a social entity, is strongly connected to work and economic systems and is considered to be one of the nation's largest employers. It is also emphasized by Andersen and Taylor (2010) that the conflict theory focuses on the significance of inequality of social structure in society. It can be deduced from the conflict aspect that imbalanced access to medical care is due to inequality rooted in our society.

2.3: Overview of the Healthcare System in Japan

Japan's medical and health care system is summarised by Raffel (2007). Their system does have certain individualities because of its societal background, however there are some common points with that of Western systems. Children sheltered by the head of a family hold universal coverage by social insurance in Japan. Retirees and self-employed people seem to stick to the plan that is being carried out by the local government. Employees are supposed to unite to the plan that is being offered by the employer as there is no room for choice of plans.

The people living in Japan factually come under the category of the world's healthiest people and live longer than citizens of other countries. The health care system of Japan is thought to be tough, as outlined superficially by Kadonaga and Kanzler (2009). A universal access is provided by the country's National Health Insurance (NHI).

Japan has gained the durability and low toddler mortality rate with comparatively lower ratio between health expenses to gross domestic product. Universal medical care insurance has sheltered the citizens of Japan and everyone is offered with entirely free door to same medical care facilities. Thus due to its outstanding efficacy and equality Japanese healthcare system has been categorised as one of the best in the whole world according to Tokita (2002) and Jonse (2009). People who are employees of small scale firms fit in government run stratagem whereas employees of large companies are roofed by health insurance companies. Contribution is made by both employees and employers which is crowned by national and local government; finance Japan's insurance-based healthcare system (Anthamatten & Hazen 2012).

Japan and South Korea Report (2009) states that co-payments are made by patients, these co-payments are established on a standard agenda of cost, for the treatment of people who are admitted into the hospital or not, that is for the sake of in-patient and outpatient management. For temporary or private employees, there is a national health insurance proposal and additional proposal for national employees, whereas other insurance resources donate in support of the health programme for the old ones. In accordance to the Economist Intelligence Unit (2009 a), Kaigo Hoken is a programme designed for old-age but due to the escalating expenditure of administration, the government is being encouraged to modify it in such a way that younger ones can also get the advantage so that, premiums can be obtained at the age of twenties and thirties as well. However, Kaigo Hoken was initially established in 2000 for helping and nursing of elder people, the person gets the calculated amount of payment if he/she reaches the age of 40 and also meets the particular condition.

Japan certainly does not provide adequate public insurance treatment in contrast with other OECD countries as staff of Organisation for Economic C-operation and Development (2009) states that each person consulted 14 times to the doctor in 2005, which is twice the OECD standard whereas, number of each doctor was three times higher as well, indicating that patients have had shorter meetings with the physicians, therefore the number of consultations increased per person. Though, government wants to make the basic and necessary medical services available for every person, effectively. So that, everyone can be treated at a lower cost, quite the opposite some medical facilities which were highly developed in quality or rates are being restricted due to this government policy.

In accordance with Gyu-Jin (2008), medical doctors should manage all the hospitals as well as private clinics because they are not built for the sake of earning revenues. Two-third of the hospitals are private along with an addition of 3 percent privately owned clinics in 2007. However, the competition which is seen commonly among the high class or low class people is not even imagined here because every person is provided with equal services according to their position of employment or residence. As, Gyu-Jin (2008) further says that, due to the welfare ministry's consistent obligation of rules, there is no chance for the insurance providers to impose their personal decisions on any one or in any case, everyone is going to obtain equivalent healthcare benefit package. Thus, a consumer or a health insurer cannot impose their own interests in the provision of services.

2.4: Overview of the Healthcare System in Canada

The health care system in Canada mainly symbolizes "Medicare" which is universal. In 1962, it was initiated by Tommy Douglas (head of state) to the province of Saskatchewan (Gregorio 2011, p. 3; Irvine, Ferguson & Cacket 2005). Private and public channels help the health care system of Canada economically; therefore it is known to be publicly supported health organization (Marchildon 2005). According to Bernier (2006), methodology of each province is different with regard to health plan as overall authority of healthiness is within the hands of federal government and 10 provinces in Canada. However, there are great differences in terms of finances, management, delivery modes and scope among 13 provinces and regions in Canada, therefore federal Canada Health Act presented "insured services", which can be described as complete systems of hospital and attention of major doctor.

The Canada health Act of 1984 was achieved with authority to facilitate moderate avenue to health services without financial or any sort of obstacle, and to look after, support and bring back the physical as well as psychological comfort of the citizen of Canada. The foregoing policies and principles have benefits in the creation of magnificent, complete and traditionally free healthcare system. The reason for the admixture of Canadian system is because Canadian health policy have been influenced by various other system (Scabloski 2008).On the performance of the healthcare system, when compared with other six nations, Canada ranked sixth in position placing ahead of United States which is the country that does not have universal health care. Excellent attention, contact, effectiveness, justice and health outcome are the reasons for this consistency.

Landmark Lalonde report of 1973-74 is responsible to start the focus on the health system policies in Canada, as described by Belcon et al. (2009) in Canada. Five essential programs are included in the criteria of federal Canada health Act that is comprehensiveness, accessibility, universality, portability and public administration. Canada by contradiction entrust on a public healthcare system , providing coverage of hospital as well as physician care for whole population on basis of residence these are accepted as general values accompanying the Medicare Canadian scheme(Cacace and Schmid 2008).

It is presented by Common wealth Fund (2010) that , Canada follows a pro-autonomy model of healthcare where primary care is left to family physician and community-based facilities as well as the hospitals are specializes in deeply perceptive and accidents (Malchildon 2005) usually, family physician/GPs transfers health services on profit-based fee-for service basis while privately practicing. For profit providers, dental service and pharmaceuticals are also delivered by private .The conclusion made by Canadian federal and provincial health commission is that a strong primary health care foundation is the key to maintain healthcare system.

Surely, the concept is at its early stage of growth, responsiveness clasp features of respect of human right, as in interpersonal aspect of care including quality of basic convenience, respecting patients liberty and nobility as acceded by Robone, Nigel and Smith (2011). Direct access to the physician is not prohibited and Canadians are entitled to choose their own family physician because the Canadian Health Act constrains user charges for guaranteed services and medically important physicians' services are free at the time of care. Several provinces object to immediate contact to the ace by paying low fees for non-accredit buzz, a family physician's recommendation to specialist care is usual in Canada. According to Hutchison et al (2011), the physician judges that whether the payment has to be done conventionally after each service, or not in the after-hours care as it varies region to region.

Each province will probably go after the chiefs in its own time and in its own style as it is common in Canadian health care. The standard activities of progressing provinces and the rate of trademarked federal grant for the advancement of primary health care development plan will certainly affect the rate of evolution (Hutchison et al. 2011). As compared to United States, a greater ratio of population is provided with health care successfully in Canada at low cost. Over a variety of health indicators, there are improved health outcomes in Canada than in America. But all of these rewards cannot be credited to heath care (LaPierre 2012). However, in rural areas of Canada there is geographic hindrance to care, less health care professionals available and thus greater rates of disease than in urban areas (Glazier et al. 2009).

2.5: Overview of the Healthcare System in Saudi Arabia

All over the world, many countries are trying for advancement of healthcare standards, control or contain prices and making healthcare accessible to their public (Walton, Al-Harbi and Al-Omar 2008). Saudi Arabia has an estimated population of 26 million residents and an annual growth rate of 2.2%. Healthcare sector ministers to a fast growing population and there is a parallel increasing demand on healthcare zone (Ahmed and Damrah 2012). For many years, Saudi Arabia has offered inclusive and widespread access. But now the healthcare zone is totally changing because of increasing costs and impressions of low quality. Now there are private health insurance, private hospitals and charge for provision medicine in civil hospitals.

The government is making efforts to create a public awareness that state provision of series of services to such a large level cannot be continued for a longer period. Despite of these efforts most of the Saudi people think that free public healthcare is right of everyone. The local political culture is one of the refrains in the development of private healthcare. It is the part of Saudi state's claim to legality to provide wide series of services for free or at a low cost (Economist Intelligence Unit 2009 b). All Saudi citizens and emigrants working in public zone are enjoying free healthcare in Saudi Arabia mainly through the Ministry of Health and improved by other governmental health services. The government demands that employers should also pay some level of healthcare treatment for the emigrants working in public sector.

The Arabian healthcare systems are rapidly changing although healthcare costs in the Gulf Cooperation Council (GCC) stay low by international standards. Because the behaviours to increased life expectancies and towards lifestyle diseases have changed, healthcare sector is developing rapidly as there is increase in demand for healthcare (Kirsten & Karch 2012). The healthcare for the wealthy and the healthcare for the poor workers are different; they are often classified as the nationals and migrants workers respectively. The healthcare sector is mainly supported by the government and bears about three quarters of the total expenses. In the starting, the main focus was on the fundamental construction of hospitals, pharmacies, laboratories, clinics and research facilities. Dramatic changes were brought to Saudi health care system by the first four expansion plans (1970-1989) (Royal Embassy of Saudi Arabia n.d).

The improvement in quality of healthcare and services was the focal point, after the establishment of these facilities. The Saudi Government took actions to fascinate trained medical employees from abroad and encouraged the public to practise medical careers. Knowledge and equipment was updated continuously and modern medical technologies were built-in. The private sector is encouraged by the government greatly by donating long-term interest- free loans for the development of hospitals, pharmacies and clinics. All over the country the healthcare services are provided by the Ministry of Health and other government agencies.

The MOH association of hospitals is the largest source of medical care in the empire and offer more than 62% of healthcare. Though the MOH is responsible for the healthcare of whole nation, governmental and private sectors also play important role in healthcare and offer over 20% and 17% of healthcare services respectively. Thus there are three major healthcare sectors working in Saudi Arabia: primary healthcare zones and the MOH association of hospitals which are provided all over the country, government organizations and the private zone.

To provide free and reachable medical services to every Saudi national and migrants working within public sector, the Saudi Arabian government has donated huge amount of funds for the betterment of healthcare system (Aldossary, While & Barriball 2008). Healthcare aid in Saudi Arabia is mainly provided by the government although employers are required to sponsors the migrants working in private sector. The government budget largely relies on oil and gas reservoirs (Aldossary, While &Barriball 2008). As a result of changing healthcare attitudes due to adaptation of comfortable, rich and healthy living styles, healthcare system is developing rapidly in Saudi Arabia. The pattern of service relief is intricate with a variety of donors supporting the different care delivery organisations. This may create problems about effective cross-boundary working and the progress of expertise across the nursing workforce (Aldossary, While & Barriball 2008).

2.6: Overview of Hospitals

2.6.1: Introduction

Sultz and Young (2008) define a hospital as a multifunctional institution. Its functions may include one or all from: treating the sick and injured people, providing educations to medical professionals, conducting research and providing jobs to people (Sultz and Young 2008). McKee and Healy (2002) while tracing the origin of hospitals argue that hospitals in the past were deemed as a place for sick people to seek refuge in where they will be provided with the treatment and the nurse care they needed. Earlier, hospitals also served as places for quarantining patients suffering from transmittable infections. McKee and Healy (2002), subsequently argued that the notion that served as the basis of earlier hospitals and philanthropic activities was driven by the Christian belief regarding healing the sick.

Initially, between 661-750 AD, Muslims were of the view that treatment for all diseases is provided by Allah (God). The Islamic history of hospitals can be traced back to the Prophet Muhammad (P.B.U.H). The very first hospital offset up by Muslims was established in the "Nabwi" mosque of Madina during the time of Prophet Muhammad (P.B.U.H). Also, under his injunction, "Rufaida Al Aslmiya" provided hospital services in a tent in the courtyard of the mosque. A major focus was on providing nursing services and training other women in the service. It aimed to provide social and health support to the community by equipping women with health related education (Rahman 2004; Aldossary2008).

Islamic history encountered the growth of many hospitals. Initially, they were named "Bimaristan"; this being a Persian word meaning a home or place to house the sick (Horden 2005). These hospitals were open to all, irrespective of gender, race, citizenship or religion (Nagamia, 2003).

The construction of first ever "bimaristan" can be traced back to the Ummayad caliphate. Caliph "Al-Walid ibn Abd Al-Malik" was the first Ummayad caliph to undertake the construction of "bimaristan" in 707 in Damascus (Rahman 2004). These hospitals consisted of salaried staff comprising of well trained physicians and properly equipped dispensaries (Rahman, 2004). These places were set up to treat the blind, the disabled and the leper. Separate treatment facilities were also offered to people suffering from leprosy (Rahman, 2004).

The modern sponsored hospitals are deemed as an effort to secure heaven by indulging in charity. Moreover, they are also a means of showing ones social standing (through wealth) in the community. Wall (2013) indicated various social and cultural developments that served as the cause for the transformation from merely being charitable guesthouses to the centres of scientific excellence that at present the hospitals in the Western world.

There are other factors that also contributed in the evolution of hospitals such as geographic location, the perceived needs of populations, economics, religion and ethnicity, scientific and technological growth, the socioeconomic status of clients, and new disease. According to the Canadian Medical Journal (1928), studying the ancient society in Asia, Europe and Northern Africa leads us to see all the information in a broader spectrum thus it can be established that the hospitals came into being long before the Christian era as the places to look after for the sick.

2.6.2: Types of Hospitals

- **General Hospitals**

According to Griffin-Valade (2012), for hospitals to qualify as general hospitals they must be able to deliver complete medical and surgical care to the sick and injured along with maternity care. The type of a hospital is determined by the types of services it is providing. Moreover, the hospitals must include:

1. A well-equipped staff with people having professional, technical and administrative talent. Besides the staff there is a chief or chairman of the attending staff, in addition to the department heads of different departments;
2. Besides other services it must include appropriate Housing and lighting services for the laboratory so that all the required tests can be performed to precision. The laboratory must be approved as being equipped with all the necessary equipment to conduct biochemical, bacteriological, serological and phraseological tests. The laboratory should also provide consulting clinical pathological services. The equipment needed to constitute the pathological specimens should also be present (Griffin-Valade 2012).

- **Tertiary (Referral) Hospital**

According to (Hensher et al. 2006), referral hospitals perform multiple roles in enhancement of quality by training the staff and setting principles and values of treatment; by giving the other administrative and managerial hold to the different rudiments of the health system and carrying out the research relevant to the country and by introducing the novel technologies. Primary function of tertiary referral hospitals is indicated by Hensher et al. (2006), that it is to provide the intricate clinical care to such patients who are shifted to these hospitals from the lower levels, however, even if the tertiary hospitals are within the same country the accurate number of services can diverge considerably. Referral hospitals through direct involvement in public health interventions, also give population–level health benefits.

- **Teaching Hospitals**

Reddy (2011) pointed out that the main purpose of teaching hospitals besides the treatment of sick is to teach and prepare the student doctors and nurses. These hospitals are associated to medical or nursing schools or universities. (Reddy 2011)

2.7: Overview of Surgery

Gerbode (1963) argues that surgery is no longer just a provision to physicians but nowadays surgery involves an element of art as well as applied science and also includes large areas of physiology, biochemistry, and other basic sciences. However, Gerbode (1963) identified that traditionally surgery was considered as an art that has transformed over time. The American Board of Surgery (2012) identifies that acquaintance and understanding is required with a broad range of diseases by the discipline of general surgery and it may necessitate surgical treatment. The identified content areas of surgery include the following: Abdomen and its Contents Alimentary Tract (including Bariatric Surgery), Surgical Oncology (including Head and Neck Surgery), Breast, Skin and Soft Tissue, Paediatric Surgery Endocrine System, Solid Organ Transplantation, Surgical Critical Care, Trauma/Burns and Emergency

Surgery, Vascular Surgery. Further, the board identified that General surgery is not restricted to the recital of operations and procedures (including endoscopies) but as a field consists of the content areas listed above. (Grill 2012) stated that surgery by any instruments which include lasers, ultrasound, ionizing, radiation, scalpels, probes and needles is the indicative as well as therapeutic cure of situation or disease processes causing restricted adjustment or transportation of live human tissue. Moreover, Grill (2012) showed that surgery is a process part of the practice of medicine and is done for the intention of physically changing the human body by cutting or obliteration of tissues.

According to Debas, et al. (2006) surgery is best defined by stating what is meant by a surgical condition. In view of this they defined a *surgical condition* as such state that may requires manoeuvring, stitch, slit, removal, or other insidious procedure that typically, but not always, needs local, regional, or general anaesthesia (Debas, et al. 2006).

2.7.1: History of Surgery

Wilde (2010) presented the history of surgery by stating that in the late nineteenth century the boom in surgery gave importance to the double improvements of different methods of anaesthesia from the 1840s, and ever more successful methods to avert post-operative illness from the 1880s. Wilde (2010) further cites the work of Owsei Temkin in the 1950s, the importance of surgical point of view is also enhanced by the historians who gave the notion that the body was acquiescent to mend by altering around with its internal workings, initially by cutting out parts and later attempting to reinstate usual function by restoration and even transplantation.

Lord Lister, by the early twentieth century through his progress of antiseptic operating techniques, almost independently initiated modern surgery with the purpose of killing detrimental organisms in and around the wound, and in particular had come to be accredited by his many fans. According to (Wilde 2010) these procedures incorporated the abundant use of sterile substances such as carbolic, whether used in lesion dressings or during surgery sprayed into the air.

The growth and development of hospitals gave rise to the practice of medicine in Islamic history. This practice gave birth to surgical practices. In fact, during the medieval era, physicians were acquainted with surgical procedures. This acquaintance was merely a result of the procedural descriptions of initial texts (Pormann et al, 2007).

A vast and compounded array of literature on medicine was established by Islamic scholars and physicians. This explored, analysed and synthesised the theoretical practice of medicine. Allegedly, Ibn al-Nafis, a thirteen century physician from Syria, made significant advancements in the sphere of physiology and human anatomy (Huff, 2003; Savage-Smith, 1995).

The skeleton was studied in depth by Al-Baghdadi. He agreed with Galen in his conclusion that the “mandible” has only one part (Prioreschi, 2001). The physiology of a lion’s stomach was examined and described by an Iraqi physician “Ahmad Ibn Abi Al-Ash’ath” in the year 959. Later on, after 900 years, William Beaumont regarded “Ahmad ibn al-Ashath” as the first person to work on “gastric physiology” (Haddad, 2007).

In the early Islamic period, “Ophthalmology” was regarded as the most proficient area of medical research. Ibn Al Haithan was regarded as the most renowned scientist of the 11th century in this field (Hehmeyer & Khan, 2007). Certain vision related disease like cataracts and trachoma were considered important in relation to surgery. During the surgery, an instrument was used to keep the eye open, followed by the usage of certain “small hooks” meant to lift, and a minutely small “scalpel” meant for performing excision. A small cut was made in the sclera with the help of a “lancet”. This was followed by the insertion of a probe which, in turn, depressed the lens. In this way, the lens was pushed aside from the eye (Pormann et all, 2007).

Upper Palaeolithic peoples living tens of thousands of years ago however can be marked out for the abstraction and insidious wound-healing processes, which practiced bone-setting as well as slight surgical procedures, with actually substantial information about human anatomy. Randolph (2000) on the other hand indicated that surgical history is related to thousands of years back to the grand people of premature evolution in Athens, Rome, and Alexandria. (Randolph 2000) argues that surgeons of the Eighteenth-century were superior because of the rapid abstractions, over and above because of the processes such as removing bladder stones, cancers, and even cataracts from the eye. In addition between 1700 and 1799 surgeons and patients all without benefit of anaesthesia were agreeable to try abstractions as well as complex and even daring surgeries on foremost organs of the body, which until the nineteenth century was not present.

2.7.2: Types of Surgery

- **Elective Surgery**

The Australian Government (2011) defined elective surgery as the one which for more than 24 hours can be postponed securely. The Australian Government (2011) states that it is also known as planned or booked surgery. Elective surgery does not mean that the surgery is not obligatory, however elective surgery is frequently life saving such as amputation of a tumour or very important to a patient's health and well-being such as a hip surrogate so the purpose of using this 'elective' name is only to differentiate it from emergency surgery, which must be given within 24 hours.

Patients often undergo long waiting times which has a negative consequence on health and quality of life. Valente et al. (2009) state that waiting lists for elective surgery (WLES) are challenging for public healthcare systems. This line of thought is accentuated by Hurst and Siciliani (2003) who show that such delays can cause a number of problems and complications, including: the worsening of the condition for which treatment is expected which can end up with death; the failure of utility particularly if cure can alleviate momentous pain or disability; accretion of any loss of income from work; and accrual of income support payments for example sickness benefits; the total cost of the treatment can increase, pre- or post-surgery. According to (Hurst and Siciliani 2003) these costs are probable to diverge significantly through time across circumstances, and across countries.

- **Emergency Surgery**

It is noted that high level of physical discomfort and pain for the surgeon comes as a result of using MIS i.e. a method that leads to lesser pain and shorter recovery times for patients. the American college of surgeons published a study in their Journal where the investigators from the University of Maryland state that 87% of surgeons involved in MIS experience regularly sow physical symptoms of discomfort (Women in surgery 2010).Women in surgery (2010) state that the minimally invasive surgery-MI is known for its ability to causes less pain and shorter recovery times for patients (Women in surgery 2010).

Milsom et al. (2009) while trying to explain on the future of Minimally Invasive Surgery provided that at present minimally invasive procedures can be used to perform a lot of surgeries be it highly complex or very simple because of the because of the technological developments in the field of medicine. During endoscopy the bowel can be expanded by using carbon dioxide CO_2 as a substitute to air which puts it into the second class of surgical procedures (Milsom et al. 2009). The procedure of conducting minimal invasive procedures was consequently described by Rosen et al. (2001) as a procedure where a miniature video camera and instruments are inserted through small portals. Whereas in earlier times were made to conduct such operations these large incisions needed extensive amount of time for recovery unlike the modern methods of surgery (Rosen et al. 2001).

2.8: Overview of the Operating Room (Surgical Suite)

Area designated for surgical operations where all the required materials are stored and made available for surgery is generally known as operating room suite of simply surgical suite. The whole area in some literature is described as “operation suite” / OR (U.S. Army n.d). It is also defined as the core unit of “operative” procedures conducted in the entire surgical clinic. Due to the invasive manipulation on patients, it is considered as a sensitive element.

Terminologies to define these surgical suite settings have evolved and now operating rooms and pre-operative departments are used to refer to these settings. Operating suite establishments have a strong impact on hospital economy. Therefore careful designing of operating room is crucial given the high costs involved (Berry et al 2008; Guerriero & Guido 2011).

Another study depicts OR as one of the most profitable service, and together with surgical and interventional processes, it is regarded as core engines of modern hospitals (Watkins et al. 2011). Few parameters such as construction of OR, operational inefficiencies and associated safety risks can put restriction on the economic efficiency of this revenue centre. Coordination of other activities with the surgical procedures including patient recovery, patient intake and surgical procedure involved are widely recognised as important in surgical service improvement (Gul et al., 2011).

2.9: Operating Room Management

Profit can easily be generated by means of efficiency in for-profit organizations whereas in not-for-profit organizations, same economics can be used to for operational procedures through efficiency (Wright, Roche & Khoury, 2010). Another critical issue is the low transparency of decisive steps which are made to restrict the liability of ones owing top medical hierarchy (Vashdi et al., 2007).

One survey study reports that majority of hospital settings prefer maximizing patients' satisfaction in limited economics thus preserving financial assets (Cardoon et al. n.d). Operating room is the most critical unit because it requires huge expense and also considered as revenue centre. Its proper management determines the hospital performance. A number of factors are affected by surgical suites operation management such as costs, patients flow and hospital resource consumption (Gupta, 2007). Operating room is of significant importance because of the amount of expense they involve and revenue generation (Urman & Eappen, 2012).

According to Marjama, Vakkuri and Kirvela (2008) different parameters such as resident surgeons training, anaesthetic method selection, operation monitoring, effective scheduling, shortening case duration through parallel processing and overall performance should be kept in consideration while developing ways to augment operational efficacy. Important decisions which need careful planning and are taken by the highest hierarchy of hospital management team are type of surgery to be performed, number of surgical suites to be established and types and number of equipment and machines to be installed in the allocated surgical suite (Gupta, 2007).

2.9.1: Overview of Operation Room Organisation

The Surgical suite is an organizational unit. It is an organization of healthcare professionals, which provides multidisciplinary healthcare to different procedures by means of surgery in a specific functional area (Ministry of health, social policy & equality 2011).

Major medical decisions including appropriate time for surgery are generally taken by physicians whereas nurse heads participate more vibrantly in long-term planning and scheduling than the group of anaesthesiologists. Transparency can be improved by implementing modern technologies e.g. installation of dash-board-like monitors because it facilitates the identification of casual relation which result in process variation (Marjamaa & Kirvela, 2007). Anaesthesiologists are considered as the most suitable personals who can overview surgical activities because of their diverse medical knowledge and unbiased nature.

Analysis of on-going-inefficiencies of operational schedule and procedures is the responsibility of health care manager. Root cause of the related issues are supposed to be determined by him and then subsequent training sessions for staff including physician, surgeons, nurses and anaesthesiologists for a particular surgical suite are organized to improved efficiency (Ozcan, Yasar & Ph 2009).

2.10: Patient Flow in Surgical Care

Studies indicate that scheduling a surgical block is a complex process because there are numerous parameters which should be kept in consideration while planning a schedule (Santibanez, Begen & Atkins, 2007). Priorities for services, surgical specialities, combination of elective and emergency cases and surgical specialty are the few of influencing elements which complicate this process. Speed of healthcare treatment is critical i.e. short waiting time for patients and it depicts the quality of health care facility. Time allocation from the total available time is made for each surgical service and this is mentioned in block schedules designed for this purpose. Then time slots specific to a surgeon is determined by the surgical services for routine basis (Rohleder, Sabapathy & Schorn, 2005).

Recently, there exists an increasing trend for hospitalization due to the advent of modern technology for diagnostic and therapeutic purposes. This assures quality service with high standard for clinical safety (Ortiga et al., 2012). However any physical damage to the designed facilities and operational disruption and supply chain mismanagement will impart a negative impact on the performance efficiency of OR department and it may also result in emergency condition (Arboleda, Abraham & Lubitz, 2007; p. 302). According to a research, if flow is maximized then throughput delays will get reduced (Jenkins & Gisler, 2012).

Patient flow affects operational as well as clinical imperatives and therefore, increment in occupancy rates for hospital management is uneconomical and counterproductive (Amoud et al., 2007). Bed availability also affects the process of patients experience at the hospital. It implies that emergency cases should have access to quality health care service (appropriate bed provision on time) upon their admission to the hospital. This decreases the chances of unpleasant situation faced by patient while waiting for services. In case if a patient is admitted in hospital and put on waiting list for elective surgery then chances of surgery cancellation should be reduced because too much delay can result in bed unavailability (Ortiga et al., 2012).

A research study suggests that majority of the cases with adverse situations appeared due to medical mismanagement instead of deficiencies in intra-operative care and it implies that such instances can be reduced by bringing improvements in care provided to patients outside the OR (Hinami et al., 2011). Recurrent operational failures are observed in hospital settings where coordination between concerned departments is absent and nominal (Frendendall et al., 2009). Therefore establishing effective management strategies influence the surgical centre cost-containment process and that is why a great stress is give on it due to the increasing health care costs (Ferreira et al. 2008).

Comprehending the outcomes of elective surgery scheduling decisions requires a thorough analysis of path followed by patients from decision point to surgical services (Sobolev et al., 2008). Similarly it is important to understand the patient flow model for assessment of hospital decision consequences and policies adapted (Helm, Ahmedbeygi & Oyen, 2009).

Effective transformation of inputs into outputs requires effective planning for patient volume and control (Vissers, 2005). This assists in the determination of accurate type and level of health care service to the patient seeking treatment at the very initial stages. Further detailed redesigning of this check is essential as the framework complicates. Factors which influence and help in the verification of health care appropriateness with the respect to patient conditions are type of resources and departments involved and type of operational activities to be performed. In case of surgical patients, operating rooms are used for conducting surgical procedures. In these cases, assessment of service appropriateness is relative to the relation between operations, resources and patients and complete evaluation of it will be a complex process (Vissers, 2005).

One proposition which was found to be effective in optimization of hospital care resources is effective management of case admission and discharge. Hospital productivity can be augmented by adopting this multiple intervention project. A primary effect of admission process is on stay length. Particularly in schedule admissions where pre-surgery admission stay is less because majority of the patients are admitted on the day of surgery. Beside this, it is generally preferred in most of the surgery procedures. In addition to this, planned discharge of patients improves information sharing process and teamwork at workplace. Information management and preparation for each patient is the responsibility of house officers (Ortiga et al., 2012). A good teamwork spirit ensures patients' safety and it produces an environment where assistance from officers and staff members are vibrant (Gregory & Andropoulos, 2012).

Upon referral, surgeons first evaluate patient's disease severity and need to operate (Belson & Hall, 2006). Operative decisions are made upon indication of surgery. In case if immediate surgery is not possible then patient are hold on the surgeons' waiting list. Situations where there are not chances of mortality due to delay in surgery, rule of first come and first serve is encouraged for patients. In case of potentially life-threatening conditions, registration of patients is made on the basis of priority wait list. Ranking of patients is made on the basis of urgency to operate and allocation of priority class for each patient is done to determine their position and status on wait list. High priority patients are dealt first regardless of their arrival time in comparison to the low priority patients similarly different patients having same priority are position in wait list according to their time of arrival (Belson & Hall, 2006).

Patients are discharged once the physician is satisfied with the provided intervention and also the condition of patient when considered to be easily managed outside the intensive care ambiance of hospital. Discharge orders are issued to the patients by their doctors. There can be front end delays due to the physician schedule for patient rounds, consultation, delay in lab results and other similar reasons (Jenkins & Gisler; 2012). There is a great emphasis on patient flow and the hospitals settings which acquire standard patient flow are appraised with the need of disciplined and proven process enhancement in the established methodology. It should be considered as system in which hindrances to patient flow are supposed to be determined and possible ways of elimination should be proposed (Johnson & Capasso, 2012).

2.11: Evaluating Operating Room Performance

2.11.1: Introduction

In a research study conducted by Dexter, Watchel & Epstein (2011), it has been depicted that former research work doesn’t contain the description of methods that can be used for assessment of decision-making policy and practice having significant impact on the efficacy of OR performance. Though remarkable advancements have been made in the areas of surgery and anaesthesia and upgrading in pre-operative care has been made but still there exists variation in surgical outcomes (Bratzler, 2006). Majority of the health care facility involves only full time workers and direct care staff in competence assessment process while the remaining staff members such as the ones on contract, part-time duty and on-call staff members are left ignored and this compromises the efficiency of ORs (Joint Commission on Accreditation of Healthcare organizations, 2002). This study is has been derived from the published report “Statistical process control as a tool for controlling OR performance; retrospective analysis and benchmarking.”

Many studies report the monitoring of surgical performance through statistical process control for example comparative analysis of groups to check the impact of small process shifts. Some of the proposed studies show stability in this process.

In addition to this, there are certain methods which have the potential to alter the impact of these patterns and consequently outcomes of procedures will also be affected (Flin & Mitchell, 2009). Few parameters which help assess the performance of OR and its outcomes are financial efficiency, practitioner centred efficiency, operational efficiency, patient-centred efficiency and scheduling efficiency (British Columbia Medical Association, 2011).

2.11.2: Evaluation of Surgical Performance through Mortality and Morbidity Rate

Quality of high risk surgery is depicted by the associated mortality rate. A little attention has been given to the reliability adjustment factor. Statistical reliability adjustment is required in conditions when the considered sample size is too small. In such instances, sample size limits the study and it is hard to determine that whether observed high mortality rates are associated with poor quality of operating room or by chance (Dimick et al 2010). Effective teamwork is essential for high safety of surgical procedures that involve great risks (Nestel et al., 2009). Presence of reliable system is more important than having strict monitoring of clinical performance (Rees & Dineschandra, 2005). ORs staff members have a direct impact on its efficacy through their activity and practices (Pandit, J. Westbury & Pandit, M, 2007).

2.11.3: Use of Teamwork to Evaluate Surgical Performance

Anca (2007) highlights the importance of teamwork and harmony among staff members in workplace. It defines the ambiance of working environment of organization and this also depicts the performance of that health care facility. The standard processes then ingrained in health care professionals and this brings it in their routine practice (Summers, Humphrey & Ferris 2012). This also facilitates the recurrent problem identification introduced by hierarchical and cultural barriers.

Pandit, Stubs and Pandit (2009) sets down that productivity augmentation which assure efficient performance of staff members in the allocated time duration. In addition to this, satisfaction of stakeholders including patients, health care managers and politicians are necessary that their investment in the process is improving the efficiency of operating rooms.

2.12: Planning And Scheduling Operating Room Activities

In one of the studies (Testi & Tanfani, 2009) highlighting the significance of Surgery Departments in hospitals during the last few decades different researches proposing organization and proper planning of surgical activities have been discussed. There are many different parameters which affect the surgical activities planning and it should not be ignored while designing surgical management system. Presence of emergency cases raises the issue of uncertainty in the formulation (Gul et al., 2011). Limitations on hospital resources results when the semi-urgent surgeries schedule is uncertain and this impart a considerable impact on surgical planning for elective patients as any delay would create a negative impression on the patient and it may also pose health concerns for them (Zonderland et al., 2010).

Health professionals have to face embarrassment in such instances of surgery cancellation and reschedule. Semi-urgent status is given to the cancelled elective patient’s surgery and this in turn cause delay or cancellation in another elective patient’s surgery. Further time management is surgical procedures becomes critical when the time taken for the completion of one surgery is unpredictable and this greatly influenced by the type of operation conducted (Stepaniak, Heij & de Vries, 2010). There are two depending factors which affect the overall process; arrival of semi-urgent patients arrival, cancellation schedule of elective patients in the given timeline

(Zonderland et al., 2010). These scheduling issues appear due to mismanagement in procedure selection, time allocation for it, procedure sequence in the given time slots. Resource time is defined as the time utilized by surgeons such as blocking time. In addition to this, surgical scheduling is affected by Brick & Mortar decisions and staff schedule to provide personnel's support.

There are numerous problems associated with surgical scheduling process and it can be explained on the basis of planning horizon that staff member opt for. The overall process includes all the decisions which are of stakeholders concern. Hospital administrators and surgeons are involved in facilities improvement process. They assign different time slots to assigned surgeons. Few other responsibilities of are allocation of time to patient, last minute adjustment and execution of planned schedule (May et al., 2011). Implementation of resulting tools is a real challenge for OR managers. Scheduling process is affected by all the staff members' availability thus, imparting a considerable impact on OR schedule (Van, Bredenhoff Hans, 2010).

Session planning problem/SPP is the first phase in which time distribution to different wards is performed. Subsequently, a Master Surgical Schedule is developed which can be defined as a cyclic timetable which and it explains which block or time slot is allocated to a particular surgical unit. In the last phase Elective Case Scheduling/ECS is planned and the available time is distributed among elective cases is their assigned blocks and all the cases are arranged with respect to time in a sequence (Testi, Tafani & Torre 2007). Main objective of this schedule practice is time management for elective cases which ultimately increases the performance efficiency of OR department (Persson & Perrson, 2010).

There are two types of vendors that market OR suites software in both the private and government sectors: computer-based patient record (CPR) system vendors, and niche software companies. Every product differs in how well it supports integration with, or interfaces, the care delivery organisation's internal applications (including the hospital's CPR) and connectivity with outside stakeholders (Kelly 2005). Tables 1 and 2 present the illustrative vendors in each category that have successfully been made available on the market.

Computer-based Patient Record (CPR) system	
Company	**OR Software Product**
Cerner	SurgiNet (internally developed as part of the Cerner Millennium product line)
Eclipsys	Sunrise Surgical Manager (offered through a partnership with Surgical Information Systems)
Epic	OpTime (internally developed as part of the Epic acute and ambulatory care product line)
GE Medical	Centricity Perioperative Surgery Management (acquired from iPath and incorporated with the Centricity product line)
IDX Systems	Carecast OR (offered through partnership with Picis)
McKesson	Horizon Surgical Manager (internally developed as part of the Horizon product line)
Meditech	Operating Room Management (internally developed as part of the Health Care Information System product line)

Table 1 Computer-based Patient Record (CPR) System - Source: Garther 2005

Niche OR Software Product	
Niche Vendor	**OR Software Product**
Picis	Caresuite
Surgical Information Systems	Surgical Information System
Per-Se Technologies	ORSOS One-Call
Mediware	Perioperative Solutions
Unibased Systems Architecture	Perioperative Resource Management System

Table 2 Nich OR Software Product - Soursce: Garther 2005

All the systems listed above form a tools for facilitating the Operating Room management process to coordinate staff, equipment, surgical suites and patients. It also enable the communication process to allow surgical staff to place requests from remote locations.

These solutions permit access to the common data elements including the patient's medical records, and statistical data among the surgeons, anaesthesiologists and surgical staff. Also, these solutions help ensure accurate patient records, as well enabling the placing of laboratory orders to ensure specimens arrive on time.

Hence, it is clear that these solutions are coordinating and data recording programs and do not play any performance analytical role. Therefore, it became a goal of this study to develop an evidence based Operating Room Assessment Framework to analyse the statistical data derived from the existing solutions, to work in parallel with these systems, in order to be able to evaluate Operating Room performance and to serve as a decision-making tool.

Most of these software types are compatible with Microsoft Excel, which can be used as a link between this software and the new Operating Room Assessment Framework, to transfer the data in order to evaluate Operating Room performance.

2.13: Operating Room Workload

OR workload bring about the concerns regarding the scale of patient and treatment protocol along with the high level of technology and coordination which is mandatory for managing the changing conditions in surgical operations quickly and effectively (Christian et al. 2006). He et al. (2011) in defining workload states that workload can be deemed as the hours sent in the operating room on a certain day by a medical specialist to carrying out surgical procedures. When it comes to the health care industry there is no doubt that operating room (OR) offers a work environment with maximum complexity.

The workload can be defined as a vibrant balance between the challenge of a task and how an individual reacts to that task. Another major definition of OR workload is established by Leedal and Smith (2005) According to their definitions of workload they are very complex procedures.

Vincent et al. (2004), highlighted the multiple stage process approach aims at expanding the operative assessment to not only the confines of patient factors and the technical skills of the surgeon; to include in it the assessment of surgical skills further than bench models to the operating theatre so that interventions can be assed better and surgical outcomes could be improved because of better understanding. OR workload can be managed by applying a number of approaches like many hospitals use the multiple stage process approach for the long term allocation of operation room time to the surgical specialties like total surgery hours each year (Vanberkel et al. 2010).Another major theoretical approach in OR workload management is the systems theoretical approach to surgical quality and safety.

An economic system of strategic behaviour can be deemed as the Game theory it is also known as the “theory of social situations.” The game theorymore than often applicable in OR workload management. In application of this theory it is patent that surgery and the operating room environment both require a number of social situations comprising of cooperative as well as non-cooperative behaviours (McFadden et al. 2012).

Athanasiou and Darzi (2011) suggested that game theory modelling in health care is used to come up with a solution for a pre-defined game setting. Lastly, as advanced by Salmon and Hall (1997), the application of the postoperative fatigue theory is central in the management of OR workload. The behavioural and subjective change when applied with this theory has devised an assumption that the physiological and metabolic outcomes of surgery cause these changes.

Effective OR management is essential in the sustainability of a hospital. As noted by Cardeon et al. (2011), maximum cost revenue for the hospital is generated by this facility and it is a fundamental element that determines the overall performance of the hospital. Workload management comprises of the allocation of operating room time regarding the strategic decision to have more ORs. There are two stages of allocation: a long-term tactical stage and a short-term operational stage (Dexter et al. 2005).

For the distribution of workload OR workload management requires development of empirical models (He et al. 2010). Based on a study conducted on operation room time, although intervention management had little effect on costs, it reduced the operation time. Dexter et al. (2006) notes that the management factors are related to the fact that every case is different thus requires different OR time. Labour costs will not be reduced as the hospital operating rooms have to deal with undefined workload causing disorganisation in the structure.

According to Larson et al. (2005), an all-inclusive evaluation on areas like clinical performance, professional behaviour, technical skill, and number of procedures performed all comes under the OR workload evaluation. The surgical results through some researchers have been declared as effected by surgeon's intra-operative non-technical skills. The assessment of Non-technical Skills for Surgeons is equally influential in OR workload evaluation (Yule et al. 2008). .

2.13: Operating Room Utilization

In containing costs, optimally utilizing expensive resources is of great significance according to Augusto and his colleagues (Augusto et al 2010). Due to this, keeping operating rooms completely in use when staffed is suggested as one economic consideration (Tyler et al 2003). In their respective operating suites, operating room managers will aim to fully maximise labour productivity. Reducing daily variability in the hours of operating will also be attempted. For this, no cases may exist though the presence of staff is ensured (Dexter et al 1999).

In evaluating the operating room's performance, operating room utilization has risen to be a major source of concern (Viapiano and Ward 2000). Moreover, according to Faiz and his partners, Trusts across the United Kingdom use utilization as one of the principal managerial yardsticks of operating room performance. The surgical volume successfully admitted and operated on from elective lists is broadly reflected by operating room utilization. Within individual trusts, administrative process failure may also be exposed at the extreme point (Faiz et al 2008).

The total time consumed in performing each surgical procedure (inclusive of preparation of the patient in the operating room, emergencies, and anaesthesia induction) plus the total turnover time divided by the budgeted time available, altogether presents the classic definition of operating room utilization (Strum et al 1997; Tyler et al 2003). However, the classical measure of utilization does not explain the utilization of operating suites adequately according to Sturm and his associates (1997). Due to its failure in differentiating the quality of utilization, they stressed upon the improvement needed in the classic definition of operating room utilization in 1999. In this regard, the following example was presented by them: A single OR budgeted for 8 hours with two 4 hour surgeries scheduled. Classic utilization was measured as 100 (4 + 4) ÷ 8 = 100% (devoid of wasted resources) if the surgeries are performed consecutively within the budgeted workday. In comparison, consider the same OR when one 4 hour surgery is done in the regular working time while the other is done after hours. In the latter case, an expensive OR is unused for 4 hours, together with an additional 4 hours for which personnel must be called in again, resulting in overtime costs. The phenomenon of 100% classic utilization is depicted by each scenario, but both under and overutilization is presented in the latter case (Strum et al 1999).

An attempt was made to develop a model for operating room utilization by Sturm and his associates. Under this, a distinction between usage and utilization was clearly made. The total amount of time for which operating suites were used defined the usage while utilization was explained as a function of the sum of the time used and budgeted for the operating suites. In order to create a better measure of utilization, two new terminologies, namely underutilization and overutilization, have been defined by the authors. In the surgical suite, several types of utilization may occur, which have been defined by the authors as follows: cases commencing before/after the budgeted block time are categorised as overutilization; surgical cases commencing and ending during budgeted OR block time are classified as budgeted utilization; while underutilization is explained as the budgeted time unused for surgery. Preparing along with the appropriate allocation of portions was carried out for cases overlapping the budgeted and non-budgeted OR block time. As evaluating the quality of OR schedules and the efficiency of OR utilization was a possibility, an emphasis was placed on underutilization and overutilization as vital measures by the authors (Strum et al 1997; Strum et al 1999).

However, in order to ensure that the services offered by the OR are suitable, careful analysis of the health care environment needs to be done. Ensuring that the greatest number of cases are done is not merely OR utilization. Balancing several conflicting needs is needed for appropriate utilization of the operating room. Without understanding the part played by the OR in the institute's finances, mission, various departments, and the actual data pertaining to the costs and utilization, this cannot be done (Viapiano and Ward 2000).

Meaningful use of utilization as a tool for benchmarking theatre performance can be obstructed by various factors amongst organisations with respect to inconsistent methodologies and overrun rates used in calculations. Moreover, as a marker of OR performance in the public sector, little investigation has been conducted in order to ascertain the validity of operating room utilization (Faiz et al 2008).

Managerial investigation is facilitated by extreme utilization rates. For future decision making, quantitative measures of OR efficiency and workload will most probably be used (Faiz et al 2008).

Hence, maximising productivity and cost efficiency for success in the long term must be the targets of all those working in the OR. Facilitating various stakeholders (nurses, chief executive officer, anaesthesiologists, surgeons, chief financial officer) through reliable data is required in order to accomplish these targets. Aligning disparate goals is also included in this. In the future, managing operating rooms will call for the creation of information systems that account for all aspects of utilization, inclusive of costs and revenues, as a must (Viapiano and Ward 2000).

2.9: Conclusion

This chapter presents a critical review of the literature for the thesis, with the literature selection being based on the themes and overall objectives of the study. Firstly, the literature provides an introduction to the healthcare system in general and explains the stages of healthcare systems' development with an explanation of the healthcare systems' roles, and an indication of the types of healthcare systems pursued, informed by the healthcare systems in Japan, Canada and Saudi Arabia. The subsequent section then discusses the different types of hospitals. This is followed by a summary of the surgical procedures. The subsequent section then reviews the operating room (surgical suite) followed by an overview of operating room management and surgical patient flow. The final section of the chapter briefly reviews the topics related to operating room performance.

The following chapter presents the research design/methodology of the study.

CHAPTER 3
RESEARCH DESIGN / METHODOLOGY

3.1: Introduction

Following the literature review, this chapter presents the methodology used for the thesis. This chapter draws on the literature and offers a discourse on the research philosophy, research question, design of research, and method of research, followed by describing the use of case studies.

3.1: Research Philosophy

A specific research paradigm manifests itself in the researcher's perspective and the epistemological position which he or she takes (Saunders et al., 2003). Thus, it is extremely important that the researcher has a very clear understanding of the paradigm that underpins their research (Hines, 2003).

With respect to the research paradigm, positivism and interpretivism have to date received approval from researchers as being highly influential lenses through which to view the world of knowledge within the social sciences (Corbetta, 2003). For positivism, it is stated that it is "a position which advocates application of the methods of the natural sciences to the study of social reality" (Bryman and Bell, 2003:14). According to the perspective of positivism, reality (knowledge) is something invariable because it is governed as such (Snape and Spencer, 2005). Therefore, positivist research employs theoretical ground work; its research tools for investigation and its statistics are mainly derived from the core natural sciences (Corbetta, 2003) to develop a position of common conceptual statements that helps in generating knowledge (Stiles, 2003). Positivism offers the assumption that reality is researchable and objective, and so its epistemology carries a deductive research design (Lincoln and Guba, 2000).

This specific standpoint with regard to reality stresses prediction and defining a natural phenomena (May, 2001); moreover, it sees replication of research as an effective strategy, thus requiring a well structured research design (Gill and Johnson, 2002). The position of an investigator using a positivist approach is to look at the phenomenon as a detached individual, interpreting the data gathered in a neutral way and then deriving their understanding and conclusions which can be stated in a law-like way (Saunders et al. 2003). Positivism, particularly in the domains of business and management sciences, is not regarded as a stance which facilitates obtaining a deep understanding of challenging issues (Swartz et al., 2003).

Conversely, regarding interpretivism, it is stated that it is a philosophical stance which uses naturalistic methods and concentrates on holistic understanding of human being experiences in context-specific settings (Oates 2006). This particular standpoint carries the common belief that life and the world are made up of different forms of reality perceived differently by different people (Stiles, 2003). Interpretivism assumes that the world can be investigated and explained, but not in terms of statistics. A vocal, illustrative, or explanatory definition could be useful, since it looks at the world as if through multiple perspectives and so its understanding should also be from multiple standpoints (Swartz et al, 2003).

It is important to state that these two positions on investigating the world are highly significant, since research issues usually require a composite methodology that relies on more than one perspective (Easterby-Smith et al., 2002). According to Swartz et al (2003), interpretivism and positivism can be taken as relevant perspectives, rather than two mutually exclusive paradigms. As a result, theoretical underpinning is situated within interpretivism and positivism. Management and business studies often blend these two standpoints, and this particular stance may be termed realism (Saunders et al. 2003).

The research in this thesis is integral, and therefore may most accurately be described as descriptive and interpretive.

3.2: Design of The Research

The research design is the primary framework for converting a problematised research issue into proper and useful evidence-based research (Ghauri and Gronhaug, 2002). A particular set research design facilitates the research by organising research related activities to arrive at the research objectives (Easaterby-Smith et al. 2002). The main purpose for following a research design is to produce evidence which helps the researcher to answer their research questions (de-Vaus, 2001).

- **Research Approach**

The connection between theory (which comes first) and data has remained a philosophical debate for decades among researchers from different schools of thought. Two approaches, deductive or inductive, can be chosen by researchers for their work (Easterby-Smith et al. 2002). As far as the inductive approach is concerned, it is the process of noting facts to develop theory (Ghauri and Gronhaug, 2002). This approach helps us develop a theory that employs empirical clues to further the process, from examination to conceptualisation (de Vaus 2001). Contrary to this, the approach of deductive research is followed by the "gathering of facts to confirm or disprove hypothesised relationships among variables that have been deducted from propositions" (Ghauri and Gronhaug 2002 p. 15). Thus, at this stage, theory is tested, and this testing begins from a concept and develops toward examination, by employing rational thinking to reach a conclusion based on the set of assumptions formerly founded on theory (de Vaus 2001). Following this interpretation of the deductive approach, it can be seen to offer some primary features: it involves a very controlled framework which permits duplication of a research method and it relies on statistical data; it intends to define causal connections between various variables (Gill and Gohnson 2003). The present research finds its ground within the inductive approach because of the nature of its aim, which is to develop clear and complete guidelines, with an adapted mathematical model and a graphical model, through the examination of the current systems used to evaluate the performance of the operating room.

- **Type of Research**

Research is of three main types: explanatory, exploratory, and descriptive. Explanatory studies are very effective in looking at issues which are superficially not organised but need to be investigated using various types of expertise, such as the expert capability of a researcher in observing and then defining some problems (Gauri and Gronhaug, 2002). Exploratory investigations are very significant in situations that require exploring certain layers of life and trying to reach some creative conclusions about a present phenomenon from a fresh perspective (Saunders et al. 2003). Contrarily, descriptive research is very useful in manifesting a clear outline of some occurring phenomena, thus, this type requires systematic regulators to approach a problem (Saunders et al. 2003). Structurally organised problems are well addressed by descriptive research (Ghauri and Gronhaug 2002). Explanatory type research endeavours to examine causal connections between different situations. Henceforth, the present research can be said to fall within the descriptive and explanatory types of research, since it intends to investigate the most favourable processes employed to evaluate the performance of the operating room.

- **Cross-sectional Structure**

The structure of cross-sectional research applies to studies that bring into focus an immediate snapshot of a specific issue at some point in time. It does not try to examine the transformation of situations stretched over a long period (Swartz et al. 2003). Thus, it gauges the cause and effect of something at one point in a timeslot (Ghauri and Gronhaug 2002). The present study will gather data from particular hospitals and will make use of interviews during a single timeframe. There are numerous merits to following a cross-sectional research structure: it helps to reach a conclusion comparatively swiftly since the researcher moves up to the stage of data analysis immediately after gathering the data, without any designated delay of any kind. Moreover, it is the most efficient design of research when it comes to research costs (de Vaus 2001).

3.3: Method of Research

There are two specific research methods within the social sciences: (i) quantitative, and (ii) qualitative. Each method carries its own strengths and weaknesses. The quantitative research paradigm (grounded within positivism) has certain key features. This type of research can be implemented in a broad spectrum of situations; it can employ quick and economic means, and can expansively employ numerical and larger samples and interpret them. Nonetheless, quantitative research (and positivism) also bears some demerits as it has an inherent deficiency in producing a theory (Easterby-Smith et al. 2002).

Conversely, interpretivism, grounded within the qualitative paradigm, carries some effective strengths. This approach employs natural ways which offer the convenience of examining some changes that take place over a period of time (Easterby-Smith et al. 2002). It is very feasible in attempting to gauge human behaviour; it is also elastic in dealing with surfacing challenges, and supportive of theory building. Nonetheless, interpretivism also has some weak points: this paradigm is highly time-consuming and the interpretation of data can pose complexities. It is also cumbersome to organise the pace of such research, and the development and conclusion of this type of research (Easterby-Smith et al. 2002).

As a result, a number of experts are of the opinion that a mixed-methods approach can be very useful for carrying out a more thorough investigation. For example, employing various means of research for various purposes within the same investigation can be useful as it creates data triangulation (Saunders et al. 2003). Triangulation in research means employing more than one specific research framework or source of data collection within the same study (Bryman and Bell, 2003). This study includes semi-structured interviews to determine the details of each system and to investigate the similarities and differences between the Operating Room Management Systems to ensure their validity, whilst also having a focusing on statistical information; therefore, the present research study will employ both qualitative and quantitative research techniques as a mixed-methods approach.

According to Yin (2003) a theory can help a researcher to conduct a case study to gain an in-depth insight into an organisation or a company. Since this research involves the study of practices in a number of hospitals, the major technique employed is therefore a case study. The very reason for choosing the case study tradition as a technique for this research is to explore and understand the various approaches, ways, and efforts employed by the hospitals to evaluate Operating Room performance.

The interviews to be conducted for the present research (semi-structured interviews to be precise) will include the staff working in the operation phase and the admissions phase. To examine the process, the researcher will pursue the general care of the patient, beginning with the before-operation evaluation of the clinic, up until an operation is performed. Management data such as documents describing policies, and rules and regulations for the management of patients and operations, will be considered.

- **Semi-structured Interviews**

In this form of interview, a set of questions to be investigated is determined. This set of questions comprises major themes, topics, and areas related to the research. Through this technique a researcher can focus on the investigation, and as the interview proceeds relevant sub-themes and topics can be added to a specific interview. The semi-structured interview also offers the freedom for the researcher to vary the order of the research (Saunders et al. 2003). Moreover, there is also flexibility for delving deeper into some of the relevant issues (Feilding and Thomas, 2004).

The present investigation will employ an open-ended approach to questioning. This specific type of questioning technique does not adhere to a pre-set scheme of listed questions, so the interviewees have the freedom to answer in their own way (Frankfort-Nachmias and Nachmias 1996). The open-ended technique of questioning in an interview allows for greater freedom in answering by an interviewee in their familiar language, and so they provide a spontaneous response (Oppenheim, 1992). It encourages the interviewee to participate in the interview as in a discussion, and to be able to take time in giving detailed responses to questions and probes (Swartz et al. 2003).

Semi-structured interviewing carries quite a few merits. It aims to invite the interviewee to share their own particular standpoint. It can emphasise the areas seen by the respondents as being significant. Moreover, it allows the researcher the opportunity to invite fresh probes within the same interview by taking clues from the respondent’s replies. In addition, it provides rich data in the form of detailed responses (Bryman and Bell 2003). Nonetheless, this approach is not devoid of weaknesses. First of all, this approach needs to be executed by a well trained researcher; secondly, a semi-structured interview can take a lot of time in discussion and then data analysis. Also, numerous factors with regard to bias can endanger its reliability (Brewerton and Millward, 2003). The present study will employ semi-structured interviews to talk to the head or the nurse in charge of the preoperative assessment clinic; the manager (or coordinator) of the surgical area; individuals in charge of the admissions office or other staff; the nurse responsible for the operating room scheduling; the head nurse on the surgical ward; the head nurse for the holding room of the Operating Room, and the surgical team leader.

In the present research no patient has been asked either to be interviewed, or for the dissipation of any private data.

- **Analysis of Data**

The present study will employs thematic content analysis to form interpretations from the interviews. This approach to data analysis requires the splitting of data collected from interviews in accordance with the stages of the regular procedure for the surgical patient, starting with the surgical clinic up until the surgery is performed.

The surgical patient flow will be analysed for each hospital in full, to find out the structure of each system and to assess the smoothness and effectiveness of the process.

A comparative analysis will be conducted between each section or service within similar areas at the other hospital to examine the similarities and differences between these systems.

The official reports have been obtained from each hospital for a one-year period accompanied by the main statistical data from OR records for the same period. The analysis of these reports and the main data has gone through a number of stages: first, hospitals were classified by the measurement unit used (time or number of procedures) on the official reports; then all data relating to weekends or official holidays was excluded; the rest of the data was divided into two parts: procedures performed during the available time (budgeted time / staffed time), and the procedures performed outside of the available time; then all terms used in the reports were recorded to find out exactly what is meant by these terms, and all the statistical factors used in these reports were identified; subsequently, each mathematical method used to evaluate OR performance was tested to ensure its validity.

- **Ethical and Other Considerations**

In this study no patients will be involved in the interviews, and no confidential patient data will be collected. All of the data collected will be used only for the academic aspect of this study.

Ethical approval has been obtained from Cardiff University and all the concerned authorities in each hospital. During the analysis process of the official reports, all data has been treated anonymously to protect the confidentiality of the hospitals participating in this study.

Research Methodology	
Research Philosophy	Interpretive
Research Approach	Inductive
Strategies	Multi case study
Type of Research	Descriptive and explanatory
Method of Research	Mixed-methods
Time Horizons	Cross-sectional
Techniques and Procedures	Data collection and data analysis

Table 3 Summary of the research philosophies and approaches

3.4: Multi Case Study

The goal of any case study research is to gain a rich, detailed vision into the ‘life’ of that case and its complex relations and processes (Oates 2006). The case study concentrates on one demand of the ‘thing’ that is to be examined. This one demand, or case, is investigated in depth, using a range of data generation methods (interviews, observations, document analysis and/or questionnaires (Oates 2006). Yin (2009) defines the case study as follows: “A case study is 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” (Yin 2009).

Since this research is a descriptive and an exploratory study, a multi case study has been used to help the researcher to compare, examine and investigate the similarities, differences, strength, weaknesses, advantages and disadvantages of each Operating Room Management Systems.

In this research, the participating hospitals have been divided into two groups: the first group includes three hospitals, for which the operating room management system has been studied in detail, including the regular stages of the surgical procedure, starting with the surgical clinic, up until the surgery is performed. This is in addition to the study of all methods used to evaluate OR performance, and how OR utilization is determined, in order to understand the structure of the operating room management system and the factors affecting it. Since this research focuses on measuring and evaluating the performance of the operating room, and to increase the number of case studies in order to collect the largest amount of data, five other hospitals have been added to concentrate only on the relevant issues related to the performance evaluation of the operating room.

General Statistical Information for the Hospitals In the Study

Country	Japan	Canada			Saudi Arabia			
Name of Hospital*	KAMEDA	RUH	SPH	SCH	KFSH&RC	KAMC	RMH	KFMC
Beds	925	471	207	675	936	950	923	1095
Consultants in the hospital	434	621†			448	533	470	*INA*
Surgeon consultants	96	86†			153	69	129	53
Anesthesiologist consultants	14	66†			38	25	28	17
Operating room§	16	10	8	11	21	18	20	20
Surgical cases performed	8,272	8,649	10,113	15,338	13,204	13,615	17,830	11,491
Surgical hours performed	18,027	20,421	14,237	16,544	33,891	19,692	*INA*‡	*INA*‡
Statistic report period	Apr 2011 Mar2012	Apr 2010 Mar 2011			Jan 2011 Dec 2011	Jan 2011 Dec 2011	Jan 2011 Dec 2011	Jan 2011 Dec 2011

*Kameda Kameda Medical Center
*RUH Royal University Hospital
*SPH St. Paul's Hospital
*SCH Saskatoon City Hospital
*KFSH&RC King Faisal Specialist Hospital & Research Center
*KAMC King Abdulaziz Medical City
*RMH Riyadh Military Hospital
*KFMC King Fahad Medical City
† Rotate between the hospitals
‡ *INA* Information Not Available
§ The actual staffed Operating Room

Table 4 A general statistical information for the hospitals participated in the study

Next is an overview of the hospitals participating in this study:

THE FIRST GROUP OF HOSPITALS

3.4.1: Kameda Medical Center (Japan)

The Kameda Medical Centre and Clinic is one of the health care organisations within the private sector. The history of this organisation dates back to the Edo period over 350 years ago. The Chairman of the Board of the hospital these days is part of the 11th generation of the Kameda's health care professionals managing hospitals in Japan (Kameda 2009).

According to Nikkei Business publications in 1997, the Kameda Medical Centre was at 9th position among all Japanese hospitals. Health Asia Publishing gave the title of 'Asian Hospital of the Year' to this hospital in 1998. The hospital succeeded in attaining enterprise-wide ISO 9001 certification in March 2000. In August 2001, Nikkei Business executed a ranking of Japanese hospitals, and this time Kameda Medical Centre stood at fourth place among the top one hundred Japanese health care organisations and ranked third in a newly introduced category of public information disclosure. Then it started consistently achieving various certifications and accreditations from the United Kingdom Accrediting Service and the British Standards Institute. Finally, in August 2009, the hospital attained accreditation from the Joint Commission International (JCI) and it was then the only healthcare facility in Japan at that time (the first one) to be accredited by this international standard (Kameda 2009).

The services and facilities at Kameda Medical Centre comprise inpatient facilities consisting of 965 beds and a freestanding outpatient facility. Nearly 430 full time physicians are serving at this hospital, which offers every speciality, including inpatient psychiatry. It has a Renal Dialysis Centre comprising 72 beds, and a chain of critical care units including an Intensive Care Unit, Coronary Care Unit, Neonatal ICU and Neurosurgical ICU. There is also an advanced Trauma Centre comprising 24 beds, including the availability of a 24 hour heliport. It serves the Kamogawa City, Chiba Prefecture (Kameda 2012).

The education and training programs offered by Kameda Medical Centre for junior residents and regular residency programs has been approved by the Ministry of Health and Welfare of Japan. Numerous residency programs are on offer at this centre, including the major ones in neurosurgery, obstetrics, internal medicine, gynaecology, urology and cardiovascular surgery. Moreover, numerous nursing education programs are offered at the three nursing colleges situated in the grounds of the main hospital, educating over 460 nursing students. Various programs related to health care at home are also conducted to educate the local community (Kameda 2009).

Kameda's Healthcare Informatics Institute has made Kameda filmless and paperless as far as medical records are concerned. The efficient electronic medical record system at Kameda facilitates all relevant individuals and has proven to be beneficial for the organisation as well as its stakeholders (Kameda 2009).

The surgical department at Kameda has two surgical suites containing 16 operating rooms, all located in the main building. Thirteen rooms are located in the main surgical suite, and the other three rooms are situated in the outpatient area. There are 14 anaesthesiologists among the consultant and senior residents working in collaboration with 96 surgical consultants. The surgical service at Kameda performs more than 8,000 various major and minor surgical procedures per year during more than 18,000 working hours (see chapter 4 page 88 and 89).

3.4.2: Royal University Hospital (Canada)

The Royal University Hospital (RUH) is situated in the University of Saskatchewan campus and is associated with the College of Medicine. It offers its services as a tertiary referral centre to more than 500,000 individuals from the local community and northern Saskatchewan. Almost all the necessary diagnostic as well as treatment services are offered at RUH (Saskatoon Health Region 2002 - 2012).

The requirement of establishment of a University Hospital with a minimum of 500 beds and offering clinical and diagnostic services, as well as research and medical education, was realised when a survey was conducted in 1944 aiming at exploring the health requirements of Saskatchewan. Eventually, the hospital with seven wings was established in 1955, but the development of this seven-story organisation took a further eight years to complete. Finally, what came into being was the largest building among all the buildings constituting the Medical Complex of the University. In spite of its huge premises, the hospital became completely occupied by 1958, and an expansion program became inevitable. In 1979, an extension and renovation project for the hospital began, comprising 333,000 square feet area allocated for operating theatres, emergency units and outpatient services. In 1990, three new floors were built on the previous extension and it has the honour of accepting royal designation from Queen Elizabeth II. Although RUH kept on serving as the primary teaching hospital of the College of Medicine, at the same time it was associated with the conglomerate Saskatoon District Health Board in 1992 (Saskatoon Health Region 2002 - 2012).

RUH turned out to be the principal educating and training institution for colleges of medicine, pharmacy, nursing and various other health care fields. The hospital offers its services in numerous important specialities, such as the neurosciences, paediatrics, obstetrics, as well as cardiovascular medicine. Its treatment is not restricted only to the local district of Saskatoon but to the whole province (Saskatoon Health Region 2002 - 2012).

The Royal University Hospital is the leading hospital within the Saskatoon region as far as the provision of acute care health services to the whole province is concerned. RUH is a trauma centre for the whole province. It provides facilities for numerous maternal and paediatric health services as well as for cardiovascular surgeries and neurosurgeries. Due to long term planning and efforts, it finally developed into a supreme health care facility equipped with the latest diagnostic machineries and laboratories associated with the University of Saskatchewan, College of Medicine. Its main objective is still to provide a complete health care program for the execution of affiliation between training and healthcare by serving as the fundamental medical facility in the whole province (Saskatoon Health Region 2002 - 2012).

At the Royal University Hospital, the surgical suite is located in the main building and holds 10 operating rooms. In 2011 More than 8,600 surgical procedures were performed in this area within 20,400 hours. There are 86 surgical consultants with 66 anaesthesiologist consultants, who rotate between RUH and other hospitals; these conduct various types and specialties of surgical procedures within the hospital (see chapter 4 page 113).

3.4.3: King Faisal Specialist Hospital & Research Center (Saudi Arabia)

King Faisal Specialist Hospital (KFSH) was built in 1970. The foundation stone of this hospital was laid by the founder of the hospital, King Faisal Ibn Abdul Aziz Al Saud. At that time, it covered an area of around 450,000 square meters. Three years later, an agreement was signed between the government of Saudi Arabia and the Hospital Corporation of America (HCA) for operating the hospital. Finally in 1975, King Khaled Ibn Abdulaziz Al Saud inaugurated the hospital. At the beginning it comprised just 120 beds and its objective was the provision of tertiary care to the local community, thus reducing the rate of people travelling abroad for medical treatment, which was costly, as well as requiring great effort and being time consuming. However the agreement was terminated in 1985 through a Royal order and a national team was authorised for the management as well as the operation of the King Faisal Specialist Hospital & Research Centre (KFSH&RC 2011).

Today, a vast area of 920,000 square meters is occupied by the King Faisal Specialist Hospital and Research Centre (KFSH & RC) which is a health care organisation with the capacity for 936 beds providing tertiary care to the community. Approximately 8,500 workers of 63 different nationalities serve the hospital. There are over 400 consultants in KFSH and more than half

(63%) of these are of Saudi nationality. KFSH & RC has turned into one of the leading health care organisations in the country, and it is the fundamental referral centre of Saudi Arabia, providing exceptional services for different health conditions including cancers, heart disease, genetic disorders, and organ transplantations. More than 500,000 individuals receive services from the outpatient units every year. Moreover, the average patient referral to KFSH is more than 32,000 patients per year. KFSH & RC also serves as the Cancer Registry, not only for the country, but for the whole Gulf region. The hospital currently provides cancer treatment to nearly 40% of all registered cases in Saudi Arabia. KFSH & RC is also involved in promoting education and research programs related to health care, including postgraduate training programs. Moreover, research and awareness programs for the prevention of different health problems are also conducted at KFSH & RC (KFSH&RC 2006).

KFSH & RC has been admired all over the world for its commitment to continual progress in medical technology and research over the past 37 years. Since its foundation, it has successfully developed mutual relationships with the world's leading organisations. In addition to this, it has succeeded in obtaining accreditations from the College of American Pathologists (CAP); the British Standard Institute for Quality Management; the American Association of Blood Banks (AABB), the American Academy of Continuous Medical Education (AACME); the Secondary Standard Dosimetry Laboratory (SSDL); ISO 9001:2000; System and the Gamma Irradiation Facility, and the Institutional Review Board (IRB). Finally in 2000, the Joint Commission International Accreditation (JCIA) also accredited the- King Faisal Specialist Hospital and Research Centre. Organ transplantation is the feature which makes this organisation matchless among international hospitals. It was given first rank among 152 international health facilities in 2004 for bone marrow transplants for children. Similarly in 2005, it was top among 156 international health care organisations for paediatric bone marrow transplants. The hospital has witnessed a 56% increase in the frequency of transplant surgeries in just five years- in 2002 there were 279 transplants, and this number increased to 434 in 2006. Out of these 434 transplants, 239 cases were bone marrow transplants, along with 141 renal; 37 liver; two pancreas; 12 heart, and three lung transplants. Although the facility for liver transplants was introduced in 2003, since then it has performed more than 120 liver transplants. In a nutshell, KFSH & RC is performing a transplant operation every day throughout the year with the clinical outcomes of international standards (KFSH&RC 2006).

The King Faisal Specialist Hospital & Research Centre gives greatest preference to its training programs, including 67 residency and fellowship training programs for various health care areas. The framework of residency training programs is designed while taking into consideration the goals and needs of the hospital, as well as the Saudi Council for Health Specialities (SCHS). The training program is open to national as well as international individuals and physicians from other organisations, for example individuals from the Ministry of Health (MOH), Yemen and the Gulf States all enrol themselves on the fellowship programs offered at KFSH & RC. In order to facilitate these education and training programs specifically, and the overall work force generally, KFSH & RC has maintained one of the most wide-ranging and latest libraries. A bimonthly medical journal, “The Annals of Saudi Medicine”, is also published by KFSH & RC and is circulated all over the world (KFSH&RC 2011).

Considering the requirement of advancement in informatics in the era of information technology, KFSH & RC has developed a Computerized Patient Record (CPR) system thus avoiding traditionally used papers and films. CPR is basically a longitudinal record of the medical history of the patient. CPR plays a crucial role in continuously delivering high quality safe health care to patients, from their entry into the hospital until discharge, as it is easily accessible to all the relevant health professionals and offers greater accuracy (KFSH&RC 2011).

An important division of this organisation is its Research Centre which has witnessed several renovations since its commencement. This centre was initially aimed at exploring nuclear medicine to treat cancers, but it now conducts research in a wide range of medical fields. Today, its contribution to global biological research is quite significant (KFSH&RC 2011).

The King Faisal Specialist Hospital & Research Centre plays a tremendous role in providing health care to Saudi citizens as well as to people from neighbouring states, since these citizens find it very costly and difficult to go abroad either for treatment for health problems, or for education and/or medical training (KFSH&RC 2011).

King Faisal Specialist Hospital & Research Centre contains four surgical suites: the main surgical suite (OR Level 2) includes 17 operating rooms; the cardiac and thoracic surgical suite (OR Level 4) contains five operating rooms; the surgical suite in the children's cancer center (OR CCC) comprises four surgical suites, and two operating rooms are located in the labour and delivery surgical suite (OR LD). The total number of surgical procedures performed annually at KFSH&RC is more than 13,200 cases, carried out by 153 surgical consultants and 38 anaesthesiologist consultants, over more than 33,800 working hours (see chapter 4 page 139).

THE SECOND GROUP OF HOSPITALS

3.4.4: St. Paul's Hospital (Canada)

St. Paul's Hospital is a health care organisation that provides a wide range of acute care services to the individuals of Saskatoon and Northern Saskatchewan. In 1907, the hospital was formed in the house of a physician, Dr. John H. C. Willoughby. The hospital was initially set up in a house because of a typhoid epidemic that took place at the time of the construction of a bridge in Saskatoon by Canadian Pacific Railroad (SPH 2012).

Later on in 1913, a fully equipped hospital was established. The division of the hospital which was formed in 1963, and whose owners were the Grey Nuns, is currently the B Wing of St. Paul's Hospital. Later on in 1989, another division was added to the hospital which is currently A-Wing. St. Paul's Hospital signed a partnership contract in 1995 with the Saskatoon Health Region, formerly known as Saskatoon District Health. Furthermore, the ownership of the health care facility was given to Saskatchewan Catholic Health Corporation in 1999 (SPH 2012).

One of the three hospitals operating at Saskatoon, Saskatchewan is St. Paul's Hospital. Various services offered at this hospital include Chronic Disease Management; Diagnostic Imaging; Emergency Services; Ethics Services; Laboratory Services; Palliative Care Services; Renal Services; Spiritual Care Services, and services for Mental Health and Addictions. It is equipped with 207 beds and nearly 621 consultants offer their services at the hospital. Every year over 10,000 surgeries are performed in eight operating theatres at this hospital (Saskatoon Health Region 2002 - 2012).

3.4.5: Saskatoon City Hospital (Canada)

In 1907, a public hospital was established in Saskatoon, namely Saskatoon City Hospital. At that time, it was the only municipal hospital in Western Canada and second in the whole of Canada. Due to the increasing number of patients, the hospital witnessed several expansions, and by 1927 its west wing was occupied by 122 inpatients. The East Wing of the hospital was built in 1930, having the capacity of 150 beds. Moreover, a nurses' residence was also established next to the hospital. Later on, three stories were built on that nurses' residence in 1950 and this portion was referred to as the Centre Block. Finally in 1958, it became a fully established hospital equipped with 330 permanent beds and the capacity for 675 beds, despite making the area crowded with patients. Thus the hospital has undergone extensive expansions and renovations during its history which is spread over more than 75 years (Saskatoon Health Region 2002 - 2012).

On the 16th of October 1993, the current Saskatoon City Hospital was constructed and formally inaugurated. Patients started entering its premises to receive medical services on the 13th of December 1993. Saskatoon Health Region owns the hospital (Saskatoon Health Region 2002 - 2012).

Various units at the hospital exhibit significant contributions to health care delivery, including the Breast Health Centre, Geriatric Assessment Unit and Eye Care Centre. Centres of gynaecology and rehabilitation are also doing a great job. Saskatoon City Hospital is among those few health care organisations in the region which have a fully established research centre dedicated to research in various medical fields (Saskatoon Health Region 2002 - 2012).

3.4.6: King Abdulaziz Medical City (Saudi Arabia)

King Abdulaziz Medical City (KAMC) is situated in Riyadh, Saudi Arabia. It started to offer health care services in May 1983. Due to increasing demands from speedily increasing numbers of patients from the local community, KAMC has undergone several expansions since its establishment. In Saudi Arabia, there are five medical cities in total which have affiliation with National Guard Health Affairs, and KAMC is one of them. Currently, numerous well-known medical centres have become a part of the King Abdul Aziz Medical City, including the King Fahad National Guard Hospital. The capacity for beds has been raised to 690 beds since its opening in February 2001. Besides these beds, 25 Operating Rooms are fixed for surgeries and 132 beds for emergency patients. King Abdulaziz Medical City is known internationally as an eminent health care organisation, delivering high quality and safe health care to the community (NGHA 2008 - 2012).

KAMC's Emergency Unit is recognised as the leading Trauma Care Centre throughout Saudi Arabia. Regarding the provision of the Pre-Hospital Trauma and Life Support (PHTLS) program, its Emergency Care Centre is in fourth position outside the United States. Ambulatory and primary health care services at KAMC are also involved in delivering education to the community on the prevention of diseases and changes in lifestyle required to lead a healthy life, safe from health problems. The Burns Unit, Endoscopy Unit, Surgical Intensive Care Unit, Neurosurgical Units and Operating rooms are among the remarkable divisions within the medical city (NGHA 2008 - 2012).

In mid 2003, The Neurological Rehabilitation Unit was established for patients with mental disorders. Besides this, an addition to the Rehabilitation Unit was made in September 2004 with physiotherapy and occupational sections, along with the IVF clinic and OB in 2003. Furthermore, the hospital has witnessed several developments in its laboratories, pharmacies, patient wards and medical imaging facilities since their commencement (NGHA 2008 - 2012).

It is worth mentioning here that the mortality and morbidity rate at KAMC is low, despite its Emergency Care Centre being situated near the Riyadh-Dammam highway and therefore the frequency of patients entering the Emergency unit with acute injuries quite high. This is a true reflection of its high quality and safe health care delivery. It is because of this high quality performance that KAMC was accredited by the Joint Commission International (JCI) in December 2006- another remarkable success for the medical city (NGHA 2008 - 2012).

3.4.7: Riyadh Military Hospital (Saudi Arabia)

The Riyadh Military Hospital (RMH) is situated in Riyadh, which is the capital of Saudi Arabia. It is also called the Riyadh Armed Forces Hospital and is actually the Medical Services Department (MSD) working under Ministry of Defence and Aviation (MODA). It was formally inaugurated in December 1978 to offer medical services to the citizens of Riyadh. At the time of commencement, it comprised of 385 beds. In 1979, Al Kharj Military Industries Corporation Hospital was equipped with 60 additional beds, and King Abdulaziz Military Academy was equipped with 34 additional beds during 1983. Today, the hospital comprises the main campus, southwest corner and the newly developed expansion project of the southwest corner with 923 beds in total. Further expansion projects are in progress for the accommodation of the increasing number of patients and to improve the quality of health care (RMH 2012).

The Riyadh Military Hospital, which is the home of outstanding researchers and scientists as well, has made remarkable contributions in the field of biological research. It has outshined other health care organisations in Saudi Arabia by publishing over 1600 research papers and training over 1017 physicians and 577 paramedics. It was the first medical centre to conduct a renal transplant surgery in Saudi Arabia (Al –Khader et al 1996), and since then, it has executed over 710 kidney transplant surgeries. Moreover, it is among the only two hospitals in the country that have centres for bone marrow transplantation. The bone marrow transplantation centre of RMH was founded in 1989 (Al Douri et al 1996). In addition to this, it was also the first hospital in the country to perform liver transplant surgery (Jawdat et al 1993), computer operated surgery and Stereotactic Radio-surgery. In 1998, RMH started treatment of patients suffering from epilepsy. Also, it has the second largest management and referral program in the country (Engel et al 2008). Regarding the education and training facilities offered by RMH, over 33 fellowship programs and nearly 20 diploma programs are currently at work, providing training to 238 physicians and 136 trainees (RMH 2012).

3.4.8: King Fahad Medical City (Saudi Arabia)

The King Fahad Medical City Complex (KFMC) was built between 1984 and 1995 on a vast area of 505,000 square meters. It is located in the Sulemanian area of Riyadh, Saudi Arabia where it offers easy and rapid access for a wide range of communities. This medical complex has the capacity to deliver health care to over 50,000 admitted patients and more than 600,000 patients visit the out-patient facilities every year (KFMC 2010 - 2011).

The King Fahad Medical City is regarded as the largest medical complex in the Middle East, equipped with instruments and systems that use the latest technology. KFMC comprises four hospitals equipped with 1095 beds in total, and the Primary Care Clinics which also work as an outpatient section in order to screen patients. In addition to these facilities, KFMC has highly equipped laboratories, pharmacies and imaging facilities (KFMC 2010 - 2011).

The main campus of KFMC is a 459 bed hospital which has the most recent medical technology systems and equipment. The tertiary care centre delivers third and fourth levels of specialised health care through its special divisions for the diagnosis and management of different health problems. The building has seven floors, consisting of the sub-basement, basement, ground floor, and continuing up to the fourth floor. The rehabilitation division comprises 159 beds and delivers care at various levels such as inpatient, day rehabilitation and outpatient services. Tertiary Paediatric Care Centre at KFMC is a 246 bed paediatric hospital which delivers health care to infants and children in all paediatric specialties and subspecialties. The Obstetrics & Gynaecology Hospital is a 236 bed tertiary care unit delivering expert health care to women through its own outpatient facility. Besides its hospitals, KFMC also possesses thirty operating theatres, which are fully equipped with all the necessary latest devices. Also, the number of beds in the intensive care units at KFMC has surpassed all other hospitals in the region (KFMC 2010 - 2011).

3.5: Conclusion

The research methodology is an important element of any research study; it serves as a plan for any researcher to achieve the aim of his or her research. This chapter then presents the methodology used for this study, which contains a discourse on the research philosophy, research question, design of the research, method of research and research strategies, which can be summarised as follows: (a) research philosophy: interpretive, (b) research approach: inductive, (c) research strategy: multi case study, (d) type or research: descriptive and explanatory, (e) method of research: mixed-methods, (f) time horizons: cross-sectional, (g) techniques and procedures: data collection and data analysis; followed by a description of the case study samples that have participated in this research.

The following chapter presents the data reporting in detail.

CHAPTER 4
DATA REPORTING

4.1: Introduction

In order to obtain an answer to the research question, this required comprehensive fieldwork, which included eight Operating Room Management Systems within eight renowned tertiary hospitals, in three different countries on three different continents. This was in order to obtain a broad view of the Operating Room Management Systems and to find out the similarities and differences between them.

This chapter presents the data reports from the three main hospitals involved in this study: Kameda Medical Center in Japan; Royal University Hospital in Canada, and King Faisal Specialist Hospital and Research Center in Saudi Arabia. The presentation of these reports will be according to the surgical patient flow within the surgical service; the reports are in the form of open-ended interview questions.

4.2: Kameda Medical Center in Japan

4.2.1: Interview Report: Surgical Clinic

Which positions comprise the staff at the clinic?

The respondent said that staff at the clinic include: a surgical clinic receptionist, surgeon, resident and registered nurse. They also have nurses called PSRs (Patient Support Representatives) who are able to perform minor surgery and clean wounds.

What are the equipment and facilities available in the clinic?

The interviewee said that they have an examining room containing a desk; chairs; an examination couch; a trolley with dressings and instruments; a computer with access to the hospital's information system (called Main Chart System), and two digital monitors to access and view radiology results. In the patient waiting area there is a fully automatic blood pressure cuff, weighing scales and measurement equipment for height with a data entering board with printer. This equipment is used by the patient to measure his or her vital signs by themselves before entering the clinic.

What are the types of forms used by the clinic staff?

The interviewee said that there is a consent form for the procedure itself, blood transfusion, or any other procedure where consent is needed for during the surgery, and these are given to the patient by the receptionist at the surgical clinic. All forms given to the patient and the information filled in by the patient are entered into the system by the receptionist, but the original forms are signed and handed over to the main reception in the outpatient clinic by the patient after he or she has finished from the clinic; however, everything they do is also entered on the computer. Before 1995, all patients' files and charts were kept in paper format and were stored away from the hospital. If it is a new patient then they will open a new file because they will not have any history on the patient. However, when the patient first comes to the department they will be asked to fill in a form with their basic details such as personal information and medical history.

Does the clinic use an electronic information system? If yes, what is this electronic system?

The interviewee said that everything is done by computer in the clinic, and the computer connected to the hospital's information system is called the Main Chart System. It contains all of the patients' records and all relevant communication. If a patient needs an x-ray, then that information will be sent to the x-ray department and the results will come back to the physician. All processes are computer-based.

How does the patient reach the surgical clinic?

The respondent said that there are two ways that the patient can reach the surgical clinic: either they can be referred by their GP in which case they would have a letter from their doctor; or, it is possible for the patient to go themselves to the hospital and go directly to the surgical clinic without referral and without appointment.

How does the surgeon know about the patients' medical history?

The respondent said that if the patient has been in for surgery within the past five years then the physician is able to retrieve the patient's details from the system, but if it is before 1995, it will not be on the system; also, the hospital only has to keep the patient's details for five years so after that they would need to start a new file or use the referral letter from their doctor, but the patient does not need to come to the clinic with any history as any information that the clinic needs will be taken from the patient at the clinic.

What are the necessary steps or procedures required to be carried out by surgeons in the surgical clinic in order to make the surgery decision?

The respondent said that the surgeon would examine the patient first, and if the patient needs lab or radiology tests, the surgeon will transfer the patient to the lab or to the radiology department on the same day and wait for the results. Once all the lab work has been done and there is a need for surgery, it is then discussed with the patient, and if the patient agrees to the surgery, the surgeon will book a slot for surgery on the computer, unless the case is urgent.

What does the surgeon do should he or she need a further medical consultation, lab work or x-ray?

The interviewee said that if they need any consultation, they contact the physician and discuss the case with them. If they need to refer the patient or they need any x-rays or medical lab, they simply enter the details into the computer and then send the patient to the relevant department. If the patient is not familiar with the hospital, the Patient Support Representative or the receptionist can give them a map and directions.

Is there the requirement for a surgical consent form? If so, who signs it?

The respondent said that the consent form for the procedure itself is given to the patient by the receptionist at the surgical clinic, but the form is signed and handed over to the main reception in the outpatient clinic by the patient after he or she is finished at the clinic.

Is a consent form required to be signed in the surgical clinic?

The interviewee said the consent form is signed by the patient at the main reception.

Are there any other forms which the patient has to sign in the clinic? If so, what are these forms?

The respondent said the patient is not required to sign any forms at the clinic.

What is the role of the nurse in the surgical clinic?

The interviewee mentioned there is no nurse helping in the clinic or to check vital signs and initial tests because the patient measures his or her own vital signs by themselves before entering the clinic; if there is the need for help in the clinic, the PSRs (Patient Support Representatives) is called.

Who assists the patient should he or she need help?

The clinic uses PSRs (Patient Support Representatives) who can help patients if they need help getting to and from the clinic and with getting undressed/dressed, and so on.

After following all these procedures, where does the patient go after surgical clinic and before hospital admission?

The respondent said that they patient would go back to the main reception in the outpatient clinic, pay money and then go home and wait for the surgery.

4.2.2: Interview Report: Pre-Operative Assessment Clinic

At Kameda there is no department or section act as a Pre-Operative Assessment Clinic for the surgical cases. Most of medical assessment done by surgeon at surgical clinic.

4.2.3: Interview Report: Surgical Cases Coordinator

Is there a coordinator for surgical cases in this hospital?

"There is no position in this hospital to act as a coordinator for the surgical cases. Most of the booking and scheduling process is done automatically through the hospital informatics system which is called the Main Chart. This system was designed by the hospital's Informatics Technology Department, also the Bed Control Department in this hospital contacts the patients and the medical staff if there is a need as a part of this section's duty."

4.2.4: Interview Report: Booking / Scheduling

Which positions comprise the staff of the booking/scheduling section?

The respondent said that there are four coordinators, along with the head of the service, working in the bed control department.

What is the role of the booking nurse/clerk?

The respondent said that the role of the booking clerk is to control the system and to accept the bookings from the physicians and to check the availability of beds and rooms.

What equipment is available in the booking/scheduling section?

"We have normal office facility such as working desks, chairs, computers, printers, network and telephones to contact the surgeons and the surgical ward, but the most important one for our work is the Main Frame System."

What are the types of forms used by booking/scheduling section staff?

According to the respondent, all of the information is completed online; once the physician has completed the booking online it goes into holding.

Does the booking/scheduling section use an electronic information system? If yes, what is this electronic system?

"In this hospital there's a bed-controlling system built into the main computer. The physician makes the booking on the system and the surgeon can see what slots are available and decide when they are going to do the surgery."

Who fills up the booking request?

According to the respondent the booking request is completed by the physician.

What is the information required in the booking request?

The respondent said that the information in the booking request includes when the surgery should take place. It also has information about the operation, such as what is going to be done and where; its expected start time such as morning or afternoon; if it is going to take two hours and at what time; if there are any infections; the diagnosis, and whether there is a need for the anaesthesiologist or not, the anaesthesia type and anything else. It also details who will be performing the surgery as well as the assistant surgeon.

Can submission be done online or through an information system? If yes, how?

The interviewee said that all of the information about the surgery can be completed on the system.

To whom is the booking request submitted?

"The request is entered into the system by the surgeon with the selected time and date for surgery, then the request will remain as a request in the system until it's approved by the department conference one week before the surgery. Then it will come to us through the system as a booking request."

How many working hours do you have daily?

"We have 8 working hours daily, from 8:00 till 16:00, but most of our staff are here from 7:00 to prepare for the first case."

How many hours are used to schedule cases from the daily working hours?

The respondent said that they schedule the cases according to all the time.

Do you schedule turnover time between the cases?

"We allow 30 minutes between the cases.

What time is the surgical list posted in the Operating Room and distributed?

The respondent said that the approved cases are posted to all services including the Operating Room and surgical ward two days before the surgery.

4.2.5: Interview Report: Admission

Which positions comprise the staff of the Admissions Office?
The respondent said that there is the supervisor of the department, and the coordinator and clerks.

What is the role of the Admissions Office in this hospital?
"The role of the admissions office is to check that all the necessary forms have been completed and that the patient has signed the consent forms. The admissions clerk also checks the identity of the patient to make sure that that they are not trying to pretend to be someone else for insurance purposes."

What are the types of forms used by staff at the Admissions Office?
The respondent said that the patient is given forms that they need to complete at home and then bring in when they come for the surgery. "These forms ask for details such as other family members' health status and job

status. If the patient has any disability with things like, walking, listening or pain and other things like that. It also asks about some special needs for the nurses such as religion or hobbies or worries about payment.” They also have two consent forms that need to be completed which are the admissions consent and a transfusion consent form.

Other than these forms, does the clinic use an electronic information system? If yes, what is this electronic system?

“The office uses the hospital Main Chart System; also another system is used which includes all information related to the patient written by the physician, and the other one is used to print the documents and armbands for the patient.”

Who informs the Admissions Office of on-going surgical cases?

“The admissions office is informed by the physician’s clinic of surgical cases and all the information is available in the hospital on the Main Chart System.”

Who receives the patient during the admission date?

“Initially, the patient is received by the department coordinator to discuss with the patient’s if he has any special needs, then to discuss about the type of room. There are two types of room- shared and private. The coordinator illustrates the advantages of each type and the price difference between the two types, because the health insurance in Japan does not cover all the cost of the surgery. After the patient chooses the room he transfers to the clerk to complete the admission process and to send the patient to the surgical ward.”

Is there a general hospital consent form? Who signs it?

The respondent said that there are two consent forms- an admissions consent form and a transfusion consent form. These are signed by the patient and stamped by the physician because they feel that a hand-written signature is not enough.

What are the other types of forms that need to be signed? Who signs them?

The interviewee talked about a checklist that they need to go through to make sure that they have followed the right process and that they are going for the correct surgery, but the one that needs to be signed is the admissions consent and a transfusion consent form.

After the patient has received all these things, how is the patient transferred to the surgical ward?

"After the patient completes all of the admission documents, then we send him to the surgical ward by themselves."

4.2.6: Interview Report: Surgical Ward

Which positions comprise the staff on the Surgical Ward?

The respondent said that they have a head nurse and that she is mostly in charge of this ward but on Saturday or Sunday someone else controls it. Also, there are nurses working as a team within the ward, and within the team there is one leader who has experience, who understands procedure, as well as a receptionist and Patient Support Representative (PSR). These are in addition to the surgeons and anaethesiologists who come constantly to the surgical ward.

What types of forms are used by staff on the Surgical Ward?

"In this hospital we rely on the use of the informatics system, so it is rare to use paper forms. Everyone- doctors and nurses- enter data directly onto the system. Only the consent form, which is in paper form, is given to the patient to sign it here."

Does the Surgical Ward use an electronic information system? If yes, what is this electronic system?

The respondent said that all of the information is kept on the Main Chart System- all the patient data is on this system. “The receptionist compiles paper files if needed, but the nurse and doctors mainly use the computer system for most of the work.”

How does the surgical ward know about the need for surgical beds?

“All admission requests come to the surgical ward through the Main Chart System; also they are sent the list of OR surgeries two days before the surgery. If there is an emergency case then they will be told by the ER.”

Who is responsible for managing the bed bookings on the surgical ward?

The respondent said that the bed control department is responsible for the bed bookings in the hospital.

When does the Surgical Ward receive the Operating Room list?

The interviewee said that they receive the list two days before the surgery; so for example, Wednesday’s list is received on Monday.

How does the Surgical Ward address the problem of bed shortage?

The respondent said that as much as possible they try move people around and find beds for patients, but that sometimes they might have to cancel a surgery if an emergency case comes through.

Who informs the surgical ward when the patient is ready for admission?

“As I told you before, we receive the surgical patient list two days before the admission day; we inform the admission office when the bed is available, when the patient is ready there, and they send the patient directly to us.”

Who accompanies the patient to the Surgical Ward?

The respondent said if the patient needs support or if the patient's health does not support him or her to come alone, then the Patient Support Representative (PSR) will accompany the patient to the surgical ward.

Who receives the patient at the surgical ward?

The interviewee said that the receptionist meets the patient and takes their papers to start the admission process.

Upon admission to the surgical ward, what is checked from the patient?

The respondent said that the patient is weighed. "The receptionist prepares a file with the details of what is going to be done. This is given to the nurse who checks these details with the details held on the computer system. If they are all correct, then she prints the bands. She then goes into the room with the patient and checks the details again with the patient."

What is the duty of the nurse on the surgical ward?

"After the receptionist prepares the file, including the instructions, they hand it over to the nurse. Then the nurse checks the system to match the patient data. Then she goes to meet the patient inside the room to check the information with the patient again to be sure that he is the correct patient. She puts the band on his arm then takes the patient's weight and height and other vitals and follows the doctor's instructions regarding medication, changing of the bandages and providing support for the patient in general."

Does the surgeon visit the patient prior to surgery?

"Sure, the surgeon visits the patient before the surgery; also the surgeon holds a pre-operation meeting with the patient and his family to discuss any issues related to the surgery."

Does the anaesthesiologist visit the patient on the surgical ward?

“Yes the anaesthesiologist visits the patient in his room; also, the anaesthesiologist would be part of the pre-operation meeting.”

Is the site of surgery marked at the surgical ward? Who does it?

The respondent said that it depends on the surgery being done. It may be done by the nurses on the ward or it may be done by the surgeon in the OR.

Who briefs the patient about the surgery and after-surgery care?

The interviewee said that before any surgery there is a pre-operation meeting involving everyone who will be taking part in the surgery, such as the surgeon, nurses and the patient. Everything is explained again in this meeting such as what is going to be done and how long it will take.

How does the surgical ward know when the Operating Room is ready to receive the patient?

The respondent said that the ward knows the schedule of the Operating Room, so whilst one patient is in the OR they are prepping the next patient. “Then when the Operating Room is ready, they call us and a nurse from the OR will come to the ward to collect the patient with a nurse.”

How is the patient transferred to the Operating Room? Who accompanies the patient?

The respondent said that on the day of surgery, the nurses from the Operating Room and surgical ward accompany the patient to the surgical suite and return the patient to the surgical ward after surgery.

4.2.7: Interview Report: Intra-Operative

What is the capacity of the Operating Room in this hospital?

"Our hospital has two Operating Rooms as separate sections, including 16 operating rooms, all located in the main building. Thirteen rooms are located in the main Operating Room, and the other three rooms are located in the outpatient area."

How many surgeons and anaesthesiologists work in these surgical sections?

The respondent said that there are 96 surgical consultants working in association with 14 anaesthesiologists among the consultant and senior residents.

How many cases are carried out in this hospital annually?

The respondent said that the total number of surgical cases carried out last year is more than 8,000 surgical procedures.

What is the approximate number of hours taken to perform these procedures?

The respondent said that there are more than 18,000 working hours used every year to perform surgical procedures at Kameda hospital.

What are the types of forms used in Intra-Operative?

"The patient comes with their file including all the forms signed before the patient reaches the Operating Room including consent forms. Inside Operating Room we use only the count sheet and the time out sheet; this is in addition to the anaesthesia sheet which is used by the anaesthesiologists."

Do the Intra-Operative staff use an electronic information system? If yes, what is this system?

The interviewee said that the all staff in the Operating Room can see all of the information Main Chart System (MCS) about the patient and their surgery details that have been entered electronically, although they are not able to make any changes to it.

Do you have a holding area for the surgical case to keep the cases before surgery?

"No we do not have- after the patient arrived to the Operating Room, we keep the patient in the reception area till the room becomes ready."

How do the Operating Room staff know when the patient is ready in the holding or reception Area?

The respondents said that the receptionist calls the nurses in the Operating Room to inform them that the patient is ready for surgery.

Who calls for the patient when the Operating Room is ready?

The respondent said that this process is shared between the anaesthesiologist and the circulating nurse to call for the patient.

What is done by the surgical staff before the surgical insertion to avoid the wrong surgery?

"We use a "time out" method for that purpose, and everyone working in the room- doctors and nurses- participate in this process to verify the patient information."

To measure the performance of Operating Room, Do you depend on the number of cases done or the number of hours used?

The respondents said we mainly use the number of procedures only.

What is the actual average turnover time between the procedures?

The interviewees said that in this hospital the anaesthesiologist accompanies the patient to the recovery room, and stays with them to care for the patient until the patient is ready to go back to the surgical ward: "In this case, we can't start the next case until the anaesthesiologist returns to the room. This makes the turnover time between the cases too long- sometimes is up to an hour."

Do any scheduled cases remain unfinished at the end of the official working hours?

The respondents said that late running cases happen sometimes. "If there are any other cases running out of working hours they would be emergency cases."

Do you have a daily waiting surgical cases not in scheduling plan?

"No we do not have this type of list."

Do you change the scheduled plan or are you committed to it?

The respondents said that sometimes there is a need to change the scheduled plan.

If there is a change to the scheduling plan, why does it happen?

"When it happens in most of the time, we see this as a challenge to use the available time as much as we can, or sometimes it is happen because of the effect of cases cancelling."

Do you move the cases between the Operating Room?

The interviewees said that this also happens sometimes.

After the surgery is carried out, what happens next?

The respondent said that the patient will go to the recovery room which is located in front of the reception area. Then when the patient has recovered, the nurses return the patient to his or her bed on the surgical ward.

4.3: Royal University Hospital in Canada

4.3.1: Interview Report: Surgical Clinic

Which positions comprise the staff at the clinic?

The respondent said that they have a medical assistant, and her secretary, who is the one who greets patients, and hands out any paperwork or information that needs to be filled out prior to their assessment. Occasionally, there are residents who will participate in part of that process. They will do the initial testing and history taking, or just follow and listen in on the conversation. They said that the assistant is a secretary. So they do not have a physician assistant, and they do not have a nurse practitioner or a nurse in the office.

What are the equipment and facilities available in the clinic?

The interviewee said that they have an examining room which contains a desk; a computer with access to PACS; chairs; an examining couch; a blood pressure cuff and a small trolley with dressings and instruments for removing sutures or drains; and measurement tools like a coniometer and reflex hammer because their practice is in orthopaedics. They said that they have a computerised system, so information is on the computer monitor, including the medical records as well as X-rays, MRI or CT scans, or tests that they need to access.

What are the types of forms used by the clinic staff?

The respondent said that the initial consent forms are only signed after the procedure for surgery is decided on, there is a consent form which needs to be forwarded to the booking office to allow them to be placed on the list. But when they come to see the doctor at the clinic, there is no actual form stating that they agree to be seen by the doctor and his assistants, so they do not have that type of form available. The consent is given by the patient's attendance at the clinic where they will be seen by the doctor and his people. When letters need to be sent out to the referring doctor, these are dictated and then written up by the secretary. There is a form used by the region to prioritise cases. There is also a form that requires a brief summary because copies of letters go into the hospital records.

Does the clinic use an electronic information system? If yes, what is this electronic system?

The respondent said that they have a computerised system so the X-rays can be seen on the monitor. There is a computer with the medical records as well as x-rays, MRI or CT scans, or tests that they need to access. He also said that all his patients are on an electronic form called the EMR system, so they are totally electronic.

How does the patient reach the surgical clinic?

The respondent said that patients are referred to him by letter in a fax from the family doctor. This has been the traditional way of outlining the problem. When a letter comes in, he triages it. He ranks each letter based on the information provided according to urgency and how soon he needs to see them. If they have inaccurate information, the office will send the letter back to the family doctor requesting more information; whether it is an extra report or other consultations with other physicians that might be relevant to the case, or just more information from the family doctor on whether they have carried out a physical themselves to help triage that patient better. He also said that there are internal referrals and these follow the same principle- a letter is sent to his office. He will tend to accept those or see those a little more urgently because they are seen by specialists. Finally, he said that patients are not allowed to contact his office directly for an appointment- they can only be referred.

How does the surgeon know about the patient's medical history?

The interviewee said that the only information they have is from the referral letter from the family doctor. Additional information comes from the patient when they fill out the questionnaire pertaining to their problem. As part of the questionnaire is on their medical history and medical issues, the office tries to streamline that process by having the patients answer the questionnaire beforehand, either at home or in the waiting room, without the pressure of the doctor questioning them. The patient knows what their medical issue is and what medication they are on. Hopefully, giving them time to reflect and answer honestly without feeling pressured should streamline the practice. Also, the medical history can be obtained from the EMR system for patients who already have medical records in the hospital.

What are the necessary steps or procedures required to be carried out by surgeons in the surgical clinic in order to make the surgery decision?

The interviewee said that he determines this based on the patient's own expectations and their clinical needs. Orthopaedics is pain-based so it comes down to how much pain that patient is in, on an elective base. If the doctor feels that the patient is not a candidate for surgery, or if it is marginal as to whether success is expected, he may elect to do some kind of test to confirm or refute the diagnosis, including investigations like MRI, a CT scan, or ENG studies, which means further waiting lists due to being seen for the MRI medical imaging or referral for ENG studies to another physician to do the actual testing. Therefore, this creates a bit of a wait, but they need to go through those streams of investigation. The decision making can occur at any time for surgery, either at that clinic or by phone call, and if they have further questions he said they can see them in subsequent follow-ups. Once the patient has been seen by the doctor they do not need another referral.

What does the surgeon do should he or she need a further medical consultation, lab work or x-ray?

The respondent said that when they need to consult another doctor, they dictate the need and then a referral letter will be written up by the secretary and sent to the other clinic; also, any patient that they want to be seen in the pre-assessment clinic (PAC) can be referred. The surgeon usually refers any complicated procedure, anything that may require an epidural, or anybody with significant morbidity, and they are then scheduled a separate appointment at the PAC clinic. The anaesthetist will then decide whether they are happy or if they want a cardiologist or pulmunologist or somebody to see them, which they will then consult from their side. The surgeon does not get involved in that process

Is there the requirement for a surgical consent form? Who signs it?

The respondent said that the consent form for the procedure itself is signed on the day of the procedure just before the procedure itself. The patient, or the patient's parent if the patient is a child, signs it.

Is it necessary for a consent form to be signed in the surgical clinic?

The respondent said that this could be done in the clinic; also, verbal consent is fine as long as they have given consent. He said that because of location, they cannot expect a patient to come in to sign consent form, so they will take it over the phone. The doctor said that he does not put patient on a waiting list just to let them sit there. They only go on the surgical waitlist when they determine that yes they want to proceed with this surgery.

What is the role of the nurse in the surgical clinic?

The interviewee mentioned that there is no nurse helping to check vital signs and doing initial tests. These things are done by the family doctor, they have no sub-specialty practice. The doctor does not need to monitor what their heart rate or blood pressure is as it has no bearing on the surgical decision making. That type of medical management documentation is not relevant which is why they go to the family doctor to do all that.

Who assists the patient should he or she need help?

The respondent said that if the patients are too sick to get to the clinic themselves then the clinic can call for a porter.

After following all these procedures, where does the patient go after the surgical clinic and before hospital admission?

The respondent said that his secretary will send the patient information that is required and educational tools and whatever needs to be filled out by the family doctor and pre-assessment notes. So she will contact them to make sure they have received it by mail, and once they get the information back from the pre-admission clinic, or usually the patient calls back to confirm that they want to accept that date and to go ahead with the surgery as booked. So there is communication between the office staff and the patient. After the surgery, the secretary will book them for the follow-up. The doctor also said that usually the pre-assessment clinic means that the patient has been seen up to a week or two weeks before the actual surgery so those things are done immediately, and if concerns are expressed by those specialists, it may mean delaying the surgery. But because there is time between the pre-admission clinic and the surgical date, hopefully it will be arranged that the surgical date is not cancelled or they are referred at a later date.

4.3.2: Interview Report: Pre-Operative Assessment Clinic

Which positions comprise the staff of the Pre-Assessment Clinic?

The respondent said that in the pre-assessment clinic there are usually two nurses on and a clerk as permanent staff. Also there is an anaesthesiologist and General Internal Medicine available at this clinic.

What are the types of equipment and facilities available in the Pre-Assessment Clinic?

The respondent said that there are two interview rooms used by the general internal medicine and a smaller interview room used by the anaesthesiologist. These rooms contain a table, chairs, computer, examination table, and examination equipment such as the blood pressure cuff, weighing scale, and height scale. There is also a reception room and waiting area. They do not have any examining rooms such as ECG or blood sampling labs.

What are the types of forms used by staff in the Pre- Assessment Clinic?

"There are two types of forms important for us- the booking slip and the information sheet. The booking slip is filled by the surgeon and contains all the requirements we should do. The other form is the information sheet that comes from the surgical booking centre which includes the information about the surgery scheduling. Also we have a patient history form, physical sheet, vital signs record, blood work request, radiology request and ECG request."

Does the clinic use an electronic information system? If yes, what is this electronic system?

"The pre-assessment clinic is not fully connected to all informatics systems. Nowadays, the clinic is only connected with the PACS and only the physician can access it to see the x-ray results. The other results are either faxed to the department or come back with the patient."

Does the Pre- Assessment Clinic have a sample collection laboratory, ECG lab or X-Ray?

The respondent said that they do not have sample collection or ECG facilities in the clinic. For this type of test, the patients have to go to other parts of the hospital to do it. For example if they need an ECG then they go next door to the chest clinic.

How does the patient reach the Pre- Assessment Clinic?

The interviewee said that the surgeon's office initiates everything. If the surgeon believes that the patient needs to be seen at the pre-assessment clinic, then the surgeon fills in the request on the booking slip before it is sent to the Surgical Booking Center. Then the Surgical Booking Center puts the patient on a waiting list according to the patient's condition. Once their turn comes up on the waiting list, they book an appointment for the patient with the pre-assessment clinic. "It is usually a week to two weeks before the admission day for surgery and then they send the booking slips to us. On the day of visit, the patient goes first to the Admissions Office, which is located next to our clinic, to register their attendance and then they come to reception at the pre-assessment clinic."

Who examines the patient at the Pre- Assessment Clinic?

The respondent said that it depends on what the surgeon has asked for- if the surgeon requests to examine the patient for any medical reason, then most of the time the patient will be seen by both the general internal medicine physician and by the anaesthesiologist, and sometimes they may ask the cardiologist to see the patient as well. In some cases the patient is just sent by the surgeon for blood work only.

What is the normal flow of the surgical patient at the Pre- Assessment Clinic to be carried out in order to clear the patients for the surgery?

"The patient comes first to the reception area at the pre-assessment clinic. Then the clerk at the desk looks for the booking slip and the information sheet. The booking slip is filled in by the surgeon, which contains all the requirements that we should do for the patient, such as if the surgeon wants the patient to be seen by an anaesthesiologist, cardiologist or internal medicine consultant, also the type of the blood test needed and if the patient needs a chest x-ray, or any other type of radiology test or an ECG. In certain cases the surgeon asks only for blood work or a chest x-ray without requesting to be seen by any doctors. The other form which is the information sheet is filled by the Surgical Booking Centre. It tells us about the details of the patient's surgery such as type of surgery, type of anaesthesia and when the surgery is booked in for. After that, all the information is passed to the nurse to review the patient's file to see any past surgeries and medical history, prescriptions they are on and in general how their health is, then the nurse measures the patient's blood pressure, height, weight and the rest of the vital signs. From there it depends on how busy we are, whether we send the patient for blood work, chest X-ray or ECG if it is required, or to be seen by the doctors; we try to keep the system flowing so they are not sitting in the waiting room too long."

"Usually the patient is examined by the general internal medicine physician and by an anaesthesiologist, and if there is the need for a cardiologist or any other specialist to see the patient, we call the other physician to come to the pre-assessment clinic to see the patient on the same day. If the patient is not fit for surgery and needs a further follow up, we inform the Surgical Booking Center to cancel the case and send him back to our clinic with a new appointment after his medical problem is solved. If the doctors find the patient is fit for surgery, they inform the patient and ask him to come in on the day of surgery."

What does the examiner do should he or she need any other medical consultation, lab work or x-ray?

The respondent said that patients are not transferred to another clinic. If the patient needs to be seen by any other physician then the anaesthesiologist or nurse will call them and they will come down to see the patient on the same day. If there is a need for blood work, chest X-ray or ECG the appropriate form is filled in and the patients have to go to other parts of the hospital to do it.

Is there a follow-up appointment with the Pre- Assessment Clinic with the patient until he or she is ready for surgery?

The respondent said that patients do not need to return for a follow-up appointment before surgery. If there is a problem and there is something that really needs to be done before surgery, the surgery has to be cancelled and then the patient sent to another medical service to correct what needs to be corrected. After that they bring them back in for another evaluation at the pre-Assessment clinic just to make sure that everything is okay before the surgery, but they are not put to the bottom of the list because they were there already.

How many surgical cases are seen by the Pre- Assessment Clinic?

The respondent said that they see around 150 cases per month.

If the patient is found to be medically fit, where does the Pre-Assessment Clinic send the patient?

The respondent said that they go home if they are medically fit and come back on the day of surgery.

4.3.3: Interview Report: Surgical Cases Coordinator

Is there a coordinator for the surgical cases in this hospital?

The respondent said that “there is no position in this hospital called surgical case coordinator.” The person who does this this work is “the secretary of surgeon”, and there is a secretary for each surgeon follow their own surgical cases.

Who are the people involved in surgical case coordination?

The respondent said that “the people involved with the surgical case coordination process are the surgeon, the surgical clinic secretary, the patient and the surgical scheduling department”.

What is the main role of the secretary as a coordinator for the surgical cases?

The main role is to coordinate between a number of parties to determine the day of the surgery as appropriate for both the surgeon and the patient.

From whom does the secretary as a coordinator receive the surgical case?

The respondent said that the surgeon sees the patient in the clinic and he dictates notes on the patient and then he sends these to the secretary to type up the notes, and then “from the note the secretary knows that this patient will need surgery”, from this point the secretary treats the case as a surgical case and begins with the necessary procedures for surgical cases.

What are the types of forms required in this department?

The interviewee said that “there are three forms necessary to request an appointment for surgery- inpatient booking card, priority criteria tool and the consent form”. These forms need to be filled in and then sent to the surgical scheduling department.

Does the secretary as a surgical case coordinator use electronic information systems?

The respondent said that some offices are electronic but they are still using paper and charts; although he thinks that surgical scheduling is done by computer.

What are the duties of the secretary as a coordinator for the surgical cases?

The first role is to write the medical reports which are dictated by the surgeon; fill out the forms for requesting surgery; communicate with the surgical scheduling department, and send them the filled in forms and follow-up and coordination between the surgeon, surgical scheduling department and with the patient, and to contact the patient about anything related to his surgery.

What are the sets of information provided by the surgeon to the secretary as a coordinator?

The respondent said that the doctor sees the patient in the clinic and then dictates all the important information on the patient, which includes “the type of operation, the time required for this surgery, patient’s health condition, and if the case is an urgent case or a routine procedure.” If the case is an urgent procedure the surgeon will inform the secretary about all of the patient’s information immediately to start the admission process.

What is the role of the secretary as a coordinator to determine the date of the surgery?

”At the beginning of each month they get all the dates booked for our surgeon for the month and that comes from the surgical scheduling department. During the scheduling process we coordinate with the surgical scheduling department to determine the day and the time of surgery, also we are informed by the surgical scheduling about the patient’s appointment at the pre-assessment clinic, then we communicate with the patient to inform them of the appointments.”

Is it possible for the patient to choose the date of his or her surgery?

There is some flexibility for the patient. If the case is not urgent usually we call the patient to offer him a date for surgery and if they decline stating that they are busy that day or busy that weekend so in that case they do have an option to select another date if it is available. Even so, urgent patients do not usually say no to a date because they know it is urgent and needs to be done.

In case of changes to the surgical date, what does the secretary as a coordinator do?

The respondent said that he would contact them about the change. “It can happen in different situations. A patient that needed surgery urgently, so therefore they are priority over elective cases. I would have to cancel the elective and put the urgent patient in there and I would call that patient to tell them that I have to cancel and explain to them that there has been a cancer case that has come up and they need to be operated on urgently; then I will call that patient back with the next available date.”

Is the secretary as a coordinator the only person in contact with the patient?

The respondent said “I am the one who is responsible for contacting the patient”, it is very rare that the surgeon contacts the patient by himself.

Should the secretary as a coordinator keep a slot free in the surgical schedule for emergency cases?

The respondent said that they do not really keep time like that because there is a chance of losing that time. Surgical Scheduling does not let the surgery be booked less than four days before surgery. They want that time to be filled or there’s the chance of them having to give that time away to another surgeon. They do not book surgeries too far in advance just because the surgeon sees so many cancer patients that need to be operated on really quickly. So they do not really book surgeries more than a week in advance whether it is elective or an urgent case. They keep time for emergency patients like that.

4.3.4: Interview Report: Booking / Scheduling

Which positions comprise the staff of the booking/scheduling section?

The respondent said that eight people work in the department- seven schedulers and 1 co-ordinator. “They have administrative and business courses that they take. It is a job description that follows a provincial review of a job description so it is provincially called OR Scheduler They have medical terminology and an office administration background, and they do the actual scheduling.”

What is the role of the booking nurse/clerk?

The respondent said that the role of the OR Scheduler is to control the system and to accept the bookings from each service, and to check the availability of the approved time for surgery for each service, attempting to allocate accordingly.

What are the types of forms used by booking/scheduling section staff?

“There is a booking form that they order from here in the hospital. There are two separate ones- an in-patient booking form and day surgical booking form. They just keep them there and fill out the information needed, or some of them have it on their electronic system now and they just electronically fax it in some cases. There is a form which comes with the consent form to be placed on the waiting list and the priority score tool that assesses need. Those pieces of paper come for every patient and the information is entered onto the system and that develops into the waiting list.”

What equipment is available in the booking/scheduling section?

The respondent said they have a surgical system that comes from the US and it is actually a DOS-based system that was implemented in 1995 and is still running. It is called Omni Server and that is where all the information is entered so that they can have the patient on a waiting list and then they can run reports from it. Also, they have a scheduling grid that they put the patient on so that they can actually plan the whole day and see all the theatres at each site that they schedule. It is a coloured grid so that they can see the difference between in-patients and day surgery and same day patients. Thus, it is an electronic system.

Does the booking/scheduling section use an electronic information system? If yes, what is this electronic system?

The respondent said that they do use an electronic system. They have a scheduling grid that they put the patient on to so that they can actually plan the whole day and see the whole and all the theatres at each site that they schedule. It is a coloured grid so that they can see the difference between in-patient and day surgery and same day patients.

What is the information required in the booking request?

The respondent said that the information required is basic demographic information, whether they need a pre-assessment visit or not, and how far in advance. It also states whether they need anaesthesia or an Internal Medicine consultant in the pre-assessment clinic "because we book those dates with the surgery." Also, there are the particulars about the procedure and the laterality- the left, the right or bilateral. They record the time that they need for the incision up to final dressing time.

Can submission be done online or through an information system? If yes, how?

The interviewee said that the form can be mailed through the facility or faxed to the department.

To whom is the booking request submitted?

"The initial order is created by the surgeon and submitted to his secretary; then the secretary submits the order to our department."

Who fills in the booking request?

"The surgeon gives the required booking information to his secretary in the form of notes, then the secretary is the one who fill the official forms and the one who sends and submits the request to our department. We usually do not contact the surgeon directly."

How is it submitted? What time?

The interviewee said that they receive booking cards every day. They put the patient on the waiting list on the day they receive the booking card or the day after. They are always there and ready. They run a paper waiting list. The respondent said that they try to have the cut off two days before the surgery.

How many working hours do you have daily?

The respondent said that they have 8 working hours daily, from 8:00 till 16:00.

How many hours are used to schedule cases from the daily working hours?

The respondent said that they schedule cases according to all the available time.

Do you schedule turnover time between the cases?

"We schedule the turnover time between the cases as equivalent to 15% of the scheduled time for the procedure; for example, if the case is scheduled for two hours, we put 18 minutes after this case as turnover time."

What time is the surgical list posted in the Operating Room and distributed?

The respondent said that the scheduled case, which is approved for each service, are filled in and sent on a monthly basis for each service.

4.3.5: Interview Report: Admission

Which positions comprise the staff of the Admissions Office?

The respondent said that the main employees that work in the department are the Registration Clerks. “They have a basic office education and just need a medical assistant course to work in our department. Also we have a Regional Manager for the department, three managers that report to the interviewee, two Business Unit Analysts and three Support Assistants.”

What is the role of the Admissions Office in this hospital?

The interviewee said that the role of the Admissions Office is to check the patient information, to be sure it matches the operating list and that this patient is the right patient for surgery. They also make sure that all the necessary forms have been completed and that the patient has signed the consent forms. also In addition, the clerk goes into the system to see if the patient has coverage for insurance purposes. They are also involved in the patient discharge process. “The goal of the admissions clerk is just to register them and send them on their way to actually where they are supposed to go.”

What are the types of forms used by staff at the Admissions Office?

The respondent said that the forms which are commonly used in this section are the standard registration forms which they do all their charting on, the booking card, the checklist and the consent form.

Other than these forms, does the clinic use an electronic information system? If yes, what is this electronic system?

The respondent said that they use Innovation and SCI (Shared Client Index), which is run by Saskatoon Health Region, the provincial government. “When a patient arrives here to the hospital, if they do not have their health services card, they can go into that system and look them up to see if they actually have coverage for insurance purposes.”

Who informs the Admissions Office of ongoing surgical cases?

The respondent said that they get an OR slate and they also go by the booking card.

What are the kinds of information given to the patient during admission?

"We expect that any kind of questions they may have and any concerns for their care should be discussed with their care team rather than the Registration Clerks. Also the Day Surgery department or the Pre-assessment clinic will provide a brochure for them." The respondent said that they do not provide anything like that. "We used to have pamphlets for the patients with general information like parking, services in the hospital etc but we do not do this anymore."

Is there a general hospital consent form? Who signs it?

The respondent said that the patient is required to sign the consent form for the surgical procedure, but they do not have a general hospital form.

What are the other types of forms that need to be signed? Who signs them?

The interviewee said that there are no other types of forms that need to be signed other than the medical consent.

After the patient has received all these things, how is the patient transferred to the surgical ward?

"In this hospital we do not admit the patient to the surgical ward before the surgery, and the patient comes to the hospital only on the day of surgery in the morning time, so we send the patient directly to the surgical suite (Operating Room)."

4.3.6: Interview Report: Surgical Ward

Which positions comprise the staff of the Surgical Ward?

The respondent stated that they have registered Nurses, Licensed Practical Nurses, Special Carers, Unit Assists. They said that Special Carers are unlicensed providers that help with personal care and mobility. Unit Assists are aids on the ward that help with cleaning of equipment, moving patients, and portering patients to the OR. Furthermore the interviewee said that they have a clinical coordinator who actually manages the bed movement on the ward, discharges and admissions. This person coordinates the whole unit, including patients that are coming and going. There is also a Clinical Nurse Educator on the unit who helps with the educational aspect for all staff on the unit.

What types of forms are used by staff on the Surgical Ward?

The respondent said that because most of the patients are emergencies, registration usually takes place in the emergency department and then they are transferred up to the ward when there is a bed available. Paperwork is usually part of the emergency assessment, and the admission papers just provide demographic information. "The doctor's assessment is in that and once they get up to the unit then the nursing care plan, nursing notes and doctor's notes are added. There is a whole chart that is put together. There is a basic consent form that they have to sign when they are admitted or, if they are unable to, then the family has to sign. The registration form is mostly demographic and just completed in the emergency doctor's room where they do their medical assessment on the patient."

Does the Surgical Ward use an electronic information system? If yes, what is this electronic system?

The respondent said that they do not have one at this time. They are working on a region-wide system. Currently, the nurses will order lab work, any of the therapies or dietary needs through the computer and that actually goes right to those departments. "They get those requisitions and they know this is what is needed for that patient. Other than that, everything is paper right now." The interviewee said that the system that they use for the lab is very simple but he does not know what it is called. The results from the lab, according to the interviewee, are sent by fax.

How does the surgical ward know about the need for surgical beds?

The respondent said that they get a slip faxed from Registration in Emergency to say that a patient needs a bed. The physician writes on the slip whether it is a ward bed, observation bed, the type of bed, and roughly what their medical condition is so that the coordinator from the unit can plan where that patient needs to go, but it actually gets faxed up from Emergency. Even if the patient goes straight to OR, the ward is still aware of that patient. As soon as the bed is called for they are registered. The interviewee said that they do not do any elective cases, just general surgery. Those are all pre-booked through the surgical booking system and so they know about those ahead of time, and would receive those slips. There may be the odd Orthopaedic elective surgery that cannot be handled at Saskatchewan City Hospital.

Who is responsible for managing the bed bookings on the surgical ward?

The respondent said that this is usually the responsibility of the bed coordinator, and it depends on what type of care the patient needs after surgery- whether the patient needs an observation bed or a regular bed on the ward. Also, if something changes in the Operating Room or if the patient becomes medically unstable they will call and say this has changed. So the ward's preparation is really word of mouth concerning what that patient needs.

When does the Surgical Ward receive the Operating Room list?

"We receive the list one day before the surgery day, so 1pm today we will get tomorrow's list from scheduling, which is sent to us on a daily basis."

How does the Surgical Ward address the problem of bed shortage?

The respondent said that they have daily bed rounds where all the Coordinators from all the units go down to do bed rounds, and there is an overall supervisor in the hospital who manages the beds. If they run into over capacity situations, there are times during those bed rounds when a decision is made as a group that there are not going to be five electives that day. So they look at the cases and see which ones are urgent- urgent 1s, urgent 2s- whether they are cancer cases and which ones are going to be cancelled. "In the units, the General Surgery unit may make that decision if they weren't anticipating 3 discharges and those 3 fell apart and are medically unstable and the OR cases are coming later. They may say later that we cannot handle this." He said that they have had surgical elective patients actually staying in the recovery room overnight because there is no place on the wards.

Who informs the surgical ward when the patient is ready for admission?

"The OR notifies the unit or the desk who lets the Coordinator know that the patient is ready to come up. Somehow the ward is notified that the patient is ready to come up. The ward lets them know whether bed is ready or not or if they need to continue holding them in recovery until they can be brought back up to the unit."

Who accompanies the patient to the Surgical Ward?

The respondent said that the operating nurse accompanies the patient and hands over orders from the OR and surgeon and they go through the orders. She explained what happens in recovery, in case of blood loss, and so on.

Who receives the patient at the surgical ward?

The patient is received by the assigned nurse.

Upon admission to the surgical ward, what is checked from the patient?

According to the respondent, the ward has a nursing database that has to be filled out. There is a pre-op checklist that has to be gone through before they go to the OR. These are all set in place, even for trauma patients. If they go up on the ward before they go then they have that pre-op checklist.

What is the duty of the nurse on the surgical ward?

The respondent said that overall, she is basically assessing throughout her whole shift concerning what that patient needs, vital signs, and reporting to the physician if there is a change in the patient's health condition.

Does the surgeon visit the patient prior to surgery?

The respondent said that they would in a general ward, but not in trauma. In some cases they will do their initial assessment in emergency so they may order basic blood work.

Does the anaesthesiologist visit the patient on the surgical ward?

The respondent said that because they do not do elective surgery here they are not aware of the process now.

Is the site of surgery marked at the surgical ward? Who does it?

The respondent said that because it is trauma it is not too hard to figure out which leg they need to operate on when it is broken, "but when we used to do elective surgery, the surgeon did the marking."

Who briefs the patient about the surgery and after-surgery care?

The respondent said that usually the surgeon is the person who gives the patient the information related to his case, and the nurse gives the patient the information related to the dressing and changing of bandages on the wound, or some medication information according to the surgeon's instructions.

How does the surgical ward know when the Operating Room is ready to receive the patient?

"The patient is on call for the OR and we have them MPO. We basically wait for a call from the OR clerk or whoever is down there, and they call us on the ward to say that the patient can come down now. We really do not have a lot of notice for patients when they are waiting in the trauma centre. Often it is not a planned surgery."

How is the patient transferred to the Operating Room? Who accompanies the patient?

The interviewee said that the OR porters take them down and a nurse does not accompany them. "Most of the time our patients are stable enough that we do not need a nurse."

4.3.7: Interview Report: Intra-Operative

What is the capacity of the Operating Room in this hospital?

"We have at RUH a surgical suite located in the main building and this holds 10 operating rooms."

How many surgeons and anaesthesiologists work in these surgical sections?

The respondent said that there are 86 surgical consultants with 66 anaesthesiologist consultants working in different specialties. "The consultants are not permanent for our hospital- they rotate between RUH and other hospitals."

How many cases are carried out in this hospital annually?

The respondent said that the total number of surgical procedures that were carried out last year was more than 8,600.

What is the approximate number of hours used to perform these procedures?

The respondent said that the surgical procedures for last year were performed in this area within 20,400 hours.

What are the types of forms used in Intra-Operative?

“The patient comes with their book and all of their charts that the department uses to make sure that there is consent signed; also the nurse needs to fill out the pre-operative checklist. The anaesthesiologist uses the anaesthesia sheet to record the anaesthesia progress.”

Do the Intra-Operative staff use an electronic information system? If yes, what is this system?

The interviewee said that they do not use any electronic systems but that they will be starting to next year. It will be a Surgical Information System (SIS) with Pisces which is the software specialising in Operating Rooms.

Do you have a holding area for the surgical case to keep the cases before the surgery?

“Yes we have. This holding area is located close to the Operating Room reception area.”

How do the Operating Room staff know when the patient is ready in the Holding or reception Area?

The respondents said that they the receptionist calls the nurses in the Operating Room to inform them that the patient is ready for surgery.

Who calls for the patient when the Operating Room is ready?

The respondent said that it is the responsibility of the circulating nurse to call for the patient.

What is done by the surgical staff before the surgical insertion to avoid the wrong surgery?

The respondents said that if the briefing has not been done in the holding area, then the surgeon by him/herself will do all the checks related to the surgery side and location there in the OR. They will also confirm the patient’s name before they go to sleep. This confirmation is called ‘time out’.

To measure the performance of the Operating Room, do you depend on the number of cases done or the number of hours used?

"We mainly use the number of procedures, according to my knowledge, so that the statistical department can determine the used time for the surgical procedures.

What is the actual average turnover time between the procedures?

"In fact, I do not know the accurate amount of the actual turnover time between the cases."

Do any scheduled cases remain unfinished at the end of the official working hours?

The respondents said that late running cases occur most of the time.

Do you have a daily waiting list for surgical cases not in the scheduling plan?

"No we do not have this type of list, but we have unscheduled cases coming as an emergency cases to OR, but these cases are not on any waiting list because these case are emergency and need to be done immediately."

Do you change the scheduled plan or are you committed to it?

The respondents said that sometimes there is a need to change the scheduled plan.

If there is a change to scheduling plan, why does it happen?

The respondent said that it happens most of time, but they stick to the available time as much as possible. It may happen because of the impact of cases cancelling.

Do you move the cases between the Operating Room?

The interviewees said that this also happens most of the time, but sometimes the cases are scheduled in the same room to different surgeons, so in that case the first surgeon delays finishing his cases according to the scheduled time. “We move the other surgeon’s case to any other empty room to save time.”

After the surgery is carried out, what happens next?

The interviewees said that the patient will go to recovery before they are moved to the ward. “Usually, the bed is confirmed before surgery but if it has not been confirmed then they will have to wait in recovery until a bed becomes available. There is no overnight recovery but there is an overflow sometimes.”

4.4: King Faisal Specialist Hospital & Research Center in Saudi Arabia

4.4.1: Interview Report: Surgical Clinic

Which positions comprise the staff at the clinic?

The respondent said that they have a clinic clerk, staff nurse, consultant surgeon, resident surgeon, interpreter, and if any arrangements are needed, they can call the case manager. Finally, the clinic has a Patient Care Assistant (PCA).

What are the equipment and facilities available in the clinic?

The respondent said that they have a computer; everything is logged on the computer, they have a system whereby they give the patients a number and they call them by this number. They have weighing scales, measurement equipment for height, a stethoscope, a hammer, all the casts, and they have all the equipment for surgery. They have a room completely set up for examination- the table, a bed, chairs, and a stretcher. They have oxygen, suction and a sink, along with all the computer services and printers, in addition to gloves and a sharps container; in other words, it is a completely set up room.

What are the types of forms used by the clinic staff?

The interviewee said that they have various forms. They have the progress notes where they chart the patient; all the history notes; the vital signs sheet, and the physician chart as well. There is also an interdisciplinary form because they have interdisciplinary outpatient clinic progress forms where they chart the history and the vital signs, and where the physician makes his notes, and then the nurse charts the instructions that they give to the patients, for example if they are referred to x-ray or any other referral. And then they have a consultation sheet to refer to another service. They also have an appointment slip. Everything is entered into the system. It is automated but they still give the patient a piece of paper with their instructions on for physical therapy, a straight forward appointment, or radiology appointment, so all that is recorded on a piece of paper and given to the patient. They have created a patients' requirements guideline, which the patient can fill in before entering the clinic if he or she needs to ask questions or requires a medical report, sick leave, or statement of visit, for example. When there is a need for surgery, the patient schedule form, consent form, mark side if they are going for a procedure like a guided biopsy, and an agreement form are required. There are many other forms because it depends on the package for each procedure.

Does the clinic use an electronic information system? If so, what is this electronic system?

The respondent said that they use Integrated Clinical Information System (ICIS) for everything- for recording all of the patient's details and for getting all of their results.

How does the patient reach the surgical clinic?

The interviewee said that there are usually two different ways: either a referral from another hospital, for example the patient is primarily under referral or the referral decided to refer the patient, so this will be an internal affair. Or, an external referral where the patient gets his or her report from the acceptance centre to be reviewed by the hospital; if the physician accepts the case then they can determine an appointment. The initial appointment is from the acceptance centre, and then that patient comes as a new patient.

How does the surgeon know about the patients' medical history?

The respondent said that there is a chart. Everything is in there: the report the patient brought will be in the chart, and a copy of his or her acceptance should be in the chart because if the copy of acceptance is not in the chart, they have to dig more and more into the appointment to see who accepted the case and why that case in our clinic. Everything should be in a hard copy in the chart for the new patient. Also, the medical history can be obtained from the ICIS system for patients who already have medical records in the hospital.

What are the necessary steps or procedures required to be carried out by surgeons in the surgical clinic in order to make the surgery decision?

The surgeon consultant will discuss the situation with the patient and explain the need for surgery. If the surgeon and the patient agree in the clinic on the same day to do the surgery, the surgeon then fills out a booking request for the surgery and transfers the patient to the pre-anesthesia clinic. If the patient needs more time to make the decision about the surgery, then the patient is given time to make the decision and is provided with a contact number to call to the clinic and inform them of his or her decision. If the decision is positive then the clinic starts the booking request, and if the decision is made over six months after the clinic visit, then a new appointment will made with the surgeon to see the patient again and to do a new lab tests or x-rays if needed before starting the surgery booking process.

What does the surgeon do should he or she need further medical consultation, lab work or x-ray?

The respondent said that if they need another referral for surgery or in general, the surgeon contacts the other physician and discusses the case with them. If the patient needs to be seen by the other doctor, then an official referral will done through the system and the consultation form will be filled in and attached to the patient's file to be filled in with the consultation report and returned to the surgical clinic. If there is anything last minute to be done, any work after this referral, they put the appointment in the system and then it is given to the patient. Sometimes some of them get seen after the referral, so they come back after the appointment. They are always told to go to their appointment for this referral and come back so they can be given an appointment. They go for the appointment, and after they are seen, they come back to for either a follow up or further work prior to surgery. If the lab work or x-rays are needed, the surgeon will request them through the system only.

Is there the requirement for a surgical consent form? If so, who signs it?

Yes, the consent form is required and it is initially filled in at the surgical clinic and signed by the patient or the patient's parent if the patient is a child. It is valid only for three months. Because the waiting list is six months to a year, the consent form needs to be updated if is over three months old; it is usually updated when they come to the pre-surgical clinic.

Is a consent form required to be signed in the surgical clinic?

The respondent said that it is signed in the clinic, but it is done again if it has been three months or more in admissions.

What is the role of the nurse in the surgical clinic?

The interviewee said that the role of the nurse starts from the beginning of the morning. They prepare the charts and the physician asks them to review the chart in the morning and make up the notes to see who needs an x-ray and so on. As the patient shows up in the clinic, the first to receive them will be the vital signs room or the triage or the screening. And then when they get the patient there, they check the complete vital signs- the blood pressure, temperature, pulse, weight, height, and auto saturation. Afterwards, they ask about allergies, vaccines if it is a child, and if they are taking any medication. Then just a brief history is requested. There are certain criteria that they have to meet and then if the patient needs an x-ray, they give them the request for x-ray and they go to the x-ray department and come back. They will go to the floor according to the appointment time to see the physician. In the room there is a nurse with the physician, along with the patient.

Who assists the patient should he or she need help?

The respondent said that if they need to leave the clinic and go to another department like x-ray, they have a patient care assistant (PCA). They have a wheelchair that belongs to the clinic and they can always get more wheelchairs from outside if necessary. So, the patient care assistant or one of the technicians helps, and sometimes if numbers are low they do it themselves.

After following all these procedures, where does the patient go after the surgical clinic and before hospital admission?

The respondent said that they will have to come on another day closer to the surgery to the pre-anaesthesia clinic.

4.4.2: Interview Report: Pre-Operative Assessment Clinic

Which positions comprise the staff of the Pre-Assessment Clinic?

The respondent said that in the pre-assessment clinic there are anaesthesiologists, one consultant and one resident, and sometimes a physician form internal medicine. “Plus we have three nurses with one team leader and one coordinator to coordinate the surgical cases between the case management team, surgeons, other services in the hospital and with the OR scheduler. Finally there is a clerk and a Patient Care Assistant (PCA).”

What are the types of equipment and facilities available in the Pre-Assessment Clinic?

The respondent said that they have three examination rooms containing a desk, chairs, an examination table, the examination equipment such as the Dinamap, the fully automatic machine for measuring vital signs, and each room has a computer to check the patients’ information through the Integrated

Clinical Information System (ICIS). “Also we have an ECG machine inside the unit. Also, we have weighing scale, height scale, because height and weight need to be measured for all patients to give us an idea about their indication during his visit to pre-anasethesia clinic.”

What are the types of forms used by staff in the Pre- Assessment Clinic?

The interviewee said that they have a several forms but now “most of the forms are done online.” “We have the physical assessment form which is filled by the nurses; we have an indication form to indicate the type of surgery and any information related to the surgery; a Referral form; Consultation form and the anaesthesia report which is filled in by the anaesthesiologist.” The interviewee said “this form is still manual filling- not online yet.” Also, the consent form which should be filled in at the clinic and signed by both the patient and the surgeon and they have “some educational pamphlets related to anaesthesia and general information about surgery” which are given to the patients accordingly.

Does the clinic use an electronic information system? If yes, what is this electronic system?

The interviewee said that they use the “Integrated Clinical Information System (ICIS) to take the medical history of the patient, last vital signs reading, lab test results, x-ray, the medication given to the patient or if there are any notes or recommendations related to the patient’s health condition. All the appointments and referring is done through the system; also we use “SurgeNet” which an informatics system special for surgical services which is totally integrated with ICIS.”

Does the Pre- Assessment Clinic have a sample collection laboratory, ECG lab, X-Ray?

The respondent said that they can do ECG in the department but any other samples need to be sent to another department. “We have the lab facilities in our department but because of the lack of manpower nowadays, we don’t have a lab technician anymore, so if the patient requires lab tests we send the patient to the laboratory to do it there. Also if there is a need for x-ray we send the patient to the Radiology department."

How does the patient reach the Pre- Assessment Clinic?

The respondent said that usually the surgeon in the surgical clinic sees the patient. Once the surgery is decided on, the surgeon starts the booking process, and if the surgery needs a general anaesthetic, then for those kinds of patients they "must be seen in the pre-anaesthesia clinic". If the surgical case will be done under local anaesthesia only, then there is no need for these patients to be seen in the pre-anaesthesia clinic. The respondent said "as a requirement during the booking process for the surgical procedure, the surgeon needs to select the type of anaesthesia- if it is a general, spinal, epidural anaesthesia or any other type of anaesthesia it needs to be given by an anaesthesiologist. The system will notify the surgeon about the need to book an appointment for the patient with the pre-anaesthesia clinic to be able to complete the booking process. So we can say that the appointment is made automatically through the system. Then the patient will be informed by the surgeon or the nurse at surgical clinic about his need to visit the pre-anaesthesia clinic. They will inform the patient about the time and the day of the visit. After this the patient only needs to come directly to the pre-anaesthesia clinic to identify himself, and all the patient data will be found on the system."

Who examines the patient at the Pre- Assessment Clinic?

The respondent said at the moment it is only the anaesthesiologist by himself who examines the patient. The respondent said "however from the beginning of the new year 2012 the nurse will be able to clear the surgical patients who are classified as ASA 1 and ASA 2, which are normal and healthy patients, but patients with ASA 3, ASA 4, and ASA 5 will be cleared by the anaesthesiologist only. Sometimes we have a cardiologist and internal medicine physician available at the pre-assessment clinic to examine the patient. In the near future they will be a permanent member of the pre-assessment clinic."

What is the normal flow of the surgical patients at the Pre- Assessment Clinic to be carried out in order to clear the patients for surgery?

The respondent said that the patient first meets the clerk at the clinic's reception disk, then the clerk retrieves the patient's information from the system to confirm the patient's appointment, and checks the state of an existing appointment. The clerk sends the patient to the waiting area and the patient's information is passed to the nurse. The nurse reviews the entire patient data in the system including the patient's medical history, last vital signs reading, lab test results, x-ray, medication given to the patient or if there are any notes or recommendations related to the patient's health condition mentioned in the system. Then the nurse calls the patient to the examination room and starts to measure the patient's vital signs; uses the scales for his weight and height; auscultates the patient chest; checks the medical history with the patient, and then evaluates his ASA classification. "If the patient is a cardiac patient or has a history of cardiac disease, or if the patient is above forty years of his age, then we must do an electrocardiogram (ECG) to test for him as a part of the initial screening without waiting for an order from the physician, because it is a part of our core standard of care." After that the anaesthesiologist is called to the examination room to check the patient. If everything is okay with the patient and they are fit for surgery then the patient will be cleared by the pre-anaesthesia clinic.

What does the examiner do should he or she need any other medical consultation, lab work or x-ray?

"If we need to refer a patient to any other clinic for consultation we fill in a referral form for the department that they need to send the patient to. This form is not on the system and needs to be completed by hand, but we coordinate with the other clinic to decide when the patient can be seen, then the appointment is made through the system. Our referral patient has priority to be seen on the same day of referral because we have one or two reserved slots in advance on a daily basis at the clinics that we routinely need such as the cardiac and internal medicine clinics. Also, sometimes we have a cardiologist and internal medicine physician available at our clinic to examine the patient." In the near future "they will be a permanent member of the pre-assessment clinic." "For lab work and x-rays we just fill in the order through the system and the patient goes directly to the section needed."

Is there a follow-up appointment with the Pre- Assessment Clinic with the patient before he or she is ready for surgery?

"If we need more testing or consultations for the surgical patient and the results are not clear we continue to follow up and treat the patient if needed until he is ready for surgery. If the patient is not fit for surgery and he needs long term treatment we inform the surgeon to postpone or cancel the case."

How many surgical cases are seen by the Pre- Assessment Clinic?

"We see around 7,000 patients per year, which is equal to 61% of the elective case done here. Our goal is to achieve 100% of elective cases."

If the patient is found to be medically fit, where does the Pre-Assessment Clinic send the patient?

"Usually the patient is sent home and we inform the case management that the case is clear for our clinic and ready for scheduling. For the same day admission we send the patient to the admissions office."

4.4.3: Interview Report: Surgical Cases Coordinator

Is there a coordinator for the surgical cases in this hospital?

"There is a case manager for each surgical section, such as the general surgery, ENT, orthopaedic and so on to coordinate for the surgical cases, and the case manager belongs to the surgical section."

Who are the people involved in case management?

"Mainly the surgeon and the case manager but also we work with the admissions department."

What is the main role of the case manager?

"The main role of the case manager is to coordinate between the surgeon, the patient and the admissions department, and sometimes we coordinate with the booking section in the Operating Room, in order to arrange for scheduling of the surgical procedures."

From whom does the case manager receive the surgical case?

"We receive the case directly from the surgeon though a phone call after he or she made the booking for the patient."

What are the types of forms required in this department?

"Usually we use an electronic sheet on Microsoft Excel which contains the medical records, name of the patient, age of the patient, type of surgery and who the surgeon is that will perform the surgical operation; and usually there's a place to say if he has been seen by the pre-anaesthesia clinic."

Does the case manager use electronic information systems?

The interviewee said that they use only a system called ATS (Admissions Transaction System), "and this system is used between the admissions department and us. Because we only care about the scheduling process and because the surgeon enters all the patient data in ICIS and SurgeNet during the booking process, we do not need to use any other system than ATS."

What are the duties of the case manager?

"To contact the surgeon on a daily basis to find out the surgical cases that have been booked for surgery; update the surgeon waiting list; follow-up with the operating room scheduling to find out the time available for the surgical slot; prioritise the surgical case based on the status of each patient; schedule the surgical cases for surgery in coordination with the surgeon, and coordinate with the patient to determine the day of surgery".

What are the sets of information provided by the surgeon to the case manager?

"The surgeon phones us to give the main information about the surgical case which contains the medical records, name of the patient, age of the patient, type of surgery and if he booked the patient to be seen by the pre-anaesthesia clinic".

What is the role of the case manager in determining the exact date of the surgery for the patient?

"The case manager needs first to review the waiting list and update it with the surgeon weekly to prioritise the surgical case based on the status of each patient. Then the case manager schedules the surgical cases according to priority and the available time. This way shows the time and exact date for the surgery."

Is it possible for the patient to choose the date of his or her surgery?

"Yes, if there is an opening surgical slot. If it's elective surgery and the patient is willing to come in earlier but there is no open surgical slot, then we put a note in to say that this patient is willing to come earlier; then they can be called if there are any available surgical times. If the case is critical or urgent and the patient insists that he doesn't want this date and wants to cancel, we do not accept the cancellation or the change until the patient speaks with the surgeon and requests to cancel his case- under his responsibility after he understands the dangerous of his situation."

In case of changes to the surgical date, what does the case manager do?

"It is the responsibility of the case manager to communicate with the patient and explain the change in the day of the surgery and then follow-up with the patient to find an alternative day."

Is the case manager the only person in contact with the patient?

“We are the main contact with the surgical patient, but also sometimes the surgeon communicates with the patient to discuss some matters relating to his state of health.”

Should the case manager keep a slot free in the surgical schedule for emergency cases?

The respondent said that they do not do this.

4.4.4: Interview Report: Booking / Scheduling

Which positions comprise the staff of the booking/scheduling section?

The respondent said that they have “the Operating Room Management Director and his deputy, and also they have the General Surgery Department coordinator, two surgical nurses works as scheduler. Finally there is the Operating Room information system co-ordinator.”

What is the role of the booking nurse/clerk?

The respondent said that the role of the schedule nurse is to try to allocate according to an allotted time already scheduled for the services.

What equipment is available in the booking/scheduling section?

”We are located at the front desk of the Operating Room to be easy to contact with surgeons and with the Operating Room Management team. We have desks, chairs, computers, printers, networks and telephones to contact the surgeons or anyone else from the team.”

What are the types of forms used by booking/scheduling section staff?

“Since two years ago, we have not used any paper forms, except for emergency cases.”

Does the booking/scheduling section use an electronic information system? If yes, what is this electronic system?

The interviewee said that “for almost two years everything is done online. We use SurgiNet which part of ICIS the Integrated Clinical Information System for all the booking and scheduling process.” They also said “we do not use any paper.”

Who fills in the booking request?

“The responsibility for entering the request for the surgery is the surgeon consultant and his assistant or resident, because they are the only ones who have this authority.”

What is the information required in the booking request?

The respondent said that there are mandatory fields on the electronic form that need to be filled in by the surgeon to be able to make the booking for his case. These fields contain the patient’s main information such as the patient’s name, gender, age, weight, and the patient’s medical record number, as well as information about the surgery such as the type of surgery; the day and time requested for the surgery; the location where the surgery will be carried out, and in which Operating Room. It also asks what type of patient- is he an inpatient patient, day surgery case, is the case an elective or an emergency case, also what is the type of anaesthesia requested for the surgery (general or local anaesthesia)? In addition, the surgeon needs to fill in the electronic section for the side of the surgery and if there is any type of precautions, or if the patient has AIDS, hepatitis or if the patient has a latex allergy. Also, one of the mandatory fields is the classification of the patient such as if the patient is a cancer case or if the patient is a VIP patient or a dependent of a member of the hospital staff.

Can submission be done online or through an information system? If yes, how?

The interviewee said that “the submission should be completed online unless it is an emergency case” in that situation the submission should be done on paper. For normal cases, “the surgeon needs to sign into SurgiNet by using his username and password then fill in all the information required, after that he needs to sign the request by clicking on submit and then it will come to us as a request on the system.”

To whom is the booking request submitted?

“The booking request is submitted directly and automatically to the scheduling section in Operating Room, which is part of Operating Room Management.”

What time it is submit?

The respondent said that the request is submitted online and they started a new system six months ago, which means that requests have to be submitted by 12 o’clock.

How many working hours do you have daily?

“We have 9 working hours daily, from 7:30 till 16:30 except Wednesdays which is the last working of the week, when we have 7 working hours, from 8:30 till 15:30.”

How many hours are used to schedule cases from the daily working hours?

“We do not assign all the time for the surgical service. Three hours out of the working hours are deducted, so we use 6 hours out of 9 to book the surgical cases.”

Do you schedule turnover time between the cases?

“Yes we do. Our average time here in KFSH&RC is 25 minutes between the cases. I mean from the patient leaving the room till the other patient enters the room.”

What time is the surgical list posted in the Operating Room and distributed?

The respondent said that the surgical list is posted at two o'clock. But this one at two o'clock is a draft, "sometimes we allow for minor changes, some surgeons they want to add a small procedure to the cases and at the same time they need to cancel. Then at two thirty, the manager will print out the list for all of the wards, and this is the final thing."

4.4.5: Interview Report: Admission

Which positions comprise the staff of the Admissions Office?

The respondent said that there are seven types of positions in the admissions office: the section supervisor, senior representatives, admissions representatives, reception clerk, admissions clerk working with the case manager, nurses and Patient Care Assistant (PCA). "These staff work in three different parts of our section. We have the reception area, which receives the patients and takes orders from the physician, the main control area and case management."

What is the role of the Admissions Office in this hospital?

The interviewee said that the main role of the admission office is to coordinate and control the bed availability in different areas in the hospital. "This requires a permanent awareness of the bed status around our hospital through direct contact with physicians and wards. Also, the admission process is one of our responsibilities, and we are involved in the patient discharge process."

What are the types of forms used by staff at the Admissions Office?

The respondent said that because the system is automated they only have electronic forms. The only form that needs to be printed is the consent form that the patient needs to sign. If the patient is a new case they may be asked to fill out an information sheet that has details such as their emergency contact.

Other than these forms, does the clinic use an electronic information system? If yes, what is this electronic system?

The interviewee said that the clinic does use an electronic system. “Physicians put the order into the system, so the others coming in the queue, then the request appears to the admissions office. As part of the hospital we use the ICIS system, which covers all the hospital. Also we use other system integrated with ICIS called the Admissions Transactions System (ATS); this shows all the patients, and they can check what is available and what is not available.”

Who informs the Admissions Office of ongoing surgical cases?

“We know about the cases by two ways, first through ICIS as all the main data are stored there, also we use our internal system which is called Admissions Transaction System (ATS) to be able to see all scheduled patients for today and tomorrow in the way with more ease and clearly.”

Who receives the patient during the admission date?

“The patient usually does not come until we call him to confirm the availability of the bed. After the patient arrives to the reception desk at the Admissions Office, the clerk receives the patient to verify his information and then enters them onto the system as an attended patient. Then the patient is transferred to one of the admission representatives who meets the patient in the interview room, and then the patient goes to the surgical ward with the Patient Care Assistant (PCA).”

What are the kinds of information given to the patient during admission?

The respondent said that after the patient’s data checked by the admission representative, and after the printing of the patient’s admission blue plat, then the hospital system is explained to the patient, including his rights as a patient, the types of services available, visiting times, entry permits for the patient’s companion, and to give the patient some instruction booklets.

Is there a general hospital consent form? Who signs it?

The respondent said that the patient is required to sign the general consent form at the Admissions Office as one of the admission processes. If the patient is a child the then the consent form needs to be signed by his or her parents.

What are the other types of forms that need to be signed? Who signs them?

The interviewee said that there are no paper forms that need to be signed other than the general hospital consent form.

After the patient has received all these things, how is the patient transferred to the surgical ward?

The respondent said that during the interview process with the patient the admissions representative calls the surgical ward to ensure the readiness of the bed, because sometimes the room is still undergoing the cleaning process. If the bed is ready, then the patient is sent to the ward accompanied by a Patient Care Assistant (PCA).

4.4.6: Interview Report: Surgical Ward

Which positions comprise the staff of the Surgical Ward?

The respondent said they have a staff nurse and a registered nurse, and they have the patient care assistant and the ward clerks. There is also the respondent, the head nurse, and an assistant head nurse and a clinical instructor.

What types of forms are used by staff on the Surgical Ward?

The respondent said that they use the general consent for surgery. “It has a consent part on the back. Then we use a sight marking form that is part of the time-out policy. They are the three papers that we use. The patient still has a medical record in paper form where the physicians put all those things and if there's a referral, the referring doctor writes notes. And all the multi-disciplinary teams just write notes, progress notes, so everyone can see what the dietician said, what the social worker said, so it's comprehensive. And like the ECG report we file them in the patient's file and stuff like that and the file contains information from the outpatient clinic and so on. There are reports from certain investigations in there as well."

Does the Surgical Ward use an electronic information system? If yes, what is this electronic system?

The respondent said that they use ICIS and maybe some of the surgeons use SurgeNet.

How does the surgical ward know about the need for surgical beds?

The respondent said that they get the information from the OR list at five o'clock in the afternoon the day before, which tells them which patients from which unit are on the OR lists for the next day. "They also get an admissions list as well, so they know that they have this amount of patients for admission, and they have the OR list to tell us these patients are on the list for tomorrow. So the two lists should match up exactly."

Who is responsible for managing the bed bookings on the surgical ward?

The respondent said that the admissions officer, the case manager and the surgical ward charge nurse are the three parties involved with this responsibility.

When does the Surgical Ward receive the Operating Room list?

The respondent said that they receive the list at five o'clock on the afternoon before the surgery.

How does the Surgical Ward address the problem of bed shortage?

The interviewee said that they have a case manger assigned to them to take care of this issue. Usually the case manager tries to manage any shortage by borrowing a bed in another surgical ward, or they have to call the physicians to try to discharge some of their patients if their health condition allows for discharge to make a bed available.

Who informs the surgical ward when the patient is ready for admission?

“The Admissions Department calls the surgical ward.”

Who accompanies the patient to the Surgical Ward?

The respondent said that a clerk from the admissions office will accompany the patient with their file.

Who receives the patient at the surgical ward?

“The patient will be received by the ward clerk and they will call the nurse who is involved with that patient’s case.”

Upon admission to the surgical ward, what is checked from the patient?

The interviewee said that the patient’s height, weight and vital signs are checked by the nurse. They will also call the surgeon and go through the documentation to make sure that everything is in order.

What is the duty of the nurse on the surgical ward?

The respondent said that there the nurse has several responsibilities, including receiving of the patient, taking the patient’s weight and height and other vitals, and going through the room orientation with them and telling them about the food service. “She has to prepare the patient preoperatively. While the doctor explains the surgery and the rest and all those things when they obtain the consent, and then the nurse is responsible for supporting the patient and making them ready with the head nurse. The primary nurse does the vital signs and administers the medication. They make sure the medication is written up by the physician and decide whether the patient needs the medication before they go to OR. Also, they have to clean the patient and make sure the patient is prepared surgically by having a shower, ensuring their skin is clean, and everything is ready. And then the patient is nil to mouth at least six hours before they go to OR. And also to see that all the documentation is done for the patient and the consent has a last check- sight marking, everything."

Does the surgeon visit the patient prior to surgery?

The respondent said that this does not always happen; sometimes it also depends on the admission of the patient. "If the patient comes at two o'clock in the morning and his list starts 6.45, there's no way he will see the patient. He will only see the patient in OR."

Does the anaesthesiologist visit the patient on the surgical ward?

The respondent said that the anaesthesiologist will see the patient at the pre-op and then they will come and check on the ward that everything is okay.

Is the site of surgery marked at the surgical ward? Who does it?

The respondent said that the site should be marked by the physician and that the consultant and the resident initial and date near to the marking.

Who briefs the patient about the surgery and after-surgery care?

"The nurse and the surgeon should give the patient information about the surgery. The nurse's role is for instance to tell them about the pain. How will the PCA will work afterwards, or the epidural or whatever, and about the internal spinal method and how to blow the air through to inflate their lungs. How to prevent blood clots, also the stockings, the anti-coagulants to prevent DVT. That kind of education the nurses do. The physicians have to explain about the actual procedure that's involved, any problems or complications that there can be."

How does the surgical ward know when the Operating Room is ready to receive the patient?

"The surgical time for the Operating Room, they call us to say to give the pre-med to the patient, and often as you put the phone down, the trolley is already here to pick up the patient."

How is the patient transferred to the Operating Room? Who accompanies the patient?

The interviewee said that the porter from the OR holding will come with a stretcher and the nurse will then help the patient get on the stretcher with the IV pump. “Then the nurse accompanies the patient with his file to OR and hands the patient over to the holding bay staff. Then they check again for allergies, sight, the consent- they check the list again.”

4.4.7: Interview Report: Intra-Operative

What is the capacity of the Operating Room in this hospital?

“We have at KFSH&RC four surgical suites. OR Level 2 is the main surgical suite and includes 17 operating rooms which are considered as the main Operating Room in this hospital. Also we have OR Level 4, it is for cardiac and thoracic surgeries; it contains five operating rooms. We have an Operating Room called OR CCC. This surgical suite specialises in treating children’s cancer cases, and it comprises four surgical suites, and two operating rooms located in the labour and delivery surgical suite (OR LD).”

How many surgeons and anaesthesiologists work in these surgical sections?

The respondent said that there are 153 surgical consultants and 38 anaesthesiologist consultants working in various specialties.

How many cases are carried out in this hospital annually?

“According to the statistical information for last year we performed more than 13,200 cases.”

What is the approximate number of hours taken to perform these procedures?

The respondent said that the total number of hours used last year to perform these procedures was more than 33,800 working hours.

What are the types of forms used in Intra-Operative?

"We use at holding area the consent form and handover sheet, but inside the Operating Room we don't use any forms accept for accounting, and the anaesthesia sheet."

Do the Intra-Operative staff use an electronic information system? If yes, what is this system?

The respondents said that the main system they use is SurgeNet as this has been integrated into ICIS.

Do you have a holding area for the surgical cases to keep the cases before surgery?

"Yes we have had this room from more than 13 years ago. This holding area has the capacity to receive all surgical cases for the start of the day at the same time."

How do the Operating Room staff know when the patient is ready in the Holding or reception Area?

The respondents said that they can see on SurgeNet that the patient has arrived and that all the patient's details have been entered in the holding area. This means that the patient is ready for surgery.

Who calls for the patient when the Operating Room is ready?

The respondent said that it is the responsibility of the circulating nurse to call for the patient.

What is done by the surgical staff before the surgical insertion to avoid the wrong surgery?

They said that at the moment it is the responsibility of the nurse to make sure all the information is correct and that officially there is no communication. However, one of the respondents said that they felt that it should not just be the responsibility of one person to check the information. They also said that from January they will be introducing a new system based on the international 'time out' which is a check list set up by the WHO. That will mean that the sign in process will involve the nurse, the doctor and the anaesthesiologist.

What is the information entered into the electronic system?

The respondents said that if there are any complications during the surgery and the procedure has to be changed then that is recorded in SurgeNet. There is also what they call a 'come in box' if anything is not included on SurgeNet: "if something happens like an arrest or if the patient leaves the operating theatre with swabs packed into the abdomen- all the extra comments- then there is a space where it can be written and documented for future reference. They would also have relief people coming in and SurgeNet also makes provision for that. It says exactly what time you came in, so it doesn't matter if you started with five people in the room and end up with fifteen all of them are recorded with the time."

To measure the performance of the Operating Room, do you depend on the number of cases done or the number of hours used?

"We use a combination of both. All information is available on SurgiNet. We can display this information in any way we like- case numbers only, hours only, or both numbers and hours."

What is the actual average turnover time between procedures?

The interviewees said that according to the latest statistics, the actual average turnover time is 18 minutes between cases.

Do any scheduled cases remain unfinished at the end of the official working hours?

The respondents said that late running cases occur on a daily basis.

Do you have a daily waiting list for surgical cases not in the scheduling plan?

"Yes we have, and the average number is 20 cases per day; this does not include the emergency cases."

Do you change the scheduled plan or are you committed to it?

"Yes, the plan is changed almost every day."

If there is a change to scheduling plan, why does it happen?

The respondent said that it happens often and "we do this in an attempt to use the time as much as we can."

Do you move the cases between the Operating Room?

The interviewees said that this also happens most of the time: "sometimes the cases scheduled for the same room are allocated to different surgeons, so one surgeon is delayed in finishing with his cases according to the scheduled time. If possible, we move the other surgeon's case to any other empty room to save time."

After the surgery is carried out, what happens next?

The interviewees said that whenever they finish they put it in the system that the surgery has finished. Then "We get the patient safely moved onto a stretcher and we take the patient out. Then recovery will be ready to receive the patient because they have seen this final on the screen. Everyone goes with this patient- the circulating nurse, consultant anaesthesiologist, technologist- they go with the patient to recovery. Then from recovery, the circulating nurse hands over to the staff nurse in recovery about the surgery, about the blood loss, about patient condition, about any drains. And the consultant anaesthesiologist gives handover to the staff nurse about medication and about the painkillers needed after surgery."

4.8: Conclusion

Throughout this comprehensive data reporting, no written guidelines or models containing any equations or formulas that can be used as standard to evaluate Operating Room performance have been found. Instead, the existing practices in all of the hospitals do not exceed individual efforts to use simple formulas in an attempt to analyse Operating Room performance through the use of Excel software.

In the literature on this subject, there are a number of developed methods available, which are written in a professional mathematical manner. These equations and/or formulas are presented in a purely statistical manner, containing a number of quadratic equations with a focus mainly on economic topics, and there is an absence of illustrative cases. Accordingly, it seems to be confusing for most medical practitioners regarding how to execute the existing procedures to evaluate OR performance (along with a lack of consensus); therefore, most concepts have not been applied successfully until now.

Throughout the data reporting, this study has identified the primary statistical factors required to start the Operating Room assessment process. These factors have been informed by the comprehensive literature review and the fieldwork (reported in chapter 4). All statistical factors used in the hospital reports have been identified and tested to ascertain the extent of their impact on the evaluation process; thus a number of unimportant factors have been excluded which do not affect the overall assessment of the performance of the Operating Room. Also, some new important factors have been added, which did not exist before. This has resulted in the identification of 14 primary statistical key factors (Table 10) which are essential to the beginning of the OR evaluation process.

Due to the presence of new statistical factors that were not present before, along with the absence of a suitable method for analysing these factors, a practical oriented mathematical model has been proposed and developed, namely the Operating Room Assessment Model (ORAM). This model comprises 18 basic concept linear equations with completely new simple notations inferred from the original sentence- these have been used to make it easier to remember them. The ORAM can be used to analyse the primary statistical factors clearly, sequentially, and in detail for both the Operating Rooms and the entire Surgical Suite.

In this chapter, all data obtained from the hospitals that have participated in this study has been presented in detail, followed by the data analysis.

CHAPTER 5
DATA ANALYSIS

5.1: Introduction

The OR management systems in all of the hospitals that have participated in this study have been examined over the years 2010 to 2012. The study includes fieldwork, data collection, observation, analysis of statistical data, and examining official reports in the form of monthly or annual reports provided by these hospitals, which include more than 98,500 procedures (Table 2).

The official reports were obtained from each hospital for a one-year period accompanied by the main statistical data from OR records for the same period. The analysis of these reports and the main data has been through a number of stages:

a. First, hospitals were classified by the measurement unit used (time or number of procedures) on the official reports; then all data located on weekends or official holidays was excluded; the rest of the data was divided into two parts- procedures carried out during the available time (budgeted time / staffed time) and the procedures done outside of the available time;
b. Then, all terms used in the reports were recorded to find out exactly what is meant by these terms, and all the statistical factors used in these reports were identified;
c. After that, each mathematical method used to evaluate OR performance was tested to ensure validity.

An analysis of the data reveals the existence of considerable variations in the techniques used for evaluating OR performance between hospitals that participated in this study, such as in the unit of measurement used to determine OR performance. At KFMC they use time (number of hours) as the mean measurement unit (KFMC 2011), while at Kameda, RUH and RMH they use the number of procedures only (see chapter 4 page 88 and 89). Also, at RMH and at KFSH&RC, they both use the time and the number of procedures at the same time (see chapter 4 page 139). Furthermore, there were some differences observed in determining the available time for surgery. RUH considers the available time to be all the budgeted / staffed time (see chapter 4 page 105). While in RMH, two hours are deducted from the ORs' budget time to cover the turnover time between procedures (RMH 2011). Also, it has been found in KFSH&RC that the deduction from the budgeted time is increased to three hours for the same reason (see chapter 4 page 129).

At RMH, the procedures are scheduled to cover all the available time, without adding time between cases to cover the turnover time (RMH 2011). In other systems such as at KAMC, 15 minutes are added between the procedures during the booking process as turnover time, while at RUH they calculate 15% of the procedure time to be deducted from the available time to cover the turnover time between procedures (see chapter 4 page 106). In addition, the definition of turnover time differs between these systems. KFSH&RC and RUH describe the turnover time as the time from one patient leaving the OR to the next patient entering the same room (see chapter 4 page 130); while KFMC define it as the time from one patient leaving the room until the anaesthesia start time for the next patient in the same OR (KFMC 2011), whereas at Kameda there is no precise definition for OR turnover time.

The use of certain terms which are unusual in this field have been noted, such as the word *Injection Time* being used in KFMC official reports for the meaning of *Procedure Time* (KFMC 2011); the use of the term *Allotted Time* in place of *Allocated Time* is used in KFSH&RC's Operating Room reports (KFSH&RC 2011-2012), and the use of *Utilized Time* intended to mean *Utilization*, and also the use of *Changeover time* for the meaning of *Turnover time* are terms used at KFMC (KFMC 2011). It is also noted that the hospitals targeting assessing OR performance have used the traditional OR utilization method, as with KFSH&RC and KAMC (KFSH&RC 2011-2012; KFMC 2011). Meanwhile, some systems such as at Kameda and RMH involve simply comparing the results that have been achieved with previous results, or for benchmarking with other organizations (Kameda 2011; RUH 2011).

5.2: Surgical Patent Flow

The aim of this section is to describe and analyse the flow of surgical patients within the Operating Room Management System for the main hospitals which participated in this study (Kameda, RUH, and KFSH&RC). This will be presented in the form of flow charts, for the purpose of displaying the similarities and differences between these systems.

5.2.1: Surgical Patent Flow at Kameda Medical Center

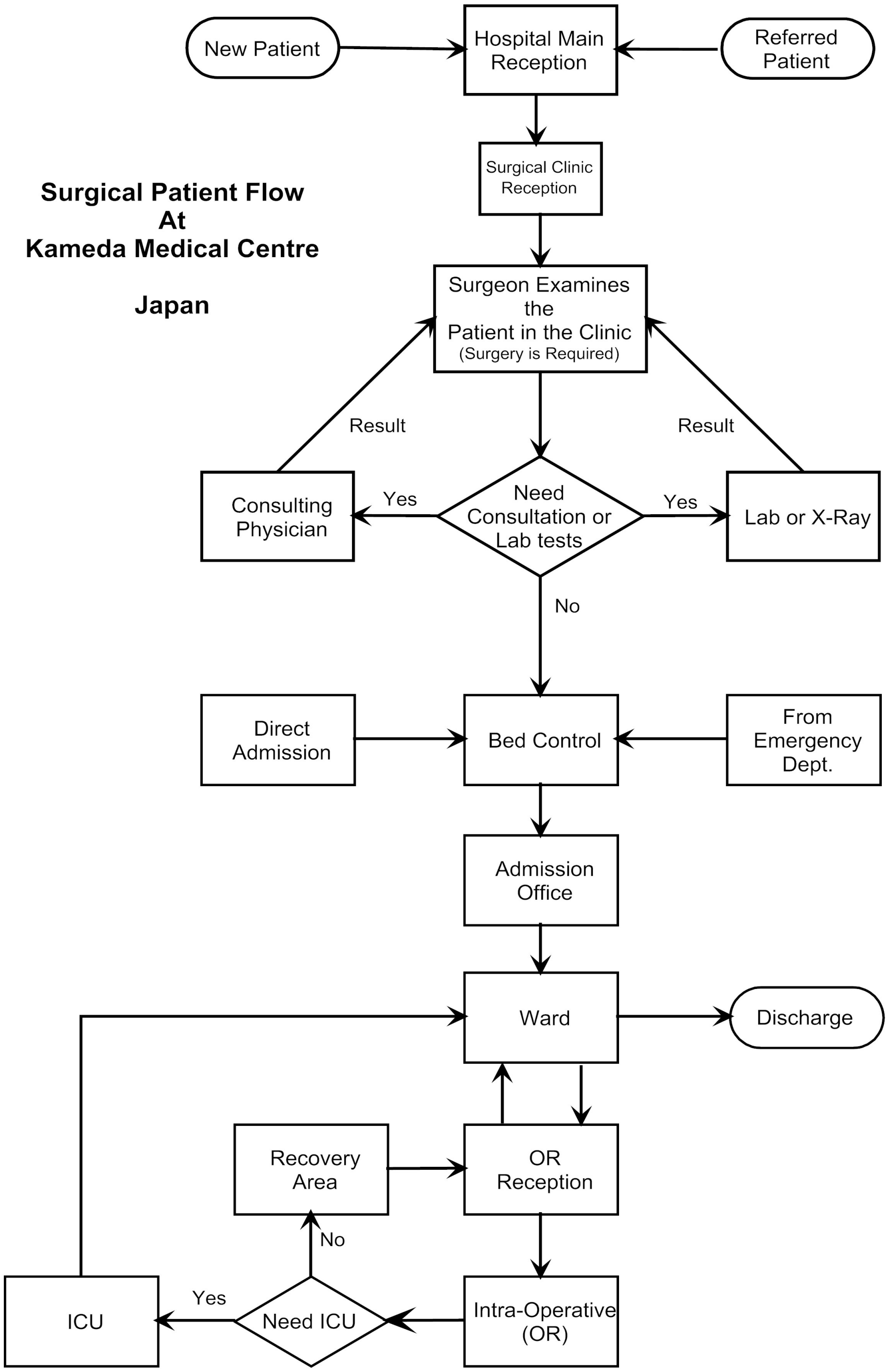


Figure 1 Surgical patient flow at Kameda Medical Centre

5.2.2: Surgical Patent Flow at Royal University Hospital

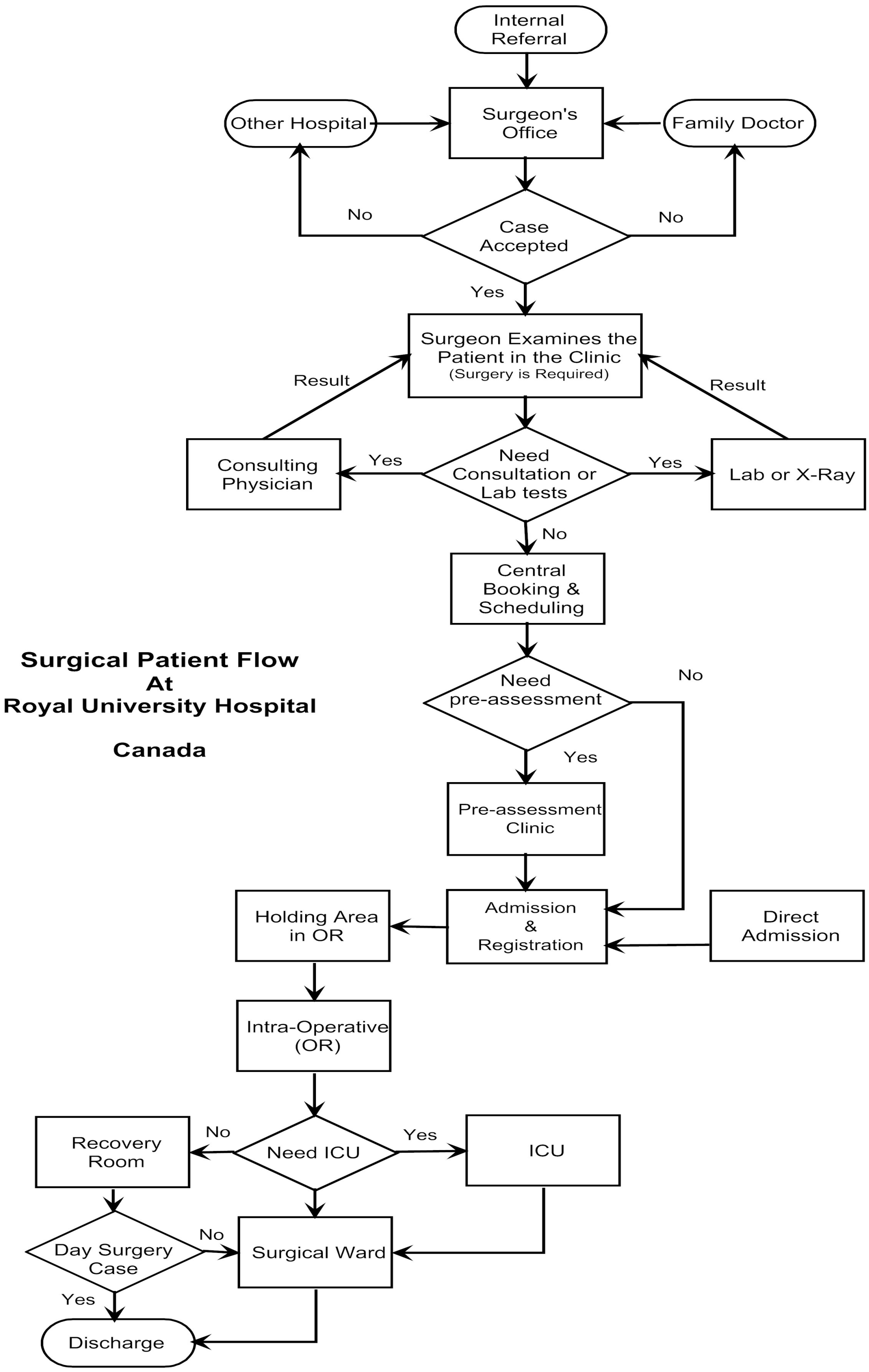


Figure 2 Surgical patient flow at Royal University Hospital

5.2.3: Surgical Patent Flow at King Faisal Specialist Hospital & Research Center

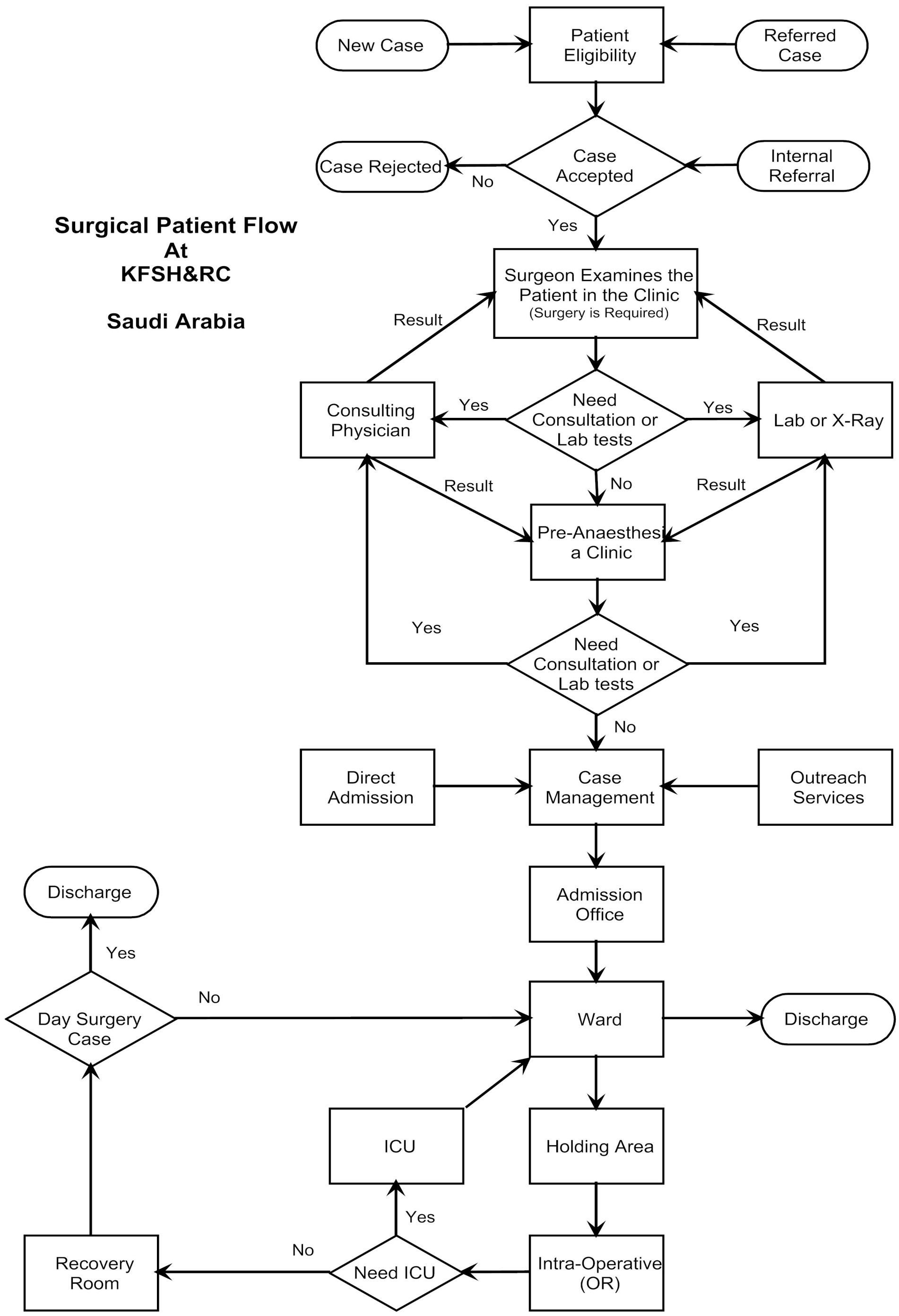


Figure 3 Surgical patient flow at King Faisal Specialist Hospital and Research Centre

5.2.4: The Main Observations of the Three Systems (Kameda, RUH and KFSH&RC)

In addition to what has been mentioned in the introduction to this chapter on the variations in the techniques used for evaluating OR performance between the hospitals that participated in this study, there are some main notes about the structure and the flow of the surgical patients at these systems which include the following:

Concerning the method used to accept the surgical cases, at Kameda- according to the Japanese healthcare system- in addition the referred cases, the patient can go directly to the hospital without referral from a family doctor or any other medical service. From the hospital's main reception, the patient is transferred directly to the surgical clinic, or any other clinic, according to the patient's request without an appointment; whether the patient is a new or former patient. The patient is received at the specialised clinic as a show up patient. While at the Royal University Hospital, the referral cases are sent directly to the clinic from external medical organisations without passing through any other section of the hospital, and the accepting or rejecting of the case is made by the surgical clinic directly. The patients are not allowed to contact the surgical clinic and no other section in the hospital can accept the case without referral. However, at KFSH&RC, there is a section called Patient Eligibility which specialises in the acceptance or rejection of the cases and considers both the referral cases. Also, patients are allowed to contact the hospital directly for the case to be accepted without referral, on condition that the patient provides a medical report containing the patient's medical history with an initial diagnosis of the case.

Clearly, it is possible to note a wide variation between these systems. In the first system, there is no procedure that distinguishes between the patient in real need of specialised care and other patients who do not need this type of service. Also, there is a waste of resources and time, which increases the workload of the staff. In the Canadian system there is a tight referral procedure which may result in delays in the arrival of cases because of the goalkeeper role played by the family doctor. The system used in Saudi Arabia at KFSH&RS may provide a compromise solution between these systems.

Regarding practice within the surgical clinic, the surgeon at Kameda conducting a full examination of the patient includes laboratory and radiology testing to make sure whether the patient needs surgery or not. The surgical clinic works as a filter to determine the cases that need a surgical service, and the cases that do not need it. While at the Royal University Hospital, the surgeon directly examines the diagnosed area in need of surgery; also, the patient's vital signs are not taken during his or her visit to the surgical clinic or at any other place in the hospital, as it has no bearing on the surgical decision-making. The patient is only referred to another medical department or laboratory if there is a specific need which has an influence on the surgical diagnosis. At KFSH&RC, the patient's vital signs, in addition to weight, height and medical history, are taken by the nurse every time the patient visits the clinic. Then the patient is fully examined by an assistant surgical physician with regard to the referral cause, before being seen by a surgical consultant for decision-making regarding the surgery.

In Japan, there is a waste of time, effort and resources before determining whether the patient needs surgery or not. In Canada, examination in the surgical clinic is specifically for surgical needs only, neglecting any other aspects not related to the cause of the need for surgery. The above two cases show the impact of the family doctor in this regard. In Canada, the surgeon depends on the good follow-up arrangements made by the family doctor before the patient is referred; while there is an absence of the role of the family doctor in Japan. In Saudi Arabia, and due to the fact that the role of the family doctor is not fully active, there is a need to be placed between the other two cases.

The Pre-Operative Assessment Clinic does not exist in the Japanese system. In Canada, there is a clinic called the Pre-Assessment Clinic, which is managed by nursing staff and controlled by any specific department interested in examining the surgical patient; it covers all specialties as needed. While in Saudi Arabia there is a clinic called the Pre-Anesthesia Clinic managed by the department of anaesthesiology; this clinic involves examining of the surgical patients by an anaesthesiologist, with a focus on matters relating to anaesthesia.

This research finds that the Canadian system is the best in this area.

In relation to the admission of surgical cases, the Japanese system required the admitting of the surgical patient to the hospital the day before the surgery, regardless of the nature of the surgical case; also, it does not believe in the application of one-day surgery. At the Royal University Hospital in Canada, the surgical patient is admitted to the hospital only after surgery, and no patient is admitted to the hospital before that. While at KFSH&RC in Saudi Arabia, the one day surgery cases are not admitted to the hospital, either before or after the surgery, while all other surgical patients are admitted to the hospital the night before surgery.

In the first case, in Japan, the resources are drained by the occupation of hospital bed by the cases that did not require admission. In the second case, in Canada, there is no guarantee of the patient being present at the right time and ready for surgery in terms of the patient’s health and fasting properly before anaesthesia, which creates a high possibility of case cancellation. Considering the points mentioned, Japan and Canada could take on board the way in which KFSH&RC operates as an appropriate solution.

Overall, the main observations are that the Japanese system which is applied at Kameda depends on a fewer number of workers, with more responsibilities and tasks for each member of staff, and the hospital is working as an independent health care unit not linked in a sequence in the healthcare system. In Canada, it is noted that the system in place at the Royal University Hospital is aimed at reducing the cost and focusing on the principle of specialisation. While at KFSH&RC in Saudi Arabia, the system depends on a large number of human resources working in a more complex structure, which forms a costly healthcare system.

This study has not specified one of the three systems mentioned above as an ideal one, but it may be possible to form an ideal system using the data reported in this study.

5.3: Horizontal Comparison for the Three Surgical Management Systems

In this section, each part of the Operating Room Management System for each hospital will be compared with the other three hospitals that have participated in this study. This will involve a horizontal comparison in the form of tables to facilitate access to information.

5.3.1: Surgical Clinic

Surgical Clinic		
Kameda	**RUH**	**KFSH&RC**
Staff		
• Consultant Surgeon • Surgical residents • Patient Support Representatives (PSR) • Receptionist	• Consultant Surgeon • Surgical residents • Medical assistant • Secretary	• Consultant Surgeon • Resident Surgeon • Staff nurse • Clinic clerk • Interpreter • Patient Care Assistant • Case manager (if needed)
Equipment and facilities		
• Desk • Chairs • Examining couch • Trolley with dressings and instruments • Computer	• Desk • Chairs • Computer • Printers • Examining couch • Blood pressure cuff	• Table • Chairs • Computer • Printers • Patients waiting System • Pyxis Machine for drug

• Two radiology o radiology digital monitors • Fully automatic blood pressure cuff • Fully automatic weighing scale • Fully automatic height scale	• Small dressing trolley • Instruments for removing sutures or drains • Measurement tools	and supply • Weighing scales • Height scales • Stethoscope • Examination bed • Stretcher • Oxygen • Suction • Sink • Sharps container
Information system		
• Main Chart System	• EMR system	• Integrated Clinical Information System (ICIS) • Pyxis system the Automated drug and supply dispensing system
Patient reach the surgical clinic		
• Patient referred by the family doctor • Directly without referral & without appointment	• Patient referred by letter via fax outlined by the family doctor • Internal referrals	• Referral from another hospital • Internal affair • Referral from eligibility treatment centre
Patients' medical history		
• From the hospital information system called Main Chart System • From the referral letter • Taken from the patient in the clinic	• From the family doctor • From the referral letter • From the questionnaire filled in by the patient • From the EMR system if the patient already has medical records	• From the referral report • From the ICIS system if the patient already has medical records • From a hard copy in the chart for old patients
Surgery decision		
• Agreed at that clinic	• Agreed at that clinic • Agreed by phone call	• Agreed in the clinic on the same day, or: • By a call to the clinic • After six months a new appointment is needed before accepting the decision
Medical consultation		
• Contact the other physician and discuss • Official referral to another clinic through the system	• Refer to another clinic • Refer to pre-assessment clinic	• Contact the other physician and discuss • Official referral to another clinic through the system
Surgical consent		

• It is not necessary to sign it in the Clinic	• Signed in the Clinic • Verbal consent accepted	• Initially filled in at the clinic • Signed in the Clinic • Valid for three months • Updated in pre-surgical clinic
Forms		
• Consent form • Blood transfusion consent form • Patient information sheet • Patient medical history form	• Initial consent form • Cases priority form • Brief summary form • Referring letter • Priority form • Patient questionnaire	• Progress notes: History notes Vital signs sheet Physician chart • Interdisciplinary form • Nurse charts • Consultation sheet • Appointment slip • Consent form • Procedure agreement form • Patients' requirement guidelines
Role of the nurse		
• No nurse available in surgical clinic	• No nurse available in surgical clinic	• Prepare the charts for the surgeon • Make the notes • Receive the patients • Check the pt. vital signs • Check the pt. history • Write pt. brief history • Fill the request for lab or x-ray • Gives instructions to pt.
Where does the patient go after surgical clinic		
• To the main reception in the outpatient clinic • Surgery request to surgical clinic meeting on Thursday	• Patient transferred to a pre-assessment clinic or to outpatient clinic. • Surgery request to Central Booking	• Patient transferred to pre-anaesthesia clinic • Surgery request to Case Manager

Table 5 Horizontal Comparison for Surgical Clinics

5.3.2: Pre-Operative Assessment Clinic

Pre-Assessment Clinic		
Kameda	**RUH**	**KFSH&RC**
Section Name		
Not Available	Pre-Assessment Clinic	Pre-Anesthesia Clinic
Staff		
	• Two nurses • Clerk • Anaesthesiologist • General Internal Medicine Consultant	• Anaesthesiologists • Anaesthesia resident • Three nurses • Team leader • Coordinator • Clerk • Patient Care Assistant
Equipment and facilities		
	• Three interview rooms • Reception • Waiting area • Desk • Chairs • Computer • Examining table • Blood pressure cuff • Weighing scale • Height scale	• Three examination rooms • Table • Chairs • Computer • Examination table • Automatic vital signs machine • ECG machine • Weighing scale • Height scale
Forms		
	• The booking slip • The information sheet • Patient history form • Physical sheet • Vital signs record • Blood work request • Radiology request • ECG request	• Physical assessment form • Indication form • Referral form • Consultation form • Anaesthesia report • Consent form • Educational pamphlets
Information system		
	• PACS System	• Integrated Clinical Information System (ICIS) • SurgeNet
How does the Patient reach the surgical clinic?		
	• Through the Surgical Booking Center	• Referral from Surgical Clinic

Who examines the patient at the Pre- Assessment Clinic?		
	• Internal medicine physician • Anaesthesiologist • Cardiologist if needed	• The anaesthesiologist • The nurse starting from 2012
Medical consultation		
	• Patients are not transferred to another clinic • Call the required consultant to see the patient in the clinic	• Official Referral to another clinic through the system
Is there a follow-up appointment		
	• No	• Yes
How many surgical cases are seen per year		
	• 1,800 case per year	• 7,000 case per year
Where does the patient go after surgical clinic		
	• Patient goes home	• Patient sent home • To admissions office

Table 6 Horizontal Comparison for Pre-Operative Assessment Clinic

5.3.3: Surgical Cases Coordinator

Surgical Cases Coordinator		
Kameda	**RUH**	**KFSH&RC**
Section Name		
Not Available	The Secretary of Surgeon	Case Manager
People involved in surgical case coordination		
	• The secretary • The surgeon • The surgical scheduling department	• The case manager • The surgeon • Admissions department
The main role of the coordinator		
	• To coordinate between the hospital and the patient to determine the day of the surgery.	• To coordinate between the surgeon, the patient and the admission in order to arrange the surgical day
From whom does the coordinator receive the surgical case?		
	• Direct referral of the patient's chart to the surgeon	• Directly from the surgeon though a phone call
Forms Used		
	• Inpatient booking card • Priority criteria tool • The consent form	• Case management electronic sheet (Microsoft Excel)
Electronic information systems used		
	• Paper work	• Admissions Transaction System (ATS)
Duties of the coordinator		
	• To write the medical reports • Filling out the forms • Communicate with surgical scheduling department • Follow-up the booking process • Contact with the patient	• Contact the surgeon on a daily basis • Find out the surgical cases booked for surgery • Update the surgeon's waiting list • Follow-up with the OR scheduling • Prioritise the surgical cases • Schedule the surgical cases • Coordinate with the patient

Information provided to the coordinator		
	• All patient's medical records • The type of operation • The time required for this surgery • Patient's health condition • Urgent or a routine procedure	• The patient's medical records • Name of the patient • Age of the patient • Type of surgery • If the patient is booked to be seen by pre-anaesthesia clinic or not
The role of the coordinator in determining the date of the surgery		
	• Book the time for the surgeon in OR. • Coordinate with surgical scheduling to determine the day. • Communicate with the patient to confirm the date.	• Review the waiting list • Update the waiting list with the surgeon • Prioritise the surgical case • Book the case according to the available time
Is it possible for the patient to choose the date of his or her surgery?		
	• There is some flexibility if there is an available time	• Yes, if there is an open surgical slot
The role of the coordinator in case of changes to the surgical date		
	• Inform the patient • Explain the reason to the patient • Look for the next available date.	• Communicate with the patient • Explain the reason for the change to the patient • Follow-up with the patient • Find an alternative day
Is the coordinator the only person in contact with the patient?		
	• The coordinator is officially responsible for contacting the patient	• The coordinator is the main contact with the surgical patient
Is a slot kept free in the surgical schedule for emergency cases		
	• No	• No

Table 7 Horizontal Comparison for Surgical Cases Coordinator

5.3.4: Booking and Scheduling

BOOKING / SCHEDULING		
Kameda	**RUH**	**KFSH&RC**
Section Name		
Bed Control	**Booking Services**	**Booking and Scheduling**
Staff		
• Head of the service • Four coordinators	• Head of the service • Seven coordinators	• OR Director • OR Deputy Director • General Surgery Department coordinator • Two surgical nurses as schedulers • OR information system coordinator
Role of the Booking / Scheduling		
• Confirm the surgery with the surgical wards • Locate beds for surgical cases	• Locate dates and times for surgical cases	• Locate times for surgical cases
Forms		
• No paper forms	• In-patient booking form • Day surgical booking form	• Booking form for emergency cases only
Information system		
• Main Frame Work	• Omni Server	• SurgiNet
Who submit the booking request?		
• Consultant Surgeon	• Secretary of surgical department	• Consultant Surgeon • Resident Surgeon
To whom is the booking request submitted?		
• To Main Frame Work	• Booking Services	• To SurgiNet
Information required in booking request		
• Patient's name • Patient's gender • Patient's age	• The patient's basic demographic information	• Patient's name • Patient's gender • Patient's age

• Patient's weight • Surgeon's name • Type of surgery • Day of surgery • Start time of surgery • Surgical duration • If there is any infection • Need for anaesthesia or not.	• If the patient needs pre-assessment visit • The desired day for surgery • Type of surgery • Site of the surgery • Time of the surgery	• Patient's weight • Patient's medical record number • Type of surgery • The day and time of the surgery • Location where the surgery will be carried out • Which Operating Room • Type of patient (inpatient or day surgery case) • Elective or an emergency • Type of anaesthesia • Site of surgery • Type of precaution (AIDS, hepatitis etc) • Cancer case or not
Can the order be submitted online?		
• Must be online	• No	• Must be online
Duration of the booking process		
• Weekly	• Monthly	• Daily
How many working hours you have daily?		
• 8 hours	• 8 hours	• 9 hours
How many hours are used to schedule cases from the daily working hours?		
• 8 hours	• 8 hours	• 7 hours
Do you schedule turnover time between the cases? If yes how long?		
• 38 min	• 15% of the procedure time	• 25 min
What time is the surgical list posted?		
• Two days before surgery	• Daily	• Daily

Table 8 Horizontal Comparison for Booking and Scheduling

5.3.5: Admission

Admission Office		
Kameda	**RUH**	**KFSH&RC**
Section Name		
Admission / Discharge Consultation	**Admission and Registration**	**Admission Office**
Staff		
• Supervisor • Coordinator • Clerks	• Registration Clerks • Admission Clerks • Regional Manager • Three managers • Two Business Unit Analysts • Three Support Assistants	• Section supervisor • Senior representatives • Admissions representatives • Reception clerk • Admissions clerk • Nurses • Patient Care Assistant (PCA
Roles of Admission Office		
• To find out the Patient's needs. • To select the type of bed. • To check the forms • To check the identity • To check the insurance	• To check the patient information • To check the forms • To check the insurance	• Coordinate and control the beds • Admission process • Discharge process
Forms		
• General information form • Admissions consent form • Transfusion consent form	• The standard registration form • The booking card • The checklist • The consent form	• The consent form • Information sheet for new patient only
Information system		
• Main Chart System • Internal System	• Shared Client Index (SCI)	• Integrated Clinical Information System (ICIS) • Admissions Transactions System (ATS)
How does the Admissions Office know about the need for admission?		
• Through the Main Chart System • From the Surgical Clinic	• Through the surgical list	• Through ICIS and ATS
Who receives the patient at the Admissions Office?		

• Section Coordinator	• Registration Clerks	• Reception clerk
Is there a general hospital consent form?		
• Admission consent	• No	• Yes
Are there any other types of forms that need to be signed?		
• Transfusion consent	• No	• No
How is the patient transferred to the surgical ward?		
• By him/herself	• No direct transfer to surgical word	• Accompanied by Patient Care Assistant (PCA)

Table 9 Horizontal Comparison for Admission

5.3.6: Surgical Ward

Surgical Ward		
Kameda	**RUH**	**KFSH&RC**
Section Name		
Surgical Ward	**Surgical Ward**	**Surgical Ward**
Staff		
• Head nurse • Lead nurse • Nurses • Receptionist • Patient Support Representative (PSR) • Surgeons • Anaethesiologist	• Registered Nurses • Licensed Practitioner Nurses • Special Carers • Unit Assists • Clinical coordinator • Clinical Nurse Educator • Surgeons • Anaethesiologist	• Head nurse • Assistant head nurse • Staff nurse • Registered nurse • Clinical instructor • Patient care assistant • Ward clerks • Surgeons • Anaethesiologist
Forms		
• Electronic forms • Consent form	• Doctor's notes • Nursing notes • Whole chart • Basic consent form • Registration form	• The general consent • Sight marking form • Referral form • Doctor's written notes • Progress notes

Information system		
• Main Chart System	• Not at this time	• ICIS • SurgeNet
Who is responsible for managing the bed bookings on the surgical ward?		
• Bed control department	• Clinical coordinator	• The case manager
When does the Surgical Ward receive the Operating Room list?		
• Two days before	• One day before the surgery	• At 5:00 pm for next day's surgeries
From where does the patient reach the surgical clinic?		
• From Admissions Dept.	• From Admissions Dept. • From Emergency Dept.	• From Admissions Dept. • From Emergency Dept.
Who receives the patient at the surgical ward?		
• The receptionist	• The assigned nurse	• The ward clerk
Role of the nurse		
• Check patient data • Meet the patient • Put the armband on • Take the patient's vital signs • Follow the doctor's instructions • Change surgical bandages • Support for the patient	• Overall, for all the patient's needs	• Receive the patient from the ward clerk • Take the patient's weight and height • Take the patient's vital signs • Patient orientation to the surgical ward • Prepare the patient for surgery • Support the patient • Take care of patient's medications • Check sight marking and consent
Does the surgeon visit the patient prior to surgery?		
• Yes, and holds a pre-operation meeting with the patient and his or her family	• Not all the time	• Not all the time
Does the anaesthesiologist visit the patient on the surgical ward?		
• Yes, and attends the pre-operation meeting with the patient and his or her family	• Does not visit for an elective procedure on surgical ward	• If not seen at Pre-anesthesia clinic
Is the site of surgery marked at the surgical ward? Who does it?		

• Some times and it is done by the nurse	• Not all the time- it depends on the case	• Yes, if the patient is not seen at the pre-anaesthesia clinic
Who accompanies the patient to the Operating Room?		
• The nurses from Operating Room and surgical ward	• OR porters • (No nurse)	• The surgical ward nurse • The OR porter

Table 10 Horizontal Comparison for Surgical Ward

5.3.7: Intra-Operative

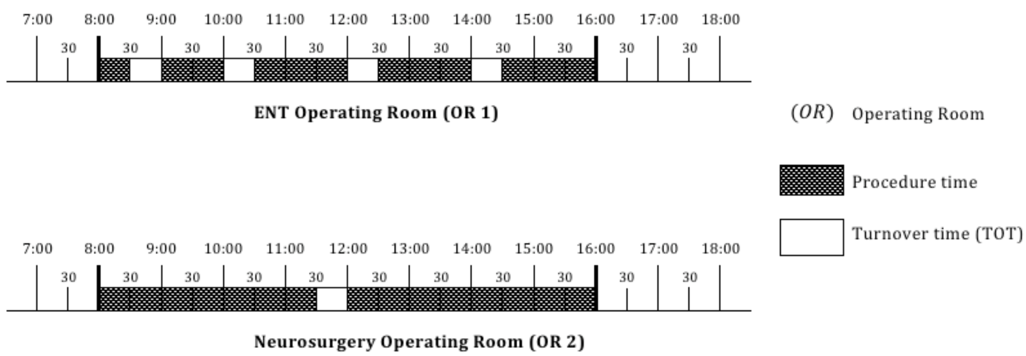
Intra-Operative		
Kameda	**RUH**	**KFSH&RC**
Section Name		
Operating Room	**Operating Room**	**Operating Room**
Number of Surgical Suites and Operating Rooms		
• Two Surgical Suites • 16 Operating Rooms	• One Surgical Suite • 10 Operating Rooms	• Four Surgical Suites • 28 Operating Rooms
Number of Surgeons and Anaesthesiologists		
• 96 Surgeons • 14 Anaesthesioloists	• 86 Surgeons • 66 Anaesthesioloists	• 153 Surgeons • 38 Anaesthesioloists
Number of surgical procedures carried out per year		
• > 8000 Procedures	• > 8600 Procedures	• > 13,200 Procedures
Number of hours used to perform the surgical procedures per year		
• > 18,000 Hours	• > 20,400 Hours	• > 33,800 Hours
Forms used in Operating Room		
• Consent form • Count sheet • Time out sheet • Anaesthesia sheet • Time out sheet	• Consent form • Pre-operative checklist • Anaesthesia sheet	• Consent form • Accounting sheet • Anaesthesia sheet • Time out sheet
Information system		

• Main Chart System (MCS)	• No	• SurgeNet
What is used to avoid the wrong surgery?		
• Check list • Time out sheet	• Verbal ‘time out” check	• Time out sheet
Performance measurement unit		
• Number of procedures only	• Number of procedures only	• Both numbers and hours
Actual turnover time between the procedures		
• Up to an hour	• Unknown	• 18 minutes
Are there any late running procedures?		
• Sometimes	• Most of the time	• Most of the time
Do you have a daily waiting list for elective surgical procedures?		
• No	• No	• Yes
Do you change the scheduled plan during the surgical day?		
• Sometimes	• Sometimes	• Sometimes
Do you move the cases between the Operating Rooms?		
• Rarely	• Sometimes	• Sometimes
After the surgery carried out where the patient goes?		
• To recovery room	• To recovery room	• To recovery room

Table 11 Horizontal Comparison for Intra-Operative

5.4: Conclusion

From the data analysis, it is clear that most of the hospitals use the number of procedures performed, or the time used to complete the surgical procedures as a unit, to measure the level of Operating Room performance. This study does not consider both units- the time and the number of the procedures- as a valid measurement unit to determine the level of the Operating Room performance. To clarify this point, figure 4 presents a comparison between two Operating Rooms; one carrying out ENT procedures, which are small and quick procedures, and the other Operating Room containing neurosurgery procedures which are extensive and long procedures.



Scenario of the daily practice occurring in an ENT Operating Room (OR 1) and Neurosurgery Operating Room (OR 2). In this scenario, the daily working hours are 8 hours, from 8:00 till 16:00.

Figure 4 Daily Scenario of ENT and Neurosurgery Operating Rooms

In both rooms, the surgeons performed the scheduled procedures evenly and during the eight official working hours, but when calculating the number of procedures completed, there were five cases done in OR 1 by the ENT surgeon, while there were two cases performed by the Neurosurgeon. Also, when calculating the time used for surgery to perform these operations, it is clear that the ENT surgeon took six hours to perform five cases, while the Neurosurgeon took 7.5 hours to perform two neurosurgeries. In both

Operating Rooms, this is the normal time for these types of surgeries, and both surgeons work properly according to their specialty.

If the number of cases performed is used as a measuring unit to measure the performance, the result will show that the ENT surgeon performed better because the number of cases performed is more that the number of the cases performed in the other room. Therefore, this unit will give incorrect information. And in the other situation, when using the time as a unit of measurement, the result will show that the Neurosurgeon performed better because they took more time than the ENT surgeon; once again, the use of time as a measurement unit will give wrong information.

Therefore, the aim of this study is to find an appropriate method for evaluating operating room performance, taking into account these variations.

This chapter has clarified the surgical patient flow in each system and the information has been presented in the form of flow charts; also, the similarities and differences between each part have been presented in the form of a table containing a horizontal comparison.

The next chapter will address the proposed Operating Room Assessment Framework (ORAF).

CHAPTER 6

OPERATING ROOM ASSESSMENT FRAMEWORK

6.1: Introduction

This chapter is concerned with developing clear and complete guidelines and an underpinning model which can be used (in practice) to assist OR managers, directors or any other medical professionals in evaluating the performance of an OR, This is in order to determine accurate scheduling for the use of the OR; discover the differences in the quality of time used in the OR, and to determine OR utilization.

Through this study, an Operating Room Assessment Framework (ORAF) has been developed, which consists of a number of logically connected components to form an integrated assessment framework for evaluating Operating Room performance. The ORAF includes: Operating Room Concept Definitions; the Primary Factors; Operating Room Assessment Model (ORAM); Derived Factors; Operating Room Rings Model (ORRM) and the OR Assessment Outcome (Figure 4). These components form the stages of the assessment process.

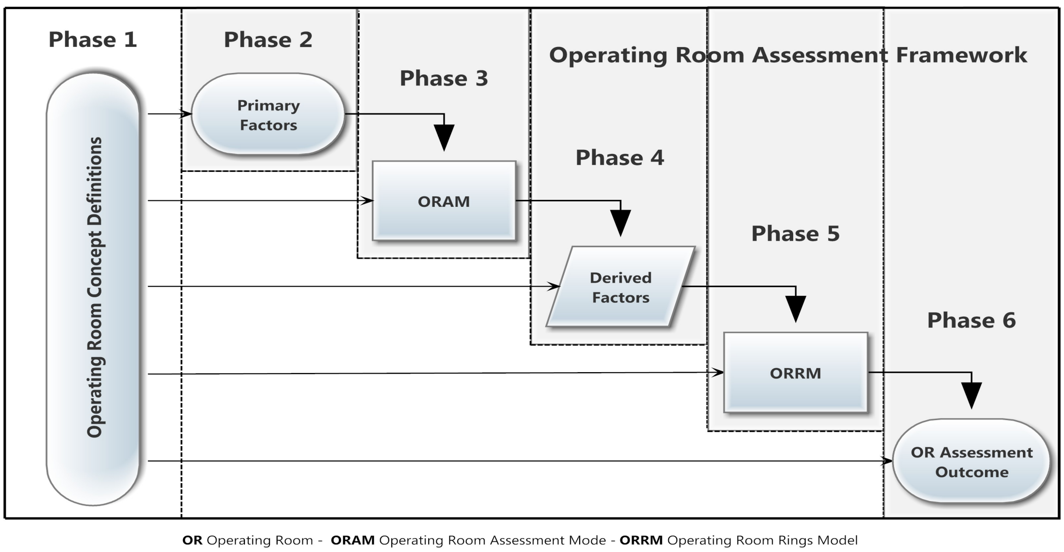


Figure 5 Stages and configuration of Operating Room Assessment Framework (ORAM)

The development of the ORAF went through a number of stages before final consolidation. These stages are incremental and involve:

1. **Operating Room concepts definition**: The definitions of the most important terms used in this field have been improved, and new terms and definitions proposed. This has been informed both by the literature review and the comprehensive fieldwork reported in Chapter 4. This stage is a prerequisite for the other follow on stages of the OR evaluation process.

2. **Primary Statistical factors identification**: The primary statistical factors affecting the evaluation of OR performance have been identified. These have been informed by both the literature review and the comprehensive fieldwork reported in Chapter 4.

3. **Operating Room Assessment Model** (ORAM): A practical oriented mathematical model (ORAM) has been developed to analyse the primary statistical factors identified in the previous stage.

4. **Derived statistical factors**: New statistical factors have been derived using the ORAM developed in the previous stage.

5. **Operating Room Rings Model** (ORRM): A visualisation metaphor (ORRM) has been proposed to interpret the newly derived statistical factors.

6. **Operating Room Assessment Outcome:** This final stage provides holistic reporting of the Operating Room Assessment Outcome.

6.2: Phase 1 - Operating Room concepts definition

Throughout the fieldwork and the data analysis, all terms used in the hospital reports gathered were identified and analysed with a view to understanding their underpinning semantics. It has been noted during this study that there is often a conflict between the definition and understanding of the most important statistical terms used to evaluate OR performance across participating hospitals. This is due to the introduction and use of terms which are not usually used in this field. Also, there is incorrect use of some terminology, or it is sometimes employed in the wrong context, such as the use of the word *Injection Time* for the meaning of *Procedure Time*; the use of the term *Allotted Time* in place of *Allocated Time*, and the use of *Utilized Time* intended to mean *Utilization*, as well as the use of *Changeover Time* or *Interval Time* for the meaning of *Turnover Time* (KFSH&RC 2011; KAMC 2011; KFMC 2011; RUH 2011).

The purpose of this section is to define the most important terms commonly used in scientific articles in the field. Also, new terms and definitions have been added for the purpose of elaboration and clarification of the existing terms.

Most of the existing terms used in the OR jargon have been clarified and improved in a formal way. This involved some semantic amendments to clarify their meaning and provide a suitable form for application in the context of the proposed mathematical model. Also, new terms have been identified such as: *Time Off* and *Extended Working Time*; the term *Time off* facilitates the process of calculation in the event of the partial or full closure of any OR within the surgical suite, in order to find the accurate available time for the OR and surgical suite. As the main concern in evaluating OR performance is to find out the exact amount of time used out of the available time (budgeted time), a new term '*Extended Working Time'* has been introduced to distinguish between the time used during and after working hours. This is because there is a difference between performing the surgical procedures within the budgeted time and after official working hours. Some of the existing definitions have also been restructured. For instance, Turnover Time is now decomposed into four types: *Planned Turnover Time*, *Scheduled Turnover Time, Extended Turnover Time* and *Total Turnover Time.* This is to clarify the difference between each type during the calculation process in order to determine the passive and negative effect of turnover time during the phases of OR data analysis, as well as to differentiate between OR workload and the OR's actual workload.

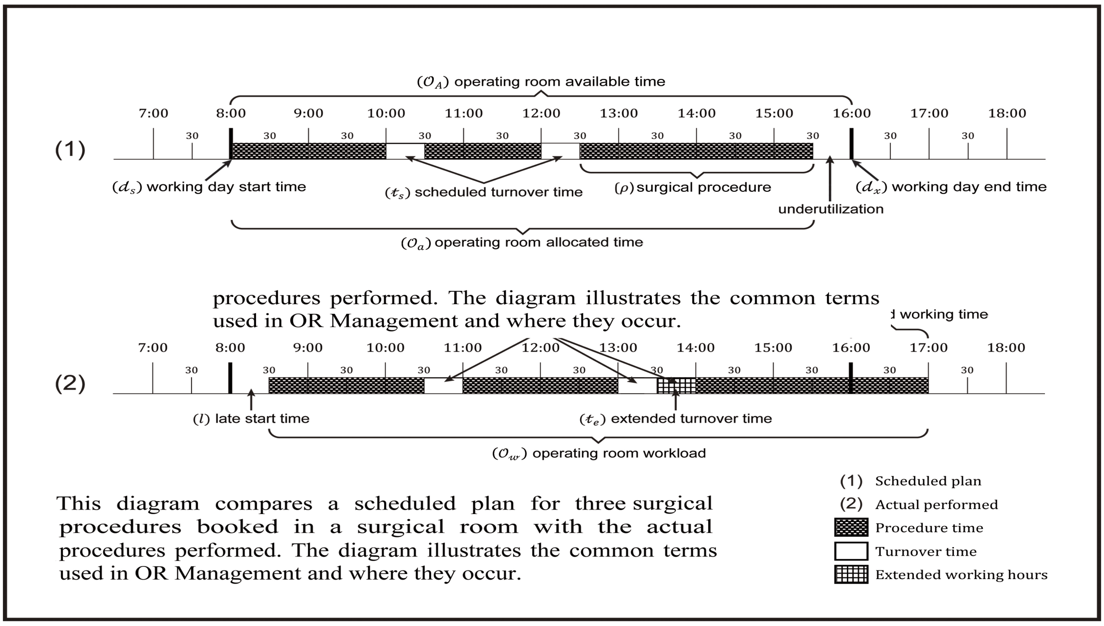


Figure 6 Comparison of a scheduled plan with actual performance in an Operating Room

Figure 5 illustrates the OR scheduling plan compared with actual performance. Key notations are shown in the figure.

Below, the definition of key OR terms, including improved and new terms, is given supported by notations (inferred from the original meaning), so as to improve their clarity.

$\mathcal{O}$: Operating Room (OR):

Place where the surgical procedure is performed.

$\mathcal{S}$: Surgical Suite:

Section of the hospital containing a set of Operating Rooms.

d **: Working Days:**

Official working days of the week- usually eight hours per day, not including weekends.

In figures 5 and 6, one working day equals eight hours.

d_s **: Working Day Start Time:**

Official start time of the budgeted working day- usually between 7:00 and 9:00.

d_x **: Working Day End Time:**

Official end time of the budgeted working day- usually between 16:00 and 18:00.

h **: Working Hours:**

The number of budgeted working hours per working day per Operating Room.

f **: Time Off:**

The number of days off, or hours off, out of the working days.

ρ **: Procedure:**

A single surgical case per Operating Room.

ρ_r **: Number of Procedures:**

The total number of surgical cases entering the Operating Room.

ρ^{st}**: First Procedure:**

The first surgical case, which begins the surgical day in the Operating Room.

ρ^{l} **: Last Procedure:**

The last surgical case, which ends the surgical day in the Operating Room.

ρ_s : Procedure Start Time:

The beginning of the surgical case; it starts at the time when the patient enters the Operating Room.

ρ_x : Procedure End Time:

The end time of the surgical case; it ends at the time when the patient leaves the Operating Room.

ρ_t : Procedure Time:

The period of time starting from when the patient enters the Operating Room for the surgical procedure until the patient leaves the Operating Room.

l : Late Start Time:

The difference between the planned start time and the actual start time for the first procedure in the Operating Room.

t: Turnover Time:

The period of time starting from one patient leaving the Operating Room, to the entering of the next patient into the same Operating Room (Dexter et al 1999; Dexter et al 2001; Dexter et al 2003). This time is usually used for cleaning and preparing between procedures.

t_p : Planed Turnover Time:

The amount of time planned by the Operating Room management to be added between surgical procedures during the scheduling process: this study assumes that the planned turnover time is 30 minutes.

t_s : Scheduled Turnover Time:

The total of the planned turnover time that is added between the procedures during the scheduling process for the Operating Room.

t_e : Extended Turnover Time:

A term used in this study to define the unplanned additional time added to the scheduled turnover time during the budget time (surgery day) for any reason between the procedures.

t_t : Total Turnover Time:

A term used in this study to define the sum of the scheduled turnover time and extended turnover time.

$O_{\mathcal{E}}$: Operating Room Extended Working Time:

The period of time that the operating room is used for after the planned end time of the working day, up until the end time of the last scheduled procedure.

$S_{\mathcal{E}}$: Surgical Suite Extended Working Time:

The total of the extended working time for those operating rooms used after the planned end time of the working day until the end time of the last scheduled procedure for the entire surgical suite.

O_A: Operating Room Available Time:

The available staffed (budgeted) time per Operating Room.

S_A: Surgical Suite Available Time:

The total available staffed (budgeted) time in the entire surgical suite.

O_a: Operating Room Allocated Time:

The total time of the scheduled procedures for surgery, including the scheduled turnover time for a single Operating Room.

S_a: Surgical Suite Allocated Time:

The total time of the scheduled procedures for surgery, including the scheduled turnover time between the procedures for the entire surgical suite.

O_w: Operating Room Workload:

The total amount of time the Operating Room is used, which includes the procedure time and the total turnover time either in or out of the Operating Room available time (normal working hours) (Dexter and Macario 2002; McIntosh et al 2006).

S_w : Surgical Suite Workload:

The total amount of time the surgical suite is used for, including the procedure time and the total turnover time

O_{Aw}: Operating Room Actual Workload:

The total amount of time that the Operating Room is used, excluding the extended turnover time.

S_{Aw}: Surgical Suite Actual Workload:

The total of the actual workload for the entire surgical suite.

O_{Ow} : Operating Room Over Workload:

The actual Operating Room workload that exceeds the Operating Room available time.

S_{Ow} : Surgical Suite Over Workload:

The actual Surgical Suite workload that exceeds the Surgical Suite available time.

O_u : Operating Room Utilization:

The ration of the actual Operating Room workload divided by the Operating Room available time. The operating room utilization is 100% or less.

S_u : Surgical Suite Utilization:

The ration of the total of the actual Operating Rooms' workloads divided by the surgical suite's available time. The surgical suite utilization is 100% or less.

6.3: Phase 2 - Primary Statistical Factors Identification

The statistical data provides the main indicators in the process of evaluating OR performance. Therefore, this study has identified the primary statistical factors required to start the Operating Room assessment process. These factors have been informed by the comprehensive literature review and the fieldwork (reported in chapter 4). All statistical factors used in the hospital reports have been identified and tested to ascertain the extent of their impact in the evaluation process; thus a number of unimportant factors have been excluded which do not affect the overall assessment of the performance of the Operating Room, such as *Patient Call Time*, *Anaesthesia Start Time and End Time*. Also, some new important factors have been added, such as *Extended Work Time*, *Extended Turnover Time*, and *Total Turnover Time*. This has resulted in the identification of 14 primary statistical key factors (Table 10) which are essential to the beginning of the OR evaluation process.

The Primary Statistical Factors			
Factors		**Factors**	
1.	Working days	8.	Procedure start time
2.	Working day start time	9.	Procedure end time
3.	Working day end time	10.	First procedure’s start time
4.	Working hours	11.	Last procedure’s end time
5.	Time off (hours or days)	12.	Late start time
6.	Number of procedures	13.	The planned turnover time
7.	Procedure time	14.	Scheduled turnover time

Table 12 The primary statistical factors

6.4: Phase 3 - Operating Room Assessment Model (ORAM)

In this section, a proposed practical oriented mathematical model, namely the Operating Room Assessment Model (ORAM) is developed. This model comprises 18 equations to be used as a tool to analyse the primary statistical factors obtained from the OR records clearly, sequentially and in detail for both the Operating Rooms and the entire Surgical Suite.

Operating Room Assessment Model (ORAM):

ρ_t : Procedure Time:

$$\rho_t = \rho_x - \rho_s \tag{1}$$

l : Late Start Time:

$$l = \rho_s^{st} - d_s \tag{2}$$

t_s : Scheduled Turnover Time:

$$t_s = (\rho_r - 1)\, t_p \tag{3}$$

t_e : Extended Turnover Time:

$$t_e = [\rho_x^l - \rho_s^{st}] - \sum_{r=1}^{r=n} \rho_t^r - t_s \quad ;\ t_e \geq 0 \tag{4}$$

n: number of procedures performed in the OR.

t_t : Total Turnover Time:

$$t_t = t_s + t_e$$

$\mathcal{O}_{\mathcal{E}}$: Operating Room Extended Working Time:

$$\mathcal{O}_{\mathcal{E}} = \rho_x^l - d_x \quad (5)$$

$\mathcal{S}_{\mathcal{E}}$: Surgical Suite Extended Working Time:

$$\mathcal{S}_{\mathcal{E}} = \sum_{r=1}^{r=n} \mathcal{O}_{\mathcal{E}}^r \quad (6)$$

$\mathcal{O}_A$: Operating Room Available Time;

$$\mathcal{O}_A = [d - f]h \quad (7)$$

$\mathcal{S}_A$: Surgical Suite Available Time:

$$\mathcal{S}_A = \sum_{r=1}^{r=n} \mathcal{O}_A^r \quad (8)$$

n: number of OR s in the surgical suite.

$\mathcal{O}_a$: Operating Room Allocated Time:

$$\mathcal{O}_a = \sum_{r=1}^{r=n} \rho_t^r + t_s \quad (9)$$

n: number of procedures in the ORs.

$\mathcal{S}_a$: Surgical Suite Allocated Time:

$$\mathcal{S}_{a=} \sum_{r=1}^{r=n} \mathcal{O}_a^r \tag{10}$$

n: number of ORs.

$\mathcal{O}_{w}$: Operating Room Workload:

$$\mathcal{O}_{w} = \rho_x^l - \rho_s^{st} \tag{11}$$

$\mathcal{S}_{w}$: Surgical Suite Workload:

$$\mathcal{S}_{w} = \sum_{r=1}^{r=n} \mathcal{O}_{w}^r \tag{12}$$

n: number of ORs in the surgical suite.

$\mathcal{O}_{Aw}$: Operating Room Actual Workload:

$$\mathcal{O}_{Aw} = \mathcal{O}_{w} - t_e \tag{13}$$

$\mathcal{S}_{Aw}$: Surgical Suite Actual Workload:

$$\mathcal{S}_{Aw} = \sum_{r=1}^{r=n} \mathcal{O}_{Aw}^r \tag{14}$$

n: number of ORs in the surgical suite.

$\mathcal{O}_{Ow}$ **: Operating Room Over Workload:**

$$\boldsymbol{\mathcal{O}_{Ow} = \mathcal{O}_{Aw} - \mathcal{O}_{A} \quad ; \ \mathcal{O}_{Ow} \geq 0} \tag{15}$$

$\mathcal{S}_{Ow}$ **: Surgical Suite Over Workload:**

$$\boldsymbol{\mathcal{S}_{Ow} = \mathcal{S}_{Aw} - \mathcal{S}_{A} \quad ; \ \mathcal{S}_{Ow} \geq 0} \tag{16}$$

$\mathcal{O}_{u}$**: Operating Room Utilization:**

$$\mathcal{O}_{u} = \frac{\mathcal{O}_{Aw}}{\mathcal{O}_{A}} \times 100 \quad ; \ \mathcal{O}_{u} \leq 100 \tag{17}$$

$\mathcal{S}_{u}$**; Surgical Suite Utilization:**

$$\mathcal{S}_{u} = \frac{\mathcal{S}_{Aw}}{\mathcal{S}_{A}} \times 100 \quad ; \ \mathcal{S}_{u} \leq 100 \tag{18}$$

6.4.1: ORAM Illustration and Pre-Validation

In order to illustrate, explain, and pre-validate the above mathematical model, a comprehensive and fictitious scenario of a surgical suite containing four operating rooms (informed by the selected case studies described in Chapter 3), has been elaborated on and then tested using a large set of data. For further clarification, all of the details of this surgical suite are illustrated in figure 6 to enable the reader to understand and apply these equations easily.

In this model the "hour" is the measurement unit written in a 24-hour format in decimal form (i.e., 01:20 pm is considered as 13.33 hrs.) used as a variable in the mathematical equations of the proposed Operating Room Assessment Model (ORAM).

To convert Time into a decimal format the following formula has been used;

$$Time = \left[hrs + \left(\frac{min}{60}\right) hrs\right]$$

Example:

$$10{:}45 \ = \left[\ hrs + \left(\frac{min}{60}\right) hrs\right]$$

$$10{:}45 \ = \left[\ 10 + \left(\frac{45}{60}\right) hrs\right]$$

$$10{:}45 \ = [\ 10 + \ 0.75\ hrs]$$

$$10{:}45 \ = 10.75\ hrs$$

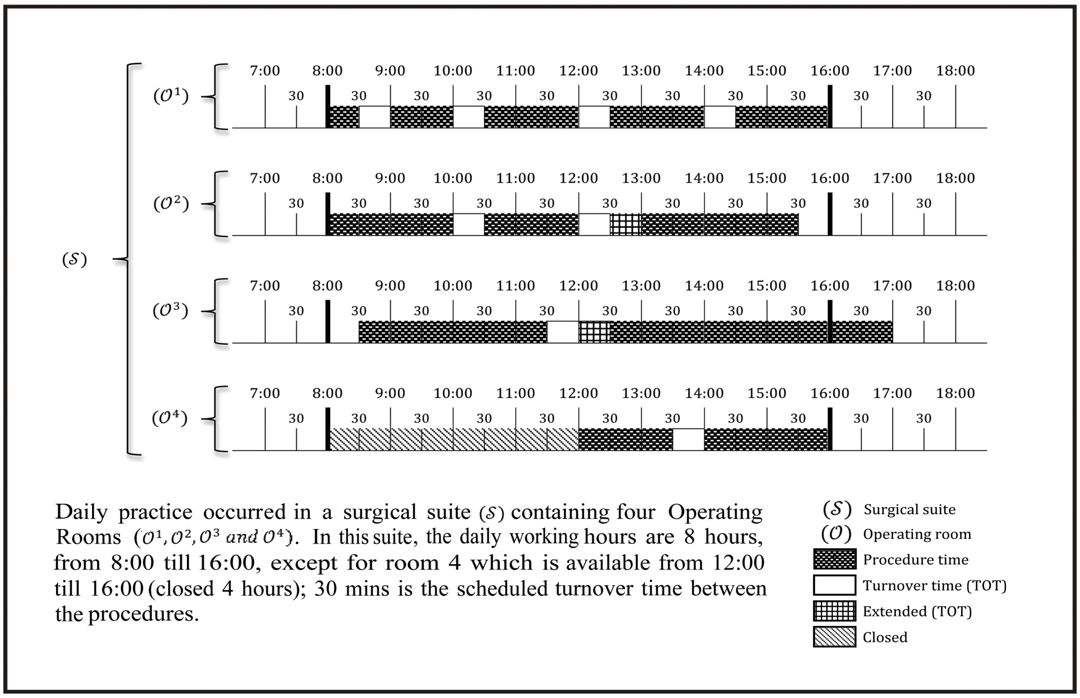


Figure 7 A scenario of surgical suite containing four operating rooms

In this section, all the mathematical equations have been applied in sequence to evaluate the performance level of the OR and to determine OR utilization.

ρ_t : Procedure Time;

This can be calculated using the following equation:

$$\rho_t = \rho_x - \rho_s \qquad (1)$$

The procedure time for the first case in room one (Figure 6) can be calculated using equation (1) as follows:

$$\rho_t^1 = \rho_x - \rho_s$$
$$\rho_t^1 = 8.5 - 8$$
$$\rho_t^1 = 0.5$$

The procedure time for the first case in room one is 30 min (0.5 hour).

l : Late Start Time;

This can be calculated using the following equation:

$$l = \rho_s^{st} - d_s \qquad (2)$$

The late start time in room three in figure 6 can be calculated using equation (2) as follows:

$$l^3 = \rho_s^{st} - d_s$$
$$l^3 = 8.5 - 8$$
$$l^3 = 0.5$$

The late start time in room 3 is 30 min.

t_s : Scheduled Turnover Time.

This can be calculated using the following equation:

$$t_s = (\rho_r - 1)\, t_p \qquad (3)$$

The scheduled turnover time in room one in figure 6 can be calculated using equation (3) as follows:

$$t_s^1 = (\rho_r - 1)\, t_p$$
$$t_s^1 = (5 - 1)\, 0.5$$
$$t_s^1 = 4 \times 0.5$$
$$t_s^1 = 2$$

The scheduled turnover time in room one is 2 hours.

t_e **: Extended Turnover Time.**

This can be calculated using the following equation:

$$t_e = [\rho_x^l - \rho_s^{st}] - \sum_{r=1}^{r=n} \rho_t^r - t_s \quad ; \; t_e \geq 0 \qquad (4)$$

n: number of procedures performed in the OR.

The extended turnover time in room two in figure 6 can be calculated by using equation (4) as follows:

$$t_e^2 = [\rho_x^l - \rho_s^{st}] - \sum_{r=1}^{r=n} \rho_t^r - t_s$$

$$t_e^2 = [\rho_x^l - \rho_s^{st}] - [\rho_t^1 + \rho_t^2 + \rho_t^3] - t_s$$

$$t_e^2 = [15.5 - 8] - [2 + 1.5 + 2.5] - 1$$

$$t_e^2 = 7.5 - 6 - 1$$

$$t_e^2 = 0.5$$

The extended turnover time in room two is 30 min.

t_t **: Total Turnover Time:**

This is the sum of the scheduled turnover time and extended turnover time. It can be calculated as follows:

$$t_t = t_s + t_e$$

The total turnover time in room two (figure 6) can be calculated as follows:

$$t_t^2 = t_s^2 + t_e^2$$

$$t_t^2 = 1 + 0.5$$

$$t_t^2 = 1.5$$

The total turnover time in room two is 1 hour and 30 min.

$\mathcal{O}_{\mathcal{E}}$: Operating Room Extended Working Time;

This can be calculated using the following equation:

$$\mathcal{O}_{\mathcal{E}} = \rho_x^l - d_x \qquad (5)$$

The extended working time in room three in figure 6 can be calculated by using equation (5) as follows:

$\mathcal{O}_{\mathcal{E}}^3 = \rho_x^l - d_x$

$\mathcal{O}_{\mathcal{E}}^3 = 17 - 16$

$\mathcal{O}_{\mathcal{E}}^3 = 1$

The extended working time in room three is 1 hour.

$\mathcal{S}_{\mathcal{E}}$: Surgical Suite Extended Working Time;

This can be calculated using the following equation:

$$\mathcal{S}_{\mathcal{E}} = \sum_{r=1}^{r=n} \mathcal{O}_{\mathcal{E}}^r \qquad (6)$$

From figure 6, the extended working time in the surgical suite can be calculated using equation (6) as follows:

$$\mathcal{S}_{\mathcal{E}} = \sum_{r=1}^{r=n} \mathcal{O}_{\mathcal{E}}^r$$

$\mathcal{S}_{\mathcal{E}} = \mathcal{O}_{\mathcal{E}}^1 + \mathcal{O}_{\mathcal{E}}^2 + \mathcal{O}_{\mathcal{E}}^3 + \mathcal{O}_{\mathcal{E}}^4$

$\mathcal{S}_{\mathcal{E}} = 0 + 0 + 1 + 0$

$\mathcal{S}_{\mathcal{E}} = 1$

The extended working time in the surgical suite is 1 hour only.

$\mathcal{O}_A$ **: Operating Room Available Time:**

This can be calculated using the following equation:

$$\mathcal{O}_A = [d - f]h \qquad (7)$$

From figure 6, the available time in room one can be calculated using equation (7) as follows:

$\mathcal{O}_A^1 = [d - f]h$

$\mathcal{O}_A^1 = [1 - 0]8$

$\mathcal{O}_A^1 = 1 \times 8$

$\mathcal{O}_A^1 = 8$

Available time in room one is 8 hours.

While the available time in room four is as follows:

$\mathcal{O}_A^4 = [d - f]h$

$\mathcal{O}_A^4 = [1 - 0.5]8$

$\mathcal{O}_A^4 = 0.5 \times 8$

$\mathcal{O}_A^4 = 4$

Available time in room four is 4 hours.

$\mathcal{S}_A$ **: Surgical Suite Available Time:**

This can be calculated using the following equation:

$$\mathcal{S}_A = \sum_{r=1}^{r=n} \mathcal{O}_A^r \qquad (8)$$

n: number of ORs in the surgical suite.

From figure 6, the available time in the surgical suite can be calculated using equation (8) as follows:

$$\mathcal{S}_A = \sum_{r=1}^{4} \mathcal{O}_A^r$$

$$\mathcal{S}_A = \mathcal{O}_A^1 + \mathcal{O}_A^2 + \mathcal{O}_A^3 + \mathcal{O}_A^4$$

$$\mathcal{S}_A = 8 + 8 + 8 + 4$$

$$\mathcal{S}_A = 28$$

The available time in the surgical suite is 28 hours.

$\mathcal{O}_a$: Operating Room Allocated Time:

This can be calculated using the following equation:

$$\mathcal{O}_a = \sum_{r=1}^{r=n} \rho_t^r + \boldsymbol{t_s} \qquad (9)$$

n: number of procedures in the ORs.

From figure 6, the allocated time for room two can be calculated using equation (9) as follows:

$$\mathcal{O}_a^2 = \sum_{r=1}^{3} \rho_t^r + \boldsymbol{t_s}$$

$$\mathcal{O}_a^2 = [\rho_t^1 + \rho_t^2 + \rho_t^3] + \left[(\rho_r - 1)\boldsymbol{t}_p\right]$$

$$\mathcal{O}_a^2 = [2 + 1.5 + 2.5] + [(3 - 1)0.5]$$

$$\mathcal{O}_a^2 = [2 + 1.5 + 2.5] + [2 \times 0.5]$$

$$\mathcal{O}_a^2 = 6 + 1$$

$$\mathcal{O}_a^2 = 7$$

The allocated time for room two is 7 hours.

$\mathcal{S}_a$: Surgical Suite Allocated Time;

This can be calculated using the following equation:

$$\mathcal{S}_{a=}\sum_{r=1}^{r=n}\mathcal{O}_a^r \qquad (10)$$

n: number of ORs.

The surgical suite allocated time in figure 6 can be calculated using equation (10) as follows:

$$\mathcal{S}_{a=}\sum_{r=1}^{4}\mathcal{O}_a^r$$

$$\mathcal{S}_{a=}\ \mathcal{O}_a^1+\mathcal{O}_a^2+\mathcal{O}_a^3+\mathcal{O}_a^4$$

$$\mathcal{S}_{a=}\ 8+7+8+4$$

$$\mathcal{S}_{a=}\ 27$$

The surgical suite allocated time is 27 hours for that day.

$\mathcal{O}_w$: Operating Room Workload:

This can be calculated using the following equation:

$$\mathcal{O}_w=\rho_x^l-\rho_s^{st} \qquad (11)$$

The workload in room three (figure 6) can be calculated using equation (11) as follows:

$$\mathcal{O}_w^3=\rho_x^l-\rho_s^{st}$$

$$\mathcal{O}_w^3=17-8.5$$

$$\mathcal{O}_w^3=8.5$$

The workload in room three is 8.5 hours.

$\mathcal{S}_{w}$**: Surgical Suite Workload:**

This can be calculated using the following equation:

$$\mathcal{S}_{w} = \sum_{r=1}^{r=n} \mathcal{O}_{w}^{r} \qquad (12)$$

n: number of ORs in the surgical suite.

From figure 6, the surgical suite workload can be calculated using equation (12) as follows:

$$\mathcal{S}_{w} = \sum_{r=1}^{r=n} \mathcal{O}_{w}^{r}$$

$$\mathcal{S}_{w} = \mathcal{O}_{w}^{1} + \mathcal{O}_{w}^{2} + \mathcal{O}_{w}^{3} + \mathcal{O}_{w}^{4}$$

$$\mathcal{S}_{w} = 8 + 7.5 + 8.5 + 4$$

$$\mathcal{S}_{w} = 28$$

The surgical suite workload is 28 hours.

$\mathcal{O}_{Aw}$ **: Operating Room Actual Workload:**

This can be calculated using the following equation:

$$\mathcal{O}_{Aw} = \mathcal{O}_{w} - t_{e} \qquad (13)$$

Figure 6, the actual workload in room three can be calculated using equation (13) as follows:

$$\mathcal{O}_{Aw}^{3} = \mathcal{O}_{w} - t_{e}$$

$$\mathcal{O}_{Aw}^{3} = 8.5 - 0.5$$

$$\mathcal{O}_{Aw}^{3} = 8$$

The actual workload in room three is 8 hours.

$\mathcal{S}_{Aw}$: Surgical Suite Actual Workload:

This can be calculated using the following equation:

$$\mathcal{S}_{Aw} = \sum_{r=1}^{r=n} \mathcal{O}_{Aw}^{r} \qquad (14)$$

n: number of ORs in the surgical suite.

The actual workload for the surgical suite in figure 6 can be calculated using equation (14) as follows:

$$\mathcal{S}_{Aw} = \sum_{r=1}^{r=n} \mathcal{O}_{Aw}^{r}$$

$$\mathcal{S}_{Aw} = \mathcal{O}_{Aw}^{1} + \mathcal{O}_{Aw}^{2} + \mathcal{O}_{Aw}^{3} + \mathcal{O}_{Aw}^{4}$$

$$\mathcal{S}_{Aw} = 8 + 7 + 8 + 4$$

$$\mathcal{S}_{Aw} = 27$$

The actual workload for the surgical suite is 27 hours.

$\mathcal{O}_{Ow}$: Operating Room Over Workload:

This can be calculated using the following equation:

$$\mathcal{O}_{Ow} = \mathcal{O}_{Aw} - \mathcal{O}_{A} \qquad ; \ \mathcal{O}_{Ow} \geq 0 \qquad (15)$$

The over workload in room two (figure 6) can be calculated using equation (15) as follows:

$$\mathcal{O}_{Ow}^{2} = \mathcal{O}_{Aw}^{2} - \mathcal{O}_{A}^{2}$$

$$\mathcal{O}_{Ow}^{2} = 7 - 8$$

$$\mathcal{O}_{Ow}^{2} = -1$$

As $-1 < 0$, which mean that the over workload in room two is 0 hour. There was no over workload in room two.

By using the same equation (15) the over workload in room three is as follows:

$$\mathcal{O}_{Ow}^{3} = \mathcal{O}_{Aw}^{3} - \mathcal{O}_{A}^{3}$$

$$\mathcal{O}_{Ow}^{3} = 8 - 8$$

$$\mathcal{O}_{Ow}^{3} = 0$$

The over workload in room three (figure 6) is 0 hours even though the last case finished one hour after the end of the official working time, because the total workload contains late start time and extended turnover time, which is differs from the actual workload.

$\mathcal{S}_{Ow}$: Surgical Suite Over Workload:

This can be calculated using the following equation:

$$\mathcal{S}_{Ow} = \mathcal{S}_{Aw} - \mathcal{S}_{A} \qquad ; \ \mathcal{S}_{Ow} \geq 0 \qquad (16)$$

The over workload in room two (figure 6) can be calculated using equation (16) as follows:

$$\mathcal{S}_{Ow} = \mathcal{S}_{Aw} - \mathcal{S}_{A}$$

$$\mathcal{S}_{Ow} = 27 - 28$$

$$\mathcal{S}_{Ow} = -1$$

As $-1 < 0$, which mean that the over workload in in the surgical suite is 0 hour. Overall there was no over workload in in the surgical suite.

$\mathcal{O}_u$: Operating Room Utilization:

This can be calculated using the following equation:

$$\mathcal{O}_u = \frac{\mathcal{O}_{Aw}}{\mathcal{O}_A} \times 100 \quad ; \; \mathcal{O}_u \leq 100 \qquad (17)$$

The utilization in room three (figure 6) can be calculated using equation (17) as follows:

$$\mathcal{O}_u^3 = \frac{\mathcal{O}_{Aw}}{\mathcal{O}_A} \times 100$$

$$\mathcal{O}_u^3 = \frac{8}{8} \times 100$$

$$\mathcal{O}_u^3 = 1 \times 100$$

$$\mathcal{O}_u^3 = 100\%$$

The utilized time in room three is 8 hours and the utilization is 100%, even with one hour working time exceeded the available time.

While it is found by using the same equation (17) that the utilization in room two is as follows:

$$\mathcal{O}_u^2 = \frac{\mathcal{O}_{Aw}}{\mathcal{O}_A} \times 100$$

$$\mathcal{O}_u^2 = \frac{7}{8} \times 100$$

$$\mathcal{O}_u^2 = 0.875 \times 100$$

$$\mathcal{O}_u^2 = 87.5\%$$

The utilized time in room two is 7 hours and the utilization is 87.5%, with the fact that this room finished only half an hour before the working day end time.

$\mathcal{S}_u$**; Surgical Suite Utilization:**

This can be calculated using the following equation:

$$\mathcal{S}_u = \frac{\mathcal{S}_{Aw}}{\mathcal{S}_A} \times 100 \quad ; \ \mathcal{S}_u \leq 100 \qquad (18)$$

The utilization for the surgical suite in figure 6 can be calculated using equation (18) as follows:

$$\mathcal{S}_u = \frac{\mathcal{S}_{Aw}}{\mathcal{S}_A} \times 100$$

$$\mathcal{S}_u = \frac{27}{28} \times 100$$

$$\mathcal{S}_u = 0.964 \times 100$$

$$\mathcal{S}_u = 96.4$$

The utilization of the surgical suite is 96.4%.

6.5: Phase 4 - Derived Statistical Factors

The operating room assessment model (ORAM) and its underpinning mathematical equations, which make use of the primary factors (Phase 2), have informed the development of a new set of factors, in the form of statistical data which forms the second set of important factors in the Operating Room evaluation process. These derived factors have been divided into three sections: (a) Factors containing general statistical information: Extended Working Time, Extended Turnover Time, and Total Turnover Time; (b) Factors related to the Operating Rooms: Operating Room's Available Time, Operating Room's Allocated Time, Operating Room Workload, Operating Room Actual Workload, Operating Room Over

Workload, and Operating Room Utilization; and (c) Factors regarding the inter Surgical Suite: Surgical Suite's Available Time, Surgical Suite's Allocated Time, Surgical Suite Workload, Surgical Suite Actual workload, Surgical Suite Over Workload, and Surgical Suite Utilization, making a total of 15 new derived factors (Table 11).

Derived Statistical Factors		
Operating Room's Factors	**General Statistical Factors**	**Surgical Suite's Factors**
• Operating Room's Available Time • Operating Room's Allocated Time • Operating Room Workload • Operating Room Actual Workload • Operating Room Over Workload • Operating Room Utilization	• Extended Working Time • Extended Turnover Time • Total Turnover Time	• Surgical Suite's Available Time • Surgical Suite's Allocated Time • Surgical Suite Workload • Surgical Suite Actual Workload • Surgical Suite Over Workload • Surgical Suite Utilization

Table 13 Derived statistical factors from using ORAM.

6.6: Phase 5 - Operating Room Rings Model (ORRM).

The in-depth analysis of the data obtained from the participating hospitals points out to a lack of attention regarding the value of OR available time: six out of eight official statistical reports (Kameda, RUH, SPH, SCH, RMH, KFMC) have not determined the amount of OR available time. This is not even mentioned throughout in their reports.

This research highlights the significance of "OR available time", not only in the evaluation process of the Operating Room, but also for use as an indicator to plan and evaluate OR productivity. This is because the OR available time is the budgeted/staffed time per OR that is allotted to be used entirely for a surgical procedure. Therefore, if this time is not used, or used incorrectly, it can be considered a waste of money and resources. In addition, if the OR available time is used in full consistently but does not cover the daily surgical needs, then this must be considered as there is a need to expand OR capacity, either by increasing the number of ORs or by increasing the working time. Thus, the study has found that the OR available time is the main point which the evaluation of the Operating Rooms revolves around.

Therefore, an equation has been developed (equation 7), which is part of the proposed mathematical model (ORAM), to calculate the OR available time while taking into consideration reaching the highest possible accuracy by adding the *time off* (f) to the equation to cover the variables that occur through the partial closure of some ORs; in fact, this study has noted that this lost time was not being calculated before.

In this section, an evidence based model has been developed to demonstrate and measure the performance of the Operating Room in the form of overlapping rings. These rings represent: OR available time, OR allocated time, OR workload and OR actual workload; all of these values are derived from the mathematical model developed. In this model, the available time will be the center of the measurement unit. This model is called Operating Room Rings Model (ORRM). The aim of this model is to facilitate and speed up the process of measuring and reading Operating Room performance, and for it to be used as a dashboard to represent Operating Room performance.

6.6.1: Design of ORRM

The aim of this section is to develop a visualisation metaphor model to enable the reader to convey holistic information about the performance of the Operating Room quickly and easily, thereby creating a decision making tool for the operating room management team.

The idea of this model is based on the OR available time (O_A), therefore the value of OR available time is assumed to be 100% all of the time. This can be done simply by using equation (19). As a consequence, this value (100%)

forms a fixed circle grounded on a base, and in this circle, the value at the base is equal to 0% and at the top of the circle it is 100% (Figure 7).

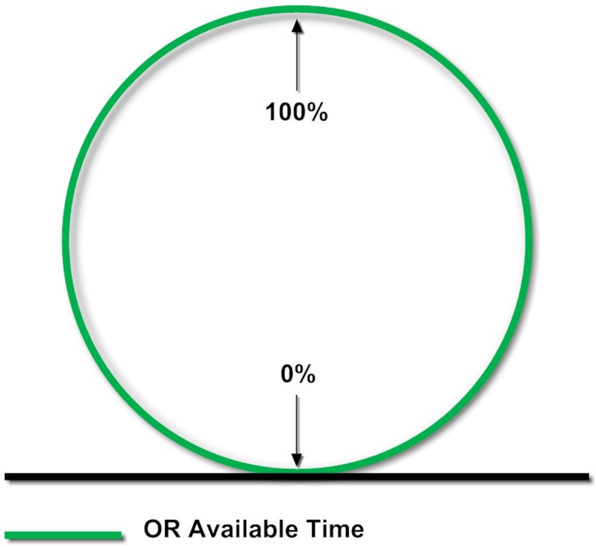


Figure 8. Operating Room Rings Model (ORRM) available time.

The next step is to convert the values of the other measurement units: OR allocated time ($\mathcal{O}_a$), OR workload ($\mathcal{O}_w$) and OR actual workload ($\mathcal{O}_{Aw}$) into percentages by comparing these values to the value of the OR available time. This can be done by using the equations (20, 21 and 22), and then the percentage values form circles of different sizes that fit according to their respective percentages, compared to the circle of the OR available time. All these circles are grounded on the same base overlapping each other (Figure 8).

$$\frac{\mathcal{O}_A}{\mathcal{O}_A} \times 100 \qquad (19)$$

$$\frac{\mathcal{O}_a}{\mathcal{O}_A} \times 100 \qquad (20)$$

$$\frac{\mathcal{O}_w}{\mathcal{O}_A} \times 100 \qquad (21)$$

$$\frac{\mathcal{O}_{Aw}}{\mathcal{O}_A} \times 100 \qquad (22)$$

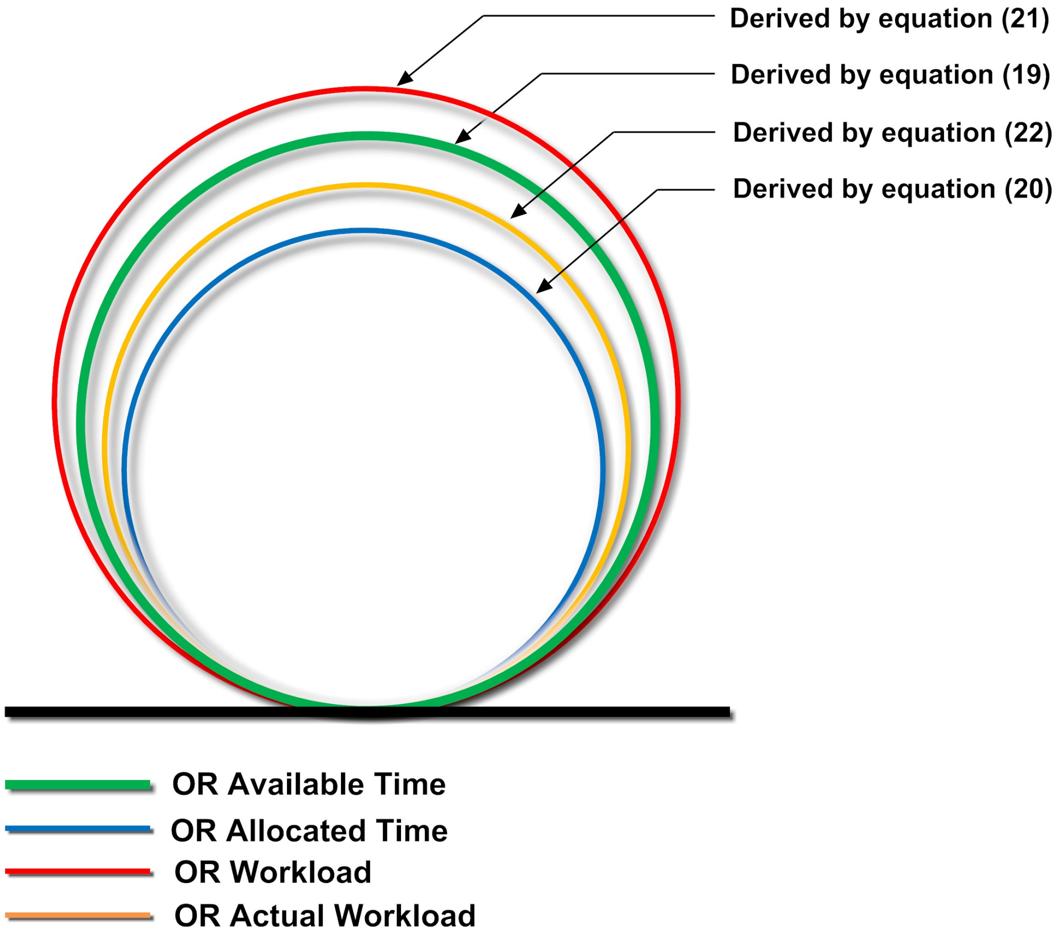


Figure 9. Operating Room Rings Model (ORRM)

6.7: Phase 6 - Operating Room Assessment Outcome.

Using the four elements (OR available time, OR allocated time, OR workload and OR actual workload) that underpin the proposed model, the user can immediately visually assess the differences between these very important elements. The most important aspect that can be determined from this model is through the consideration of what the differences between these circles mean, whereby three important factors of OR performance can be deduced: OR scheduling level, the type of OR workload and OR utilization.

6.7.1: OR Planning and Scheduling Activities

The proper use of the OR available time can only be achieved through an accurate OR scheduling plan. This can be produced through the accurate recognition of the value of the OR available time, and then by scheduling a proper time for surgical procedures with proper scheduling of the turnover time between the cases to cover the entire OR available time.

Verifying the quality of the OR scheduling level can be done through a comparison of OR allocated time with OR available time. This study has classified the quality of OR scheduling levels into three types, which are: under scheduling, ideal scheduling and over scheduling; these can be read clearly from the ORR model (Figure 9).

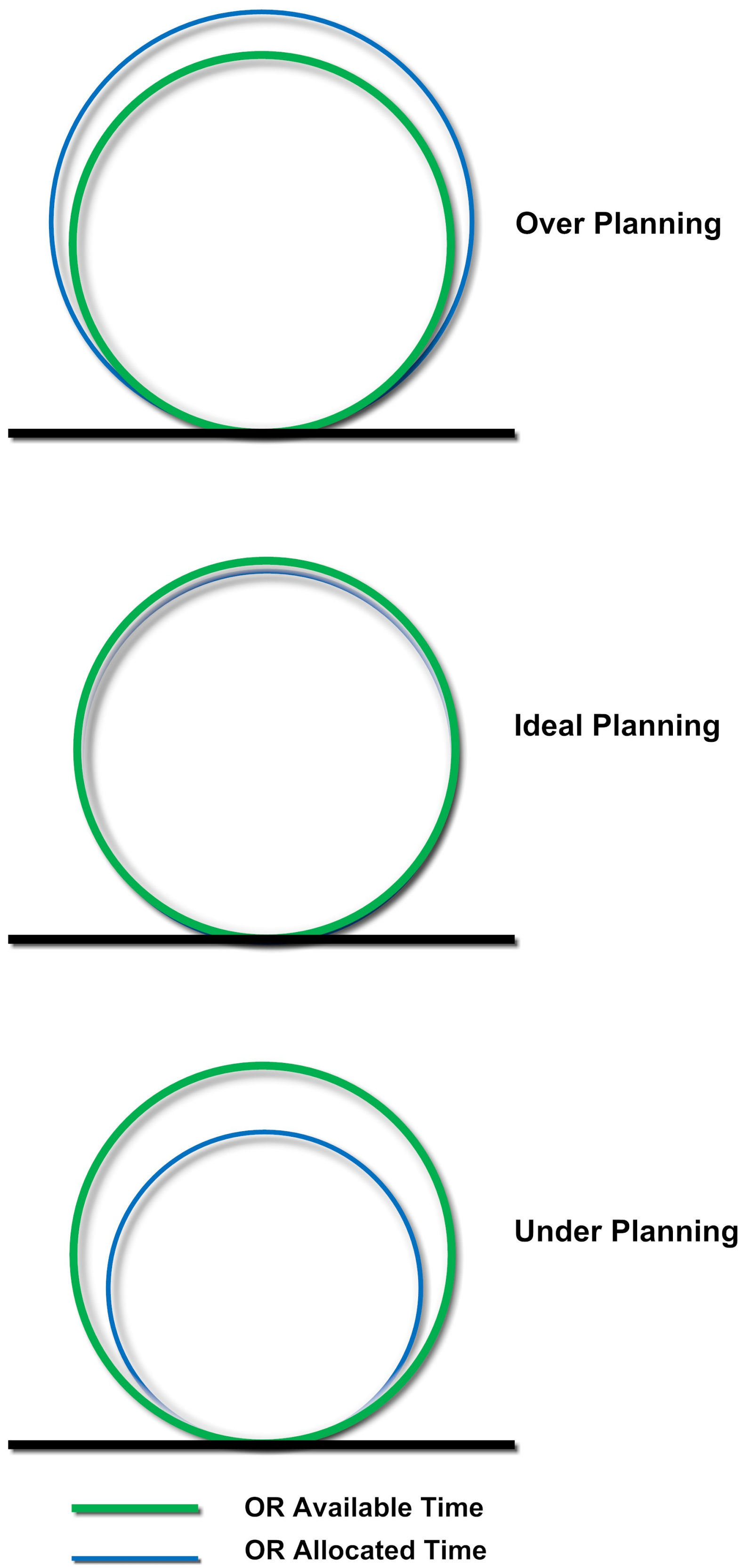


Figure 10. ORRM Planning and scheduling activities

6.7.2: The types of OR workload

In previous studies, the OR workload has been presented as a broad term, which is defined as the total amount of time that the OR is used for elective procedures, including the turnover time (Dexter and Macario 2002; McIntosh et al 2006). This study has classified the turnover time into four types: Planned Turnover Time, Scheduled Turnover Time, Extended Turnover Time and Total Turnover Time, since the aim of it is to differentiate between OR workload and the OR's actual workload. Through the use of these two new classifications of the workload with the OR available time in this model, another three new types of workload have been determined, which are: unnecessary workload, which is the outcome of the difference between the workload and the actual workload, the over workload which occurs in the case of the actual workload being over the OR available time, and unexpected workload which is the difference between OR allocated time and OR actual workload. Thus, this study has classified the OR workload into five types: total OR workload (the gross workload), OR actual workload, over workload, unnecessary workload and unexpected workload (Figure 10).

There is a strong relationship between the workload and the OR Allocated time, where the main objective of any Operating Room Management is to ensure these two objectives are equal, since the Allocated time represents the plan and the workload represents the achievement. The Allocated time- the management plan- is placed in order to achieve the best performance. It is rare that the workload, in particular the actual workload, will be less than the Allocated time, except if there is an unexpected cancellation of the surgical procedures or closure of the Operating Rooms. Usually, the workload is more than the Allocated time due to the presence of the unnecessary workload.

Moreover, the comparison of these factors (workload and Allocated time) can verify the quality of the OR scheduling and planning level.

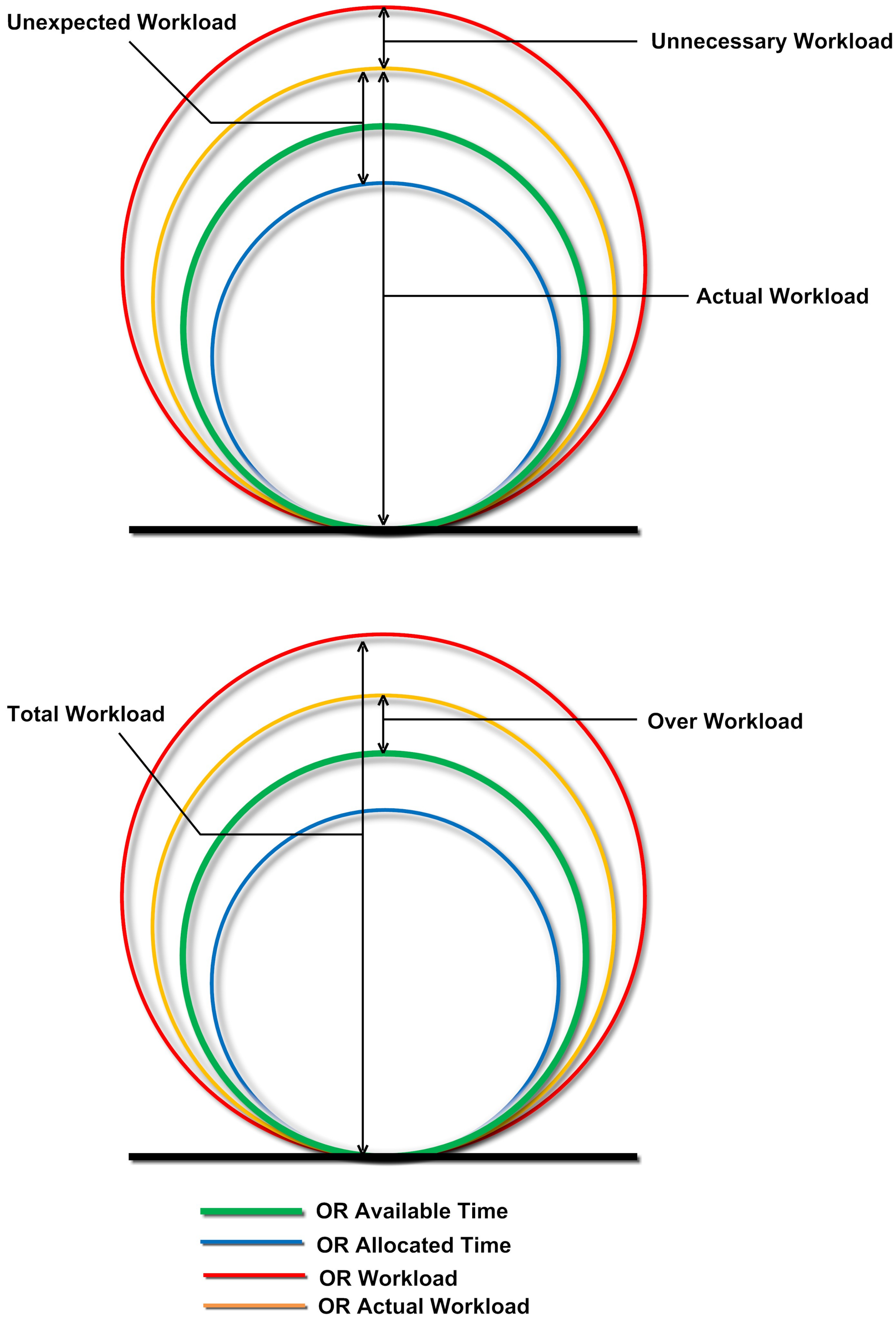


Figure 11. ORRM Types of workload

6.7.3: OR Utilization

Throughout the previous section, OR utilization has been identified as the ration of the actual Operating Room workload divided by the Operating Room available time. Also here, the OR Utilization can be described as the actual workload that occurs within the available time. Therefore, through the use of the mathematical model, the result of OR utilization will be 100% or less, which reveals OR utilization as having two types: ideal utilization or underutilization. Through the use of the ORR model, the OR utilization can be determined by the difference between the OR available time and the OR actual workload. If the actual workload fits the OR available time then it is classified as ideal utilization; if the actual workload is less than the OR available time, then it will be underutilization, and if it is over the OR available time then the OR performance is better described as 100% utilization with over workload (Figure 11).

6.7.4: Convert the ORAM and ORRM to Software

To facilitate and speed up the handling of these models, all equations in ORAM were converted to Microsoft Excel, which presented the results in the form of a table. Also, there is on-going work attempting to convert ORRM to software by using Action Script with the aim of using Microsoft Excel as a link between the hospital's software and the new Operating Room Assessment Framework, to transfer the data to evaluate Operating Room performance.

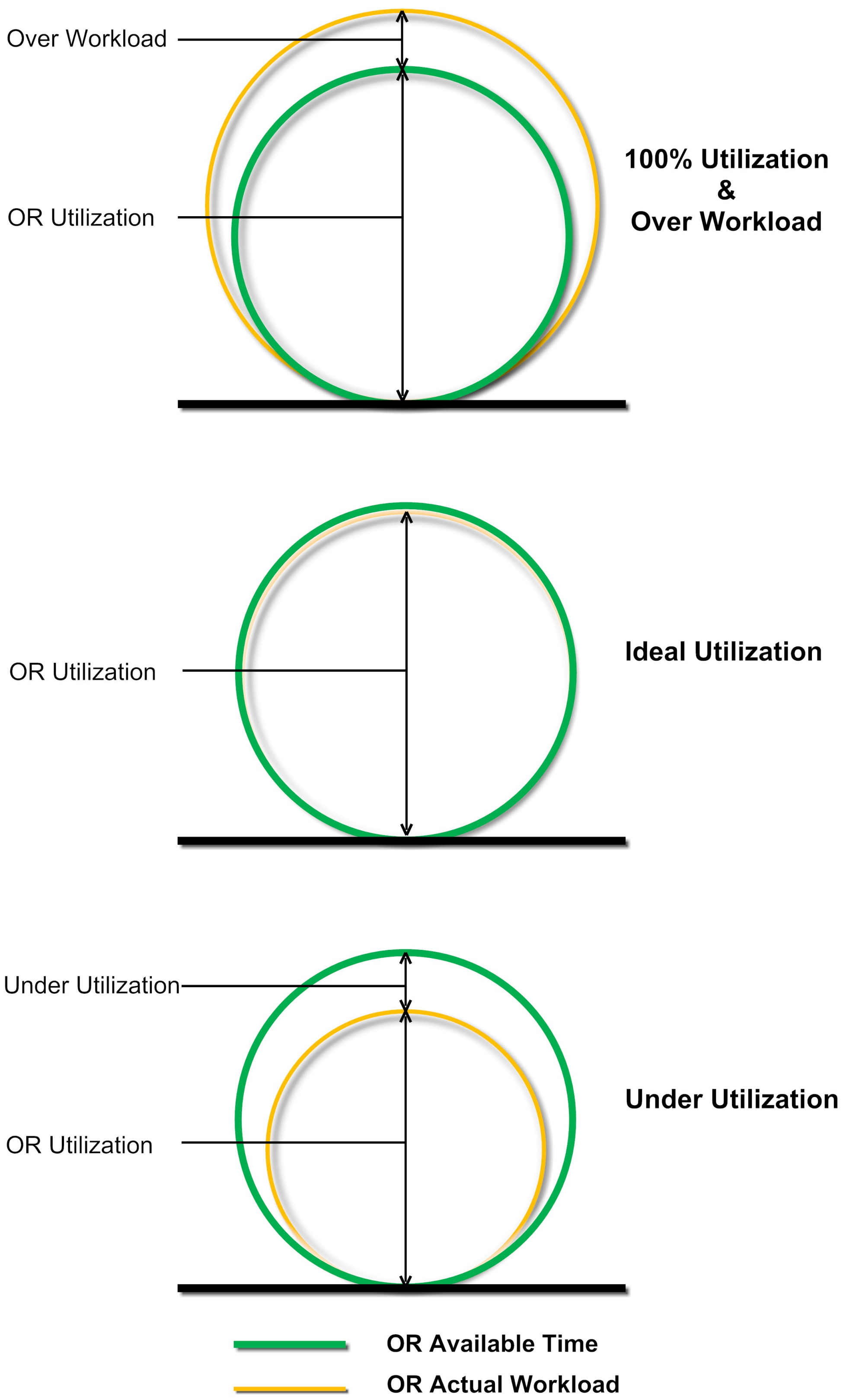


Figure 12. ORRM Types of OR Utilization

6.8: Conclusions

This chapter has proposed an evidence based Operating Room Assessment Framework (ORAF) to evaluate Operating Room performance (Figure 12). The design of this framework involves several stages, as seen throughout the previous sections in this chapter. These included (1) improving the definition of important terms used for OR performance evaluation with a definition of relevant new terms; (2) identification of the primary statistical factors affecting the evaluation of OR performance; (3) development of a practice-oriented mathematical model; (4) deriving 15 new factors through the use of the ORAM: (5) development of a visualisation metaphor (model) to analyse the newly derived factors, and then (6) the results were derived from the ORRM analysis.

These six stages involve five logical connected phases to form ORAF, which are (a) the primary factors, (b) ORAM (the proposed model), (c) the derived factors, (d) ORRM (the second proposed model), and (e) the framework outcome.

By using ORAF, three important outcome elements of OR performance can be deduced, which are: OR scheduling level, the type of OR workload, and OR utilization. These elements can easily be read to reach the end result of determining Operating Room performance, which includes three types of scheduling levels: under scheduling, ideal scheduling and over scheduling; five types of OR workload: OR total workload (the gross workload), OR actual workload, over workload, unnecessary workload and unexpected workload, and three types of OR utilization: underutilization; ideal utilization, and 100% utilization with over workload.

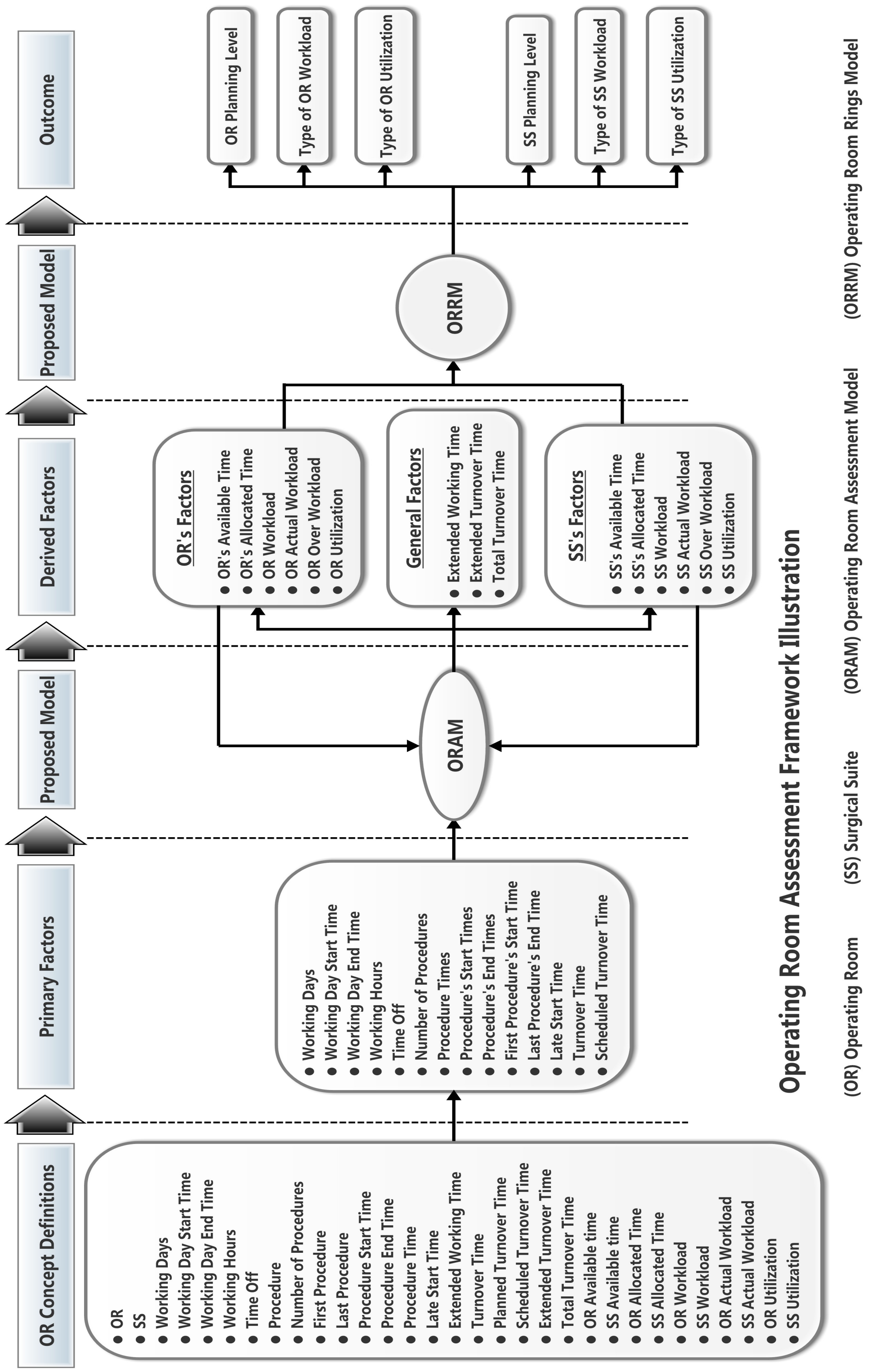


Figure 13. Operating Room Assessment Framework (ORAF) illustration

CHAPTER 7
VALIDATION AND DISCUSSION

7.1: Introduction

Following the previous chapter, which presents the Operating Room Assessment Framework (ORAF) including illustrations and pre-validation of its contents, this chapter is concerned with real-world validation of the ORAF. Castle (2007) argues that validation does not only assist in identifying the abilities of a model but also enables the discovery of its limitations.

Model Validation aims to test and establish that the model at hand, performs with satisfactory accuracy, within its field of applicability, in line with the study objectives. For the application of this principle, both developed models (ORAM and ORRM) have been tested on a new set of data obtained from King Faisal Specialist Hospital and Research Center (KFSH&RC) for the two main surgical suits which contain 22 Operating Rooms, where 975 surgical procedures were conducted throughout 2,645 working hours in the month of October 2012.

7.1.1: Cases Selection Approach

In order to achieve impartial validation, the following points were considered during the selection of the cases, which these models will apply to:

- KFSH&RC has been selected for the reason that its informatics systems has an extensive Operating Room database which is not available to the same extent in other hospitals participating in this study; this type of database helps to extract the primary factors required by this study. Also, the researcher is able to gain access to the data more easily in this hospital than the others.

- Taking into account the development and changes, the latest completed and approved data available at KFSH&RC has been selected, which is for the month of October 2012.
- The two new developed models have been applied to 22 Operating Rooms located in the main two surgical suites (OR Level 2 and OR level 4), which deal with different types of surgeries and different length of procedures, to test the performance and consistency of these models with different applications.
- To avoid selection bias, the 15th of October was chosen as it is the middle of the month and it falls on Monday, which is the middle of the working week- according to the working days system- in Saudi Arabia-, for the selection of an operating room to test ORAM for one day's performance. The purpose of this selection is to ensure that the operating room's performance is stable and not affected by any external factors.
- Operating Room number 3 was selected to apply ORAM to evaluate this room for one day's performance. The scheduling plan in the preceding rooms (DMU1, DMU2, OR1 and OR2) was changed on that day by adding or cancelling the procedures. Therefore Operating Room 3 was the most appropriate room for this analysis.

7.1.2: Stages of Validation

The validation process has been through six logical stages to cover the required objectives; the details of these stages are given below:

1. The Operating Room Assessment Model (ORAM) has first been applied in full to one Operating Room for one day's performance.
2. The ORAM has been applied in full to the Cardiac, Thoracic and Vascular Surgical Suite Level 4 (OR L4) for the performance throughout all of the month of October 2012.
3. The ORAM has been applied to each operating room in both surgical suites level 2 and 4 (OR L2 & L4) for the entire month of October 2012; then a summary of the results of each operating room has been presented in this chapter.

4. The ORAM has been applied to the main Surgical Suite Level 2 (OR L2) for the entire month of October 2012, and the results summary is given in this chapter.
5. All the newly derived factors from the use of the ORAM have been analysed by the Operating Room Rings Model (ORRM)- the second developed model used to complete the analysis process to reach the end result of determining Operating Room performance.
6. Finally, the results of these two models have been presented together, including the final outcome of each Operating Room and Surgical Suite, along with determining planning and scheduling efficiency, the type of workload and utilization level.

In the next sections the details of the validation results are presented according to the points mentioned above.

7.2: Performance Analysis for One Operating Room for One Working Day by Using ORAM.

During this stage, Operating Room number 3 in surgical suite level two was chosen based on its sequence among the Surgical Suites, on the 15th of October 2012, when five surgical procedures were performed according to the scheduling plan for this room. The first procedure started at 07:35 and the last procedure ended at 16:45. Below are the details of the analysis process for ORAM.

ρ_t : Procedure Time;

$$\rho_t = \rho_x - \rho_s \qquad (1)$$

The procedure times for the cases in room three in the Surgical Suite Level 2 can be calculated using equation (1) as follows:

First procedure;

OR Case Number (ORL2-2012-12621)
The case began at 7:35 and ended at 8:27

$$\rho_t^1 = \rho_x - \rho_s$$
$$\rho_t^1 = 8.45 - 7.58$$
$$\rho_t^1 = 0.87\ hrs$$

The procedure time for the first case in room three in Surgical Suite Level 2 is 0.87 hours (52 minutes).

Second procedure;

OR Case Number (ORL2-2012-12614)
The case began at 8:43 and ended at 10:10

$$\rho_t^2 = \rho_x - \rho_s$$
$$\rho_t^2 = 10.17 - 8.72$$
$$\rho_t^2 = 1.45\ hrs$$

The procedure time for the second case in room three in Surgical Suite Level 2 is 1.45 hours (1 hours and 27 minutes).

Third procedure;

OR Case Number (ORL2-2012-12668)
The case began at 10:34 and ended at 12:35

$$\rho_t^3 = \rho_x - \rho_s$$
$$\rho_t^3 = 12.58 - 10.56$$
$$\rho_t^3 = 2.02\ hrs$$

The procedure time for the third case in room three in Surgical Suite Level 2 is 2.02 hours (2 hours and 1 minute).

Fourth procedure;

OR Case Number (ORL2-2012-12676)
The case began at 12:50 and ended at 14:48

$$\rho_t^4 = \rho_x - \rho_s$$
$$\rho_t^4 = 14.80 - 12.83$$
$$\rho_t^4 = 1.97\ hrs$$

The procedure time for the fourth case in room three in Surgical Suite Level 2 is 1.97 hours (1 hours and 58 minutes).

Fifth procedure;

OR Case Number (ORL2-2012-12671)
The case began at 15:02 and ended at 16:45

$$\rho_t^5 = \rho_x - \rho_s$$
$$\rho_t^5 = 16.75 - 15.03$$
$$\rho_t^5 = 1.72\ hrs$$

The procedure time for the fifth case in room three in Surgical Suite Level 2 is 1.72 hours (1 hours and 43 minutes).

l : Late Start Time:

The late start time for room three in Surgical Suite Level 2 can be calculated using equation (2) as follows:

The first procedure (ORL2-2012-12621) began at 7:35, while the working time for Surgical Suite Level 2 started at 7:30.

$$l = \rho_s^{st} - d_s \qquad (2)$$

$l^3 = \rho_s^{st} - d_s$

$l^3 = 7.58 - 7.50$

$l^3 = 0.08\ hrs$

The late start time in room three is 0.08 hour (5 min.).

t_s : Scheduled Turnover Time:

The agreed turnover time between the cases in Surgical Suite Level 2 at KFSH&RC is 25 minuets. This is what has been used during the scheduling process for room 3 on this day, but it has been noted that the turnover time scheduled between the third and the fourth procedure was 40 minutes for unknown reasons.

The extended working time for room three in Surgical Suite Level 2 can be calculated using equation (3) as follows:

$$t_s = (\rho_r - 1)\ t_p \qquad (3)$$

$t_s^3 = (\rho_r - 1)\ t_p$

$t_s^3 = (5 - 1)\ 0.42$

$t_s^1 = 4 \times 0.42$

$t_s^1 = 1.66\ hrs$

The scheduled turnover time in room three is 1.66 hours (1 hour and 40 min.).

t_e : Extended Turnover Time:

The extended turnover time for the room three in the Surgical Suite Level 2 can be calculated using equation (4) as follows:

$$t_e = [\rho_x^l - \rho_s^{st}] - \sum_{r=1}^{r=n} \rho_t^r - t_s \;\; ; \;\; t_e \geq 0 \qquad (4)$$

n: number of procedures performed in the OR.

The extended turnover time in room three can be calculated by using equation (4) as follows:

$$t_e^3 = [\rho_x^l - \rho_s^{st}] - \sum_{r=1}^{r=n} \rho_t^r - t_s$$

$$t_e^3 = [\rho_x^l - \rho_s^{st}] - [\rho_t^1 + \rho_t^2 + \rho_t^3 + \rho_t^4 + \rho_t^5] - t_s$$

$$t_e^3 = [16.75 - 7.58] - [0.87 \; + 1.45 + 2.02 + 1.97 + 1.72] - 1.66$$

$$t_e^3 = 9.17 - 8.03 - 1.66$$

$$t_e^3 = -\,0.52\; hrs$$

As $-0.52 \; < \; 0$, which means that the extended turnover time in room three is 0 hour (0 min.) there was no extended turnover time in room three.

t_t : Total Turnover Time:

The total turnover time in room three in Surgical Suite Level 2 can be calculated as follows:

$$t_t = \; t_s + \; t_e$$

$$t_t^3 = \; t_s^3 + \; t_e^3$$

$$t_t^3 = \; 1.66 + 0$$

$$t_t^3 = \; 1.66$$

The total turnover time in room three is 1.66 (1 hour and 40 min.).

$\mathcal{O}_{\mathcal{E}}$: Operating Room Extended Working Time:

The extended working time for the room three in the Surgical Suite Level 2 can be calculated using equation (5) as follows:

The last procedure (ORL2-2012-12671) ended at 16:45, while the working time for surgical suite level 2 ends at 16:30.

$$\mathcal{O}_{\mathcal{E}} = \rho_x^l - d_x \qquad (5)$$

$\mathcal{O}_{\mathcal{E}}^3 = \rho_x^l - d_x$

$\mathcal{O}_{\mathcal{E}}^3 = 16.75 - 16.50$

$\mathcal{O}_{\mathcal{E}}^3 = 0.25\ hrs$

The extended working time in room three is 0.25 hour (15 min.).

$\mathcal{O}_A$: Operating Room Available Time:

Daily working time for Surgical Suite Level 2 was 9 hours, on the 15th of October 2012; all working hours were available and there was no time off on this day for room three.

The available time for room three in Surgical Suite Level 2 can be calculated using the following equation:

$$\mathcal{O}_A = [d - f]h \qquad (7)$$

The available time in room three can be calculated using equation (7) as follows:

$\mathcal{O}_A^3 = [d - f]h$

$\mathcal{O}_A^3 = [1 - 0]9$

$\mathcal{O}_A^3 = 1\times 9$

$\mathcal{O}_A^3 = 9$

Available time in room three is 9 hours.

$\mathcal{O}_a$: Operating Room Allocated Time:

The allocated time for room three can be calculated using the following equation:

$$\mathcal{O}_a = \sum_{r=1}^{r=n} \rho_t^r + \boldsymbol{t_s} \qquad (9)$$

n: number of procedures in the ORs.

$$\mathcal{O}_a^3 = \sum_{r=1}^{3} \rho_t^r + \boldsymbol{t_s}$$

$$\mathcal{O}_a^3 = [\rho_t^1 + \rho_t^2 + \rho_t^3 + \rho_t^4 + \rho_t^5] + \left[(\rho_r - 1)\boldsymbol{t}_p\right]$$

$$\mathcal{O}_a^3 = [1 + 1 + 1 + 1.75 + 1.35] + [(5 - 1)\ 0.42]$$

$$\mathcal{O}_a^3 = [1 + 1 + 1 + 1.75 + 1.35] + [4 \times 0.42]$$

$$\mathcal{O}_a^3 = 6.1 + 1.68$$

$$\mathcal{O}_a^3 = 7.78\ hrs$$

The allocated time for room three is 7.78 hours (7 hours and 47 min).

$\mathcal{O}_w$: Operating Room Workload:

The workload in room three can be calculated using the following equation:

$$\mathcal{O}_w = \rho_x^l - \rho_s^{st} \qquad (11)$$

$$\mathcal{O}_w^3 = \rho_x^l - \rho_s^{st}$$

$$\mathcal{O}_w^3 = 16.75 - 7.58$$

$$\mathcal{O}_w^3 = 9.17\ hrs$$

The workload in room three is 9.17 hours (9 hours and 10 min).

$\mathcal{O}_{Aw}$: Operating Room Actual Workload:

The actual workload in room three can be calculated using the following equation:

$$\mathcal{O}_{Aw} = \mathcal{O}_{w} - t_e \qquad (13)$$

$\mathcal{O}_{Aw}^{3} = \mathcal{O}_{w} - t_e$

$\mathcal{O}_{Aw}^{3} = 9.17 - 0$

$\mathcal{O}_{Aw}^{3} = 9.17\ hrs$

The actual workload in room three is 9.17 hours (9 hours and 10 min).

$\mathcal{O}_{Ow}$: Operating Room Over Workload:

This can be calculated using the following equation:

$$\mathcal{O}_{Ow} = \mathcal{O}_{Aw} - \mathcal{O}_{A} \qquad ; \ \mathcal{O}_{Ow} \geq 0 \qquad (15)$$

The over workload in room three in Surgical Suite Level 2 can be calculated using equation (15) as follows:

$\mathcal{O}_{Ow}^{3} = \mathcal{O}_{Aw}^{3} - \mathcal{O}_{A}^{3}$

$\mathcal{O}_{Ow}^{3} = 9.17 - 9$

$\mathcal{O}_{Ow}^{3} = 0.17\ hrs$

The over workload in room three in Surgical Suite Level 2 is 0.17 hour (10 min).

$\mathcal{O}_u$: Operating Room Utilization:

This can be calculated using the following equation:

$$\mathcal{O}_u = \frac{\mathcal{O}_{Aw}}{\mathcal{O}_A} \times 100 \quad ; \; \mathcal{O}_u \; \leq 100 \qquad (17)$$

The utilization in room three in Surgical Suite Level 2 can be calculated using equation (17) as follows:

$$\mathcal{O}_u^3 = \frac{\mathcal{O}_{Aw}}{\mathcal{O}_A} \times 100$$

$$\mathcal{O}_u^3 = \frac{9.17}{9} \times 100$$

$$\mathcal{O}_u^3 = 1.02 \times 100$$

$$\mathcal{O}_u^3 = 102$$

As it is $102 \; > 100$, this means that the utilization in room three in Surgical Suite Level 2 is 100% with over workload.

7.3: Performance Analysis for The Entire Surgical Suite Level 4 for October 2012 Activities Using ORAM.

The Surgical Suite in Level 4 at KFSH&RC includes five Operating Rooms. All procedures related to cardiac, thoracic and vascular are performed in this Surgical Suite. In October 2012, 106 surgical procedures were performed throughout 586 working hours. The following presents the results of ORAM being applied to this surgical suite.

$\mathcal{S}_A$: Surgical Suite Available Time:

The available time in Surgical Suite Level 4 can be calculated using equation (8) as follows:

$$\mathcal{S}_A = \sum_{r=1}^{r=n} \mathcal{O}_A^r \qquad (8)$$

n: number of ORs in the surgical suite.

$$\mathcal{S}_A = \sum_{r=1}^{5} \mathcal{O}_A^r$$

$$\mathcal{S}_A = \mathcal{O}_A^1 + \mathcal{O}_A^2 + \mathcal{O}_A^3 + \mathcal{O}_A^4 + \mathcal{O}_A^5$$

$$\mathcal{S}_A = 88 + 170 + 145 + 127 + 136$$

$$\mathcal{S}_A = 666$$

The available time in the Surgical Suite Level 4 is 666 hours.

$\mathcal{S}_a$: Surgical Suite Allocated Time;

Surgical Suite Level 4's allocated time can be calculated using equation (10) as follows:

$$\mathcal{S}_{a=} \sum_{r=1}^{r=n} \mathcal{O}_a^r \qquad (10)$$

n: number of ORs.

$$\mathcal{S}_{a=} \sum_{r=1}^{5} \mathcal{O}_a^r$$

$$\mathcal{S}_{a=} \mathcal{O}_a^1 + \mathcal{O}_a^2 + \mathcal{O}_a^3 + \mathcal{O}_a^4 + \mathcal{O}_a^5$$

$$\mathcal{S}_{a=} 22.91 + 101.53 + 118.95 + 80.35 + 89.30$$

$$\mathcal{S}_{a=} 413.05$$

Surgical Suite Level 4's allocated time is 413.05 hours for that month.

$\mathcal{S}_{w}$: **Surgical Suite Workload:**

Surgical Suite Level 4’s workload can be calculated using equation (12) as follows:

$$\mathcal{S}_{w} = \sum_{r=1}^{r=n} \mathcal{O}_{w}^{r} \qquad (12)$$

n: number of ORs in the surgical suite.

$$\mathcal{S}_{w} = \sum_{r=1}^{r=n} \mathcal{O}_{w}^{r}$$

$$\mathcal{S}_{w} = \mathcal{O}_{w}^{1} + \mathcal{O}_{w}^{2} + \mathcal{O}_{w}^{3} + \mathcal{O}_{w}^{4} + \mathcal{O}_{w}^{5}$$

$$\mathcal{S}_{w} = 23.82 + 158.42 + 151 + 138.12 + 123.78$$

$$\mathcal{S}_{w} = 595.14$$

Surgical Suite Level 4’s workload is 595.14 hours.

$\mathcal{S}_{Aw}$: **Surgical Suite Actual Workload:**

The actual workload for Surgical Suite Level 4 can be calculated using equation (14) as follows:

$$\mathcal{S}_{Aw} = \sum_{r=1}^{r=n} \mathcal{O}_{Aw}^{r} \qquad (14)$$

n: number of ORs in the surgical suite.

$$\mathcal{S}_{Aw} = \sum_{r=1}^{r=n} \mathcal{O}_{Aw}^{r}$$

$$\mathcal{S}_{Aw} = \mathcal{O}_{Aw}^{1} + \mathcal{O}_{Aw}^{2} + \mathcal{O}_{Aw}^{3} + \mathcal{O}_{Aw}^{4} + \mathcal{O}_{Aw}^{5}$$

$$\mathcal{S}_{Aw} = 18.57 + 153.25 + 151 + 136.78 + 123.78$$

$$\mathcal{S}_{Aw} = 583.38$$

The actual workload for Surgical Suite Level 4 is 583.38 hours.

$\mathcal{S}_{Ow}$: Surgical Suite Over Workload:

This can be calculated using the following equation:

$$\mathcal{S}_{Ow} = \mathcal{S}_{Aw} - \mathcal{S}_{A} \qquad ; \ \mathcal{S}_{Ow} \geq 0 \qquad (16)$$

The over workload in Surgical Suite Level 4 can be calculated using equation (16) as follows:

$$\mathcal{S}_{Ow} = \mathcal{S}_{Aw} - \mathcal{S}_{A}$$

$$\mathcal{S}_{Ow} = 583.38 - 666$$

$$\mathcal{S}_{Ow} = -82.62$$

As it is – $82.62 < 0$, this means that the over workload for Surgical Suite Level 4 is 0 hour. Overall, there was no over workload in in this surgical suite.

$\mathcal{S}_{u}$; Surgical Suite Utilization:

This can be calculated using the following equation:

$$\mathcal{S}_{u} = \frac{\mathcal{S}_{Aw}}{\mathcal{S}_{A}} \times 100 \qquad ; \ \mathcal{S}_{u} \leq 100 \qquad (18)$$

The utilization for Surgical Suite Level 4 can be calculated using equation (18) as follows:

$$\mathcal{S}_{u} = \frac{\mathcal{S}_{Aw}}{\mathcal{S}_{A}} \times 100$$

$$\mathcal{S}_{u} = \frac{583.38}{666} \times 100$$

$$\mathcal{S}_{u} = 0.8759 \times 100$$

$$\mathcal{S}_{u} = 87.59$$

The utilization of Surgical Suite Level 4 is 87.59%.

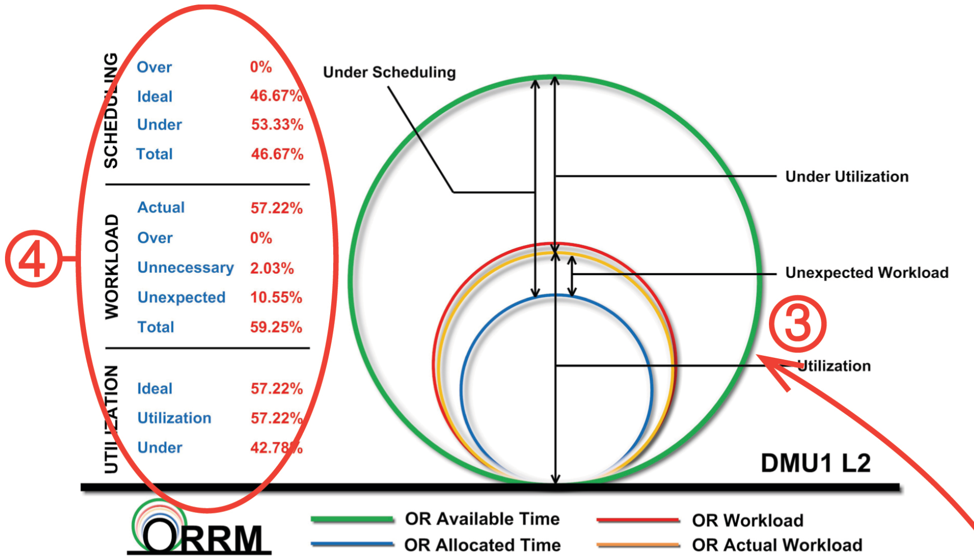
7.4: Analysis of the Operating Rooms by using both ORAM and ORRM.

In this section, the ORRM will be used to analyse the new factors derived by ORAM as a complementary step to reach an accurate analysis of the Operating Rooms and Surgical Suites' performance. This process will conclude with the final three important outcome elements of OR performance which appear in this model. It is possible to easily read and reach the end result, which includes three types of scheduling levels: under scheduling, ideal scheduling and over scheduling; five types of OR workload: OR total workload (the gross workload); OR actual workload; over workload; unnecessary workload; unexpected workload, and three types of OR utilization- underutilization: ideal utilization, and 100% utilization with over workload.

In order to facilitate and abbreviate the analysis process, the data for each Operating Room and for the Surgical Suite has been introduced on one page containing the results of the ORAM and ORRM analysis in the form of a table and figure.

First, all the outcomes of ORAM are displayed in the upper part of the table (see no.1 in figure 14). The next step was to convert the values of OR allocated time, OR workload and OR actual workload into percentages by comparing these values to the value of the OR available time (see no.2 in figure 14), by using the equations described in section (6.6.1). The third step was to transform these values to rings through the use of ORRM (see no.3 in figure 14).

Operating Room performance has been determined by this model through the consideration of the differences between these circles, whereby three important factors of OR performance has been deduced: OR scheduling level, the type of OR workload, and OR utilization (see no. 4 in figure 14).



DMU 1 Surgical Suite Level 2 (DMU1 L2)			
Values Derived by ORAM			
Factor	Hours	Factor	Hours
Working Days	11	Scheduled Turnover Time	9.58
Available Time	93	Extended Turnover Time	1.89
Procedures Time	43.63	Total Turnover Time	11.47
Allocated Time	43.4	Workload	55.1
Late Start Time	2.5	Actual Workload	53.21
Extended Working Time	0	Utilization	57.22%
Percentage to Availabel Time			
Factor	%	Factor	%
Available Time	100%	Workload	59.25%
Allocated Time	46.67%	Actual Workload	57.22%

Figure 14 Illustrate the content and the relationship between ORAM Table and ORRM Figure

This analysis begins with the Operating Rooms located in Surgical Suite Level 2, then the Operating Rooms in Surgical Suite Level 4, before analysing the entire Surgical Suite Level 2, followed by the Surgical Suite Level 4.

7.4.1: DMU 1 in Surgical Suite Level 2

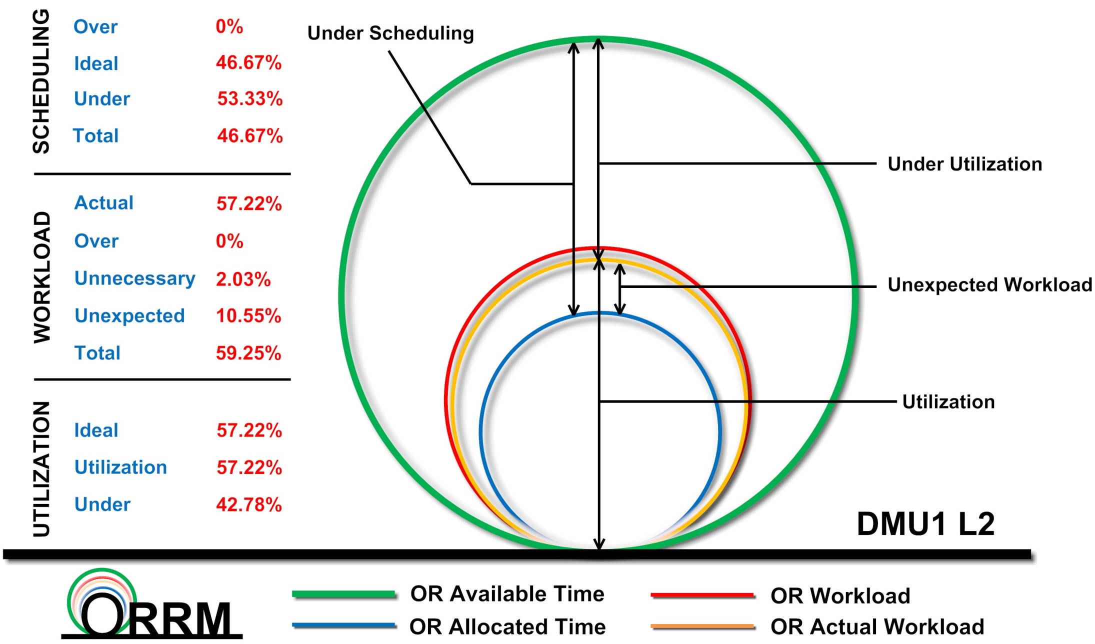


Figure 15 ORRM applied to DMU 2 Surgical Suite Level 2

DMU 1 Surgical Suite Level 2 (DMU1 L2)			
Values Derived by ORAM			
Factor	Hours	Factor	Hours
Working Days	11	Scheduled Turnover Time	9.58
Available Time	93	Extended Turnover Time	1.89
Procedures Time	43.63	Total Turnover Time	11.47
Allocated Time	43.4	Workload	55.1
Late Start Time	2.5	Actual Workload	53.21
Extended Working Time	0	Utilization	57.22%
Percentage to Availabel Time			
Factor	%	Factor	%
Available Time	100%	Workload	59.25%
Allocated Time	46.67%	Actual Workload	57.22%

Table 14 ORAM applied to DMU 1 Surgical Suite Level 2

7.4.2: DMU 2 in Surgical Suite Level 2

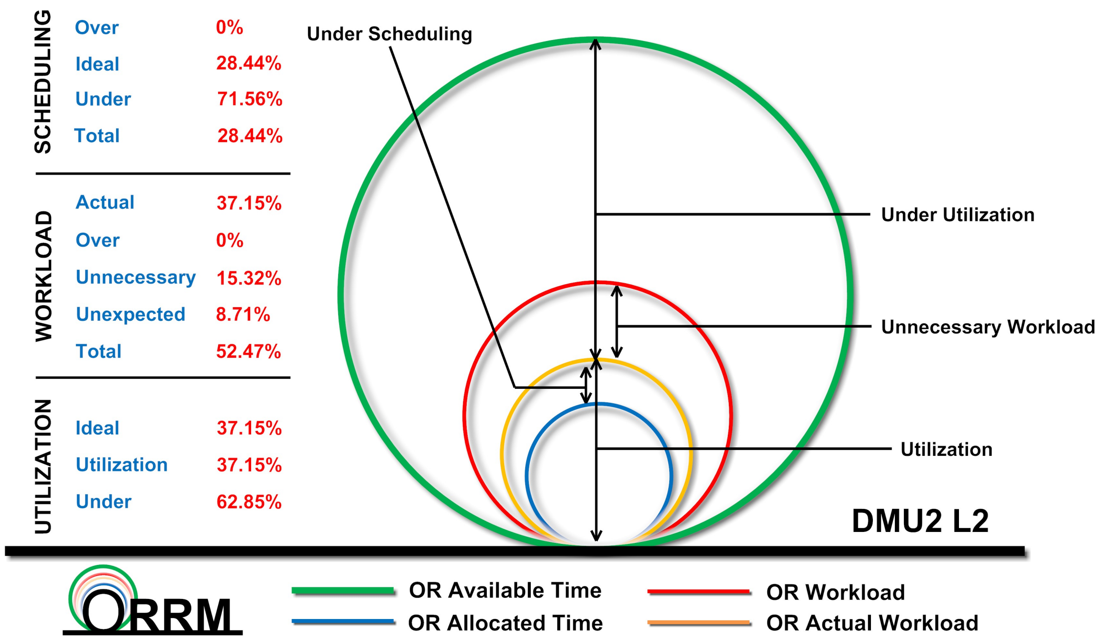


Figure 16 ORRM applied to DMU2 Surgical Suite Level 2

DMU2 Surgical Suite Level 2 (DMU2 L2)			
Values Derived by ORAM			
Factor	Hours	Factor	Hours
Working Days	9	Scheduled Turnover Time	10.42
Available Time	79	Extended Turnover Time	12.1
Procedures Time	18.93	Total Turnover Time	22.52
Allocated Time	22.47	Workload	41.45
Late Start Time	14.35	Actual Workload	29.35
Extended Working Time	0	Utilization	37.15%
Percentage to Availabel Time			
Factor	%	Factor	%
Available Time	100%	Workload	52.47%
Allocated Time	28.44%	Actual Workload	37.15%

Table 15 ORAM applied to DMU 2 Surgical Suite Level 2

7.4.3: Operating Room 1 in Surgical Suite Level 2

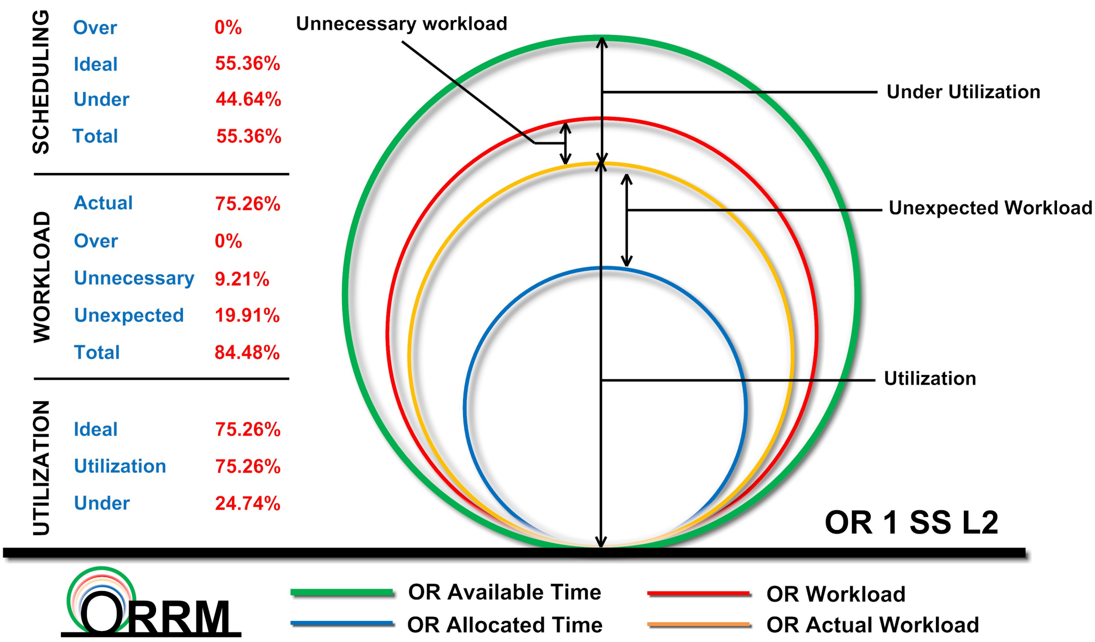


Figure 17 ORRM applied to Operating Room 1 Surgical Suite Level 2

Operating Room 1 Surgical Suite Level 2 (OR1 L2)			
Values Derived by ORAM			
Factor	Hours	Factor	Hours
Working Days	18	Scheduled Turnover Time	7.08
Available Time	163	Extended Turnover Time	15.02
Procedures Time	115.6	Total Turnover Time	22.1
Allocated Time	90.23	Workload	137.7
Late Start Time	8.25	Actual Workload	122.68
Extended Working Time	18.23	Utilization	75.26%
Percentage to Availabel Time			
Factor	%	Factor	%
Available Time	100%	Workload	84.48%
Allocated Time	55.36%	Actual Workload	75.26%

Table 16 ORAM applied to Operating Room 1 Surgical Suite Level 2

7.4.4: Operating Room 2 in Surgical Suite Level 2

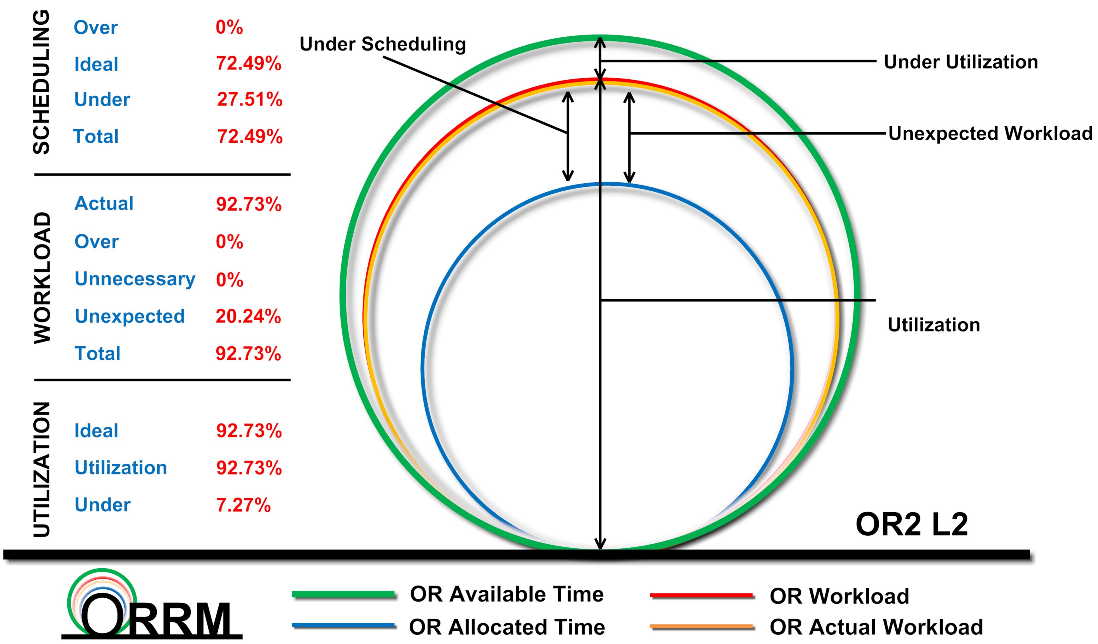


Figure 18 ORRM applied to Operating Room 2 Surgical Suite Level 2

Operating Room 2 Surgical Suite Level 2 (OR2 L2)			
Values Derived by ORAM			
Factor	Hours	Factor	Hours
Working Days	20	Scheduled Turnover Time	11.67
Available Time	172	Extended Turnover Time	0
Procedures Time	166	Total Turnover Time	11.67
Allocated Time	124.68	Workload	159.5
Late Start Time	16	Actual Workload	159.5
Extended Working Time	20.1	Utilization	92.73%
Percentage to Availabel Time			
Factor	%	Factor	%
Available Time	100%	Workload	92.73%
Allocated Time	72.49%	Actual Workload	92.73%

Table 17 ORAM applied to Operating Room 2 Surgical Suite Level 2

7.4.5: Operating Room 3 in Surgical Suite Level 2

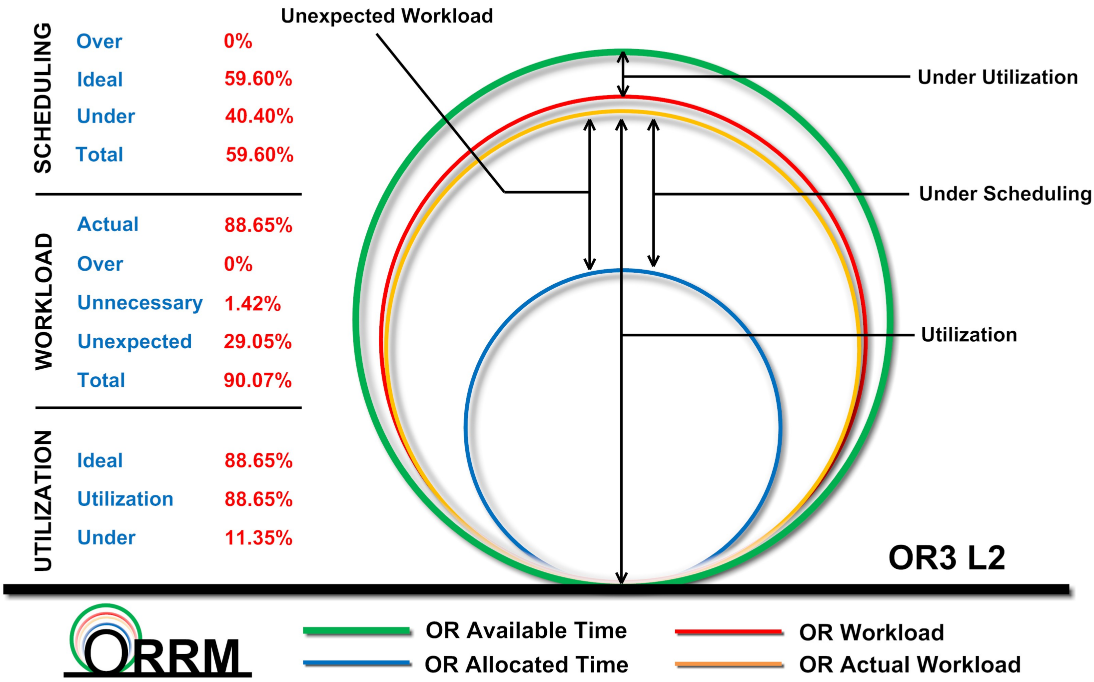


Figure 19 ORRM applied to Operating Room 3 Surgical Suite Level 2

Operating Room 3 Surgical Suite Level 2 (OR3 L2)			
Values Derived by ORAM			
Factor	Hours	Factor	Hours
Working Days	21	Scheduled Turnover Time	13.33
Available Time	179	Extended Turnover Time	2.55
Procedures Time	145.35	Total Turnover Time	15.88
Allocated Time	106.68	Workload	161.23
Late Start Time	8.15	Actual Workload	158.68
Extended Working Time	11.47	Utilization	88.65%
Percentage to Availabel Time			
Factor	%	Factor	%
Available Time	100%	Workload	90.07%
Allocated Time	59.60%	Actual Workload	88.65%

Table 18 ORAM applied to Operating Room 3 Surgical Suite Level 2

7.4.6: Operating Room 4 in Surgical Suite Level 2

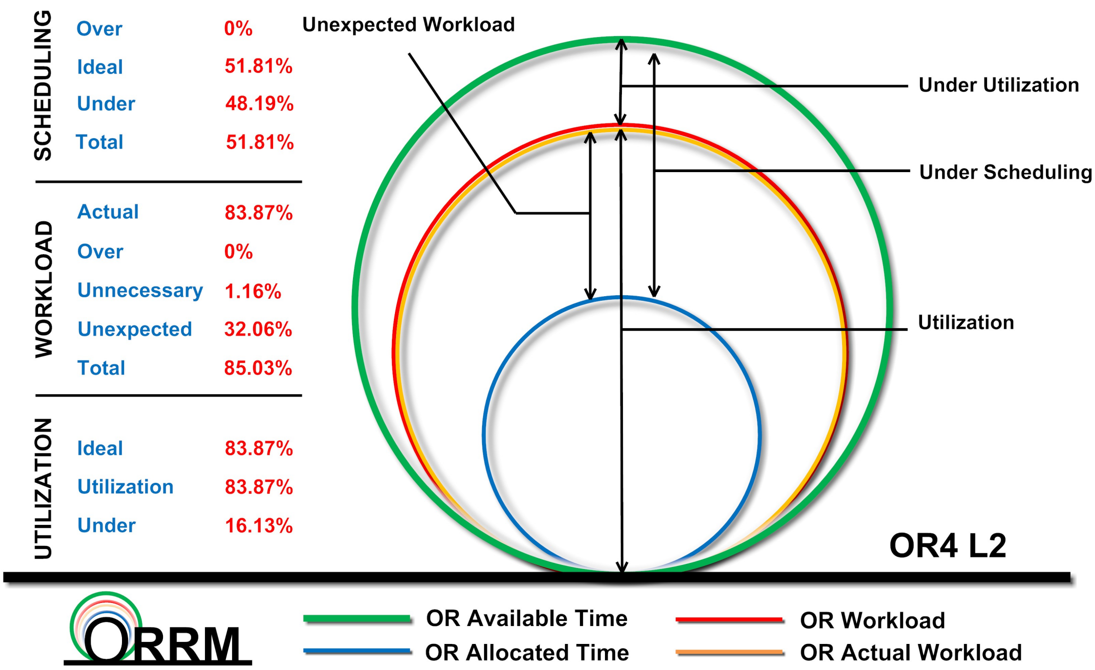


Figure 20 ORRM applied to Operating Room 4 Surgical Suite Level 2

Operating Room 4 Surgical Suite Level 2 (OR4 L2)			
Values Derived by ORAM			
Factor	Hours	Factor	Hours
Working Days	18	Scheduled Turnover Time	5.42
Available Time	152	Extended Turnover Time	1.77
Procedures Time	122.06	Total Turnover Time	7.19
Allocated Time	78.75	Workload	129.25
Late Start Time	14.93	Actual Workload	127.48
Extended Working Time	9.17	Utilization	83.87%
Percentage to Availabel Time			
Factor	%	Factor	%
Available Time	100%	Workload	85.03%
Allocated Time	51.81%	Actual Workload	83.87%

Table 19 ORAM applied to Operating Room 4 Surgical Suite Level 2

7.4.7: Operating Room 5 in Surgical Suite Level 2

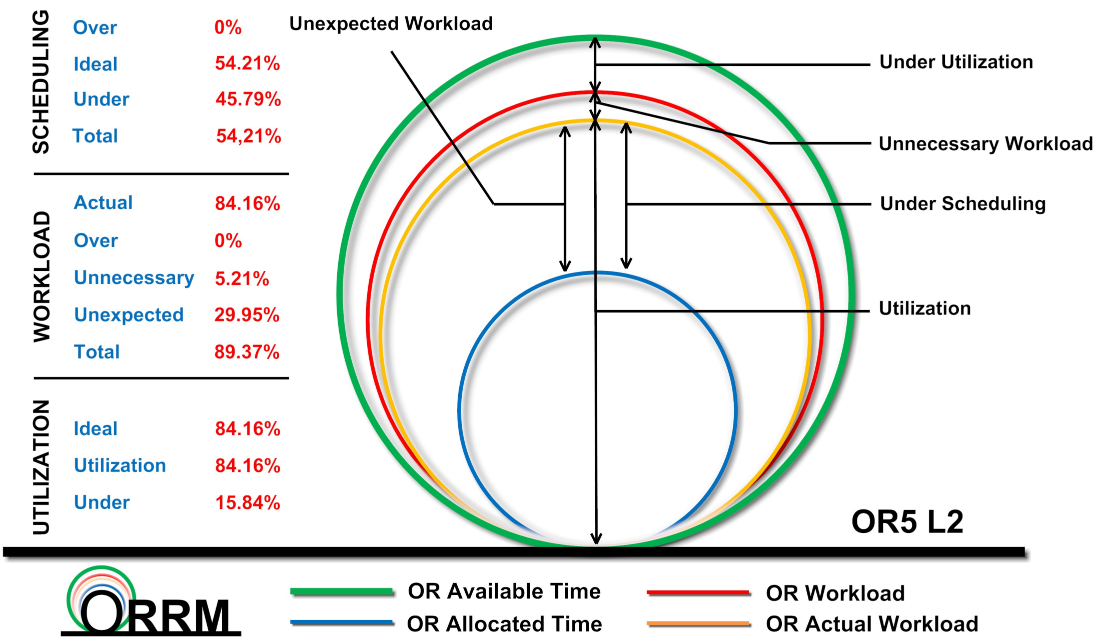


Figure 21 ORRM applied to Operating Room 5 Surgical Suite Level 2

Operating Room 5 Surgical Suite Level 2 (OR5 L2)			
Values Derived by ORAM			
Factor	Hours	Factor	Hours
Working Days	19	Scheduled Turnover Time	0.83
Available Time	154	Extended Turnover Time	8.03
Procedures Time	128.77	Total Turnover Time	8.86
Allocated Time	83.48	Workload	137.63
Late Start Time	7.45	Actual Workload	129.6
Extended Working Time	0	Utilization	84.16%
Percentage to Availabel Time			
Factor	%	Factor	%
Available Time	100%	Workload	89.37%
Allocated Time	54.21%	Actual Workload	84.16%

Table 20 ORAM applied to Operating Room 5 Surgical Suite Level 2

7.4.8: Operating Room 6 in Surgical Suite Level 2

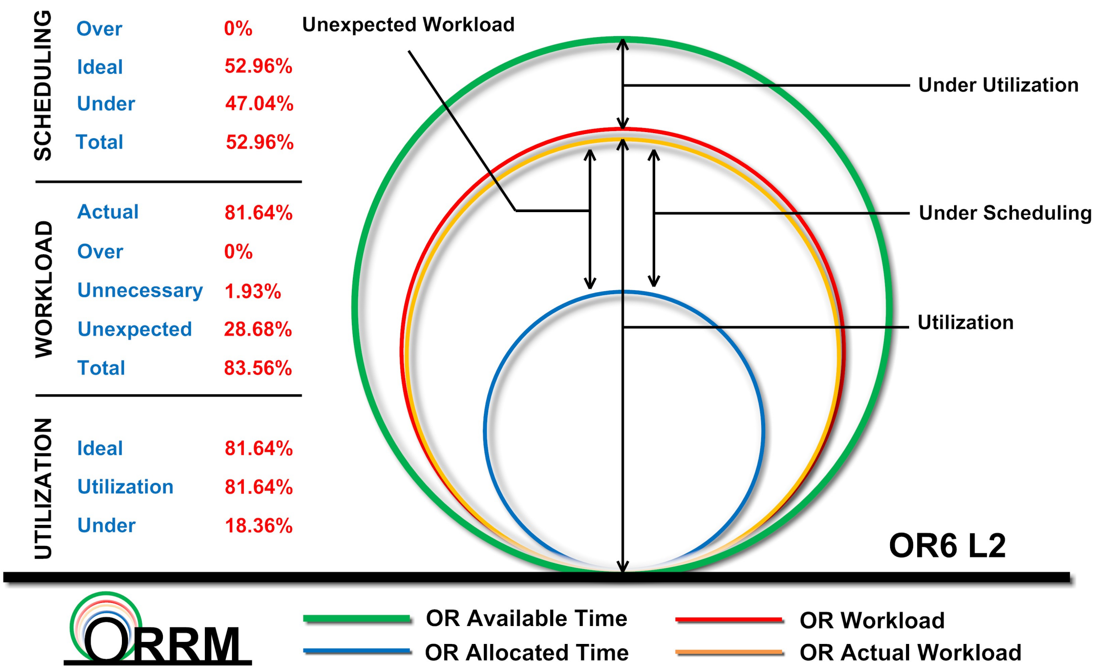


Figure 22 ORRM applied to Operating Room 6 Surgical Suite Level 2

Operating Room 6 Surgical Suite Level 2 (OR6 L2)			
Values Derived by ORAM			
Factor	Hours	Factor	Hours
Working Days	22	Scheduled Turnover Time	12.5
Available Time	188	Extended Turnover Time	3.62
Procedures Time	140.98	Total Turnover Time	16.12
Allocated Time	99.57	Workload	157.1
Late Start Time	6.73	Actual Workload	153.48
Extended Working Time	4.92	Utilization	81.64%
Percentage to Availabel Time			
Factor	%	Factor	%
Available Time	100%	Workload	83.56%
Allocated Time	52.96%	Actual Workload	81.64%

Table 21 ORAM applied to Operating Room 6 Surgical Suite Level 2

7.4.9: Operating Room 7 in Surgical Suite Level 2

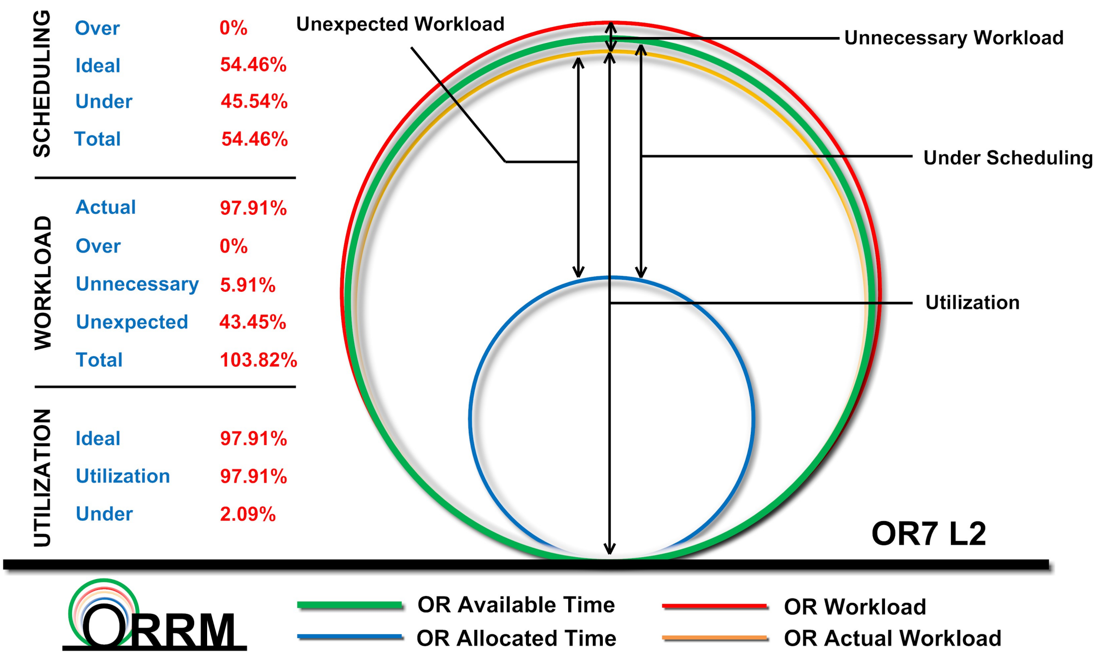


Figure 23 ORRM applied to Operating Room 7 Surgical Suite Level 2

Operating Room 7 Surgical Suite Level 2 (OR7 L2)			
Values Derived by ORAM			
Factor	Hours	Factor	Hours
Working Days	21	Scheduled Turnover Time	19.17
Available Time	179	Extended Turnover Time	10.58
Procedures Time	156.08	Total Turnover Time	29.75
Allocated Time	97.48	Workload	185.83
Late Start Time	3.9	Actual Workload	175.25
Extended Working Time	24.25	Utilization	97.91%
Percentage to Availabel Time			
Factor	%	Factor	%
Available Time	100%	Workload	103.82%
Allocated Time	54.46%	Actual Workload	97.91%

Table 22 ORAM applied to Operating Room 7 Surgical Suite Level 2

7.4.10: Operating Room 8 in Surgical Suite Level 2

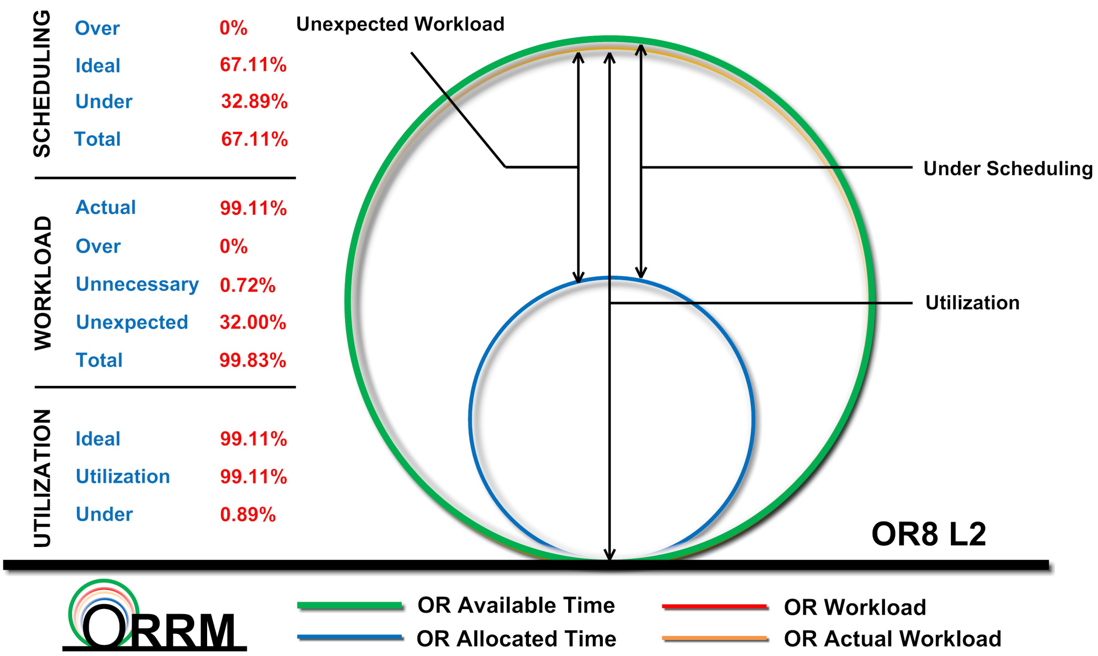


Figure 24 ORRM applied to Operating Room 8 Surgical Suite Level 2

Operating Room 8 Surgical Suite Level 2 (OR8 L2)			
Values Derived by ORAM			
Factor	Hours	Factor	Hours
Working Days	22	Scheduled Turnover Time	12.08
Available Time	188	Extended Turnover Time	1.35
Procedures Time	174.25	Total Turnover Time	13.43
Allocated Time	126.17	Workload	187.68
Late Start Time	4.35	Actual Workload	186.33
Extended Working Time	17.13	Utilization	99.11%
Percentage to Availabel Time			
Factor	%	Factor	%
Available Time	100%	Workload	99.83%
Allocated Time	67.11%	Actual Workload	99.11%

Table 23 ORAM applied to Operating Room 8 Surgical Suite Level 2

7.4.11: Operating Room 9 in Surgical Suite Level 2

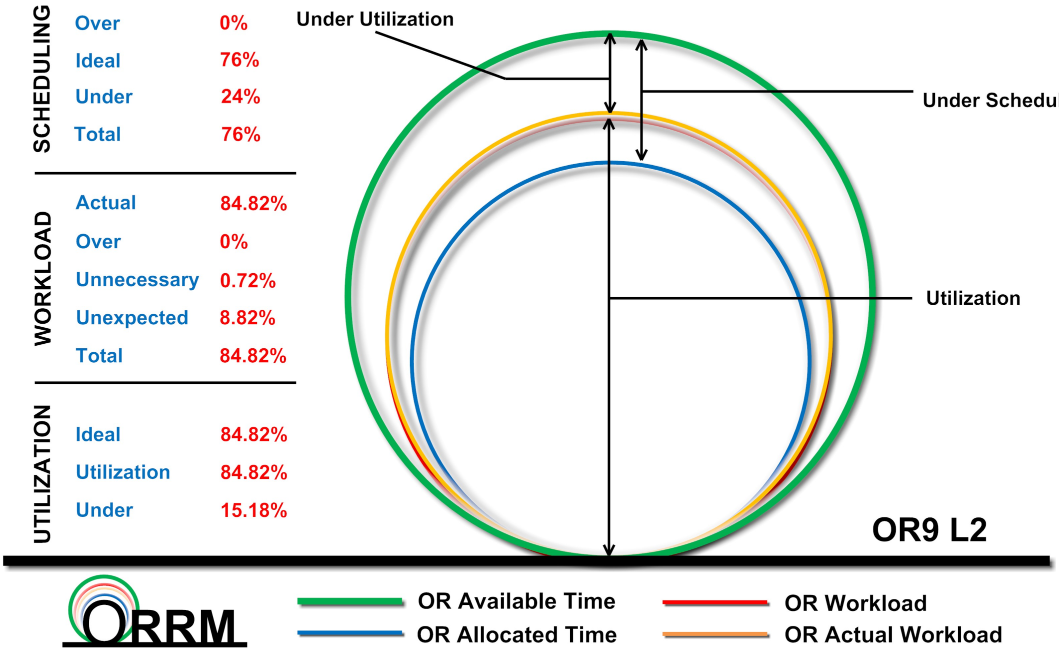


Figure 25 ORRM applied to Operating Room 9 Surgical Suite Level 2

Operating Room 9 Surgical Suite Level 2 (OR9 L2)			
Values Derived by ORAM			
Factor	Hours	Factor	Hours
Working Days	19	Scheduled Turnover Time	6.25
Available Time	163	Extended Turnover Time	0
Procedures Time	154.33	Total Turnover Time	6.25
Allocated Time	123.88	Workload	138.26
Late Start Time	6.5	Actual Workload	138.26
Extended Working Time	5.5	Utilization	84.82%
Percentage to Availabel Time			
Factor	%	Factor	%
Available Time	100%	Workload	84.82%
Allocated Time	76.00%	Actual Workload	84.82%

Table 24 ORAM applied to Operating Room 9 Surgical Suite Level 2

7.4.12: Operating Room 10 in Surgical Suite Level 2

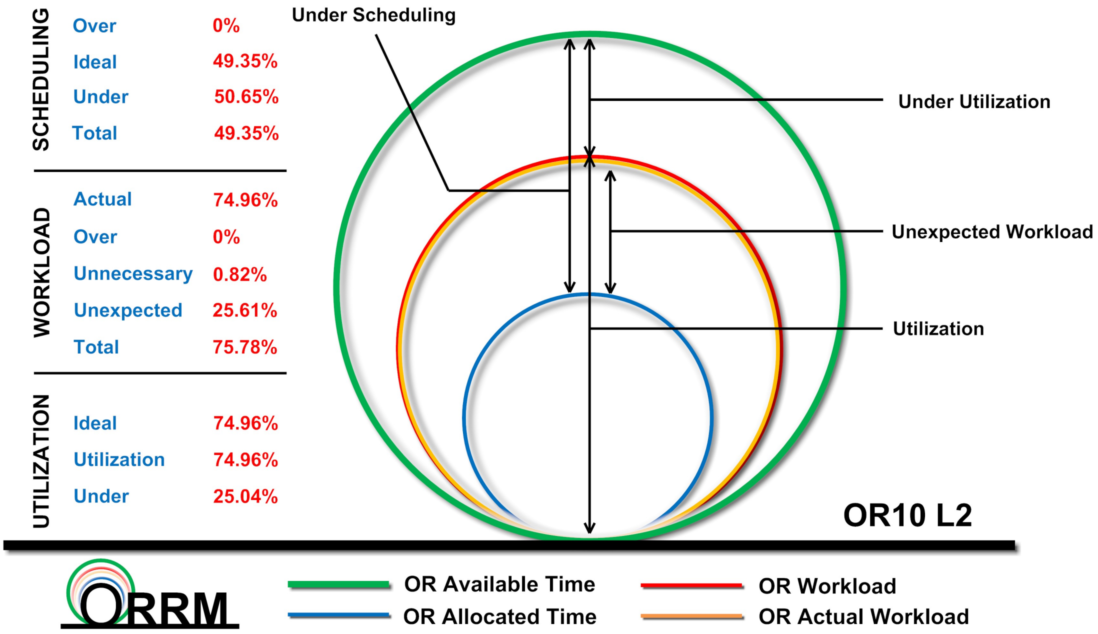


Figure 26 ORRM applied to Operating Room 10 Surgical Suite Level 2

Operating Room 10 Surgical Suite Level 2 (OR10 L2)			
Values Derived by ORAM			
Factor	Hours	Factor	Hours
Working Days	14	Scheduled Turnover Time	12.08
Available Time	120	Extended Turnover Time	0.98
Procedures Time	77.87	Total Turnover Time	13.06
Allocated Time	59.22	Workload	90.93
Late Start Time	2.77	Actual Workload	89.95
Extended Working Time	0.58	Utilization	74.96%
Percentage to Availabel Time			
Factor	%	Factor	%
Available Time	100%	Workload	75.78%
Allocated Time	49.35%	Actual Workload	74.96%

Table 25 ORAM applied to Operating Room 10 Surgical Suite Level 2

7.4.13: Operating Room 11 in Surgical Suite Level 2

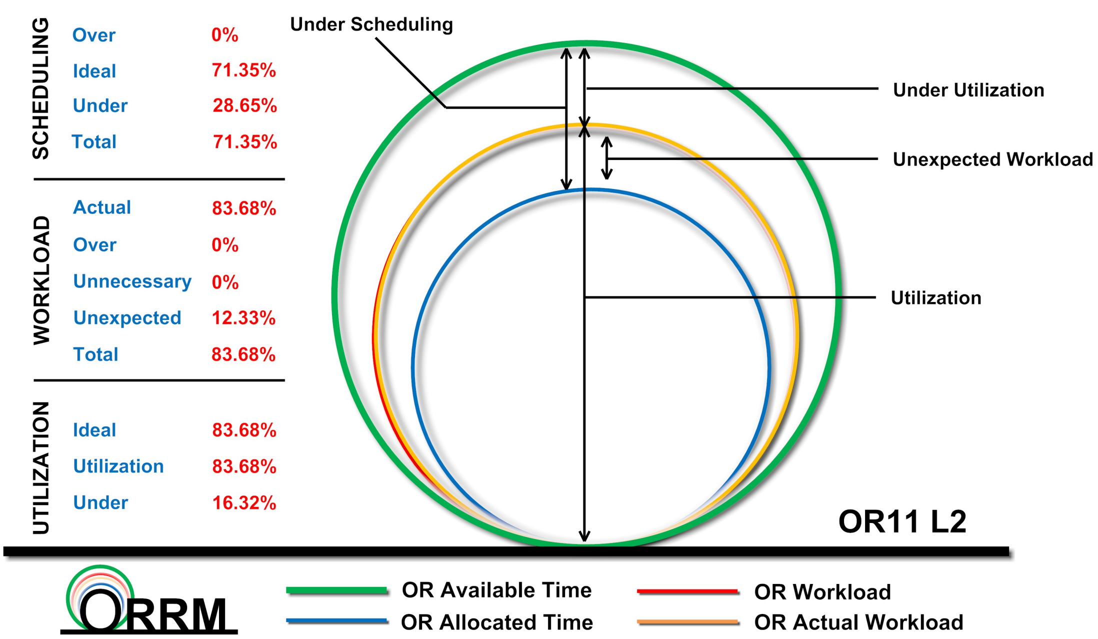


Figure 27 ORRM applied to Operating Room 11 Surgical Suite Level 2

Operating Room 11 Surgical Suite Level 2 (OR11 L2)			
Values Derived by ORAM			
Factor	Hours	Factor	Hours
Working Days	19	Scheduled Turnover Time	8.75
Available Time	161	Extended Turnover Time	0
Procedures Time	143.17	Total Turnover Time	8.75
Allocated Time	114.88	Workload	134.73
Late Start Time	19.15	Actual Workload	134.73
Extended Working Time	20.25	Utilization	83.68%
Percentage to Availabel Time			
Factor	%	Factor	%
Available Time	100%	Workload	83.68%
Allocated Time	71.35%	Actual Workload	83.68%

Table 26 ORAM applied to Operating Room 11 Surgical Suite Level 2

7.4.14: Operating Room 12 in Surgical Suite Level 2

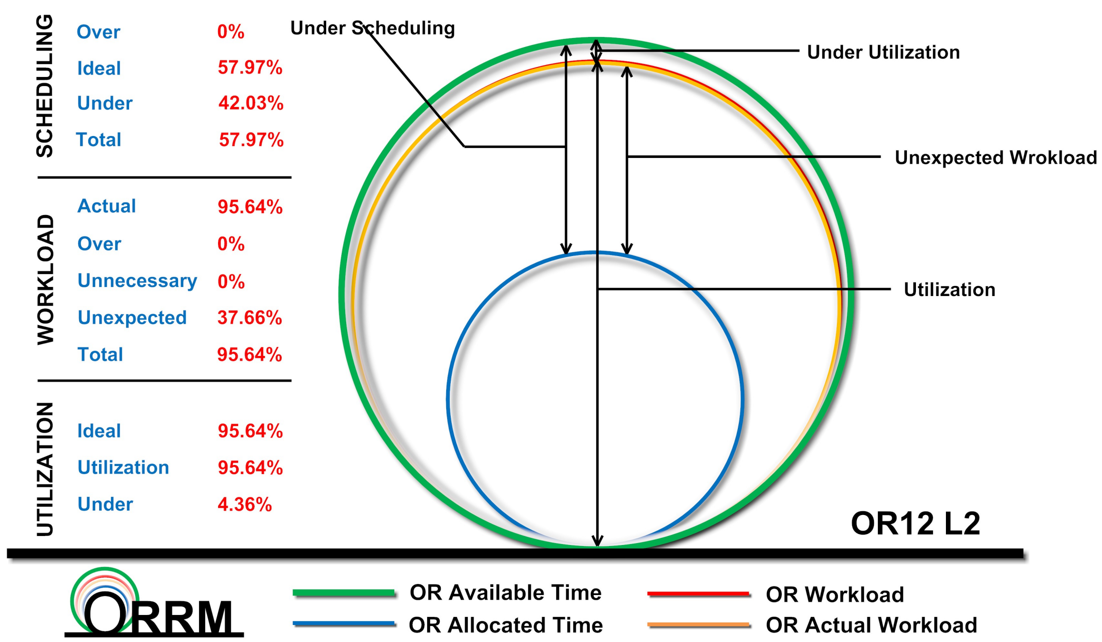


Figure 28 ORRM applied to Operating Room 12 Surgical Suite Level 2

Operating Room 12 Surgical Suite Level 2 (OR12 L2)			
Values Derived by ORAM			
Factor	Hours	Factor	Hours
Working Days	20	Scheduled Turnover Time	13.33
Available Time	170	Extended Turnover Time	0
Procedures Time	155.13	Total Turnover Time	13.33
Allocated Time	98.55	Workload	162.58
Late Start Time	4.8	Actual Workload	162.58
Extended Working Time	8.67	Utilization	95.64%
Percentage to Availabel Time			
Factor	%	Factor	%
Available Time	100%	Workload	95.64%
Allocated Time	57.97%	Actual Workload	95.64%

Table 27 ORAM applied to Operating Room 12 Surgical Suite Level 2

7.4.15: Operating Room 13 in Surgical Suite Level 2

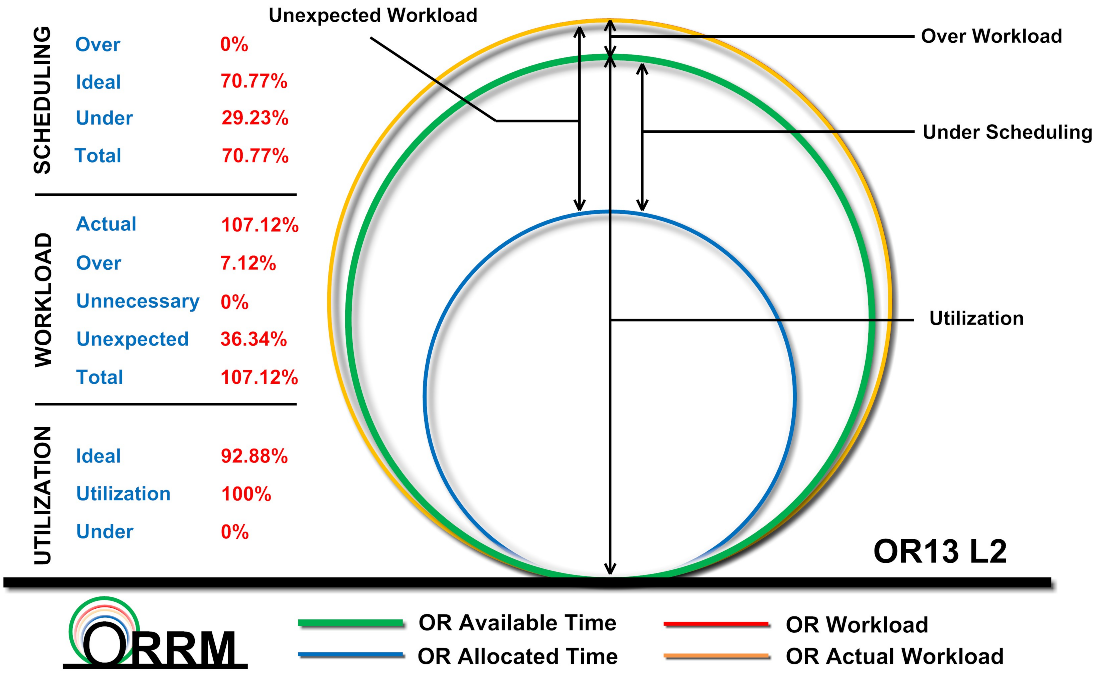


Figure 29 ORRM applied to Operating Room 13 Surgical Suite Level 2

Operating Room 13 Surgical Suite Level 2 (OR13 L2)			
Values Derived by ORAM			
Factor	Hours	Factor	Hours
Working Days	19	Scheduled Turnover Time	20
Available Time	145	Extended Turnover Time	0
Procedures Time	151.47	Total Turnover Time	20
Allocated Time	102.62	Workload	155.32
Late Start Time	5.85	Actual Workload	155.32
Extended Working Time	11.12	Utilization	100.00%
Percentage to Availabel Time			
Factor	%	Factor	%
Available Time	100%	Workload	107.12%
Allocated Time	70.77%	Actual Workload	107.12%

Table 28 ORAM applied to Operating Room 13 Surgical Suite Level 2

7.4.16: Operating Room 14 in Surgical Suite Level 2

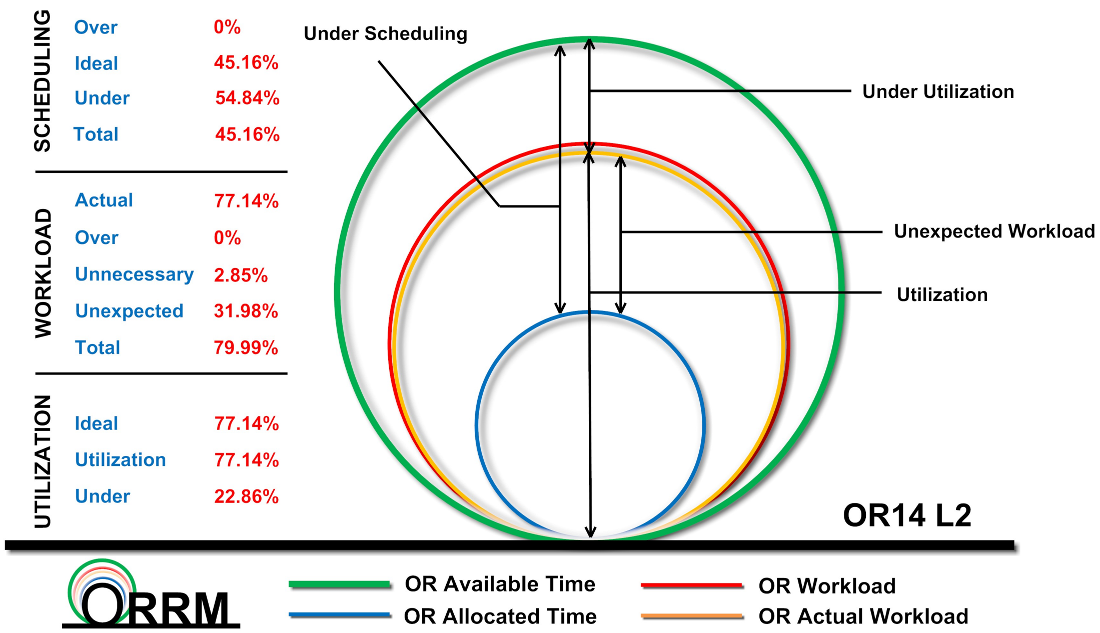


Figure 30 ORRM applied to Operating Room 14 Surgical Suite Level 2

Operating Room 14 Surgical Suite Level 2 (OR14 L2)			
Values Derived by ORAM			
Factor	Hours	Factor	Hours
Working Days	17	Scheduled Turnover Time	10
Available Time	145	Extended Turnover Time	4.13
Procedures Time	101.85	Total Turnover Time	14.13
Allocated Time	65.48	Workload	115.98
Late Start Time	3.92	Actual Workload	111.85
Extended Working Time	7.93	Utilization	77.14%
Percentage to Availabel Time			
Factor	%	Factor	%
Available Time	100%	Workload	79.99%
Allocated Time	45.16%	Actual Workload	77.14%

Table 29 ORAM applied to Operating Room 14 Surgical Suite Level 2

7.4.17: Operating Room 15 in Surgical Suite Level 2

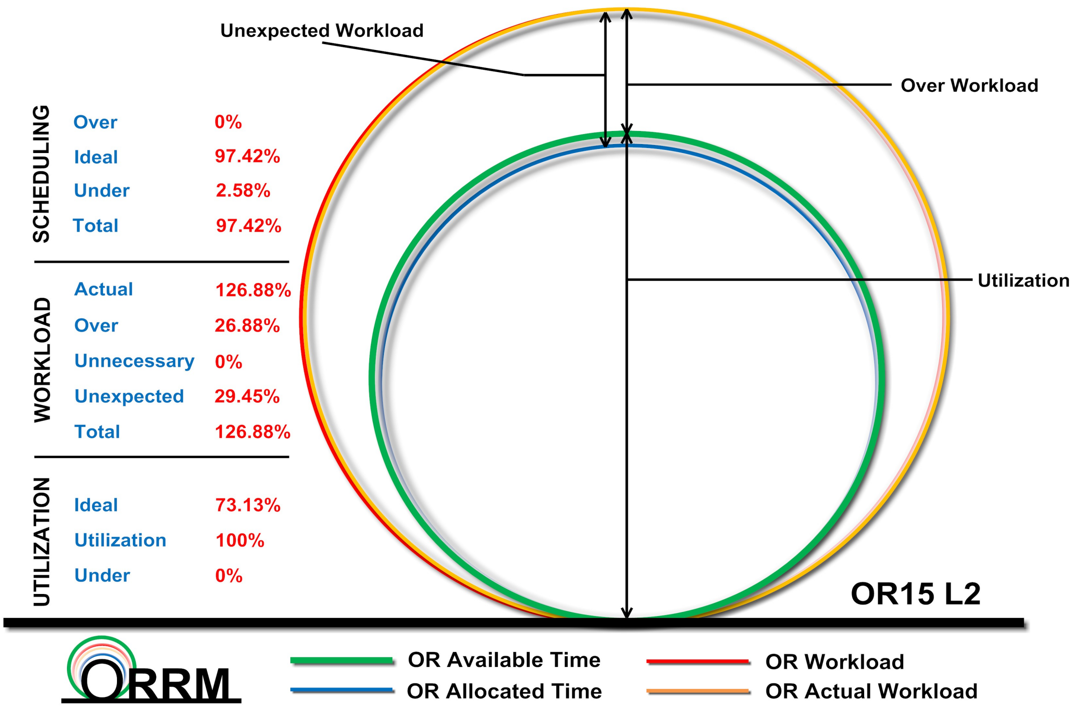


Figure 31 ORRM applied to Operating Room 15 Surgical Suite Level 2

Operating Room 15 Surgical Suite Level 2 (OR15 L2)			
Values Derived by ORAM			
Factor	Hours	Factor	Hours
Working Days	16	Scheduled Turnover Time	13.33
Available Time	88	Extended Turnover Time	0
Procedures Time	102.98	Total Turnover Time	13.33
Allocated Time	85.73	Workload	111.65
Late Start Time	5.95	Actual Workload	111.65
Extended Working Time	5	Utilization	100.00%
Percentage to Availabel Time			
Factor	%	Factor	%
Available Time	100%	Workload	126.88%
Allocated Time	97.42%	Actual Workload	126.88%

Table 30 ORAM applied to Operating Room 15 Surgical Suite Level 2

7.4.18: CSICU in Surgical Suite Level 4

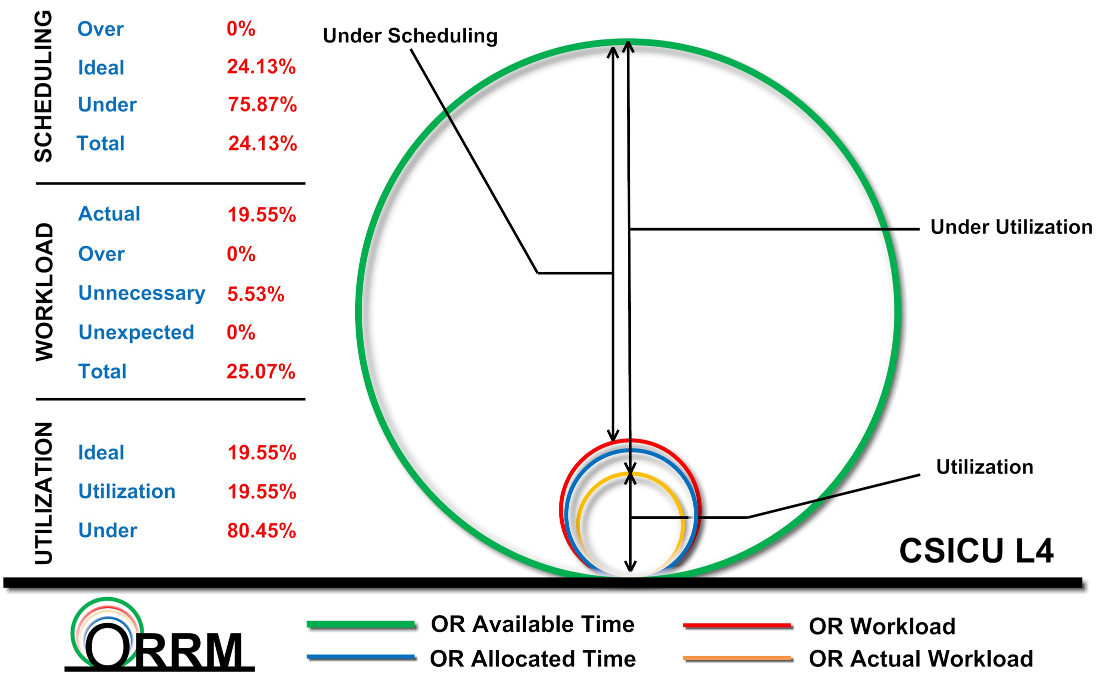


Figure 32 ORRM applied to CSICU Surgical Suite Level 4

CSICU Surgical Suite Level 4 (CSICU L4)			
Values Derived by ORAM			
Factor	Hours	Factor	Hours
Working Days	11	Scheduled Turnover Time	2.5
Available Time	95	Extended Turnover Time	5.25
Procedures Time	16.07	Total Turnover Time	7.75
Allocated Time	22.92	Workload	23.82
Late Start Time	20.08	Actual Workload	18.57
Extended Working Time	0.4	Utilization	19.55%
Percentage to Availabel Time			
Factor	%	Factor	%
Available Time	100%	Workload	25.07%
Allocated Time	24.13%	Actual Workload	19.55%

Table 31 ORAM applied to CSICU Surgical Suite Level 4

7.4.19: Operating Room 1 in Surgical Suite Level 4

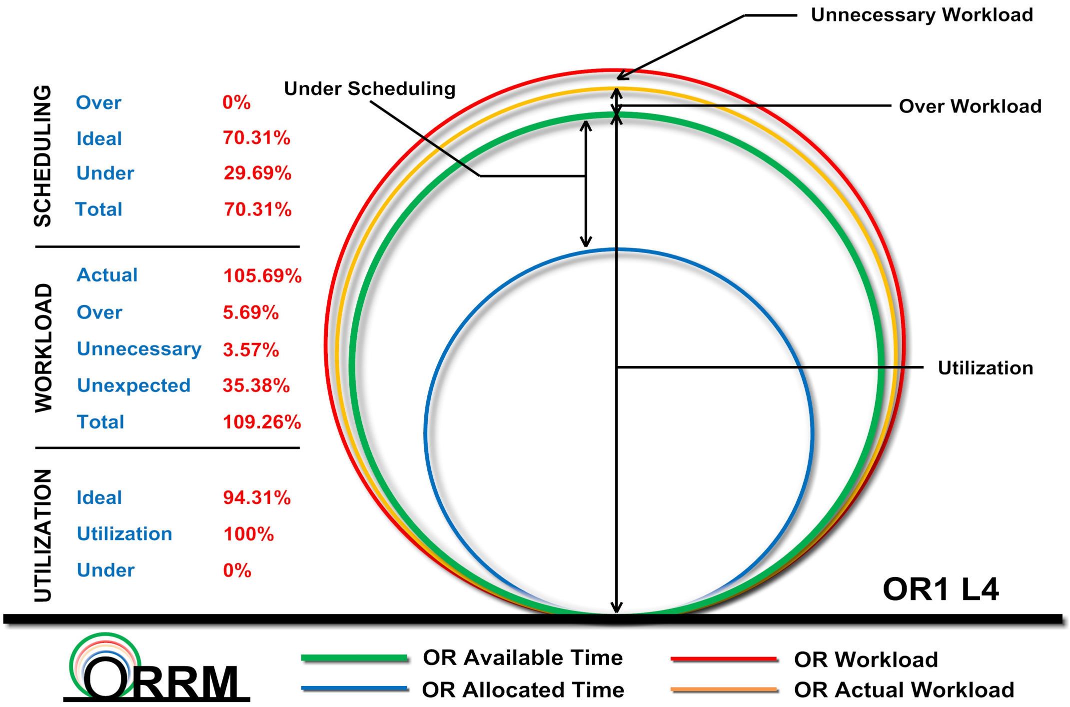


Figure 33 ORRM applied to Operating Room 1 Surgical Suite Level 4

Operating Room 1 Surgical Suite Level 4 (OR1 L4)			
Values Derived by ORAM			
Factor	Hours	Factor	Hours
Working Days	20	Scheduled Turnover Time	5.85
Available Time	145	Extended Turnover Time	5.17
Procedures Time	147.4	Total Turnover Time	11.02
Allocated Time	101.95	Workload	158.42
Late Start Time	20.48	Actual Workload	153.25
Extended Working Time	18.52	Utilization	100.00%
Percentage to Availabel Time			
Factor	%	Factor	%
Available Time	100%	Workload	109.26%
Allocated Time	70.31%	Actual Workload	105.69%

Table 32 ORAM applied to Operating Room 1 Surgical Suite Level 4

7.4.20: Operating Room 2 in Surgical Suite Level 4

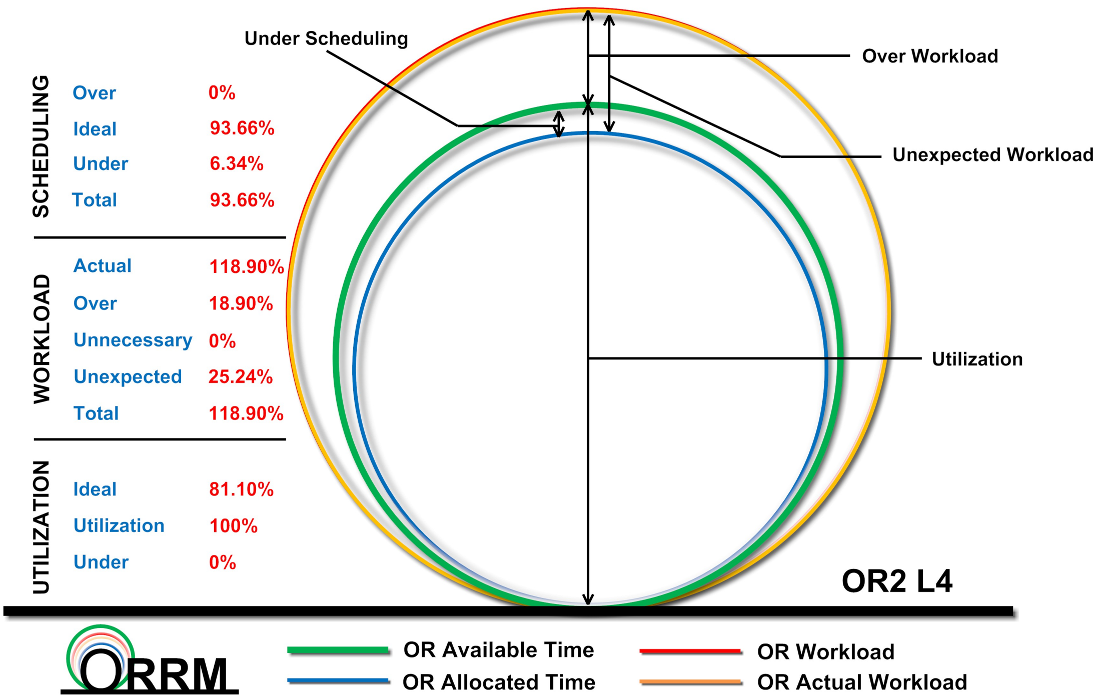


Figure 34 ORRM applied to Operating Room 2 Surgical Suite Level 4

Operating Room 2 Surgical Suite Level 4 (OR2 L4)			
Values Derived by ORAM			
Factor	Hours	Factor	Hours
Working Days	17	Scheduled Turnover Time	6.67
Available Time	127	Extended Turnover Time	0
Procedures Time	157.67	Total Turnover Time	6.67
Allocated Time	118.95	Workload	151
Late Start Time	20.48	Actual Workload	151
Extended Working Time	26.17	Utilization	100.00%
Percentage to Availabel Time			
Factor	%	Factor	%
Available Time	100%	Workload	118.90%
Allocated Time	93.66%	Actual Workload	118.90%

Table 33 ORAM applied to Operating Room 2 Surgical Suite Level 4

7.4.21: Operating Room 3 in Surgical Suite Level 4

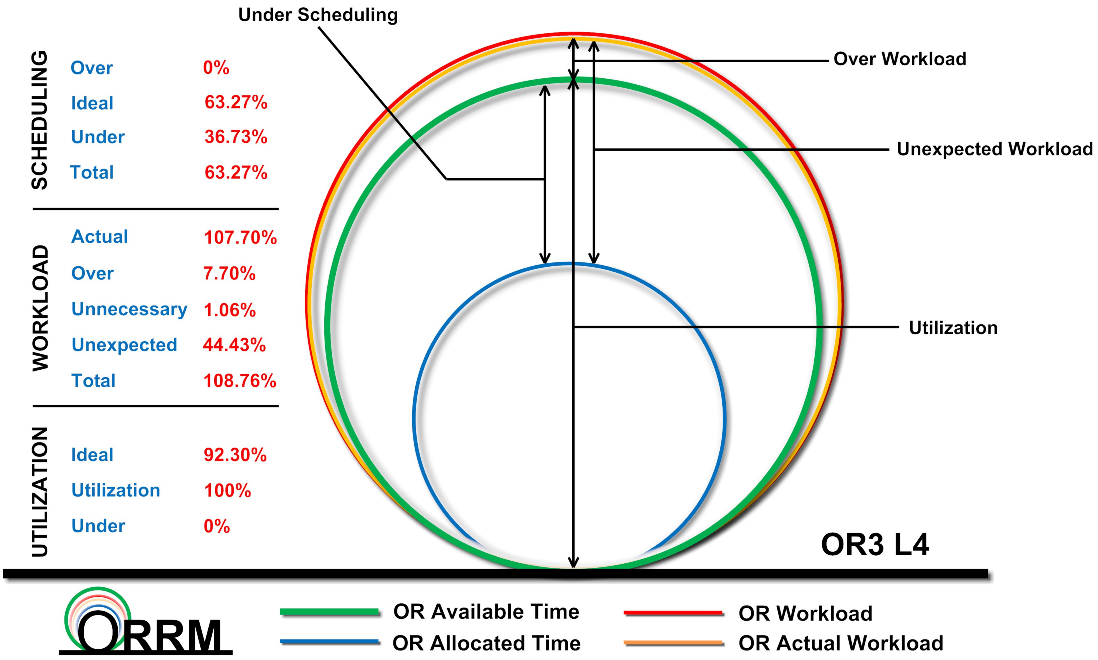


Figure 35 ORRM applied to Operating Room 3 Surgical Suite Level 4

Operating Room 3 Surgical Suite Level 4 (OR3 L4)			
Values Derived by ORAM			
Factor	Hours	Factor	Hours
Working Days	15	Scheduled Turnover Time	5
Available Time	127	Extended Turnover Time	1.34
Procedures Time	131.78	Total Turnover Time	6.34
Allocated Time	80.35	Workload	138.12
Late Start Time	9.4	Actual Workload	136.78
Extended Working Time	29.65	Utilization	100.00%
Percentage to Availabel Time			
Factor	%	Factor	%
Available Time	100%	Workload	108.76%
Allocated Time	63.27%	Actual Workload	107.70%

Table 34 ORAM applied to Operating Room 3 Surgical Suite Level 4

7.4.22: Operating Room 4 in Surgical Suite Level 4

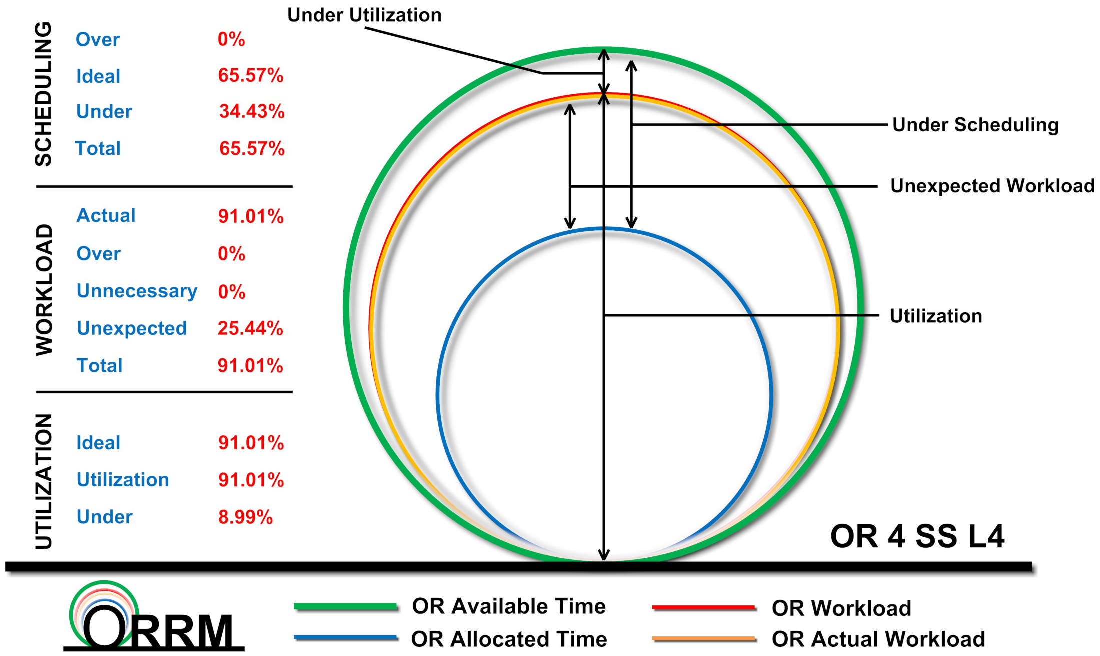


Figure 36 ORRM applied to Operating Room 4 Surgical Suite Level 4

Operating Room 4 Surgical Suite Level 4 (OR4 L4)			
Values Derived by ORAM			
Factor	Hours	Factor	Hours
Working Days	16	Scheduled Turnover Time	5
Available Time	136	Extended Turnover Time	0
Procedures Time	127.13	Total Turnover Time	5
Allocated Time	89.18	Workload	123.78
Late Start Time	24.65	Actual Workload	123.78
Extended Working Time	18.65	Utilization	91.01%
Percentage to Availabel Time			
Factor	%	Factor	%
Available Time	100%	Workload	91.01%
Allocated Time	65.57%	Actual Workload	91.01%

Table 35 ORAM applied to Operating Room 4 Surgical Suite Level 4

7.5: Analysis of the Surgical Suites using both ORAM and ORRM

In this section the ORAM and ORRM have been applied to the entire surgical suites (Operating Room Level 2 & 4) at King Faisal Specialist Hospital and Research Center to evaluate the performance of these two surgical suites for the month of October 2012.

7.5.1: Surgical Suite Level 2 (The main Operating Room)

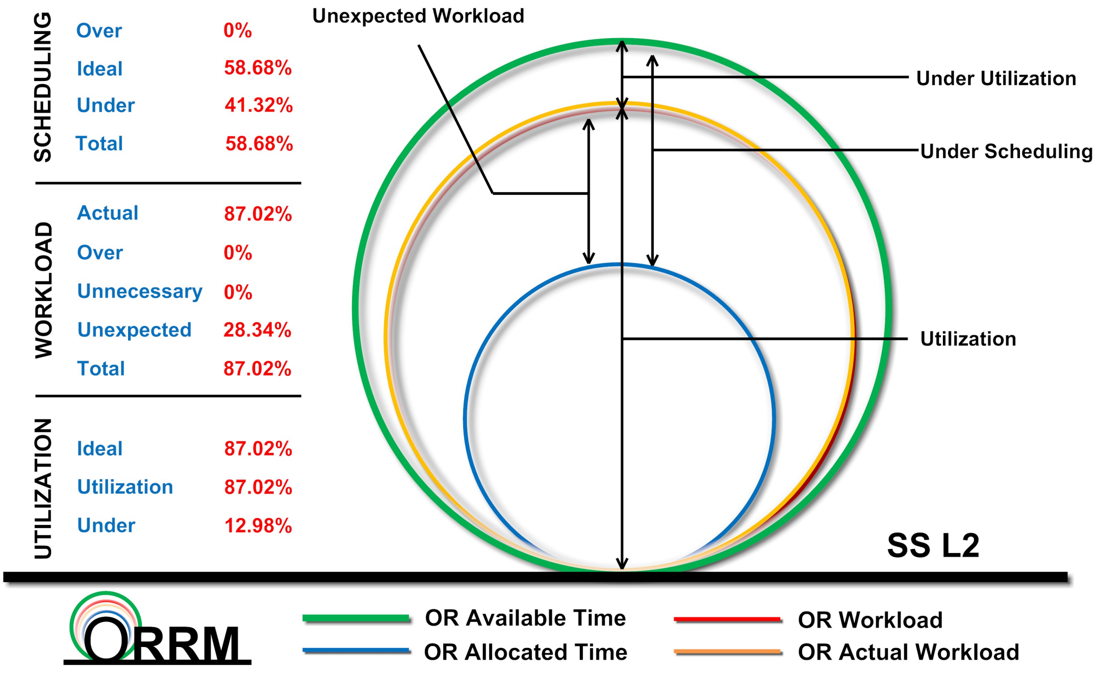


Figure 37 ORRM applied to Surgical Suite Level 2

Surgical Suite Level 2 (OR L2)			
Values Derived by ORAM			
Factor	Hours	Factor	Hours
Working Days	304	Scheduled Turnover Time	185.83
Available Time	2596	Extended Turnover Time	0
Procedures Time	2098.97	Total Turnover Time	185.83
Allocated Time	1523.43	Workload	2259
Late Start Time	135.1	Actual Workload	2259
Extended Working Time	164.37	Utilization	87.02%
Percentage to Availabel Time			
Factor	%	Factor	%
Available Time	100%	Workload	87.02%
Allocated Time	58.68%	Actual Workload	87.02%

Table 36 ORAM applied to Surgical Suite Level 2

7.5.2: Surgical Suite Level 4 (Cardiovascular and Thoracic)

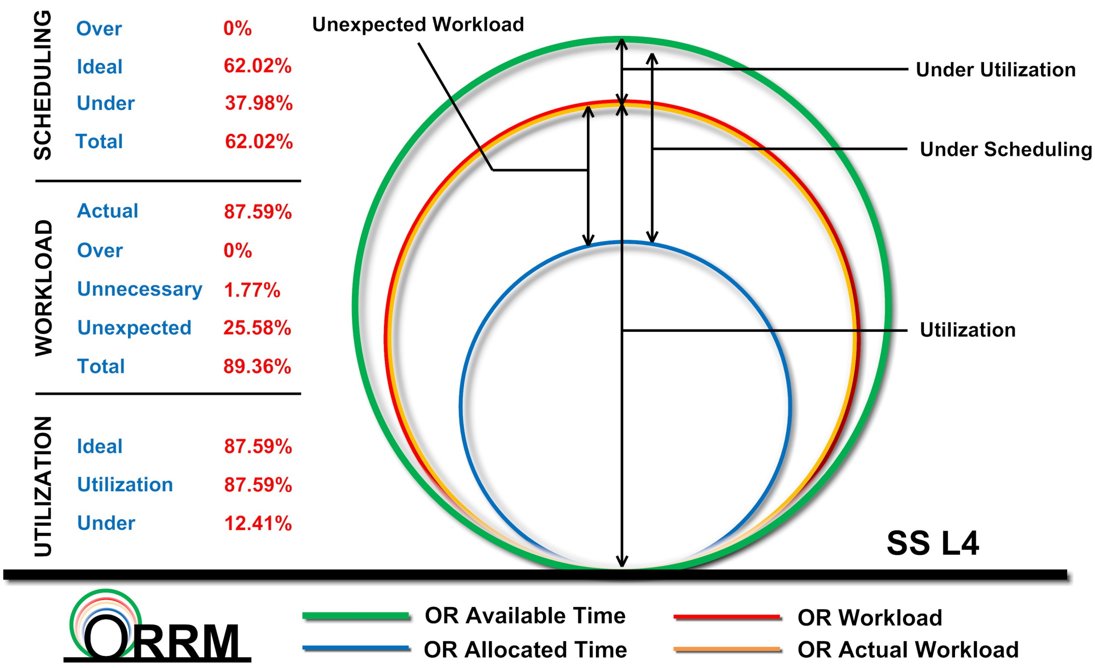


Figure 38 ORRM applied to Surgical Suite Level 4

Surgical Suite Level 4 (OR L4)			
Values Derived by ORAM			
Factor	Hours	Factor	Hours
Working Days	78	Scheduled Turnover Time	25.02
Available Time	666	Extended Turnover Time	11.76
Procedures Time	580	Total Turnover Time	36.78
Allocated Time	413.05	Workload	595.14
Late Start Time	84.68	Actual Workload	583.38
Extended Working Time	84.4	Utilization	87.59%
Percentage to Availabel Time			
Factor	%	Factor	%
Available Time	100%	Workload	89.36%
Allocated Time	62.02%	Actual Workload	87.59%

Table 37 ORAM applied to Surgical Suite Level 4

7.6: Discussion

7.6.1: Introduction

This study has revealed the existence of considerable variations and weaknesses in the techniques used to evaluate Operating Room performance, which stresses the need to develop comprehensive guidelines and models, which can be used to evaluate Operating Room performance.

In this research, an Operating Room Assessment Framework (ORAF) has been proposed, which consists of a number of logically connected components to form an integrated assessment framework for evaluating Operating Room performance. The ORAF includes: Operating Room Concept Definitions; the Primary Factors; Operating Room Assessment Model (ORAM); Derived Factors; Operating Room Rings Model (ORRM), and the OR Assessment Outcome. By using ORAF, three important outcome elements of OR performance can be deduced, which are: OR scheduling level, the type of OR workload, and OR utilization.

In this section the components of the developed Operating Room Assessment Framework (ORAF) will be discussed, along with the outcomes of this framework and the contribution towards these outcomes in assessing Operating Room efficiency. Lastly, this section will conclude with the ORAF's limitations.

7.6.2: Operating Room Concept Definitions

Each type of science has its own terminology to enable easy understanding of its field's content, and also to facilitate access to information and communication processes.

The use of certain terms which are unusual in this field have been noted during the fieldwork and analysis of statistical data. These terms are used to evaluate OR performance across participating hospitals, such as the word *Injection Time* for the meaning of *Procedure Time*; the use of the term *Allotted Time* in place of *Allocated Time*, and the use of *Utilized Time* intended to mean *Utilization*, as well as the use of *Changeover time* for the meaning of *Turnover time*.

Therefore, the most important terms commonly used in scientific articles in the field have been defined. This has involved some semantic amendments to clarify their meaning and provide a suitable form for application in the context of the proposed mathematical model. Also, new terms and definitions have been added for the purpose of elaboration and clarification of the existing terms. 34 terms supported by notations have been included, informed both by the literature review and the comprehensive fieldwork reported in Chapter 4. This was the first step and an important task to form phase one of the development process of the Operating Room Assessment Framework (ORAF).

7.6.3: The Statistical Factors

During the fieldwork of this study, it was noted that the informatics systems of most of the hospitals which participated in this study have a very good database related to operating room performance, but this is not reflected in the content of the official Operating Room reports. It is clear that the main reason for this is the lack of an obvious way to identify the important factors required in the analysis process of operating room performance. It is also observed from the literature review that there is a lack of clear illustration, in full, of the important factors needed in this process. Most of the existing practices discuss each point relating to this area separately. Thus, there was the need to identify the primary statistical factors, to enable this study to achieve its desired goal.

Therefore, this study has identified the primary statistical factors required to start the Operating Room assessment process. These factors have been informed by the comprehensive literature review and the fieldwork (reported in chapter 4). All statistical factors used in the hospital reports have been identified and tested to ascertain the extent of their impact on the evaluation process; thus a number of unimportant factors have been excluded which do not affect the overall assessment of the performance of the Operating Room, such as *Patient Call Time*, *Anaesthesia Start Time and End Time*. Also, some new important factors have been added, which did not exist before, such as *Time off, Extended Work Time*, *Extended Turnover Time*, *Total Turnover Time* and *Actual Workload*. This has resulted in the identification of 14 primary statistical key factors (Table 10) which are essential to the beginning of the OR evaluation process.

7.6.4: Operating Room Assessment Model

Through a careful literature review, including previous studies on the subject of evaluating operating room performance, it has been noted that there is a large number of developed methods available which are written in a professional mathematical manner. However, these equations and/or formulas are presented in a purely statistical manner, containing complex notations with a focus mainly on economic topics. Also, they discuss each point related to Operating Room performance separately rather than linking them with other important points, and there is an absence of illustrative cases. Accordingly, it seems to be confusing for most medical practitioners regarding how to execute the existing procedures to evaluate OR performance (along with a lack of consensus); therefore, most concepts have not been applied successfully until now.

In addition, throughout the comprehensive fieldwork and the data analysis of eight Operating Room management systems in eight tertiary and teaching hospitals, no written guidelines or models containing any equations or formulas that can be used as stander to evaluate the Operating Room performance have been found. Instead, the existing practices in all of the hospitals do not exceed individual efforts to use simple formulas in an attempt to analyse Operating Room performance through the use of Excel software (see table 36).

Because of this lack of clear systems, this research has found that there is a need to develop a model that contains basic concept equations accompanied by simple notations to cover all stages of the Operating Room assessment process in a gradual and interrelated form. It should be possible to apply this modelin practice as a tool to analyse the primary statistical factors obtained from the OR records.

Therefore, a practical oriented mathematical model has been proposed and developed, namely the Operating Room Assessment Model (ORAM). This model comprises 18 equations with completely new simple notations inferred from the original sentence- these have been used to make it easier to remember them. The ORAM can be used to analyse the primary statistical factors clearly, sequentially, and in detail for both the Operating Rooms and the entire Surgical Suite.

In order to examine the newly developed mathematical model (ORAM), it has been pre-validated through a comprehensive and fictitious scenario of a surgical suite containing four operating rooms informed by the selected case studies (see chapter 6). This has revealed the success of this model (ORAM) in the production of 15 new valuable and influential derived factors.

To assist and identify the abilities of ORAM in the real world, and to test its limitations, it has been applied to different Operating Rooms located in different surgical suites which perform multiple types of surgical procedures for different lengths of time. Also, it has been applied and tested in various forms: to one Operating Room for one day's performance; to numerous operating rooms in different surgical suits for one month's performance, and to entire surgical suites for a one month period of time. Accordingly, it has been found that the ORAM has proven its ability to perform satisfactorily, with accuracy, and consistency in all the different situations that it has been applied to.

7.6.5: Derived Statistical Factors

The Operating Room Assessment Model (ORAM) and its underpinning mathematical equations, which make use of the primary factors, have informed the development of a new set of factors in the form of statistical data. This data forms the second set of important factors in the Operating Room evaluation process.

The main aim of using the ORAM is to obtain as much useful data as possible through the analysis process of the factors. To achieve this result, the analysis process has gone through two stages of analysis: first, analysis of the primary factors; second, analysis of the results of the primary factors, which results in a new set of derived statistical factors.

These derived factors have been divided into three sections:

(a) Factors containing general statistical information:

1. Extended Working Time
2. Extended Turnover Time
3. Total Turnover Time

(b) Factors related to the Operating Rooms

1. Operating Room's Available Time
2. Operating Room's Allocated Time
3. Operating Room Workload
4. Operating Room Actual Workload
5. Operating Room Over Workload
6. Operating Room Utilization

(c) Factors regarding the inter Surgical Suite:

1. Surgical Suite's Available Time
2. Surgical Suite's Allocated Time
3. Surgical Suite Workload
4. Surgical Suite Actual workload

5. Surgical Suite Over Workload
6. Surgical Suite Utilization

The Operating Room Assessment Model (ORAM) has informed the development of 15 newly derived factors.

Table 38 The statistical report of Operating Room Level 2 for 2011
(Source: OR Management, KFSH&RC 2011)

7.6.6: Operating Room Rings Model

During the data analysis of the statistical reports for the hospitals that have participated in this study, the presence of some visual charts related to the assessment of Operating Room performance was observed. However, these charts do not exceed presenting the same statistical values in visual form; there is no link between these values, and there is no new data (see figure 37, 38 and 39). Also, nothing much different was found through the literature review related to this issue.

This study has gone well beyond displaying only the statistical information in visual form, to develop a visualisation metaphor model to enable the reader to interpret and convey holistic information about the performance of the Operating Room quickly and easily; thereby creating a decision making tool for the operating room management team. The second developed model is called the Operating Room Rings Model (ORRM).

The ORRM demonstrates and measures the performance of the Operating Room in the form of overlapping rings. These rings represent: OR available time, OR allocated time, OR workload and OR actual workload; all of these values are derived from the mathematical model developed. In this model, the available time will be the centre of the measurement unit. The most important aspect that can be determined from this model is through the consideration of what the differences between these circles mean, whereby three important factors of OR performance can be deduced: OR scheduling level, the type of OR workload and OR utilization. These new factors and their results are discussed below.

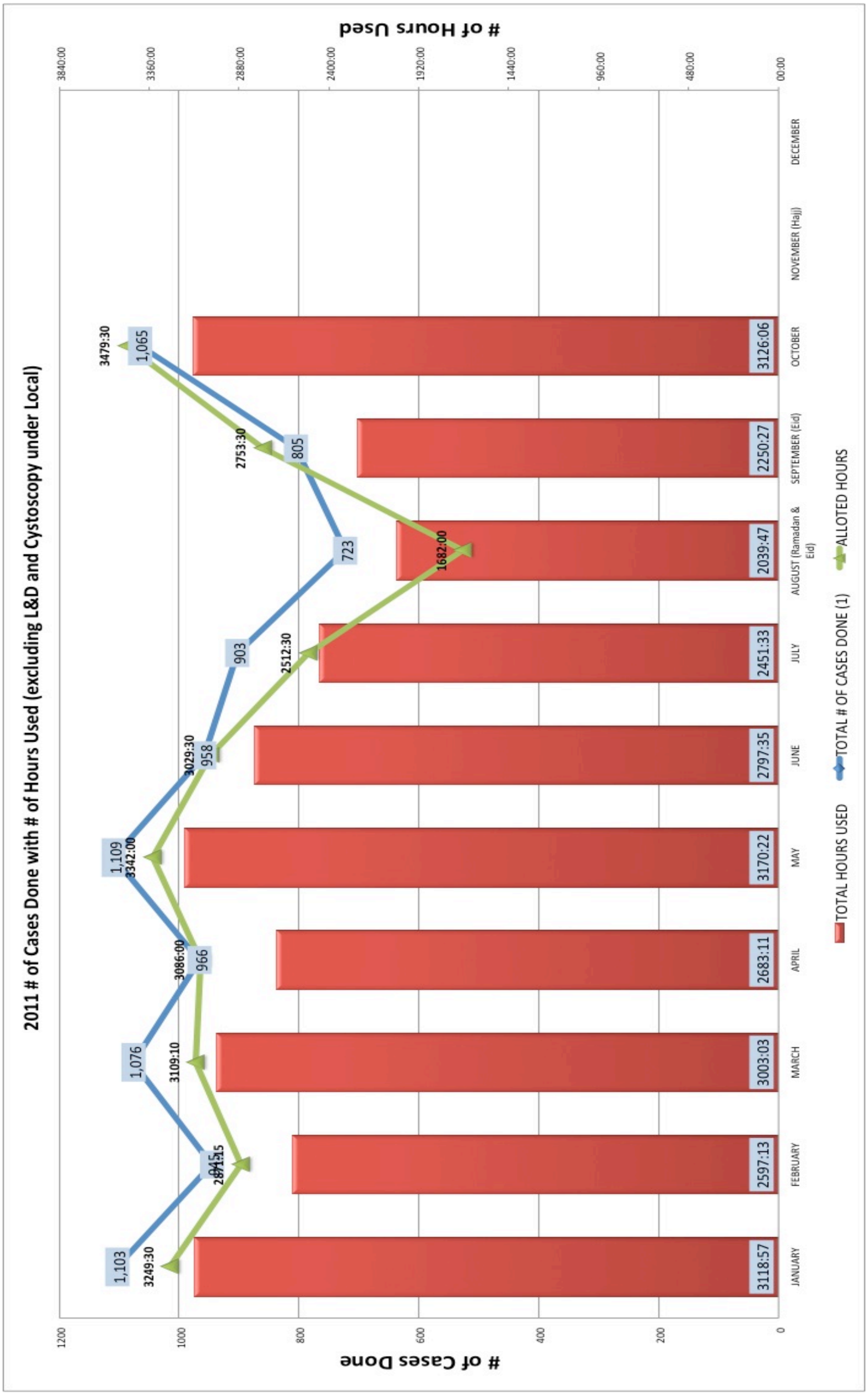


Figure 39 Number of cases done with number of hours used (KFSHRC 2011)

(Source: OR Management, KFSH&RC 2011)

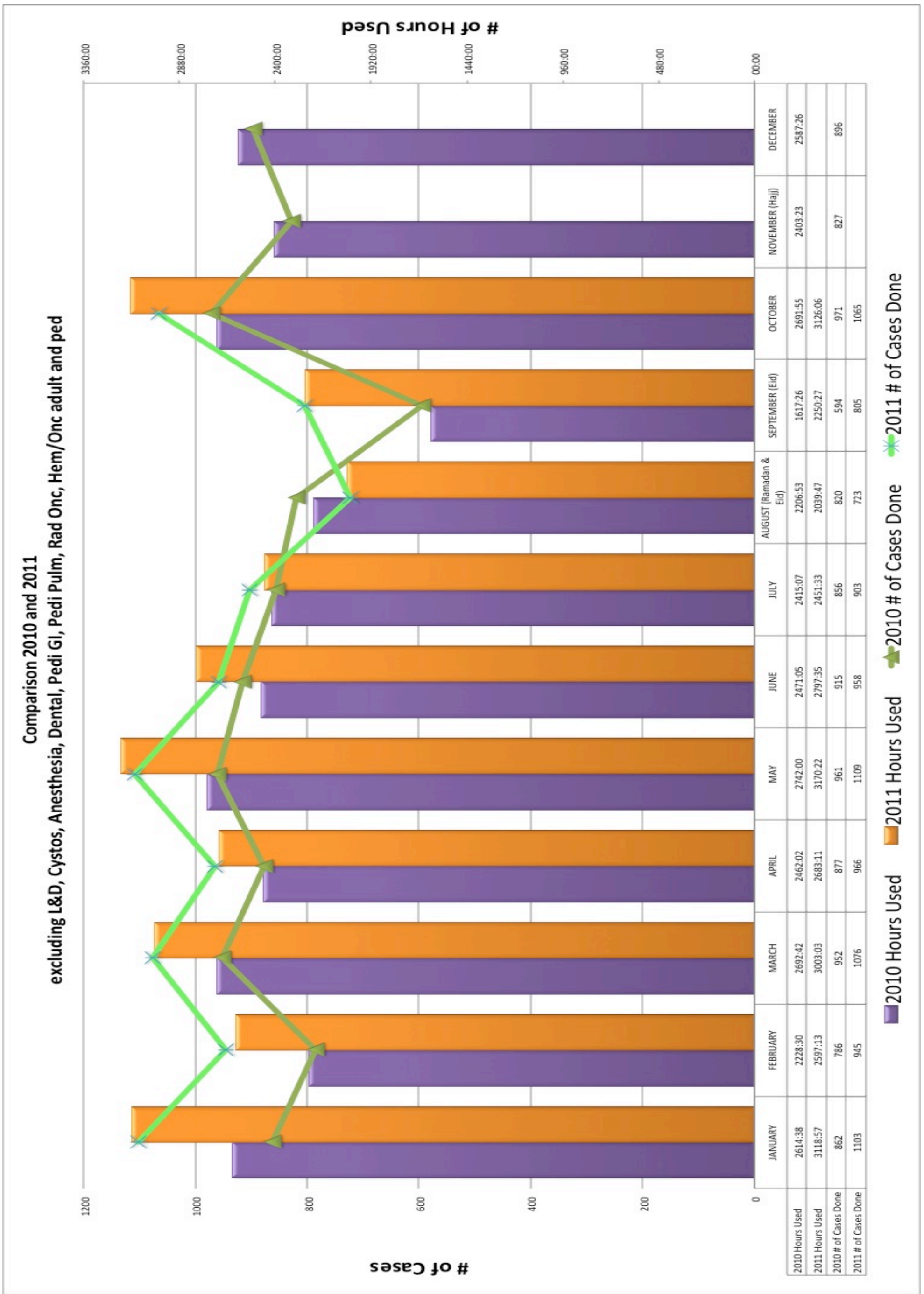


Figure 40 Comparison of Operating Room performance 2010 and 2011 (KFSH&RC)

(source: OR Management, KFSH&RC 2011)

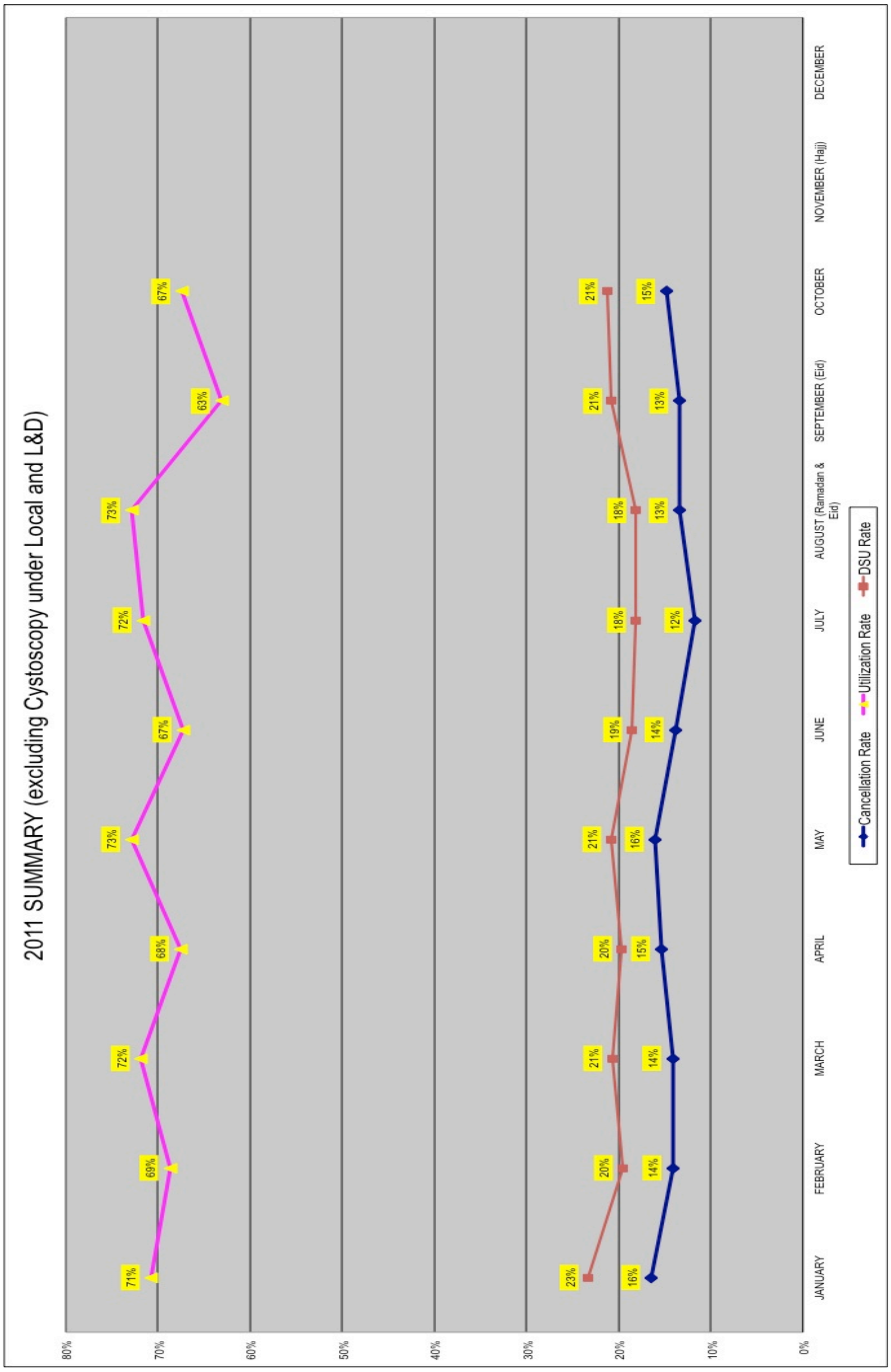


Figure 41 Summary of Operating Room performance 2011 (KFSH&RC)

(Source: OR Management, KFSH&RC 2011)

7.6.7: Operating Room Assessment Framework Outcome

Three important outcome elements of OR performance can be deduced, which are: OR scheduling level, the type of OR workload, and OR utilization, which are discussed in detail below.

- **Operating Room Scheduling and Planning**

Accurate defining of the available time value is one of the most important factors to achieve the best Operating Room Scheduling, and to be able to carry out the most successful planning for the use of the surgical suite. However, the in-depth analysis of the data obtained from the participating hospitals points to a lack of attention regarding the value of OR available time: six out of eight official statistical reports (Kameda, RUH, SPH, SCH, RMH, KFMC) have not determined the amount of OR available time. This is not even mentioned throughout their reports.

This research stresses the importance of "OR available time", for both the evaluation process of the Operating Room and for the OR scheduling and planning process. The OR available time is the budgeted/staffed time per OR that is allocated to be used entirely for a surgical procedure. Therefore, if this time is not used, or used incorrectly, it can be considered a waste of money and resources. In addition, if the OR available time is used in full consistently, but does not cover daily surgical needs, then this must be considered as there is a need to expand OR capacity.

Through the fieldwork and analysis of statistical data, there have been some differences observed in determining the scheduling plan for surgical procedures.

In some systems, the procedures are scheduled to cover all the available time without adding time between the cases to cover the turnover time. In other systems, 15 to 30 minutes are added between the procedures during the booking process as turnover time, while some systems calculate 15% of the procedure time to be deducted from the available time to cover the turnover time between the procedures. Also, some systems consider the available time to be all the budgeted time (staffed time). While in another system, two hours are deducted from the ORs' budget time to cover the turnover time between the procedures. Moreover, it was found in one system that the deduction from the budgeted time is increased to three hours for the same reason (see chapter 5).

This study has classified the quality of OR scheduling levels through a comparison between planned OR allocated time and OR available time. The result is three types of scheduling level, which are: under scheduling, ideal scheduling and over scheduling; these can be read clearly from the ORR model (Figure 9).

Through the application of the ORAF to the performance of the surgical suites at King Faisal Specialist Hospital and Research Center, it is clear that there was a clear defect in the scheduling and planning process for the month of October 2012, as there was clear under planning in all rooms, except room 15 in Surgical Suite Level 2 where the planning level was close to ideal planning at 97.42%. But in general, the planning level in Surgical Suite Level 2 was 58.68%, which means under planning for surgical activities, with 41.32% of the available time not used during the planning process. It is similar for Surgical Suite Level 4, where the planning level was 62.02%, which also means under planning and 37.02% not used during the planning and scheduling process.

The study has found that, in this hospital, a large number of standby cases are conducted daily (see chapter 4 page 133), yet if the scheduling plan was more accurate, there would not be room for these cases to be dealt with.

- **Operating Room Workload**

In previous studies, the OR workload has been presented as a broad term, which is defined as the total amount of time that the OR is used for elective procedures, including the turnover time (Dexter and Macario 2002; McIntosh et al 2006). Furthermore, He et al. (2011), in defining workload, states that workload is the number of operating room hours used by a surgeon on a certain day to carry out surgical procedures. They also provide another major definition of OR workload. According to them, definitions of workload are rarely short and simple. As such, workload may be defined as a dynamic balance between the challenge of a task and an individual's response to that task (Leedal and Smith 2005).

However, the previous studies consider the entire time used in the operating room as the Operating Room Workload, without differentiation in the types and/or quality of the time being used in the Operating Room. Therefore, this study focusses on analysing the nature of the time used during the available budgeted time to differentiate between the types and the impact of the used time on operating room performance. Thus, the Turnover Time, which is the time located between the surgical procedures, has been split into four types: *Planned Turnover Time*, *Scheduled Turnover Time, Extended Turnover Time* and *Total Turnover Time.* This is to clarify the difference between each type of turnover time to determine the passive or negative effect on operating room performance.

Through the use of the new mathematical developed model (ORAM), the negative impact of *Extended Turnover Time* has become clear. Therefore, the *Extended Turnover Time* has been removed from the Operating Room Workload, which has resulted in the introduction of a new term, “Actual Workload”. This is defined as the total amount of time that the Operating Room is used for, excluding the extended turnover time.

The two new classifications of Operating Room Workload (total OR workload and OR actual workload), have been analysed using the second developed model (ORRM). Another three new types of workload have been determined, which are: unnecessary workload, which is the outcome of the difference between the workload and the actual workload; the over workload which occurs in the case of the actual workload being over the OR available time;

and unexpected workload which is the difference between OR allocated time and OR actual workload.

There is only one type of Operating Room Workload mentioned in the previous studies, which has significant weight in the Operating Room evaluations process. This study provides greater value and importance to Operating Room Workload compared with previous practice because of the real value of this element in the Operating Room assessment process. Thus, this study has classified the OR workload into five types: total OR workload (the gross workload); OR actual workload; over workload; unnecessary workload, and unexpected workload (Figure 10).

- **Operating Room Utilization**

Most of the current studies focus mainly on Operating Room Utilization as the main measurement unit for evaluating Operating Room performance. Viapiano and Ward (2000), state that Operating Room utilization has become a major factor in evaluating the performance of the OR. In addition, Faiz and his colleagues confirm that utilization is now a key measure of performance for NHS operating theatre services (Faiz et al. 2008).

The classic definition of OR utilization is the total time consumed in performing each surgical procedure (inclusive of preparation of the patient in the OR, emergencies, and anaesthesia induction), plus the total turnover time divided by the budgeted time available (Sturm et al. 1997; Tyler et al 2003). However, in 1997, Sturm and his associates affirmed that the classical measure of utilization does not explain the utilization of operating suites adequately, due to its failure in differentiating the quality of utilization (Sturm et al. 1997). In 1999, they stressed upon the improvements needed to the classic definition of OR utilization (Sturm et al. 1997).

An attempt was made to develop a model for OR utilization by Sturm and his associates, creating a distinction between usage and utilization. The total time that operating suites are used for defined the usage, while utilization was explained as a function of the sum of the time used and budgeted for the operating suites. In order to create a better measure of utilization, two new terminologies, namely underutilization and overutilization, were defined by the authors (Sturm et al. 1997; Sturm et al. 1999).

Throughout the fieldwork and the data analysis of this study, which includes eight Operating Room Management Systems within eight renowned tertiary hospitals in three different countries on three different continents, only two hospitals (KFSH&RC and KAMC) out of eight hospitals have been found to use Operating Room Utilization as a measurement unit to evaluate Operating Room performance; it is also noted that they are still using the classical principle of Operating Room utilization which has been disproved of by Sturm and his associates since 1997.

During recent years there has been no change in the concept of Operating Room Utilization, which is defined as the time used out of the available budgeted time of the Operating Room. This determines the results according to three types of OR utilization: underutilization, ideal utilization and overutilization.

Furthermore, the previous studies consider all the time used in the operating room within the available budgeted time as utilized time, without differentiation in the quality or the type of time used. This point has been addressed through the creation of *Actual Workload* as a newly derived factor in this study. Thus, this study defines Operating Room Utilization as the ration of the actual Operating Room workload divided by the Operating Room available time.

There is a clear difference between performing surgical procedures within the capacity of the available budgeted time, compared to what is conducted beyond this capacity, in terms of cost and availability of staff. Also, the main aim of measuring utilization is to find out the OR time used out of the available time, which differs from the total amount of time the OR is used for in general. This is because the period being measured is specified as the available time (budgeted time); therefore, any time used that falls outside this range is out of the aim and thus cannot be used to measure utilization. To calculate the entire time that the OR is used, it is more accurate to measure OR workload. Thus, through the use of the ORAF, the result of OR utilization will be 100% or less. If the actual workload fits the OR available time then it is classified as ideal utilization; if the actual workload is less than the OR available time, then it will be underutilization, and if it is over the OR available time then the OR performance is better described as 100% utilization with over workload (Figure 11). This study has found that Operating Room Utilization is of three types: underutilization; ideal utilization, and 100% utilization with over workload, which differs from other studies' findings.

According to Faiz et al (2008), meaningful use of utilization as a tool for benchmarking OR performance can be obstructed by various factors with respect to inconsistent methodologies and overrun rates used in calculations. Moreover, as a marker of OR performance in the public sector, little investigation has been carried out in order to ascertain the validity of OR utilization (Faiz et al 2008). Through the development stages of ORAF, it became clear that Operating Room Utilization is the only measurement unit to evaluate Operating Room performance. Thus, this study concludes that three important elements are required to evaluate the Operating Room performance more broadly, which are: OR scheduling level, the type of OR workload, and OR utilization.

7.6.8: Operating Room Assessment Framework Limitations

Through the above methods set out in this chapter, the ORAF has been applied to different Operating Rooms located in different surgical suites, which perform multiple types of surgical procedures with different lengths of time. Also, the two developed models have been tested in various stages: to one Operating Room for one day's performance; to each operating room in both surgical suits for one month's performance, and to both surgical suites for the entire month of October 2012.

Accordingly, and based of the results provided above, it has been found that the ORAF has proven its ability to perform satisfactorily, with accuracy, and consistent within the study's objectives in all the different situations that it has been applied to.

7.7: Conclusion

The design of the Operating Room Assessment Framework (ORAF) has taken into consideration the need to address the necessary aspects of evaluating OR performance clearly, sequentially, and in detail. This is to ensure it is compatible with the normal stages required during the process of evaluating Operating Room performance.

The development of ORAM involves several stages. These include: (1) improving the definition of important terms used for OR performance evaluation with a definition of relevant new terms; (2) identification of the primary statistical factors affecting the evaluation of OR performance; (3) development of a practice-oriented mathematical model; (4) deriving 15 new factors through the use of the ORAM; (5) development of a visualisation metaphor (model) to analyse the newly derived factors, and then (6) the results can be derived from the ORRM analysis.

When examining the existing reports obtained from the fieldwork (see table 36), it is shown that these reports do not exceed presenting the basic statistical data, with an attempt to determine the Operating Room utilization in a primitive way only. Also, the visual charts do not exceed presenting the same statistical values in visual form without adding any new value (see figure 37, 38 and 39). Importantly, this study has been able to achieve an outcome by using ORAF, containing three important elements of Operating Room performance, which are: OR scheduling level, the type of OR workload, and OR utilization. These elements can simply be read to enable the reader to interpret and convey holistic information about the performance of the Operating Room quickly and easily, which includes three types of scheduling levels: under scheduling, ideal scheduling and over scheduling; five types of OR workload: OR total workload (the gross workload), OR actual workload, over workload, unnecessary workload and unexpected workload; and three types of OR utilization: underutilization, ideal utilization, and 100% utilization with over workload.

The ORRM demonstrates and measures the performance of the Operating Room in the form of overlapping rings. These rings represent: OR available time, OR allocated time, OR workload and OR actual workload by using the four elements (OR available time, OR allocated time, OR workload and OR actual workload). The aim of this model is to facilitate and speed up the process of measuring and reading Operating Room performance, and for it to be used as a dashboard to represent Operating Room performance. The user can immediately visually assess the differences between the very important elements through the consideration of what the differences between these circles mean, and the goal is to make these rings equal and overlapping on top of each other and all equal to the OR available time ring.

Therefore, the ORRM is able to facilitate and speed up the measuring process, and demonstrates the data as a dashboard to represent Operating Room performance. This makes ORRM a valid decision making tool for the operating room management team, which is not offered by existing models.

The outcome from ORAF contains three important elements of Operating Room performance, which are: OR scheduling level, the type of OR workload, and OR utilization. These elements can simply be read to reach the end result, which includes three types of scheduling levels: under scheduling, ideal scheduling and over scheduling; five types of OR workload: OR total workload (the gross workload), OR actual workload, over workload, unnecessary workload and unexpected workload; and three types of OR utilization: underutilization, ideal utilization, and 100% utilization with over workload.

Through the validation process in different situations, the ORAF has verified its ability to perform satisfactorily, with accuracy, and consistent within the research’s objectives.

CHAPTER 8
CONCLUSION

8.1: Introduction

This chapter concludes the thesis. The first section delivers an answer to the overarching research question based on the findings from this study as a whole. In the second section, the contribution of the study is presented. This is followed by a discussion of the research limitations. The final section proposes recommendations for future research.

8.2: Addressing the Research Question

With 15 years experience spent in the field of surgical operating room practice and management, the researcher has noted that most Operating Room management systems differ in some aspects from one hospital to another. Each system depends on the needs of the individual hospital and the experience available, and is targeted towards achieving the best performance in the Operating Room. It is also noted that there is a lack of clear guidelines or models to explain the relevant key concepts and methods for evaluating the performance of Operating Rooms in full.

There was an important need to develop clear and complete guidelines and a model which can be used (in practice) to assist OR managers, directors or any other medical professionals, to determine the performance of an OR; specifically, OR planning and scheduling, OR workload and OR utilization, in order to help them to evaluate, monitor and improve overall Operating Room efficiency.

The study has also sought to explore the various Operating Room management systems of different hospitals in different countries on different continents, to investigate the similarities and differences between these systems, and to evaluate and validate the methods used for measuring the performance of the operating room. After reviewing the general literature on this subject, along with the researcher's previous experience, the study seeks to answer the overarching research question:

> *Can a generic and adaptable operating room assessment framework be developed and implemented with a view to accurately establishing operating room performance, including planning surgical activities, workload, and utilization?*

The research question has been answered throughout a number of stages over the course of this research. These stages are illustrated below:

As the first step to finding the answer to the research question, it was necessary to carry out fieldwork to meet the requirements of this research. Therefore, eight tertiary and teaching hospitals in three countries (Japan, Canada and Saudi Arabia) have been involved in this study. Interviews, observations and documentation are the prime resources that have been used in order to gather information for this research during the fieldwork. All the management data used, such as the official reports, forms, and main statistical data from Operating Room records and systems, have been documented.

From the fieldwork, all the required data has been obtained from each hospital for a one-year period, accompanied by the main statistical data from Operating Rooms records. The analysis of these reports and the main data has gone through a number of stages: first, hospitals were classified according to the measurement unit used (time or number of procedures) on their official reports; then all data located for weekends or official holidays was excluded; the rest of the data was divided into two parts- procedures performed during the available time (budgeted time / staffed time), and the procedures done out of the available time; then all terms used in the reports were recorded to find out exactly what is meant by these terms, and all the statistical factors used in these reports were identified; after that, each mathematical method used to evaluate OR performance was tested to ensure validity.

A practical oriented mathematical model, namely the Operating Room Assessment Model (ORAM) was developed to analyse all the data that was sorted. This model comprises 18 equations for analysing the sorted data. By using ORAM to analyse this data, a new set of factors has been developed. These derived factors provide valuable data but are not sufficient to answer the research question; therefore there was a need to develop a new tool to evaluate the data in order to reach a better result. Accordingly, the second model called Operating Room Rings Model (ORRM) was developed. The new model is able to analyse the data to demonstrate and measure the performance of the Operating Room in the form of overlapping rings.

The above stages form the development process for an evidence based framework, namely the Operating Room Assessment Model (ORAM), which has been developed to evaluate the performance of Operating Rooms.

After validating this proposed framework using multiple types of surgical procedures with different lengths of time in different Operating Rooms located in different surgical suites, it has been found that the ORAF has proven its ability to perform satisfactorily, with accuracy, and consistent within the study's objectives in all the different situations that it has been applied to.

Accordingly, and based on the results provided above, it has been found that the ORAF is able to evaluate Operating Room performance to determine clearly the level of Operating Room planning and scheduling, types of Operating Room workload, and the level of Operating Room utilization.

8.3: The Research Objectives: the planned and what has been accomplished.

i. Compare and document various operating room management systems to be used as evidence of current operating room management systems practice.

A multi case study has been used to help the researcher to compare, examine and investigate the similarities, differences, strengths, weaknesses, advantages and disadvantages of each Operating Room Management System.

b. Intensively examine and investigate the similarities and differences between the Operating Room Management Systems within three renowned tertiary hospitals in three different countries on three different continents.

For the fieldwork phase, the participating hospitals have been divided into two groups: the first group includes three hospitals, for which the operating room management system has been studied in detail; including the regular stages of the surgical procedure, starting with the surgical clinic, up until the surgery is performed. In order to collect the largest amount of data, five other hospitals have been added to concentrate only on the relevant issues related to the performance evaluation of the operating room. Therefore, eight tertiary and teaching hospitals in three countries (Japan, Canada and Saudi Arabia) have been involved in this study.

c. Follow the regular procedure of the surgical patient in each hospital, from the surgical clinic up to performance of the surgery, to observe and document the process.

The data reports are from the three main hospitals involved in this study: Kameda Medical Center in Japan; Royal University Hospital in Canada, and King Faisal Specialist Hospital and Research Center in Saudi Arabia. The presentation of these reports will be according to the surgical patient flow within the surgical service. The reports are in the form of open-ended interview questions.

d. Investigate and analyse the details of each system via fieldwork involving semi-structured interviews conducted with key staff involved with surgical patient processes.

Interviews, observations and documentation are the main resources that have been used in order to gather information for this research during the fieldwork.

e. Gain access on the ground to the electronic or manual systems used to collect the surgical data, including how patient data is managed, what statistical method is used to evaluate Operating Room performance, and how exactly Operating Room performance is evaluated.

From the fieldwork, all the required data has been obtained from each hospital for a one year period, accompanied by the main statistical data from Operating Room records.

f. Analyse operating room statistical data, and examine the annual reports of a large number of hospitals at the same level.

The analysis of these reports and the main data has gone through a number of stages: first, hospitals were classified according to the measurement unit used (time or number of procedures) on their official reports; then all data referring to weekends or official holidays was excluded; the rest of the data was divided into two parts- procedures performed during the available time (budgeted time / staffed time), and the procedures performed out of the available time; then all of the terms used in the reports were recorded to find out exactly what is meant by these terms, and all the statistical factors used in these reports were identified.

g. Evaluate and validate the methods used for measuring the performance of the Operating Room in each hospital.

After that, each mathematical method used to evaluate OR performance was tested to ensure validity.

8.4: Contribution of the Thesis

The most important contribution from this research is an evidence based framework (ORAF) capable of comprehensively evaluating Operating Room performance. This framework is capable of determining clearly the Operating Room planning and scheduling levels, types of Operating Room workload, and the level of Operating Room utilization.

Also, this study has added new classifications for Operating Room assessment outcomes:

- The OR scheduling level has been classified into three new types of scheduling levels: under scheduling, ideal scheduling and over scheduling.
- The OR workload has been classified into five new types of OR workload: total OR workload (the gross workload); OR actual workload; over workload; unexpected workload; unnecessary workload.
- OR utilization has been classified into three new types: underutilization; ideal utilization, and 100% utilization with over workload.

This research has improved the important terms and definition used for evaluating Operating Room performance. In addition, the research has identified the primary statistical factors affecting the evaluation of Operating Rooms. These can be used in the future as a basis for the development of any other models related to Operating Room performance.

This study has developed a visualisation metaphor model, namely ORRM, which can be used as a dashboard to enable the reader to interpret and convey holistic information about the performance of the Operating Room quickly and easily; thereby creating a decision making tool for the operating room management team.

This study presents clear and complete guidelines, supported by illustrative figures and real-world examples, which can be used by operating room management to evaluate any type of Operating Room performance.

This thesis provides, in detail, a complete study of three international Surgical Operating Room Management Systems from well-established tertiary hospitals, which can be used as a reference for any hospital planning to start a new operating room service or just aiming to improve an existing one.

8.5: Study Limitations

Despite the efforts, planning, and the great support from the scholarship provider, this study has faced several difficulties due to the nature of the research, which has involved multiple case studies, including different hospitals in different countries on different continents. These difficulties are as follows:

- Operating Rooms are always busy and under constant work pressure, which formed a serious difficulty in finding a well established tertiary hospital that had the time and staff resources to participate in this research. This kept the study suspended from the start for a full year with regard to one of the hospitals.

- The reluctance of some hospitals to disclose information that would lead to assessing their level of performance, which disrupted the acceptance process of this research in some hospitals.

- The presence of long administrative processes, especially for ethical approval, halted the beginning of this research for a long time. This was the main reason that impeded the inclusion of British hospitals in this study.

- Since the case studies are located in different countries, there were a number of difficulties related to travel, transportation, expenses and residence. Obtaining a visa for Canada was a complex step that caused more difficulties in obtaining the data at the planned time.

- Language was one of the limitations in this research, particularly for the hospital in Japan, and especially during the interviews and concerning the content of the written data.

- The semi-structured interviews used in this research took a lot of time to complete during the interview process and data analysis. Also, the statistical data for eight hospitals for a period of a full year created the same difficulty in the analysis phase.

- This study concentrates only on non-profit hospitals that are paid for by the government or by national health insurance; no private or profit making hospitals have been included.

- All the hospitals that have participated in this study are tertiary or teaching hospitals, meaning they are all on one level, and the study does not include secondary or general hospitals that provide a different level of service.

- The study focuses only on planned elective procedures, which are scheduled for surgery during normal working days. This study excludes all procedures occurring on weekends or during official holidays.

8.6: Recommendations for Future Research

As discussed in the section above, there are limitations to this study, which have influenced some of the future research recommendations. These are elaborated below.

Applying ORFM to other hospitals in other countries with other healthcare systems is recommended in order to firm up the validity of this model with other systems. Also, it is recommended to apply the ORFM to different categories of hospital such as general and secondary hospitals, to verify its validity, since there are some differences between these categories.

The private sector focuses more on profit, and Operating Rooms provide hospitals with an essential source of income, therefore this model is highly recommended to be applied to private hospitals to discover whether there are any different interests with regard to this sector that are not covered by this model.

The Operating Room Assessment Framework (ORAM) is highly recommended to be applied to the hospitals that have participated in this study to measure the impact of this model compared to the current practice.

The researcher strongly encourages translating this model into a computer-based form to facilitate its application and use.

Lastly, the researcher has found through the result of this study that a good addition has been made to the field of Operating Room Management, which should be beneficial to Operating Room managers, directors or any other medical professionals to evaluate, monitor, and improve overall Operating Room efficiency.

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APPENDIX

Appendix 1 Ethical approval (Cardiff University)

Cardiff School of Engineering
Director of School Professor K M Holford BEng PhD CEng FIMechE CPhys MInstP
Research Office
Deputy Director of School-Research Professor P J Tasker BSc PhD

CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD

Cardiff University
Queen's Buildings
The Parade
Cardiff CF24 3AA
Wales UK

Tel +44(0)29 2087 0076
Fax +44(0)29 2087 4939
www.cardiff.ac.uk/engin/
Email ENGINResearch@cardiff.ac.uk

ETHICAL APPROVAL

Title of Project:	A Comparitive Study of Operating Room Management Systems
Researcher:	Mr Abdulkarim Al-Ojaimi
Supervisor:	Prof. Yacine Rezgui

The above application was considered by the members of the Cardiff School of Engineering Ethical Review Committee and was recommended to the School's Research Committee for approval.

After due consideration, the Research Committee agreed with the advice of the Ethical Approval Committee and officially approved the project at its meeting on 23rd March 2011.

If you have any queries regarding this approval please do not hesitate to contact Mrs Aderyn Reid, Research Support Administrator, on ext 74930 or e-mail reida@cf.ac.uk.

A. Reid

pp Professor PJ. Tasker
Chair – ENGIN Research Committee

23rd March 2011

Appendix 2. Ethical approval (Kameda Medical Center)

Kameda Medical Center

31st March 2010

Embassy of Japan in the U.K
101-104 Piccadilly
London
W1J 7JT

Dear Sir,

We are writing to you to confirm that we are pleased to accept Mr. Abdulkarim Al Ojaimi to carry out study at the Kameda Medical Centre, as part of his doctoral research on operating room management systems at Cardiff University.

The duration of his stay is to be for four weeks from the 10th of May until the 6th of June 2010. Mr. Al Ojaimi will be staying at the Kameda Medical Centre, and his accommodation expenses will be paid from his sponsor- the Cultural Bureau, Royal Embassy of Saudi Arabia, London. Our records contain the following personal information:

Name: Al Ojaimi, Abdulkarim Abdulmohsen D.

Address: 55 Milestone Close, Heath, Cardiff, UK, CF14 4NQ

Date of Birth: 20 Sept 1972

Place of Birth: Hail, Saudi Arabia

Nationality: Saudi

Passport No.: I631900

Issuing Authority: Hail, Saudi Arabia

Valid until: 15 July 2014

John C. Wocher M.H.A., FACHE
Executive Vice President Headquarters
Kameda Medical Centre

Appendix 3. Ethical approval (University of Saskatchewan)

UNIVERSITY OF SASKATCHEWAN

Research Ethics Office

Box 5000 RPO University
1607 – 110 Gymnasium Place
NRC/PBI Building
Saskatoon SK S7N 4J8 Canada
Telephone: (306) 966-2975
Facsimile: (306) 966-2069

To: **Yacine Rezgui, Institute of Medical Engineering, Cardiff University**
Abdulkarim Al-Ojaimi, Institute of Medical Engineering, Cardiff University
Nayyer Iqbal, Department Head Medical Oncology, Saskatoon Cancer Centre
Tahir Abbas, Department Head Medical Oncology, Saskatoon Cancer Centre

Date: July 20, 2011

Re: A Comparative Study of Operating Room Management Systems

Thank you for submitting the research ethics application for your project. This memorandum certifies that your project is exempt from the ethics review process. This exemption is based on the fact that human behavior is not the focus of your research and that the opinions solicited from participants are professional opinions as opposed to personal opinions. This decision is based on the information provided to the Research Ethics Office on July 18, 2011.

It should be noted that though your project is exempt of ethics review, your project should be conducted in an ethical manner (i.e. in accordance with the information that you submitted). It should also be noted that any deviation from the original methodology and/or research question should be brought to the attention of the Behavioral Research Ethics Board for further review.

Sincerely,

John Rigby

Dr. John Rigby, Chair
Behavioural Research Ethics Board
University of Saskatchewan

Appendix 4. Invitation letter (Royal University Hospital)

research
treatment
prevention
early detection

Saskatchewan Cancer Agency
A healthy population free from cancer

20 Campus Drive, Saskatoon, Saskatchewan Canada S7N 4H4
Telephone: (306) 655-2662 • Fax: (306) 655-2910

Embassy of Canada in Saudi Arabia
Riyadh
Saudi Arabia

Invitation Letter

To Whom It May Concern,
Dear Sir,
We are writing to you to confirm that we are pleased to accept Mr. Abdulkarim Al Ojaimi to carry out study at Royal University Hospital, University of Saskatchewan, Saskatoon, Canada, as part of his doctoral research on Operating Room Management Systems at Cardiff University, Cardiff, UK.
Dr. Tahir Abbas will act as direct local Principal Investigator (PI) for Mr. Al Ojaimi's research under my supervision.
The duration of this fieldwork will last from four weeks up to eight weeks started from second week of September 2011.
Mr. Al Ojaimi will be staying at 306 Guenter Crescent, Saskatoon, SK S7N 4P6. The study expenses will be paid from his sponsor the Cultural Bureau, Royal Embassy of Saudi Arabia, London.
Our records contain the following personal Information:
Address: 55 Milestone Close, Heath, Cardiff, UK, CF14 4NQ
Date of Birth: 20 September 1972
Place of Birth: Hail, Saudi Arabia
Nationality: Saudi
Passport No. I631900
Issuing Authority: Hail, Saudi Arabia
Valid until: 15 July 2014

Yours Sincerely,

Dr. Nayyer Iqbal
Head Medical Oncology
Saskatoon Cancer Centre

Appendix 5. Invitation letter (King Faisal Specialist Hospital and Research Center)

مستشفى الملك فيصل التخصصي ومركز الأبحاث
King Faisal Specialist Hospital & Research Centre
Gen. Org. مؤسسة عامة

Invitation Letter

27 September 2011

To Whom It May Concern:

Dear Sir,

We are writing to you to confirm that we are pleased to accept Mr. Abdulkarim Al-Ojaimi to carry out study at King Faisal Specialist Hospital and Research Centre, Riyadh, Saudi Arabia, as part of his doctoral research on Operating Room Management Systems at Cardiff University, Cardiff, UK.

Mr. Al-Ojaimi's research will follow the regular procedure of the surgical patient, starting from the surgical clinic up until the surgery is performed, this will involve a series of interviews, observation, access to documentation and statistical information relating to Operating Room under my supervision.

The anticipated duration of this fieldwork will last from two months up to three months.

Please do not hesitate to contact me should you require any further information.

Yours Sincerely,

Nezar Khalifah, MD
Medical Director, Operating Room Management
Consultant, Neuro-Anesthesiologist
King Faisal Specialist Hospital & Research Center
PO Box 3354, Riyadh 11211, KSA
Phone 966 1 464 7272 ext 31082
Fax: ext 35060

ص.ب: ٣٣٥٤ الرياض ١١٢١١ المملكة العربية السعودية . هاتف: ٤٦٤٧٢٧٢ . فاكس: ٤٤١٤٨٣٩
P.O Box: 3354 Riyadh 11211 Kingdom of Saudi Arabia . Tel: 4647272 . Fax: 4414839 . www.kfshrc.edu.sa

Form 11100-02 (Rev. 09-27) I.C. 202040

Appendix 6. Ethical approval (King Fahad Medical City)

Kingdom of Saudi Arabia
Ministry of Health
King Fahad Medical City

المملكة العربية السعودية
وزارة الصحة
مدينة الملك فهد الطبية

March 19th 2012
ERRC Number: 12-015

Dear Mr. Abdulkarim Abdulmohsen Al-Ojaimi,

It is my pleasure to inform you that the External Research Review Committee, a subcommittee of the Institutional Review Board, has approved your study titled: "**A Comparative study of Operating Room Management Systems**".

Please be informed that in conducting this study, you as the Principal Investigator are required to abide by the rules and regulations of the Government of Saudi Arabia and KFMC/ERRC. The approval of this proposal will automatically be suspended on **March 19th 2013** pending the reapplication to renew the approval. You also need to notify the ERRC as soon as possible in the case of:

1. Any amendments to the project;
2. Termination of the study.

Please observe the following:

1. Personal identifying data should only be collected when necessary for research;
2. The data collected should only be used for this proposal;
3. Data should be stored securely so that only a few authorized users are permitted access to the database;
4. Secondary disclosure of personal identifiable data is not allowed.

We wish you every success in your research endeavor.

Sincerely,

Dr. Mohamad AlTannir
Head of External Research Review Committee
Institutional Review Board
King Fahad Medical City
Riyadh, KSA

الرقم: ....
التاريخ: ....
المرفقات: ....

Appendix 7. Information Sheet (page 1)

Cardiff School of Engineering

The Institute of Medical Engineering

And Medical Physics

Cardiff University

CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD

Cardiff University

Queen's Buildings

The Parade

Newport Road

CF14 3AA

INFORMATION SHEET

(A Comparative study of Operating Room Management Systems)

PhD Research

We would like to invite you to consider whether you would like to take part in a research study.

Before deciding you need to understand why the research is being done and what it would involve for you. Please take time to read the following information carefully and discuss it with others if you wish.

Part 1 of this information sheet explains the purpose of this study and what will happen if you take part.

Part 2 gives you more detailed information about the conducting of the study.

Please ask us if there is anything that is not clear, or if you would like more information.

1

Version 1 20/06/2011

Information Sheet (page 2)

PART 1

What is the reason for the study?

Cancellations and delays of surgical procedures are common occurrences throughout the world. This results in wastage of operating room time; extends the period of hospitalisation for patients and causes inconvenience to patients and their families. Also, this leads to increases in Operating Room costs and decreases in overall efficiency.

The majority of Operating Room management systems differ in some aspects from one hospital to another. Each system depends on the needs of the individual hospital, and the experience available, targeted towards achieving the best performance in the Operating Room.

The specific aim of this comparative study is to discover and understand the different methods, systems and efforts used by different well renowned tertiary hospitals in different countries in order to reduce same day cancellations of surgical procedures in the Operating Room. The information and knowledge that will emerge from this study shall serve as key contributing factors that will critically determine the strengths, weaknesses, advantages and disadvantages of each system, in order to create a management model for the Operating Room supported by the strengths and avoiding the weaknesses discovered; also, it contains an evaluation model to measure Operating Room performance. There is also the possibility that this study will have an effect on any hospital which plans to start a new operating room service or is just aiming to improve it.

Why I have been chosen to take part in this study?

You have been invited to participate in the study as we are interviewing the staff involved with surgical patients and surgical operation processes. The interview aims to gain an understanding of the processes and practices used in each service area related to surgical patients within the hospital as part of this study.

Do I have to take part?

No, it is up to you to decide. We will describe the study and go through the information sheet with you. We will then provide the information sheet to you and ask you to sign a consent form to show that you have agreed that you are willing to take part in the study. You are free to withdraw at any time, without giving any reason.

2

Version 1 20/06/2011

Information Sheet (page 3)

What will happen if I take part in this study?

A one hour to one hour and a half meeting will be arranged with you, and a semi-structured interview will be conducted during this meeting to answer questions related to your service or department in order to understand the normal processes and practices used for surgical patients; the answers will be paraphrased to suit academic writing. This meeting will be audio recorded and this will be used for research and educational purposes only.

What are the possible benefits from taking part?

We do not expect any specific benefits for the individuals taking part; however, the information we gather from this study will help to improve the performance of the Operating Room and to reduce same day cancellations and delays in surgical procedures.

Is there any risk associated with the study?

No risks are anticipated.

What if there is a problem?

Any complaint about the way you have been dealt with during the study or any possible harm you might suffer will be addressed; detailed information is given in part 2.

What happens when the research study stops?

As soon as the interview has been completed, your participation in the study will finish. After this time you will still be free to contact the researcher with any questions or queries you may have regarding the study.

CONFIDENTIALITY

Will participation in this study be kept confidential?

Yes. We will follow ethical and legal practice and all information about you, will be handled in confidence. The details are included in Part 2.

If the information in Part 1 has interested you and you are considering participation, please read the additional information in Part 2 before making any decision.

Information Sheet (page 4)

PART 2

What will happen if I don't want to carry on with the study?

If you withdraw from the study, we will destroy all your identifiable information, but we would like to use the data collected up to your withdrawal. You are free to withdraw from the study at any time.

What if there is a problem?

It is unlikely that there will be a problem but if you are harmed by taking part in this research study, there are no special compensation arrangements. If you are harmed due to someone's negligence, then you may have grounds for legal action, but you may have to pay for it. Regardless of this, if you wish to complain, or have any concerns about any aspect of the way you have been approached or treated during the interview, the normal National Health Service and University complaints procedures will be available to you.

Confidentiality-

Will participation in this study be kept confidential?

All information which is collected about you and your department, section or division during the course of the research will be kept strictly confidential, and any information about you and your department, section or division which leaves the University will have all identifiable information removed so that they cannot be recognised.

What happens to the results of the research study?

The results of this study may be presented at conferences and published in scientific journals. If you would like, a summary of the results can be sent to you after completion of the study.

Who is organising the study?

The study is being organised by the Institute of Medical Engineering, Cardiff School of Engineering, Cardiff University. The study will be run by the main researcher Abdulkarim Al-Ojaimi in collaboration with Professor Yacine Rezgui and Dr Haijiang Li.

Information Sheet (page 5)

Who has reviewed the study?

This study has been reviewed by Cardiff School of Engineering Ethical Review Committee, Cardiff University (approved on 23/03/2011).

CONTACT FOR FURTHER INFORMATION

If you would like to discuss any part of the project in greater detail then please do not hesitate to contact Abdulkarim Al-Ojaimi at:

The Institute of Medical Engineering
And Medical Physics
Cardiff School of Engineering
Cardiff University
Cardiff, UK
CF24 3AA
Tel: +44 (0) 29 2087 9079
Email: alojaimi@cardiff.ac.uk

Thank you for your time and consideration

Abdulkarim Al-Ojaimi

Dip, AAs, BA (Hons), BSc (Hons), MSc.

5

Version 1 20/06/2011

Appendix 8. Consent Form

Cardiff School of Engineering

The Institute of Medical Engineering
And Medical Physics
Cardiff University

CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD

Cardiff University
Queen's Buildings
The Parade
Newport Road
CF14 3AA

CONSENT FORM

Title of study: **(A Comparative study of Operating Room Management Systems)**

Name of Researcher: Abdulkarim Al-Ojaimi

Please Initial Box

I confirm that I have read and understood the information sheet, version 1 dated 10.06.2011 for the above study and have had the opportunity to consider the information, ask questions and to have had these questions answered satisfactorily.	☐
I understand that I will receive no compensation for my consent to participate in this study	☐
I understand that I am free to withdraw at anytime without giving any reason.	☐
I am willing for the interview to be audio recorded and I understand that the audio recording will be used for research and educational purposes only	☐
I understand that the audio recorded will be used anonymously.	☐
I understand that all information obtained including the audio recording will remain the property of the researchers.	☐
I understand that all information about me will be kept in a confidential way	☐
I understand that use of the recordings may include, but not necessarily be limited to, the following: - A direct quote will be used for research purposes including the final research report, presentations and other academic publications	☐
I agree to take part in this study.	☐

Name of interviewee ________________________ Date ________

Signature ________________________

Name of Witness (Researcher) ________________________ Date ________

Signature ________________________

When completed, 1 Copy for interviewee, 1 Copy for researcher site file

Version 1 15/06/2011

Appendix 9. The guideline to interviews

THE GUIDELINE TO INTERVIEWS

(A Comparative Study of Operating Room Management Systems)

PhD research

Abdulkarim Al-Ojaimi
PhD Student
Supervisor: Prof. Yacine Rezgui
Co-Supervisor: Dr. Haijiang Li

School of Engineering
Medical and Physical Engineering
Cardiff University
Cardiff, UK

INTRODUCTION

Cancellations and delays of surgical procedures are common occurrences throughout the world. There have been many articles that show that this results in wastage of operating room time; extends the period of hospitalisation for patients, and causes inconvenience to patients and their families. Also, this leads to increases in Operating Room costs, and decreases in overall efficiency.

By conducting a thorough survey, it is likely to be discovered that the majority of Operating Room management systems differ in some aspects from one hospital to another. Each system depends on the needs of the individual hospital and the experience available. It can also be witnessed that operating room management systems not only differ between countries, but also between hospitals in the same city or town as well.

The specific aim of this comparative study is to discover and understand the different methods, systems and efforts used by different hospitals in different countries, in order to reduce the numbers of cancellations of surgical procedures in the Operating Room, and also to measure their success.

These interview guidelines, which include open-ended questions, will be conducted with staff involved in the admission and operating processes of surgical patients, and it aims to gather information through semi-structured interviews which will provide an accurate understanding of the management procedures implemented during the surgical patient flow at each hospital area in this study. The research will follow the regular procedure of the surgical patient -according to the hospital structure- starting from the surgical clinic up until the surgery is performed.

In this study, no patients will be involved in the interviews, and no confidential patient data will be collected.

Hospital Information

Hospital Name: …………………………………………………………………

Supervisor Name: …………………………………………………………………

City: ………………………………………………………………..

Country: ………………………………………………………………..

1– THE SURGICAL CLINIC

Name: ____

Occupation: ____

Name of this unit at this Hospital:___________________________

A. Inputs

- Which positions comprise the staff at the clinic?
- What are the equipment and facilities available in the clinic?
- What are the types of forms used by the clinic staff?
- Does the clinic use an electronic information system? If yes, what is this electronic system?

B. Processes

- How does the patient reach the surgical clinic?
- How does the surgeon know about the patients' medical history?
- What are the necessary steps or procedures required to be carried out by surgeons in the surgical clinic in order to make the surgery decision?
- Is it important to inform the patient of these procedures?
- What does the surgeon do should he or she need a further medical consultation?
- How is the patient transferred to another clinic if there is a need for medical consultation, lab work or x-ray?
- Is there the requirement for a surgical consent form? Who signs it?
- Is a consent form necessary to be signed in the surgical clinic?
- Are there any other forms which the patient has to sign in the clinic? If yes, what are these forms?
- What is the role of the nurse in the surgical clinic?
- Who assists the patient should he or she need help?
- After following all these procedures, where does the patient go after surgical clinic and before hospital admission?

C. Notes:

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2-THE PRE-ANAESTHESIA CLINIC

Name: ____

Occupation: ____

Name of this unit at this Hospital: ____________________________

A. Inputs

- Which positions comprise the staff of the Pre-Anaesthesia Clinic?
- What are the types of equipment and facilities available in the Pre-Anaesthesia Clinic?
- What are the types of forms used by staff in the Pre-Anaesthesia Clinic?
- Does the clinic use an electronic information system? If yes, what is this electronic system?
- Does the Pre-Anaesthesia Clinic have a sample collection laboratory, ECG lab, X-Ray?

B. Processes

- How does the patient reach the Pre-Anaesthesia Clinic?
- Who receives the patient at the Pre-Anaesthesia Clinic?
- Who examines the patient at the Pre-Anaesthesia Clinic- an Anaesthesiologist or Nurse?
- How does the Anaesthesiologist/Nurse know about the patients' medical history?
- What are the necessary steps or procedures required to be carried out by the Anaesthesiologist/Nurse in the Pre-Anaesthesia Clinic?
- What type of examination will be performed on the patient at the Pre-Anaesthesia Clinic?
- What does the Anaesthesiologist/Nurse do should he or she need any other medical consultation?
- How is the patient transferred to another clinic if there is a need for medical consultation, lab work or x-ray?
- In critical cases, where chronic diseases are involved, what does the Pre-Anaesthesia Clinic do with the patient?
- Is there a follow-up appointment with the Pre-Anaesthesia Clinic with the patient until he or she is ready for surgery?

- How many congenital or critical diseases are discovered in the Pre-Anaesthesia Clinic every week?
- How many surgical cases are seen by the Pre-Anaesthesia Clinic?
- If the patient is found to be medically fit, where does the Pre-Anaesthesia Clinic send the patient?

C. Notes:

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3- THE CASE MANAGEMENT / COORDINATOR

Name: ____

Occupation: ____

Name of this unit at this Hospital: ______________________________

- Is there a case manager or coordinator for each surgical department of the hospital?
- What are the roles of each case manager or coordinator?

A. Inputs

- Who are the people involved in case management?
- What are the types of forms required in this department?
- Does the case manager/coordinator use electronic information systems?

B. Processes

- From whom does the case manager/coordinator receive the surgical case?
- What are the responsibilities of the case manager/coordinator?
- What are the sets of information provided by the surgeon/nurse to the case manager/coordinator?
- What is the duty of the case manager/coordinator to be able to determine the exact date of the surgery for the patient?
- Is it possible for the patient to choose the date of his or her surgery?
- After determining the scheduled date, what does the case manager/coordinator do?
- In case of changes to the surgical date, what does the case manager/coordinator do?
- What is the responsibility of the case manager/coordinator should the scheduled case be cancelled?
- Is the case manager/coordinator the only person in contact with the patient?
- Should the case manager/coordinator keep a slot free in the surgical schedule for emergency cases?

C. Notes:

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4- ADMISSION OFFICE

Name: ____
Occupation: ______________________________________
Name of this unit at this Hospital: __________________________

A. Inputs

- Which positions comprise the staff of the Admissions Office?
- What are the equipment and facilities available in the Admissions Office?
- What are the types of forms used by staff at the Admissions Office?
- Other than these forms, does the clinic use an electronic information system? If yes, what is this electronic system?

B. Processes

- Who informs the Admissions Office of ongoing surgical cases?
- What is the role of the Admissions Office in this hospital?
- Does the Admissions Office receive a schedule list from the Operating Room? At what time?
- Who receives the patient during the admission date?
- What are the kinds of information given to the patient during admission?
- Is there a general hospital consent form? Who signs it?
- What are the other types of forms that need to be signed? Who signs them?
- After the patient has received all these things, how is the patient transferred to the surgical ward?

C. Notes:

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5- OPERATING ROOM BOOKING / SCHEDULING

Name: ______________________________

Occupation: ______________________________

Name of this unit at this Hospital: ______________________________

A. Inputs

- Which positions comprise the staff of the booking/scheduling section?
- What equipment is available in the booking/scheduling section?
- What are the types of forms used by booking/scheduling section staff?
- Does the booking/scheduling section use an electronic information system? If yes, what is this electronic system?

B. Processes

- Who fills up the booking request?
- What is the information required in the booking request?
- Can submission be done online or through an information system? If yes, how?
- If it is a paper sheet, who signs and stamps the booking request?
- To whom is the booking request submitted?
- How is it submitted? What time?
- What is the role of the booking nurse/clerk?
- Do the staff use an electronic information system to support surgical case booking?
- How many hours are used to schedule cases from the daily working hours?
- Do you schedule turnover time between the cases
- What time is the surgical list posted in the Operating Room and distributed?

C. Notes:

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6- SURGICAL WARD

Name: ____

Occupation: ____

Name of this unit at this Hospital: ______________________________

A. Inputs

- Which positions comprise the staff of the Surgical Ward?
- What is the equipment available on the Surgical Ward?
- What types of forms are used by staff on the Surgical Ward?
- Does the Surgical Ward use an electronic information system? If yes, what is this electronic system?

B. Processes

- How does the surgical ward know about the need for surgical beds?
- Who is responsible for managing the bed bookings on the surgical ward?
- What are the responsibilities of the head nurse on the Surgical Ward?
- When does the Surgical Ward receive the Operating Room list?
- How does the Surgical Ward address the problem of bed shortage?
- Who informs the surgical ward when the patient is ready for admission?
- Who accompanies the patient to the Surgical Ward?
- Who receives the patient at the surgical ward?
- Upon admission to the surgical ward, what is checked from the patient?
- What is the duty of the nurse on the surgical ward?
- Does the anaesthesiologist visit the patient on the surgical ward?
- Does the surgeon visit the patient prior to surgery?
- Is the site of surgery marked at the surgical ward? Who does it?
- Who briefs the patient about the surgery and after-surgery care?
- How does the surgical ward know when the Operating Room is ready to receive the patient?
- Is there any premedication given to the patient on the surgical ward before the patient is transferred to the Operating Room?
- How is the patient transferred to the Operating Room? Who accompanies the patient?

7- INTRA-OPERATIVE

Name: ______________________________

Occupation: ______________________________

Name of this unit at this Hospital: ______________________________

A. Inputs

- Which positions comprise the staff of the Intra-Operative?
- What are the types of forms used in Intra-Operative?
- Do the Intra-Operative staff use an electronic information system? If yes, what is this system?

B. Processes

- What is the capacity of the Operating Room in this hospital?
- How many surgeons and anaesthesiologists work in these surgical sections?
- How many cases are carried out in this hospital annually?
- What is the approximate number of hours taken to perform these procedures?
- Who calls for the patient when the Operating Room is ready?
- To measure the performance of Operating Room, Do you depend on the number of cases done or the number of hours used?
- What is the actual average turnover time between the procedures?
- Do any scheduled cases remain unfinished at the end of the official working hours?
- Do you have a daily waiting surgical cases not in scheduling plan?
- Upon entrance to the Operating Room, what process does the patient have to go through?
- What is done by the surgical staff before the surgical insertion to avoid the wrong surgery?
- What is the information entered into the electronic system?
- After the surgery, what happens next?
- After all these procedures, where is the patient brought?

Notes:..

....

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Appendix 10. Statistical Information Sheet

Statistical Information Sheet

What is the number of beds at this hospital?	
What is the number of consultants?	
What is the number of consultant surgeons?	
What is the number of Anaesthesiologist consultants?	
What are the duties and numbers of staff within the surgical operating room?	
What is the total number of surgical admissions per year?	
How many Operating Rooms do you have?	
What is the total number of surgical cases performed each year?	
What is the total number of surgical cases scheduled for surgery, whether done or cancelled, per year?	
How many surgical cases are performed each year as admission cases?	
How many day surgery cases are done per year?	
What are the types of surgical cases carried out at this hospital?	
What is the number of each type done per year?	
What is the number of surgical cases performed each year according to ASA classifications?	
What is the total number of surgical cases per year cancelled on the same day as surgery?	
What are the main reasons for same day cancellations?	
What is the percentage of cancellations for each reason?	
How many cases are cancelled by an anaesthesiologist per year?	
How many cases are cancelled because of patient no show per year?	
What is the number of delayed cases per year?	
What is the average turnover time between surgical cases?	
What is the length of the average of the waiting list for each surgical speciality?	
Do you have a daily surgical waiting list?	
How many wrong site surgeries are recorded in this hospital every year?	