A COMPREHENSIVE MODEL FOR MEASURING HEALTH CARE PROCESS QUALITY:HEALTH CARE PROCESS QUALITY MEASUREMENT MODEL (HPQMM)

A THESIS SUBMITTED TO

THE GRADUATE SCHOOL OF INFORMATICS

OF

THE MIDDLE EAST TECHNICAL UNIVERSITY

BY

ÖZKAN YILDIZ

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN

THE DEPARTMENT OF MEDICAL INFORMATICS

MAY 2012

A COMPREHENSIVE MODEL FOR MEASURING HEALTH CARE PROCESS QUALITY: HEALTH CARE PROCESS QUALITY MEASUREMENT MODEL (HPQMM)

Submitted by **ÖZKAN YILDIZ** in partial fulfillment of the requirements for the degree of **Doctor of Philosophy in Medical Informatics, Middle East Technical University** by,

Prof. Dr. Nazife BAYKAL _____
Director, **Informatics Institute**

Assist. Prof. Dr. Yeşim AYDIN SON _____
Head of the Department, **Medical Informatics**

Prof. Dr. Onur DEMİRÖRS _____
Supervisor, **Information Systems, METU**

Examining Committee Members:

Prof. Dr. Osman SAKA _____
Biostatistics and Medical Informatics, AU

Prof. Dr. Onur DEMİRÖRS _____
Information Systems, METU

Prof. Dr. Semih BİLGEN _____
Electrical and Electronic Engineering, METU

Assoc. Prof. Dr. Altan KOÇYİĞİT _____
Information Systems, METU

Assoc. Prof. Dr.Ünal Erkan MUMCUOĞLU _____
Information Systems, METU

Date: 03 May 2012

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name and Surname: **Özkan Yıldız**

Signature: _____

ABSTRACT

A COMPREHENSIVE MODEL FOR MEASURING HEALTH CARE PROCESS QUALITY: HEALTH CARE PROCESS QUALITY MEASUREMENT MODEL (HPQMM)

Yıldız, Özkan
Ph.D., Department of Medical Informatics
Supervisor: Assoc. Prof. Dr. Onur Demirörs

May 2012, 152 pages

Similar to the manufacturing sector, process improvement gains much attention in health care sector. Measuring process quality is one of the most important components of process improvement and numerous healthcare quality indicator models are developed to achieve this aim. Existing quality models focus on some specific diseases, clinics or clinical areas. Although they contain structure, process, or output type measures, there is no model which measures the quality of health care processes comprehensively. As a result, hospitals cannot compare quality of processes internally and externally. To bring a solution to the above problems, we developed Health Care Process Quality Measurement Model (HPQMM), and it is applied in three public hospital's laboratory and assessment processes. We observed that, the developed model determines weak and strong aspects of the processes, gives a detailed picture for the process quality, extends the quality aspects of existing models, and provides quantifiable information to hospitals to compare their processes with multiple organizations.

Keywords. ISO/IEC 9126, ISO/IEC 25000, JCIAS, Health Care Process Quality, Measurement

ÖZ

SAĞLIK SÜREÇ KALİTESİ ÖLÇÜMÜ İÇİN KAPSAMLI BİR MODEL: SAĞLIK SÜREÇ KALİTE ÖLÇÜM MODELİ (SSKÖM)

Yıldız, Özkan
Doktora, Tıp Bilişimi Bölümü
Tez Yöneticisi: Doç.Dr. Onur Demirörs

Mayıs 2012, 152 sayfa

Süreç iyileştirme, üretim sektöründe olduğu gibi sağlık sektöründe de büyük önem kazanmaktadır. Süreç kalitesinin ölçülmesi, süreç iyileştirmenin en önemli bileşenlerinden biridir ve bu amaçla birçok sağlık kalite gösterge modelleri geliştirilmiştir. Mevcut kalite modelleri, yapısal, süreç ve çıktı türü metrikler içermesine rağmen, sadece bazı spesifik hastalıklar, klinik veya kliniksel alanlara odaklanmakta olup, sağlık süreçlerini tümüyle ölçen bir model bulunmamaktadır. Ayrıca, süreçlerin tüm yönleriyle ölçülememesi nedeniyle hastaneler hastane içi ve hastane dışı süreç kalitesi karşılaştırması yapamamaktadırlar. Bu sorunlara çözüm bulmak amacıyla Sağlık Bakım Süreç Kalitesi Ölçüm Modeli (HPQMM) geliştirilmiş ve 3 kamu hastanesinin laboratuvar ve muayene süreçlerine uygulanmıştır. Ölçümler sonucunda, yeni geliştirilen modelin süreçlerin güçlü ve zayıf yönlerini belirleyen, süreç kalitesi için daha detaylı bilgi veren, mevcut modellerden daha geniş kalite değerlendirme perspektifi sağlayan ve süreç karşılaştırma için hastanelere ölçülebilir bilgi sağlayan bir model olduğu tespit edilmiştir.

Anahtar kelimeler: ISO/IEC 9126, ISO/IEC 25000, JCIAS, Sağlık Süreç Kalitesi, Ölçüm.

To my son, UTKU

ACKNOWLEDGEMENTS

I would like to express my most sincere appreciation to;

My supervisor Prof. Dr. Onur DEMİRÖRS; for his guidance, his precious support, his creative comments, and his very valuable friendship.

I would also like to thank Prof. Dr. Osman SAKA and Assoc. Prof. Dr. Altan KOÇYİĞİT for their valuable suggestions. I also thank to Prof. Dr. Semih BİLGEN and Assoc. Prof. Dr. Erkan MUMCUOĞLU for reviewing my work.

I would like to express my deepest gratitude to my mother and my father for their unconditional support during my life. Finally, I would also to thank my wife, "Berrin" and my son, "Utku" for their continuous patience and understanding.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

A	:	Accuracy
AC	:	Access controllability
ACHS	:	The Australian council on healthcare standards
AIR	:	Attractiveness indicator record
AR	:	Acceptance ratio
ED	:	Effectiveness of documentation
EIR	:	Efficiency indicator record
FA	:	Functional adequacy
FC	:	Functional completeness
FR	:	Fault ratio
HCQI	:	Health care quality indicators project
HIS	:	Hospital information system
HPQMM	:	Health care process quality measurement model
IO	:	Interoperability
IQIP	:	The international quality indicator project
JCAHO	:	Joint commission on accreditation of health care organizations
JCIAS	:	Joint commission international accreditation standards for hospitals
JEM	:	JCIAS evaluation matrix
LIS	:	Laboratory information system
MD	:	Measurement details
MHAQI	:	Maryland hospital association quality indicator project
MR	:	Measurement result
MU	:	Machine utilization
NA	:	Not available
NHQR	:	National healthcare quality report
OA	:	Operation audibility
PA	:	Physical accessibility

PD	:	Problems document
PEM	:	Process evaluation matrix
PS	:	Patient satisfaction
PSQ	:	Patient satisfaction questionnaire
R	:	Restorability
RT	:	Response time
SD	:	Sufficiency of documentation
SL	:	Staff adequacy level
SR	:	Staffing ratio
SS	:	User/Staff satisfaction
SSQ	:	Staff satisfaction questionnaire
UKQIP	:	United Kingdom quality indicator project
VR	:	Validation record

CHAPTER 1

INTRODUCTION

This chapter is divided into six sections. The first section explains the need for a health care process quality measurement; the second section gives the objectives of the proposed model; the third section presents the structure of the model for measuring the health care process quality; the next section describes the applications of the model; the fifth section explains the method employed for validating the model and finally the last section gives the outline of the thesis.

1.1 The Need for Health Care Process Quality Measurement

The nature of the services and the competitive demand makes quality the most prevalent improvement area for health care providers. Health care quality indicator models provide quantifiable information on the performance of the specific organization as well as enables comparison of multiple organizations. The OECD's Health Care Quality Indicators Project (HCQI) [1], Maryland Hospital Association's The International Quality Indicator Project (IQIP) [2], and Joint Commission on Accreditation of Health Care Organizations (JCAHO) indicators [3] are the three most popular models. Moreover, England, Taiwan, India, Denmark, and Poland [4-8] are the other countries which implement health care quality indicator projects. Existing quality indicator models contain structure, process, or output type measures [9]. These models and most of the quality indicator applications focus on performance measures [10,11,12] and efficiency [13]; most of the others focus on clinical indicators or specific areas such as radical prostatectomy procedures [14]; or diseases [15]. But, there is a critical lack of a model that covers all the processes of a

health care organization. As a result of the diversion each hospital selects different sets of quality indicators and consolidating and processing measurement data becomes difficult. Furthermore, as all process areas are not measured by similar process indicators, it is difficult to benchmark hospital processes internally and externally.

The need to measure health care processes comprehensively in different quality perspectives encouraged us to develop Health Care Process Quality Measurement Model (HPQMM). For building this model analogy between process and software [16] is used. They both have similar logical structures. The structure of the process with its inputs, activities and outputs is similar to that of the software with its input parameters, functions and output parameters. The relation between software and function exists between process and activity. Although, there are some differences like, process is executed by an agent, and software is executed by CPU, and there is no need to tell each detail of activity to agent, but it is a necessity for CPU, we still believe that Software Quality Indicators-ISO/IEC 9126 [17] also can be used for assessing health care processes.

1.2 The Health Care Quality Measurement Model

Objectives of developing the HPQMM can be summarized as:

Existing quality models utilize specific diseases, clinics, or clinical areas. In other words although these studies demonstrate the value of quality measurement, they show that there is a lack of a comprehensive model that enable measuring the quality across all health care processes. The HPQMM identifies a set of measures that can be utilized for all health care processes.

Another aim is to provide a model that extends the quality aspects of existing models and give a wider and more detailed picture for the quality of the process. The model evaluates the process from different perspectives such as: completeness, adequacy, accuracy, reliability, efficiency, and these perspectives give more detailed quantitative information about the process quality.

Lastly, we intend to form a model which provides hospitals to establish a quality baseline to compare their processes and process improvement results internally and benchmark with other hospitals.

To be able to identify a set of measures that can be utilized for all healthcare processes as a continuous source of guidance, we have adopted the ISO/IEC 9126 software quality standard for healthcare processes. ISO/IEC 9126 and ISO/IEC 25000 [18] are widely used standards for measuring quality of the software products. ISO/IEC 9126 categorizes internal and external software quality characteristics into six major areas: functionality, reliability, usability, efficiency, maintainability, and portability. The major characteristics are further sub-divided into sub-characteristics and for each sub-characteristic a set of measures are defined.

The HPQMM includes functionality, reliability, usability and efficiency characteristics. Other quality characteristics of ISO/IEC 9126, such as maintainability and portability were evaluated as software specific characteristics and were not included in the model. Each quality characteristic is determined with a number of measures. These measures are evaluated by analyzing ISO/IEC 9126's measures, selecting appropriate ones for health care domain, and redefining according to health care processes. The resultant eighteen quality measures of the HPQMM are given in Figure 1.1.

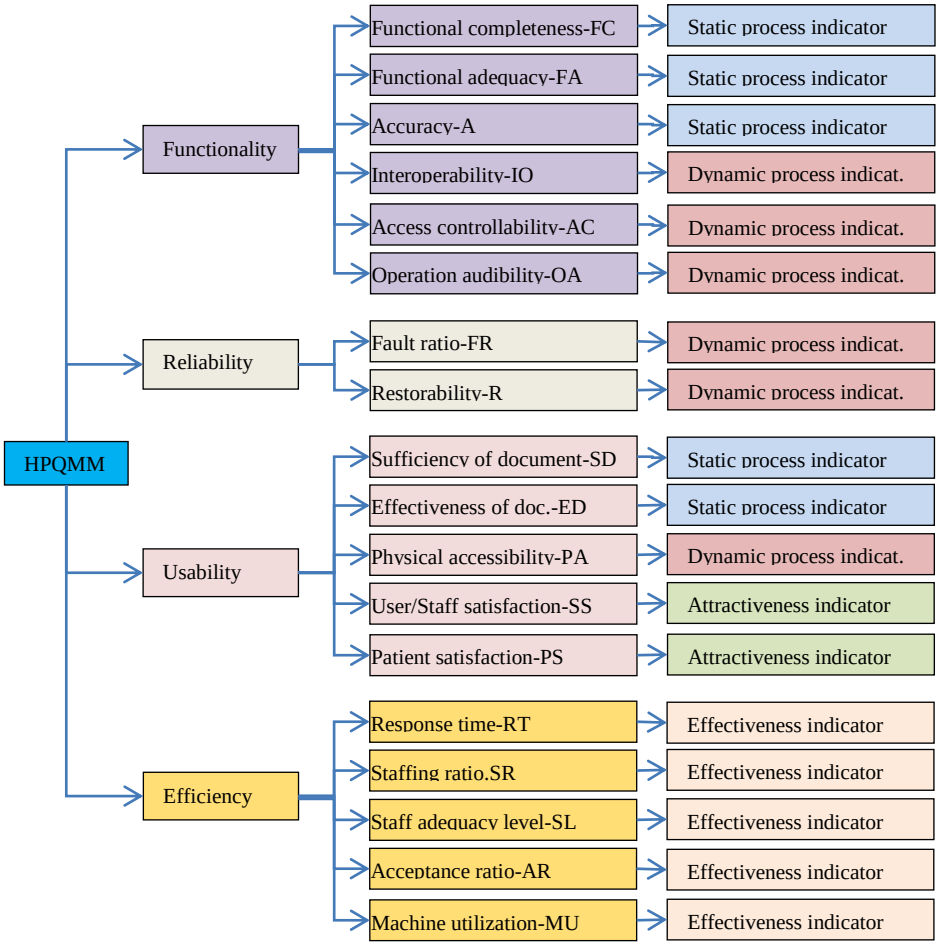

Figure 1.1 HPQMM Quality Measures

The quality measures are divided into four groups according to their types. These groups are dynamic process indicators (process execution related measures), static process indicators (functional suitability and documentation related measures), attractiveness indicators (patient and staff satisfaction questionnaires), and effectiveness indicators.

To determine quality measures of the HPQMM, firstly, ISO/IEC 9126 based Güceğlioğlu's model [19,20] was applied to laboratory processes of a public hospital. At the end of this application it was seen that some of the quality measures such as complexity, coupling, IT density, and input validity etc. were not appropriate for health care processes and there was a need for defining new measures appropriate to health care domain. After defining the HPQMM quality measures, for the refinement

of the model an exploratory case study was performed at the Entry to Care, Treatment, and Services process of the same public hospital [21]. After that, Joint Commission International Accreditation Standards for Hospitals (JCIAS) [22] measurable elements were added to model scope for unifying functional and documentation requirements. Then, to see the applicability of the model we applied the HPQMM to the laboratory and assessment processes of two hospitals in Ankara and one in Antalya.

Case study research method was used for investigating applicability and validity of the model. The case study design was described with research questions, data collection and data analysis methods. The validity of the model was investigated with two rounds of studies. In the first round, to validate the model, the respondents were asked whether the measures identify opportunities for improvement; give more detailed information about the process quality; and give contribution to the JCIAS assessment. Each attribute was measured on a 5-point scale of which 5 indicates “excellent”, 4 “very good”, 3 “good”, 2 “not good” and 1“useless”. In the second round, respondents were asked to rate the each measure on a 5-point scale. Measures which had a median value less than 3 were assumed to be invalid measures.

The case study results were also discussed with the participators at the end of the study. The results, weak and strong aspects identified by the participators and the model were compared and validity of model was investigated by open ended interviews.

1.3 Thesis Outline

The remainder of the thesis is organized as follows. Chapter 2 provides the result of a systematic review that is performed to review the literature for specifying health care quality indicator models in a concept of indicating development processes, validation studies, limitations, and scope.

Chapter 3 describes the details of the HPQMM model, where model objectives and model structure are given firstly. Then, application procedure of the model is presented. Lastly, details (description, formula, inputs etc.) of each measure are provided.

Chapter 4 gives the details of the case study design. It describes the research questions, data collection and analysis methods. Measurement results of laboratory and assessment processes are provided. Analyses of the measurement results are carried out, strong aspects, weak aspects, close to weak aspects, and pros-cons of processes are discussed. Validation of the model studies are given lastly.

In Chapter 5, firstly, contributions of the model are provided, then the models' and the applications' limitations are discussed. Lastly future study with the model is given.

CHAPTER 2

LITERATURE REVIEW

This chapter provides the results of a systematic review that is performed to review the literature for specifying health care quality indicator models in a concept of indicating development processes, validation studies, limitations, and scope.

2.1 Data Source

The systematic literature search was conducted in the Medline [23] and Oxford [24] databases for the period from January 1995 to April 2009. Medline is the bibliographic database, covering: medicine, nursing, dentistry, veterinary medicine, and pre-clinical sciences. It contains over 17 million references to journal articles, including reviews and clinical trials. Medline is gathered from 4,600 biomedical journals published in the United States and 70 other countries. The second source Oxford Journals publish over 200 academic and research journals covering social and human sciences, two-thirds of which are published in collaboration with learned societies and other international organizations.

The language of the study is English. The search strategy is both Medline and Oxford combined a truncated search for “quality indicator*” OR “clinical indicator*” in title sections, AND “health care” OR “hospital” in body section (Table 2.1).

Table 2.1 Basic Search Strings

	Title Section	Operator	Body Section
1	quality indicator*	AND	health care OR hospital
2	clinical indicator*	AND	health care OR hospital

2.2 Study Selection

One reviewer who was a Ph.D. student in Medical Informatics assessed the studies for inclusion. International studies, studies that focused on multiple functional domains and studies in which development methods have been clearly defined selected as a priority in the selection process. Models that were referenced in the identified articles were reviewed and it was observed that all the referenced models had already been added to the study's scope.

2.3 Data Extraction

As shown in Table 2.2, a total of 598 studies were identified and based on the examination of the abstracts, 533 studies were excluded since they focused on a specific indicator or a disease, or investigated the feasibility, stability, sensitivity or monitoring of quality indicators. One reviewer evaluated the remaining 65 studies and excluded a total of 47 for the following reasons; 10 had limited scope with proposed indicators only in one healthcare domain: 11 were research studies on quality indicators and evaluating the generality of indicators. 3 were repeated studies about the same model in both Oxford and Medline. 3 were literature reviews of indicators. 3 did not have validation studies. 4 were comparative studies on indicators. 3 focused on the reliability assessment of an indicator. 2 were definition of quality indicators and lastly 1 was a risk assessment study. The remaining 18 were accepted as primary studies.

Table 2.2 Search Results

Sources	**Discovered**	**Relevant**	**Primaries**
OXFORD	89	38	13
MEDLINE	509	27	5
Total	598	65	18

The information from the primary studies was stored in a table in which the data extraction format is structured as shown in Table 2.3. Then, a summary table was formed (Appendix A) then the characteristics of the studies were extracted and presented in a table. The methods and development techniques were identified and a table was created to present the techniques used by each model is formed. Next, the

validation methods used by the studies were listed and finally, limitations of the studies are extracted from the summary table.

Table 2.3 Data Extraction Format

Name	Meaning
Article Number	Number of the article
Rank	Rank of the article, 1 through 10
Name	Name of the article
Journal/Conference	Journal or Article in which article takes place
Date	Publication date
Authors	Name of the authors
Model Name	Name of the model
Development Method/Approach	Development process of the quality indicator system.
Validation of Measures	Validation approach of the model
Scope(Number of Measures)	Scope of the model, covered domains, number of measures in each domain
Types of Indicators	Types of the indicators such as structure, process and outcome
Geographic Implementation	Prevalence of the model. Is it applied locally, nationally or internationally?
Limitations	Observed limitations of the model.

2.4 Results

The generic characteristics of the models with respect to the selection criteria are shown in Table 2.4. It was observed that 4 of the models were used internationally and contained more than one domain but none aimed at a full coverage. 6 were widely used and contained more than one health care domain, and 8 were used in a limited way and contained only one health care domain. These last 8 studies were selected because they had clearly defined validity methods.

Table 2.4 Characteristics of the Systems

Characteristic	Article
Internationally used, includes more than one health care domain	[25,26,1,27]
Widely used, includes more than one health care domain	[6,5,7,1,28,29]
Limited use, includes one health care domain but validity methods are clearly defined	[30,31,8,32,33] [34,35,36]

In the reviewed studies deductive development methods were preferred over descriptive development methods; 10 were descriptive and 8 were deductive.
As can be seen in Table 2.5, the methods used in development of indicator models are categorized as literature review, peer review, questionnaire/survey, expert panel, individual development, adopting other systems, interviews, and, pilot studies.

In the literature review the latest available scientific evidence concerning indicators is summarized and synthesized. A summary is a recap of the important information of the source, but a synthesis is a re-organization, or a reshuffling, of that information. It might give a new interpretation to old material or combine new with old interpretations. In peer reviews, experts rate the benefit-to-harm ratio of the indicators usually on a scale of 1 to 9, where 1 means that the expected harm greatly outweigh the expected benefits, and 9 means that the expected benefits greatly outweigh the expected harm. In questionnaire method, questionnaires are used to specify indicators and distributed to a wide audience. In expert panels, the members meet for 1-2 days under the leadership of a moderator. Each panelist receives an individualized document showing the distribution of all the experts' ratings, together with his/her own specific ratings. During the meeting, panelists discuss the ratings, focusing on areas of disagreement and are given the opportunity to modify the original list of indications and/or definitions. After discussing each chapter of the list of indications, they re-rate each indication individually. In individual developments, a quality group or an expertise group develops indicators that are either used in a

single health care provider or in other health care providers. In some applications indicators of different existing models are used as a base then these indicators are customized by the organization to build a new model. Another method is to use interviews to specify initial indicators. In pilot studies, a constrained implementation of a model is performed to understand attributes such as suitability of the model.

Table 2.5 Methods Used in Models

Method	**Studies**
Literature Review	[4,26,30,7,1,31,30,32,33,34,36]
Peer Review	[4,26,30,7,1,27, 32,33,34,35,36]
Questionnaire/ Survey	[26,30,7,1,27,29,8,32,36]
Expert Panel	[4,26,30,7,1]
Individual Development	[25,6,28,29,8,35]
Adapting Other Models	[5,31]
Interviews	[6,27,33]
Pilot Study	[25,4,6,7,8,33]

In the selected studies, the most widely used methods were; literature review, peer review, questionnaire/survey, and expert panel which are also part of the modified Delphi method [37] and 6 of the studies [26,30,7,1,32,36] directly use this method. Additionally, it was observed that, 4 quality indicator models [5,7,34,36] were designed in line with Donabedian's structure, process, and outcome definitions. In this model, the structure indicators provide qualitative information regarding the organization's environment (infrastructure, physical layout and resources, human resources and organizational framework) that is required for the provision of quality health care and also create a snapshot of the organizational environment at a point in time. Process indicators actually measure what is being done in providing care and make quantitative data available regarding the impact or effectiveness of systems, policies and procedures. Outcome indicators refer to the result of care and provide quantitative data related to the outcomes of health system performance.

In all the models, indicators were classified according to health care domains, and selected according to importance and validity. It is also observed that individual developments and pilot studies were widely used during the development of the model.

In three studies [6,27,33] interviews with experts and patients were used to determine indicators, and in 2 studies [5,31] adaptation from other models was used to specify quality indicators.

As seen in Table 2.6 the frequently used validation studies are: Case studies, expert opinions and interviews, randomized controlled trials, survey, and Cronbach's Alpha. Expert opinions and interviews are the most frequently used validation techniques. In that technique experts give scores the indicators and decide to retain measures with high ratings on both relevance and soundness. Randomized controlled trials offer most scientific evidence about the validity and they were used by 2 studies. Furthermore, case studies giving quantitative results about the indicators were used in 3 studies. Lastly, Cronbach's Alpha, which is commonly used as a measure of internal consistency of indicators, was used in 2 studies to assure the internal validity of the quality indicators.

Table 2.6 Validity Studies Used in the Models

Method	**Studies**
Case Studies	[25,7,1]
Expert Opinion/ Interviews	[6,5,26,30, 1,28,27,31,29,8,32,33,34,35,36]
Randomized Controlled Trials	[7,33]
Surveys	[31,8]
Cronbach's Alpha	[8,36]

As seen in Table 2.7, the limitations of the models were grouped in 15 categories. The deficiency of significant domain indicators is the most common problem in the studies. In most of the models [4,5,30,7,28,29], due to the broad scope of health care

domain, only some of the domains' indicators were specified and selected for the measurement.

Table 2.7 Limitations of the Models

Limitations	**Studies**
Lack of significant domain indicators	[5,30,7,1,28]
Redundant set of indicators	[5,28,31]
Data collection problems	[1,31,33]
Insufficient validity studies	[8,33,36]
Concerns about the revision of indicators and international mechanisms to maintain project momentum	[27,34,35]
Differences in health care systems and daily practice between countries	[27,32]
Classification problems	[1,27]
Indicator to quality improvement association is not defined	[5]
Consensus technique limitations	[26]
Non quantifiable measure	[30]
Non handling of environmental or socio-demographic factors	[30]
No explicit distinction between indicators designed to assess minimum standards	[30]
Difficulties overlapping roles for external review and inspection	[4]
Limited implementation of pilot studies	[28]
Absence of tools which facilitate progress in processes	[34]

Moreover, it was observed that there is no common framework that directs quality indicator developers to specify indicators systematically. Donabedian's structure, process, and outcome approach was frequently used to establish quality indicators, but the indicators defined using this approach do not include functionality, reliability, efficiency, and usability issues.

Also specified were the limitations that appear in more than one model. The first was redundant indicators that mean the number of measures is very high or the same measures were collected from different indicators. The second was the use of unfeasible or wasteful data collection methods. The third is insufficient validity studies. This means that one or more of face, criterion, construct, and content validity of studies are absent. The fourth limitation was the difference in classification

systems such as the usage of different disease or operation codes through hospitals and hence measuring and comparing indicators requires conversion procedures. The fifth is differences in health care systems and daily practice between countries that means that data cannot be compared. Finally, there is the concern about the non-existence of international mechanisms approving the revision of indicators and maintaining project momentum. This means that for international models requiring international working groups, gathering these groups and performing improvement studies with these groups may not always be possible.

The three main contributions of this systematic review are:

- Reviewing well defined studies on health care quality indicator models to determine the extent of the application, coverage and recognition among health care providers
- Identification of the development methods, validation methods and limitations of these studies, and
- Identifying improvement opportunities for health care quality indicator models.

We conclude that most widely used quality indicator models are MHA QI [25] (now named IQIP) and HCQI [1]. These models are successfully implemented throughout the USA and in many OECD countries. In addition, quality indicators for general practice management in Europe [26] are widely implemented in Belgium, France, Germany, The Netherlands, Switzerland and the United Kingdom. It was observed that the coverage of Maryland Hospital Association Quality Indicator Project (MHAQI) [25], United Kingdom Quality Indicator Project (UK QIP) [4], National Healthcare Quality Report (NHQR) [28], and The Australian Council on Healthcare Standards (ACHS) [29] are wider than the others.

Most commonly used quality indicator development methods are reviewing literature, carrying out peer reviews, getting experts ideas, and using questionnaires. We observed that as it has a more structured approach, the Randomized Delphi

method, which includes literature review, peer review, questionnaire, and expert panel methods, is a widely accepted method for the development of indicators. It was also observed that indicators are mostly specified and grouped according to Donabedian's structure, process, and outcome approach. However, this approach does not include functionality, reliability, efficiency, and usability issues. Developing a framework which includes these issues should be beneficial to model developers.

The most widely used validation method is the consensus on experts' judgments, however, consensus techniques have limitations such as a common set of indicators not being seen as a comprehensive and this prevents the overall assessment of indicators. Moreover, country size cannot be taken into consideration and number of experts is not specified according to country size, which causes inequitable results. More robust study design methods for example, randomized controlled trials and controlled trials are only used in restricted contexts. As researchers have most frequently applied descriptive methods for establishing quality models, they have become quite similar and as a result had similar limitations.

The deficiency of some domain indicators and an absence of a comprehensive model covering all health care domains were seen as the major limitations of the studies. As the health care providers do not have comprehensive models, it is very difficult to utilize a model as a benchmark. In addition there is no common framework accepted by internationally applied models and diversity of frameworks separate models from each other.

We conclude that by using the existing models, hospitals can find the areas that lack quality or the domains that have weak characteristics. In addition, these models create an opportunity to compare hospitals, then, patients can make comparisons and can select an appropriate hospital according to their needs. In spite of these advantages health care quality indicator models need to be improved for better results. A comprehensive quality measurement model which covers all health care domains and which allows appropriate extensions and improvements or a model that

contains core measures accepted by all models might be defined for measuring health care processes in a unified way.

CHAPTER 3

HEALTH CARE PROCESS QUALITY MEASUREMENT MODEL

In this chapter, objectives of developing the HPQMM, model foundations, model usage, and measure details will be given.

3.1 Model Objectives

The objectives of the development of a model for measuring the health care process quality are given below.

- *To identify a set of measures that can be utilized for all health care processes as a continuous source of guidance:* Most of the available quality models focus on specific diseases (cancer, diabetes) or specific clinics (cardiology, emergency), and there is no model handles all health care processes. In addition, there is no framework which directs quality model developers to specify indicators systematically for hospital wide processes. With the development of the model, all hospital processes can be measured by using this quality model.

- *To provide a model that extends the quality aspects of JCIAS and give a wider and more detailed picture for the quality of the process*: The model evaluates the process from different perspectives such as: completeness, adequacy, accuracy, reliability, efficiency, and these perspectives give more detailed quantitative information about the process quality.

- *To provide a model that enables organizations to carry out interorganizational benchmarking*: With the use of JCIAS's standardized measurable elements, it can

be possible to measure quality indicators and compare the results with other hospitals.

3.2 Structure

ISO/IEC 9126 and JCIAS are the standards used to form the HPQMM model. In software domain ISO/IEC 9126 and ISO/IEC 25000 are used as standards for measuring quality of the software products. These models provide a comprehensive specification and evaluation framework for ensuring software product quality.

ISO/IEC 9126 categorizes measures as internal, external, and quality in-use measures. The external and internal qualities show how quality is viewed from a static and a dynamic view of the software. The external qualities consist of attributes that are measurable from the behavior of the software or from other artifacts produced during software development, for example test or operation reports. The internal qualities consist of attributes that are measurable from analyzing the static system or code. The external and internal metrics share the same quality model, consisting of six characteristics each with three to five sub-characteristics. By measuring internal and external quality attributes, it is possible to predict the quality of the end product. The characteristics of these qualities are: Functionality, Reliability, Usability, Efficiency, Maintainability and Portability. The quality in use refers to how the user views the quality of the software, that is from outside, and is mainly focused on how it enables the user to achieve his task. It consists of four characteristics with three to five attributes. The quality characteristics of quality in-use are: Effectiveness, Productivity, Safety and Satisfaction.

Furthermore, JSIAS has been developed to both assess the quality of patient care from admission to discharge and measure the quality of all aspects of leadership and administration. Each process includes measurable elements which list what is required to be in full compliance with the standard. These measurable elements are used by the HPQMM for standardizing health care process requirements.

The HPQMM contains a comprehensive set of measures applicable to all health care processes, an application procedure and assets to guide the application. The inspiration for the set of measures comes from the analogy between process and software. First, they both have a similar compositional structure. A process definition is partitioned into activities that receive a group of inputs and provide some outputs; similarly, a software program consists of modules with input and output parameters. Each module includes a number of statements and every statement contains a number of variables and constants. Likewise, each activity in a process includes elementary operations and each operation uses one or more pieces of input to produce outputs. Moreover, just like the interactions between modules in a software program are precisely specified, the order of activity execution in a process is predefined using logic operators such as sequences, splits and joins. When instantiating either a software program or a process, an execution flow of their elements takes place in accordance with their static representations. This flow may involve consecutive executions, concurrency or conditional routings. In the HPQMM, the quality measures for functionality, reliability, usability, and efficiency characteristics are defined for the health care domain. Comparisons of these quality characteristics for software and for health care processes are given in Table 3.1.

Table 3.1 Comparison of Quality Characteristics for Software and Health Care Processes.

Functionality
Software
Used for predicting whether the software product in question will satisfy prescribed functional requirements in Software Requirement Specification (SRS) document.
HPQMM
How complete is the functional implementation of JCIAS requirements? How adequate are the implemented functions? How completely have the accuracy requirements been implemented? How correctly have the interoperability activities been implemented? How controllable is access to the systems? How auditable are the operations?
Reliability
Software
Used to predict whether the health care process in question will satisfy prescribed reliability needs
HPQMM
How accurate are the activities performed? How completely are the activities recorded?
Usability
Software
Used for predicting the extent to which the software in question can be understood, learned, operated, attractive, and compliant with usability regulations and guidelines
HPQMM
What proportion of activities is described in the process definition? What proportion of these documentations is used effectively? What proportion of systems, devices, laboratory kits etc. are accessible to staff? How attractive is the process to the staff? How attractive is the process to the patients?
Efficiency
Software
Used in software domain to predict the efficiency of behavior of the software product during testing or operating
HPQMM
What is the rate of completing a task in specified time? What is the adequacy level of the staff in terms of executing the process? How effective are the staffs in executing the process? How effective is the department in accepting patients? How effectively do the staffs use the equipment?

Other common quality characteristics such as maintainability and portability were evaluated as software specific characteristics and were not included in the model. The resultant quality measures of the HPQMM are given in Table 3.2.

Table 3.2 Quality Measures

Character-istic	Sub-Char.	Measures	Measured From(Assets)	Type	S.Name
Functionality	Suitability	**Functional completeness**	JCIAS evaluation matrix	Static Process Indicator	FC
		Functional adequacy	JCIAS evaluation matrix	Static Process Indicator	FA
	Accuracy	**Accuracy**	JCIAS evaluation matrix	Static Process Indicator	A
	Interoperability	**Interoperability**	Process evaluation matrix	Dynamic Process Indicator	IO
	Security	**Access controllability**	Process evaluation matrix	Dynamic Process Indicator	AC
		Operation audibility	Process evaluation matrix	Dynamic Process Indicator	OA
Reliability	Maturity	**Fault ratio**	Process evaluation matrix	Dynamic Process Indicator	FR
	Recoverability	**Restorability**	Process evaluation matrix	Dynamic Process Indicator	R
Usability	Understandability	**Sufficiency of doc.**	JCIAS evaluation matrix	Static Process Indicator	SD
	Learnability	**Effectiveness of doc.**	JCIAS evaluation matrix	Static Process Indicator	ED
	Operability	**Physical accessibility**	Process evaluation matrix	Dynamic Process Indicator	PA
	Attractiveness	**User/Staff satisfaction**	Staff satisfaction questionnaire	Attractiveness Indicator	SS
		Patient satisfaction	Patient satisfac. questionnaire	Attractiveness Indicator	PS
Efficiency	Time behavior	**Response time**	Process efficiency document	Effectiveness Indicator	RT
	Resource utilization	**Staffing ratio**	Process efficiency document	Effectiveness Indicator	SR
		Staff adequacy level	Process efficiency document	Effectiveness Indicator	SL
		Acceptance ratio	Process efficiency document	Effectiveness Indicator	AR
		Machine utilization	Process efficiency document	Effectiveness Indicator	MU

The quality measures are divided into four groups according to their types. These groups are dynamic process indicators (process execution related measures), static

process indicators (functional suitability and documentation related measures), attractiveness indicators (patient and staff satisfaction questionnaires), and effectiveness indicators.

Eighteen measures of the HPQMM are measured from 4 different assets. The static process indicators utilize the JCIAS evaluation matrix, the dynamic process indicators utilize the process evaluation matrix, the process attractiveness indicators utilize user and staff satisfaction questionnaires, and lastly the process efficiency indicators utilize efficiency indicator record. These assets and the procedure that defines the model application are shown in Figure 3.1. In the diagram, the “event” activates a “function”. A “function” instance is a function that occurs in a specific process instance. It can be also considered as the activities of the process. An “information carrier” provides the input for a function or function generates output to it. Yellow “information carriers” represent the main assets and the other assets (input/output documents) are represented by the white information carriers. The HPQMM application procedure contains six contextually different sequences of events depicted in the boxes; first, planning the measurement (block 1), then, measuring the metrics (block 2,3,4,5) , and lastly, gathering and validating the results (block 6) are performed. The assets developed and used for the HPQMM are summarized below

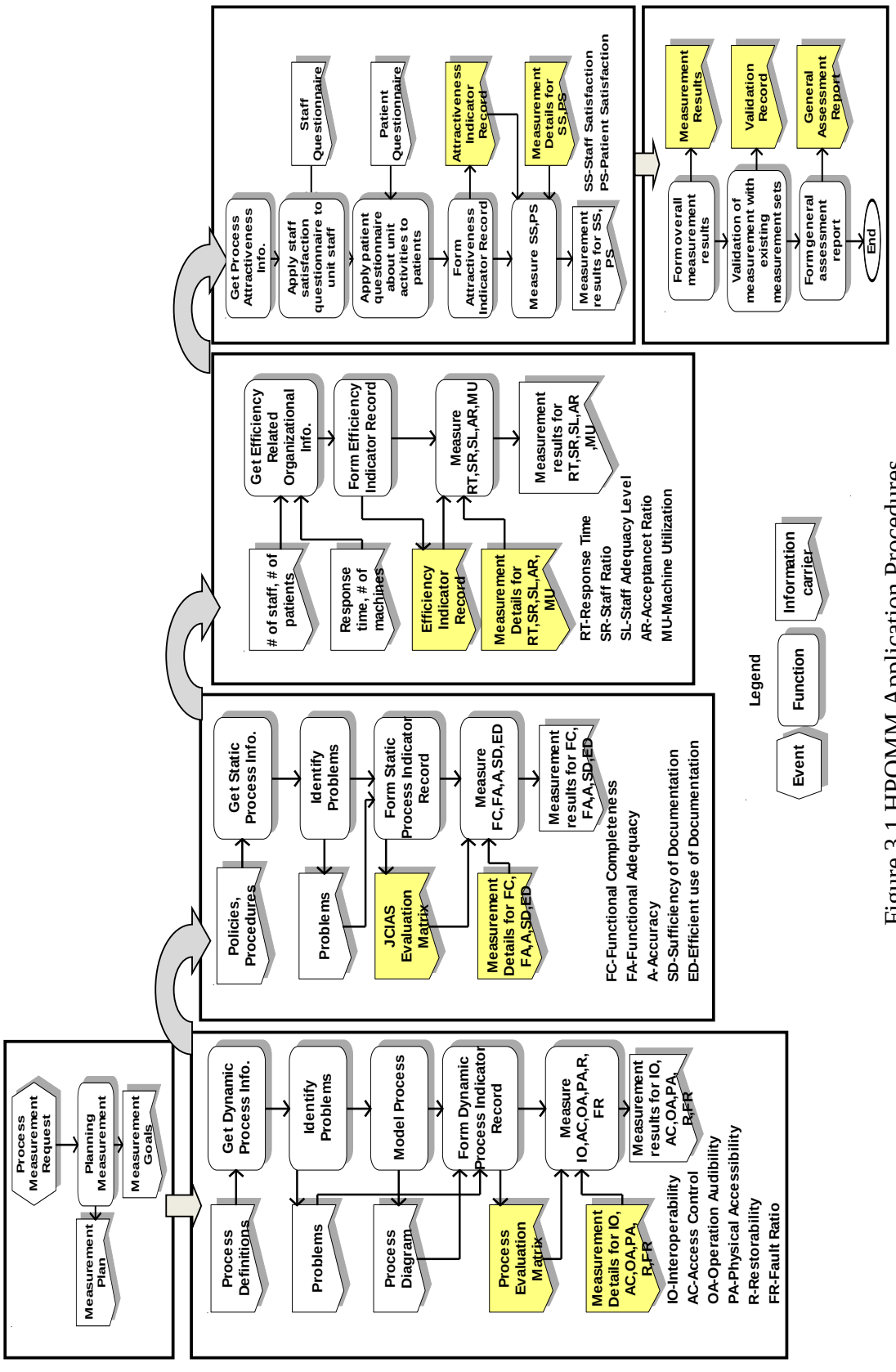

Figure 3.1 HPQMM Application Procedures

Process Evaluation Matrix (PEM): This is created to measure the dynamic process indicators (IO, AC, OA, PA, R, FR). To form this matrix, process definitions, process diagram, and problems document are used. The activities of process are shown in the rows and the process execution related measures are shown in the columns of the matrix. The matrix cells contain information about whether the activity is performed successfully or whether there is an issue with regard to the related measure. The values of the measures are normalized by the number of activities.

JCIAS Evaluation Matrix (JEM): This is used to measure static process indicators (FC, FA, A, SD, ED). The JCIAS was developed to assess the quality of patient care from admission to discharge. Each process includes measurable elements which list what is required in order to fully comply with the standard. In JEM, the measurable elements of JCIAS are shown in the rows and functional suitability related measures are shown in the columns. The cells of the matrix contain information about whether the measurement element is fulfilled or not with respect to functionality related measures.

Efficiency Indicator Record (EIR): This document is used to measure process efficiency indicators (RT, SR, SL, AR, MU) and it contains information about the response time of process, the number of staff in unit and their educational status, the number of accepted patients in each unit and the number of machines used in each unit. The EIR is used to calculate value of RT, SR, SL, AR and MU.

Attractiveness Indicator Record (AIR): This is used to measure process attractiveness indicators (SS, PS) and uses Staff Satisfaction Questionnaire (SSQ) and Patient Satisfaction Questionnaire (PSQ).These questionnaires are derived from Turkish Health Ministry Staff and Patient Satisfaction Questionnaires. The SSQ contains questions such as whether staffs need extra time to complete their work and whether they have a defined and written job definition. The PSQ contains questions such as whether it takes patients too much time to complete bureaucratic processes

and whether all of their questions answered by the related staff. The answers to all the questions are kept in the AIR.

Problems Document (PD): This document contains information about the problems specified by the process owners in relation to the process definitions and executions.

Measurement Details (MD): The MD provides guidelines for the measurement. This document records the name of measure, its detail, scale (ratio, interval, ordinal), focus (internal, external), measurement method (objective, subjective), inputs, guidance, and the formula of measure [38]. The formula for measures in the HPQMM can be generalized as two forms, 3.1 and 3.2:

$$\text{Measure} = 1 - \frac{\#\text{ of NOT performed activities OR measurable elements related to measure}}{\#\text{ of activities OR measurable elements related to measure}} \quad (3.1)$$

$$\text{Measure} = \frac{\#\text{ of performed activities OR measurable elements related to measure}}{\#\text{ of activities OR measurable elements related to measure}} \quad (3.2)$$

Measure definitions are detailed by using the fields listed in Table 3.3.

Table 3.3 Measure Details

Name	Name of the measure
Purpose of the measure	Gives reason for the usage
Detail	Gives information about the detail of the measurement process.
Measurement scale	Scale of the measurement. (ratio, nominal, ordinal etc.)
Measurement focus	Type of the measure (internal, external, quality in use).
Measurement method	Type of the measurement (objective, subjective)
Inputs	Required inputs for measurement
Documentation	Documentation needed after the measurement.
Measurement Formula	Provides measurement formula and explains the meanings of the elements
Interpretation of measured value	Interpretation method of measure.
Used For	Characteristics of measure

Measurement Result (MR): Aggregated in this document are the results which specify candidate areas for process improvement, determine the limits of the strong and weak aspects based on consensus with process owners. In the current study 0.85 or greater values are specified as strong aspects, values between 0.70 and 0.75 are specified as close to weak aspects, and 0.69 and lower values are specified as weak aspects.

Validation Record (VR): This contains the validation results and in the HPQMM there are 2 types of validation, model and measurement. The validity of the model and measurements are investigated with two rounds of studies. In the first round, to validate the model, the respondents are asked the questions given below:

- Do the measures identify opportunities for improvement?
- Do the measures give more detailed information about the process quality?
- Do the measures contribute to the JCIAS assessment?
- What is your opinion of the model and its assessment on the processes?

Each attribute is measured on a 5-point scale in which 5 indicates "excellent", 4 "very good", 3 "good", 2 "not good" and 1 "useless". In the second round, the respondents are asked to rate each measure of the HPQMM on a 5-point scale. Measures that have a median value of less than 3 are assumed to be invalid measures. In the application level, the validity of measurement results are investigated by comparing the HPQMM results with an existing process measurement set.

3.3 Application Procedure

Model usage can be summarized as: In the first stage dynamic process indicators are measured. To measure these indicators process related information is taken from process owners. Policies and procedures related to process are analyzed, and how the process is executed by the related staff is specified. If there are written process definitions, they are analyzed. Problems with the process executions are taken from the process owners and these problems are recorded into Problems Document. Then, by the usage of process related information, process diagrams are drawn. Activities

of the processes are extracted and put into Process Evaluation Matrix. Then, implemented and not implemented activities are determined according to policies and procedures, process diagrams, problems documents, and interviews. Results are recorded into Process Evaluation Matrix. By using the formulas in Measurement Details Document, value of dynamic process indicators are computed and recorded into Measurement Results Document.

In the second stage static process indicators are measured. This is analyzed by using JCIAS measurable elements. To measure related metrics JCIAS related information is taken from process owners. For getting this information, each JCIAS measureable element is evaluated with related staff, policies and procedures are analyzed, measurable elements in the unit are observed, and compatibility of measurable elements with policies and procedures are investigated. Problems with the measurable elements are taken from the staff and recorded into Problems Document. Then JCIAS Evaluation Matrix is filled. As in Process Evaluation Matrix, each static process indicators are evaluated according to measurable elements. At the end of this evaluation, the implemented and not implemented measurable elements with respect to measure are determined. By the use of Measurement Details Document and Problems Document values of JCIAS related measures are computed and recorded into Measurement Results Document.

Process efficiency is measured from organizational efficiency related information. Number of staff, their educational information, number of accepted patients to unit, response time of activities, faulty performed tasks and number of these tasks are taken from the staff. If there is documentation related to above information, these documentation is also analyzed and cross check of given information is performed. Then by using Measurement Details Document, values of SR, SL, RT, FR, AR, and MU are computed and results are recorded into Measurement Result Document.

In the fourth stage process attractiveness is measured via Staff Satisfaction Questionnaire (SSQ) and Patient Satisfaction Questionnaire (PSQ). SSQ is applied to

all staff and PSQ is applied at least 10 patient for each process. Value of SS and PS are calculated as follows: each answer in questionnaire has different points (weights) and after dividing sum of these points to sum of maximum points value of SS and PS is determined. The results are recorded into Measurement Results Documents.

Measurement results of four stages are aggregated in an overall Measurement Result Document. At the end of the measurement process a General Assessment Report, which contains measurement diagram of processes, details of strong aspects, details of weak aspects, and pros and cons of process, is formed.

3.4 Details of Measures

Details of measures are given in characteristics, sub-characteristics and measures headings.

3.4.1 Functionality Characteristic

Functionality measures are used for predicting if the health care process in question will satisfy prescribed functional requirements according to JCIAS measurable elements.

3.4.1.1 Suitability

Suitability measures indicate a set of attributes for assessing explicitly functions to prescribed tasks, and for determining their adequacy for performing the tasks. Functional completeness (Table 3.4) and Functional adequacy (Table 3.5) are the suitability measures of the HPQMM.

Table 3.4 Functional Completeness Measure

Name	Functional completeness
Purpose of the measure	How complete is the functional implementation?
Detail	Count the number of missing functions detected in evaluation in comparison to the JCIAS measurable elements, and count the number of functions described in JCIAS.
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Inputs	Policies, Procedures JCIAS Evaluation Matrix
Documentation	JCIAS Evaluation Matrix Measurement Result Document
Measurement formula	$1 - \frac{\text{Number of missing measurable elements detected in evaluation}}{\text{Number of measurable elements described in JCIAS}}$
Interpretation of measured value	The closer to1, the more adequate.
Used for	Functional Suitability

Table 3.5 Functional Adequacy Measure

Name	Functional adequacy
Purpose of the measure	How adequate are the checked functions?
Detail	Count the number of measurable elements in which problems are detected during evaluation, and count the number of implemented measurable elements that were reviewed during the evaluation process.
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Inputs	Policies, Procedures JCIAS Evaluation Matrix
Documentation	JCIAS Evaluation Matrix Measurement Result Document
Measurement formula	$1 - \frac{\text{Number of measurable elements in which problems are detected in evaluation}}{\text{Number of measurable elements reviewed}}$
Interpretation of measured value	The closer to1, the more adequate.
Used for	Functional Suitability

3.4.1.2 Accuracy Measure

Accuracy measures indicate a set of attributes for assessing the capability of the health care process to achieve correct or agreeable results (Table 3.6).

Table 3.6 Accuracy Measure

Name	Accuracy
Purpose of the measure	How completely have the accuracy requirements been implemented?
Detail	Count the number of measurable elements that have implemented the accuracy requirements and that were confirmed during the evaluation process and count the number of measurable elements with specific accuracy requirements that needs to be implemented according to JCIAS.
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Inputs	Policies, Procedures JCIAS Evaluation Matrix
Documentation	JCIAS Evaluation Matrix Measurement Result Document
Measurement formula	$\frac{\text{Number of measurable elements in which specific accuracy req. had been implemented}}{\text{Number of measurable elements for which specific accuracy req. need to be implemented}}$
Interpretation of measured value	The closer to1, the more adequate.
Used for	Accuracy

3.4.1.3 Interoperability Measures

Interoperability measures indicate a set of attributes for assessing the capability of the health care process's interaction with other processes (Table 3.7).

Table 3.7 Interoperability Measure

Name	Interoperability
Purpose of the measure	How correctly have the interoperability activities been implemented?
Detail	Count the number of successful interoperable activities, and count the number of interoperable activities that need to be implemented.
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Inputs	Policies, procedures Process definitions, Problems document, Process diagram, Process evaluation matrix
Documentation	Process evaluation matrix Measurement Result Document
Measurement formula	$\frac{\text{Number of interoperable activities that have been implemented correctly}}{\text{Number of interoperable activities in the process}}$
Interpretation of measured value	The closer to1, the more adequate.
Used for	Interoperability

3.4.1.4 Security Measures

Security measures indicate a set of attributes for assessing the capability of the health care process to avoid illegal access to the systems and/or data. Access controllability (Table 3.8) and Operation audibility (Table 3.9) are the security measures of the HPQMM.

Table 3.8 Access Controllability Measure

Name	Access controllability
Purpose of the measure	How controllable is access to the systems?
Detail	Count the number of access controllability requirements implemented correctly, and count the number of access controllability requirements in the process.
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Inputs	Policies, procedures, Process definitions, Problems document, Process diagram, Process evaluation matrix
Documentation	Process evaluation matrix Measurement Result Document
Measurement formula	$\frac{\text{Number of access controlability requirements implemented correctly}}{\text{Number of access controlability requirements in the process}}$
Interpretation of measured value	The closer to1, the more adequate.
Used for	Security

Table 3.9 Operation Audibility Measure

Name	Operation audibility
Purpose of the measure	How auditable is operations?
Detail	Document the data that has been recorded during the operation, and count the number of data items to be recorded during the process execution.
Measurement scale	Ratio
Measurement focus	External
Measurement method	Objective
Inputs	Policies, procedures, Process definitions, Problems document, Process diagram, Process evaluation matrix
Documentation	Process evaluation matrix Measurement Result Document
Measurement formula	$\frac{\text{\# of activities which have access to the data and this access can be audited with its actor}}{\text{\# of activities which have accesses to the data sources}}$
Interpretation of measured value	The closer to1, the more adequate.
Used for	Security

3.4.2 Reliability Characteristic

Reliability measures are used for predicting if the health care process in question will satisfy prescribed reliability needs.

3.4.2.1 Maturity Measures

Maturity measures indicate a set of attributes for assessing the maturity of the health care process (Table 3.10).

Table 3.10 Fault Ratio Measure

Name	Fault Ratio
Purpose of the measure	How accurate are the activities performed?
Detail	Count the number of detected failures during the process execution, and count the number of cases which have been actually executed.
Measurement scale	Ratio
Measurement focus	External
Measurement method	Objective
Inputs	Policies, procedures Process definitions, Problems document, Process diagram, Process evaluation matrix
Documentation	Process evaluation matrix Measurement Result Document
Measurement formula	$\frac{\text{Number of detected failures}}{\text{Number of performed cases during process execution}}$
Interpretation of measured value	The closer to 0, the more adequate.
Used for	Maturity

3.4.2.2 Recoverability Measures

Recoverability measures indicate a set of attributes for assessing the health care process's capability to re-establish an adequate level of performance and recover the data directly affected in case of a failure. Restorability is one of the measures of recoverability (Table 3.11).

Table 3.11 Restorability Measure

Name	Restorability
Purpose of the measure	How completely are the activities recorded?
Detail	Count the number of activities that are restorable during the operation, and count the number of activities that need restorability in process execution.
Measurement scale	Ratio
Measurement focus	External
Measurement method	Objective
Inputs	Policies, procedures Process definitions, Problems document, Process diagram, Process evaluation matrix
Documentation	Process evaluation matrix Measurement Result Document
Measurement formula	$\frac{\text{Number of activities that are restorable during operation}}{\text{Total number of activities that need restorability in process execution}}$
Interpretation of measured value	The closer to1, the more adequate.
Used for	Recoverability

3.4.3 Usability Characteristic

Usability measures are used for predicting the extent to which the health care process in question can be understood, learned, operated, attractive and compliant with usability regulations and guidelines.

3.4.3.1 Understandability Measures

Understandability measures assess whether staff can understand:

- whether the health care process is suitable
- how it can be used for particular tasks (Table 3.12).

Table 3.12 Sufficiency of Documentation Measure

Name	Sufficiency of documentation
Purpose of the measure	What proportion of measurable elements is described in the process definition?
Detail	Count the number of measurable elements which are adequately documented. And, count the number of measurable elements need to be documented, (both correctly and incorrectly implemented).
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Subjective
Inputs	Policies, Procedures, JCIAS Evaluation Matrix
Documentation	JCIAS Evaluation Matrix, Measurement Result Document
Measurement formula	$\frac{\text{Number of measurable elements documented sufficiently}}{\text{Number of measurable elements need to be documented}}$
Interpretation of measured value	The closer to 1, the more adequate.
Used for	Understandability

3.4.3.2 Learnability Measures

Learnability measures assess how long users take to learn how to use particular functions, and the effectiveness of documentation (Table 3.13).

Table 3.13 Effectiveness of Documentation Measure

Name	Effectiveness of documentation
Purpose of the measure	What proportions of measurable elements are used effectively?
Detail	Count the number of documented measurable elements that are used effectively, and number of measurable elements that are documented.
Measurement scale	Ratio
Measurement focus	External
Measurement method	Subjective
Inputs	Review report
Documentation	List of user tasks tested Record of completed tasks after accessing user documentation.
Measurement formula	$\frac{\text{Number of documented measurable elements that are used effectively}}{\text{Number of measurable elements that are documented}}$
Interpretation of measured value	The closer to1, the more adequate.
Used for	Learnability

3.4.3.3 Operability Measures

Operability measures assess whether staff can operate and control the health care process (Table 3.14).

Table 3.14 Physical Accessibility Measure

Name	Physical accessibility
Purpose of the measure	What proportion of systems, devices, laboratory kits etc. are accessible?
Detail	Count the number of functions in which physical accessibility requirement has been implemented, and count the number of functions in which physical accessibility requirement need to be implemented.
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Inputs	Policies, procedures Process definitions, Problems document, Process diagram, Process evaluation matrix
Documentation	Process evaluation matrix Measurement Result Document
Measurement formula	$\frac{\text{Number of functions in which physical accessibility req. had been implemented}}{\text{Number of functions for which physical access. req. need to be implemented}}$
Interpretation of measured value	The closer to1, the more adequate.
Used for	Operability

3.4.3.4 Attractiveness Measures

Attractiveness measures assess the patient and staff satisfaction with the health care process. User/Staff satisfaction (Table 3.15) and Patient satisfaction (Table 3.16) are the attractiveness measures of the HPQMM.

Table 3.15 User/Staff Satisfaction Measure

Name	User/Staff satisfaction
Purpose of the measure	How attractive is the process to the staff?
Detail	Compute the total points obtained from Staff Satisfaction Questionnaire and, compute the total point of Staff Satisfaction Questionnaire. 1. How often do you need extra time to complete your works? a) Frequently (0) b) Sometimes (3) c) Never(5) 2. Do you have a well-defined and written job description? a) Yes (5) b) Not well defined (3) c) No(0) 3. Does hospital management take care of your problems a) Yes (5) b) Sometimes (3) c) No(0) 4. How often do you think to resign from the unit? a) Frequently (0) b) Sometimes (3) c) Never(5) 5. What is your general assessment about the unit? a) Excellent (10) b) Very good (8) c) Good(6) d) Not bad (4) e) Bad (0)
Measurement scale	Ordinal
Measurement focus	Internal
Measurement method	Objective
Inputs	Staff Satisfaction Questionnaire
Documentation	Attractiveness Indicator Record Measurement Result Document
Measurement formula	$\frac{\text{Total points get from Staff Satisfaction Questionnaire}}{\text{Total points of Staff Satisfaction Questionnaire}}$
Interpretation of measured value	The closer to1, the more adequate.
Used for	Attractiveness

Table 3.16 Patient Satisfaction Measure

Name	Patient satisfaction
Purpose of the measure	How attractive is the process to the patient?
Detail	Compute the total point s obtained from Patient Satisfaction Questionnaire and, compute the total point of Patient Satisfaction Questionnaire. 1. Does it take to much time to complete your tasks? a) Yes, definitely (0) b) No, partially (3) c) No (5) 2. Are all of your questions answered by the related persons? a) Yes, completely (5) b) Yes, partially (3) c) No (0) 3. Would you prefer to come again that unit? a) Yes (5) b) May be (3) c) No (0) 4. What is your general assessment about the unit? a) Excellent (10) b) Very good (8) c) Good(6) d) Not bad (4) e) Bad (0)
Measurement scale	Ordinal
Measurement focus	Internal
Measurement method	Objective
Inputs	Patient Satisfaction Questionnaire Attractiveness Indicator Record
Documentation	Measurement Result Document
Measurement formula	$\frac{\text{Total points get from Patient Satisfaction Questionnaire}}{\text{Total points of Patient Satisfaction Questionnaire}}$
Interpretation of measured value	The closer to 1, the more adequate.
Used for	Attractiveness

3.4.4 Efficiency Characteristic

Efficiency measures are used for predicting the efficiency of behavior of the health care process.

3.4.4.1 Time Behavior Measures

Time behavior measures indicate a set of attributes for predicting the time behavior of the health care process (Table 3.17).

Table 3.17 Response Time Measure

Name	Response time
Purpose of the measure	What is the rate of completing a task in specified time?
Detail	Count the number of tasks which are performed in specified time, and count the total number of tasks
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Inputs	Efficiency Indicator Record
Documentation	Measurement Result Document
Measurement formula	$\frac{\text{Number of tasks which are performed in specified time}}{\text{Number of tasks}}$
Interpretation of measured value	The closer to1, the more adequate.
Used for	Time Behavior

3.4.4.2 Resource Utilization Measures

Resource utilization measures indicate a set of attributes for predicting the utilization of resources by the staff and machines. Staff adequacy level (Table 3.18), Staffing ratio (Table 3.19), Acceptance ratio (Table 3.20), and Machine utilization (Table 3.21) are the resource utilization measures of the HPQMM.

Table 3.18 Staff Adequacy Level Measure

Name	Staff adequacy level
Purpose of the measure	What is the adequacy level of staff for executing process?
Detail	Count the number of staff who received required trainings, and count the total number of staff.
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Inputs	Efficiency Indicator Record
Documentation	Measurement Result Document
Measurement formula	$\frac{\text{Number of staff who received required trainings}}{\text{Number of staff}}$
Interpretation of measured value	The closer to1, the more adequate.
Used for	Resource Utilization

Table 3.19 Staffing Ratio Measure

Name	Staffing ratio
Purpose of the measure	How effective are the staff who execute process?
Detail	Count the number of staff, and average number of daily accepted patients
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Inputs	Efficiency Indicator Record
Documentation	Measurement Result Document
Measurement formula	$\frac{\text{Number of staff}}{\text{Number of tasks}}$
Interpretation of measured value	The low value, the more adequate.
Used for	Resource Utilization

Table 3.20 Acceptance Ratio Measure

Name	Acceptance ratio
Purpose of the measure	How effective is the department to accept patients?
Detail	Find the number of daily accepted patients from HIS records, and find the number of daily applied patients from HIS records
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Inputs	Efficiency Indicator Record
Documentation	Measurement Result Document
Measurement formula	$\frac{\text{Number of daily accepted patients}}{\text{Number of daily applied patients}}$
Interpretation of measured value	The closer to 1, the more adequate.
Used for	Resource Utilization

Table 3.21 Machine Utilization Measure

Name	Machine utilization
Purpose of the measure	How effective are the machines used?
Detail	Find the number of unit related machines, and average number of daily accepted patients
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Inputs	Efficiency Indicator Record
Documentation	Measurement Result Document
Measurement formula	$\frac{\text{Number of unit related machines}}{\text{Average number of daily patients}}$
Interpretation of measured value	The low value, the more adequate.
Used for	Resource utilization

CHAPTER 4

A MULTIPLE CASE STUDY FOR MEASURING HEALTH CARE PROCESS QUALITY

In this chapter, firstly purpose of the case study is given. Then, the details of case study design are presented in research questions, settings, interpreting case study findings headings. Next, data collection method is provided and analysis of laboratory and assessment processes measurement results is given in strong aspects, weak aspects, and pros-cons of processes sections. At the end of the chapter, research questions of case study are answered.

4.1 Purpose of the Case Study

Case study research method is used for studying the following issues,

- Specifying applicability of quality measures to health care processes,
- Measuring process quality,
- Reaching a consensus with process owners on measurement results,
- Determining adequacy of measurement definitions,
- Determining unusable measures,
- Getting feedbacks to refine and improve the model.

As a preliminary study to identify the conceptual requirements of the model, ISO/IEC 9126 based Güceğlioğlu's model [19] was applied to laboratory processes of a public hospital. Manual form of the process named as "AS-IS form", and IS project-supported form of the process named as "TO-BE form" were measured. At the end of this application it was seen that:

- Some of the quality measures such as complexity, coupling, IT density, and input validity etc. were not appropriate for health care processes,
- There was a need for defining new measures appropriate to health care domain, and
- There was a need for unifying functional and documentation requirements.

To determine more appropriate model for health care domain software specific characteristics such as portability and maintainability were excluded from the model concept. Remaining measures were evaluated and appropriate ones for health care domain were selected. These measures were redefined according to health care process requirements. To unify functional and documentation requirements, internationally accepted JCIAS standard's measurable elements were integrated to the model to form a measurement baseline.

4.2 Case Study Design

The case study is planned in two university hospitals and one public hospital. We have planned to select cases that cover different rating according to JCIAS and we have also decided to select laboratory and assessment processes that are conceptually different from each other and performed in all hospitals.

Laboratory services and assessment (patient diagnosis) services are selected as the subject of the case. JCIAS measurable elements, process definitions, policies and procedures, process diagrams, staff and patient satisfaction questionnaires, organizational information about process efficiency constitute the relevant data.

The case study is both explanatory and exploratory [39]. It is an explanatory one because it aims to provide detailed information about the needs of health care process quality. It is also exploratory one because it shows applicability of the quality attributes and validity of measurement results. Research questions of the case study are given below.

Question 1: Is it possible to measure health care processes by using the HPQMM's quality indicators?

Method Used for Answering Question 1: Redefined software quality measures, JCIAS's measurable elements, staff and patient satisfaction questionnaires, and efficiency related information will be used to answer this question. After applying eighteen measures of the HPQMM, quality degree of processes will be determined.

Question 2: Does the model measure health care processes comprehensively?

Method Used for Answering Question 2: For answering this question, the model will be applied on both laboratory and assessment processes. After that, applicability of the model to other processes will be discussed.

Question 3: Does usage of these measures provide a possibility of process improvement?

Method Used for Answering Question 3: For answering this question firstly, processes will be assessed according to the HPQMM, and then, weak and strong aspects will be discussed with process owners. If there is a consensus between process owners and the model's result, then it is accepted that the model gives an opportunity of process improvement.

Question 4: How can the model be refined and therefore improved?

Method Used for Answering Question 4: According to feedbacks taken from case studies and users, model will be refined and improved.

4.3 Conducting Case Study

The conduction of the case study includes collecting the data, applying quality attributes, recording the results and observations and analyzing quality attributes' measurements. This work is explained below step by step as mentioned.

4.3.1 Cases

Case studies were performed in 3 hospitals' laboratory and assessment services. Degree of implementing JCIAS requirements, size of hospitals (a small hospital and two large hospitals) and their provided possibilities to examine the hospital processes and the human resources were the main parameters of the selection of hospitals.

The first hospital was a state run hospital in Ankara. The hospital provides treatment to all age groups. The hospital has a daily average of 400 outpatients and no inpatients. It employs 19 physicians and 12 nurses. No study related to JCIAS or any other quality standard has been carried out in hospital. The hospital processes are not defined except for certain rules and regulations related to processes.

The second case study was performed in a university hospital in Ankara. The hospital has a monthly average of 34,000 outpatients and 2,250 inpatients. It has about 850 beds and employs 250 academic personnel, 400 physicians, 475 nurses, and 350 health technicians across 32 departments. Since 2007, it has held a Joint Commission Approval Certificate [40] and all the processes of the hospital are defined and documented.

The third case study was performed in a university hospital in Antalya. The hospital has a monthly average of 50,000 outpatients and 3,000 inpatients. It has about 850 beds and employs 320 academic personnel, 440 physicians, and 490 nurses across 67 departments. The hospital gained an ISO/IEC 9001:2000 [41] Quality System Certificate in 2003.

Case study results of hospital 1 and hospital 2 are given in Appendix B and Appendix C, and case study results of hospital 3 is presented in this section as an example.

4.3.2 Collecting the Data

Data collection activities can be grouped into four sections. Dynamic process related, static process related, efficiency related, and attractiveness related activities.

In dynamic process related data collection, process definitions, documents of executing processes, forms related to processes, archival records (both manual and IS based) are analyzed. Specified problems with processes are recorded. Process executions are observed and compared with the defined process. Incompatibilities are recorded.

In static process related data collection, policies and procedures related to functional implementation are analyzed, they are also compared with the actual implementation, and incompatibilities are recorded. Problems with the functional requirements and documentation are recorded.

Efficiency related information (number of staff, acceptance ratio, response time, staff adequacy level etc.) is collected from the organizational efficiency statistics. If there is no statistics or documentation, interview results are used.

Attractiveness related information is collected from staff and patient satisfaction questionnaires.

4.3.3 Applying the Model to the Processes

At the beginning of the study objectives of the model are presented to the staff. Then application of the model explained in below steps.

- The details of eighteen measures and how they will be used to measure process quality is explained.
- Details of each JCIAS measurable elements are presented to the staff and questions related to these measurable elements are answered.
- The rating method which specifies whether an activity or measurable element is performed adequately is explained to staff. The ratings are defined as “fully performed”, “largely performed”, “partially performed” and “not performed”.

- Sample Process Evaluation Matrix (Table 4.1) and JCIAS Evaluation Matrix (Table 4.2) are prepared and how they will be used in measurement is explained.
- The details of staff satisfaction questionnaires and patient satisfaction questionnaires are given and how they will be used in measurement is explained.

Table 4.1 Sample Process Evaluation Matrix for Laboratory Process

No	**Activity**	**Interoperability**	**Operation Audibility**	**.....**
1	Entering orders to LIS			
2	Checking LIS for new orders			
3	Printing barcodes for orders			
4	Drawing blood and other specimens			
5	Sending specimens to related lab.			
6	Running tests			
7	Checking results			
8	When needed rerunning tests			
9	Approving test results			
10	Printing test results			
11	Transmitting test results to physician			

Table 4.2 Sample JCIAS Evaluation Matrix

No	**Measurable Elements**	**Suitability**		**Accuracy**	**....**
		FC	**FA**	**A**	**....**
1	A laboratory safety program is in place and is appropriate to the risks and hazards encountered.				
	The program is coordinated with the organization's safety management program.				
	Written policies and procedures address the handling and disposal of infectious and hazardous materials.				
	Appropriate safety devices are available.				
	Laboratory staffs are oriented to safety procedures and practices.				
	Laboratory staffs receive education for new procedures and newly acquired or recognized hazardous materials.				
2	Individuals with adequate training, skills, orientation, and experience administer the tests and interpret the results.				
	Those individuals who perform testing and those who direct or supervise testing are identified.				
	Appropriately trained and experienced staffs administer tests.				
	Appropriately trained and experienced staffs interpret tests.				
	There is an adequate number of staff to meet patient needs.				
	.....				

In the next section laboratory services process quality measurement and assessment services process quality measurement results of third case study are provided to show how the model works.

The details of other processes can be found in the Technical Reports [42,43,44].

4.3.3.1 Laboratory Services

In this section firstly, process is summarized, secondly, activities and measurable elements of process will be presented. Next, laboratory services process diagram is provided, and lastly measurement results and their details are given.

Process Description: Laboratory process can be defined as: Any activity that evaluates any substance removed from a human body and translates that evaluation to a result becomes a laboratory test. The results may be stated as a number, presence or absence of a cell or reaction, or an interpretation. These results are used to assess a patient's condition or make a clinical decision about a patient.

Activities: The activities employed in the laboratory services process are given in the following table.

Table 4.3 Laboratory Process Activities

No	Activity	Executed By
1	Entering orders	Physician
2	Entering cost information	Department Secretary
3	Sending patient to blood drawing section	Patient
4	Checking LIS for new orders	Nurse
5	Drawing blood	Nurse
6	Printing barcodes for tubes	Nurse
7	Transporting bloods to Central Lab.	Nurse-Pneumatic system
8	Applying blood acceptance criteria	Lab-Staff
9	Calling department secretary	Lab-Staff
10	Decomposing bloods	Lab-Staff
11	Sending decomposed bloods to related labs	Lab-Staff
12	Running tests	Lab-Staff
13	Checking test results	Lab-Chief
14	Reruning tests	Lab-Staff
15	Checking panic result	Lab-Staff
16	Calling physician	Lab-Staff
17	Approving results	Lab-Chief

JCIAS Measurable Elements: JCIAS measurable elements of laboratory services process are given in Table 4.4.

Table 4.4 JCIAS Measurable Elements of Laboratory Process

No	Measurable Elements
1	A laboratory safety program is in place and is appropriate to the risks and hazards encountered.
	The program is coordinated with the organization's safety management program.
	Written policies and procedures address the handling and disposal of infectious and hazardous materials.
	Appropriate safety devices are available.
	Laboratory staff are oriented to safety procedures and practices.
	Laboratory staff receive education for new procedures and newly acquired or recognized hazardous materials.
2	Individuals with adequate training, skills, orientation, and experience administer the tests and interpret the results.
	Those individuals who perform testing and those who direct or supervise testing are identified.
	Appropriately trained and experienced staff administer tests.
	Appropriately trained and experienced staff interpret tests.
	There is an adequate number of staff to meet patient needs.
	Supervisory staff have appropriate training and experience.
3	Laboratory results are available in a timely way as defined by the organization.
	The organization has established the expected report time for results.
	The timeliness of reporting of urgent/emergency tests is monitored.
	Laboratory results are reported within a time frame to meet patient needs.
4	There is a laboratory equipment management program and it is implemented.
	The program includes selecting and acquiring equipment.
	The program includes inventorying equipment.
	The program includes inspecting and testing equipment.
	The program includes calibrating and maintaining equipment.
	The program includes monitoring and follow-up.
	All testing, maintenance, and calibration of equipment are adequately documented.
5	Essential reagents and other supplies are regularly available.
	Essential reagents and supplies are identified.
	Essential reagents and supplies are available.
	All reagents are stored and dispensed according to guidelines.
	All reagents are periodically evaluated for accuracy and results.
	All reagents and solutions are completely and accurately labeled according to guidelines.

Table 4.4 JCIAS Measurable Elements of Laboratory Process (Cont.)

6	Procedures for collecting, identifying, handling, safely transporting, and disposing of specimens are followed
	Procedures guide the ordering of tests.
	Procedures guide the collection and identification of specimens.
	Procedures guide the transport, storage, and preservation of specimens.
	Procedures guide the receipt and tracking of specimens.
	The procedures are implemented.
	The procedures are observed when outside sources or services are used.
7	The laboratory has established reference ranges for each test performed.
	The range is included in the clinical record at the time test results are reported.
	Ranges are furnished when tests are performed by outside sources.
	Ranges are appropriate to the organization's geography and demographics.
	Ranges are reviewed and updated as needed.
8	The clinical laboratory, and other laboratory services throughout the organization, are under the direction and oversight of one or more qualified individuals responsible for carrying out the responsibilities identified in the intent statement.
	Responsibilities include developing, implementing, and maintaining policies and procedures.
	Responsibilities include administrative oversight.
	Responsibilities include maintaining quality control programs.
	Responsibilities include recommending outside sources of laboratory services.
	Responsibilities include monitoring and reviewing all laboratory services within and outside of the laboratory.
9	There is a quality control program for the clinical laboratory.
	The program includes the validation of test methods.
	The program includes the daily surveillance of test results.
9	The program includes rapid correction of deficiencies.
	The program includes the documentation of results and corrective actions.
10	The organization regularly reviews quality control results for all outside sources of laboratory services.
	Quality control results from outside sources are regularly reviewed.
	Qualified individuals review the quality control results.
11	The organization has access to experts in specialized diagnostic areas when necessary
	A roster of experts for specialized diagnostic areas is maintained.
	Experts in specialized diagnostic areas are contacted when needed.

The process model of the Laboratory process is given in Figure 4.1.

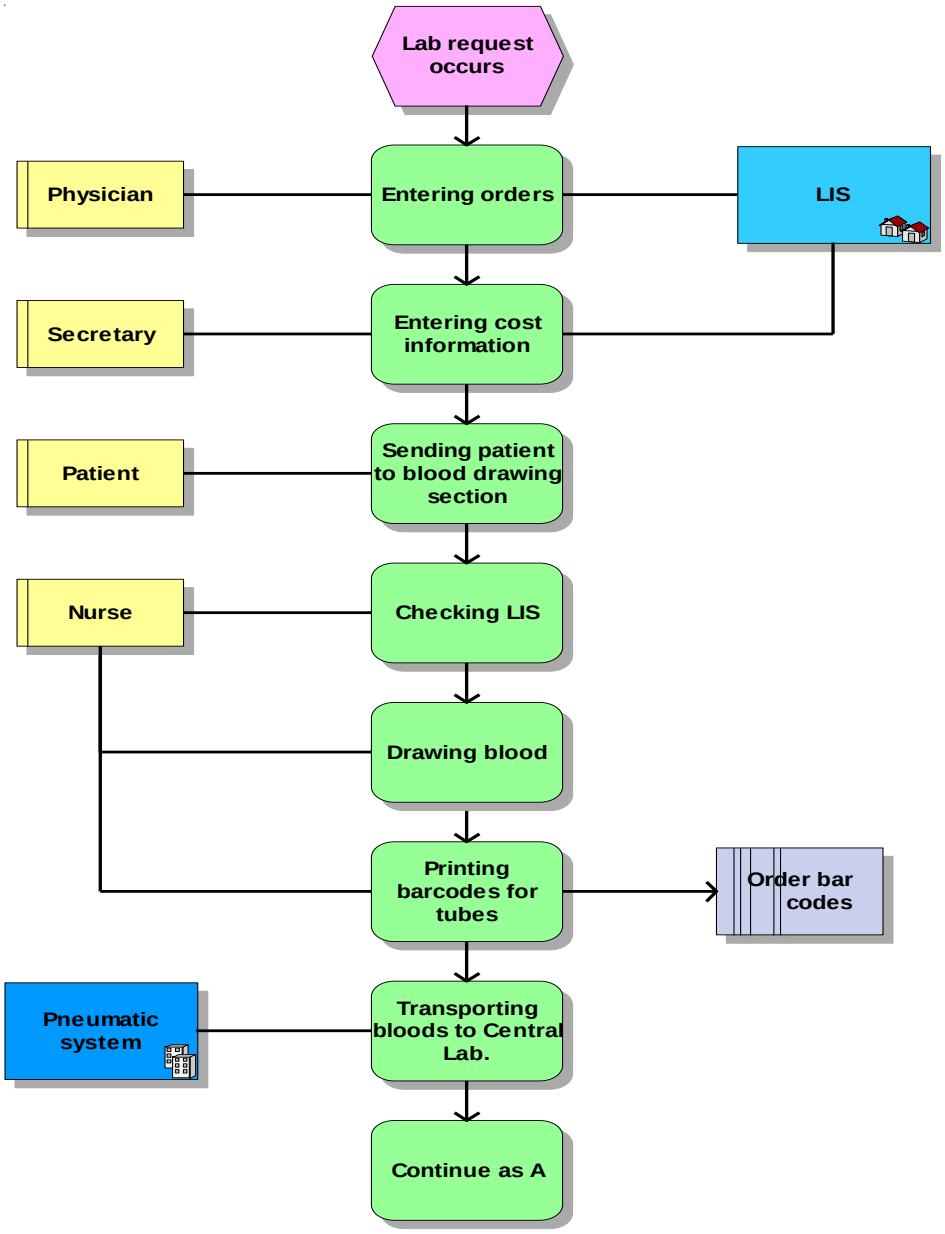

Figure 4.1 Laboratory Process Diagram

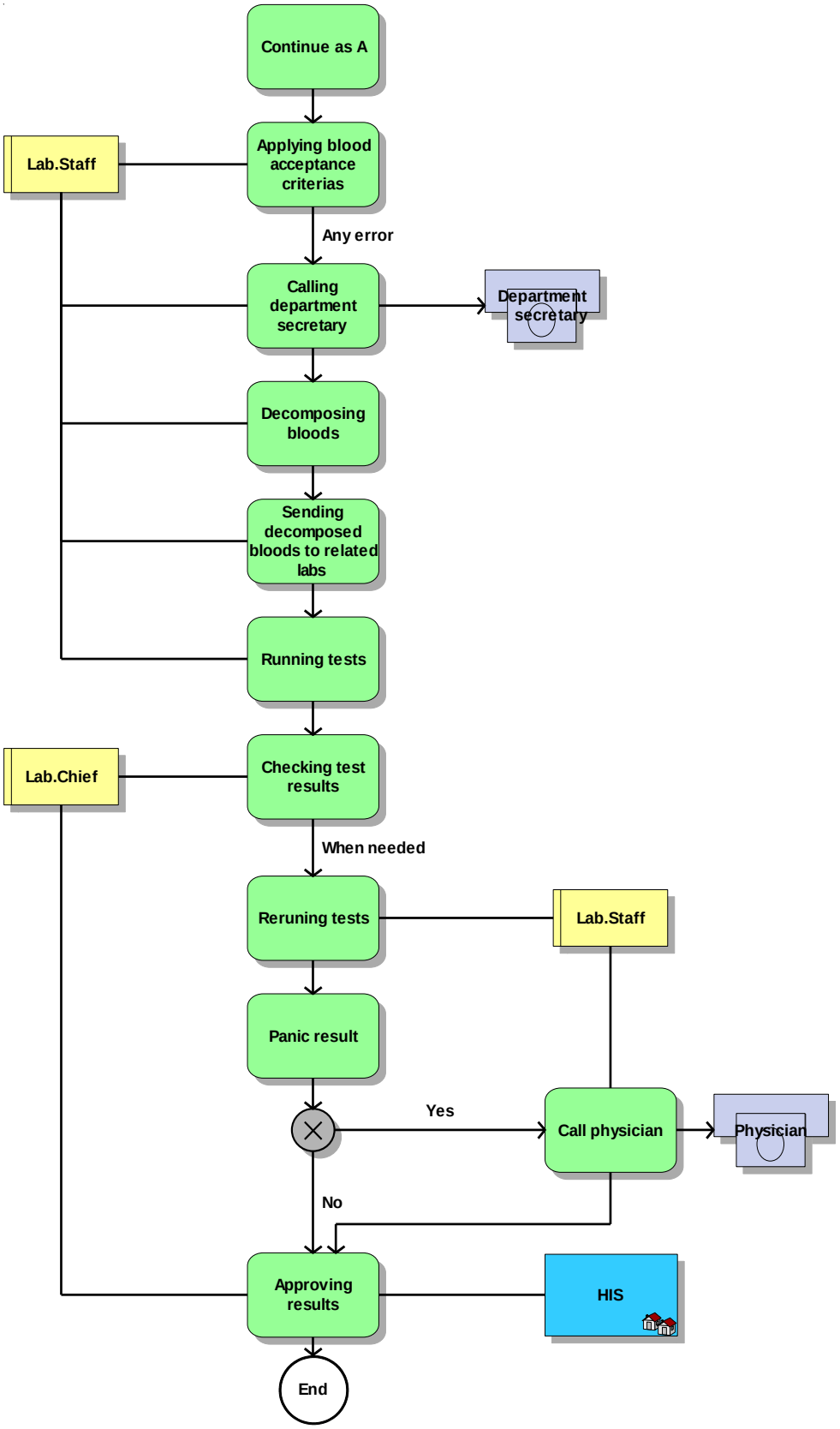

Figure 4.1 Laboratory Process Diagram (Cont.).

In the next sections, the assets of laboratory process measurement are provided in Process Evaluation Matrix, JCIAS Evaluation Matrix, Efficiency Indicator Record, and Attractiveness Indicator Record headings. After that, overall measurement result is provided.

4.3.3.1.1 Process Evaluation Matrix (PEM)

The process evaluation matrix of laboratory process is provided in Table 4.5, Table 4.6 and Table 4.7.

Table 4.5 Process Evaluation Matrix of Laboratory Process-IO-AC

No	Activity	**Interoperability (IO)**	**Access Controllability (AC)**
1	Entering orders	Interoperability between HIS and LIS, lab orders are transmitted to LIS.	Access of physicians to HIS is controlled.
2	Entering cost information	Interoperability with HIS	Access of secretary to HIS is controlled.
3	Sending patient to blood drawing section	No interoperability	No access controllability.
4	Checking LIS for new orders	No interoperability	Access of nurse to LIS is controlled.
5	Drawing blood	No interoperability	No access controllability.
6	Printing barcodes for tubes	Interoperability with barcode machine	No access controllability.
7	Transporting bloods to Central Lab.	Interoperability with pneumatic system. Procedures guide the transport, storage, and preservation of specimens is defined.	Access to pneumatic system is not under control.
8	Applying blood acceptance criteria	No interoperability	No access controllability.
9	Calling department secretary	Interoperability with department secretary. When acceptance criteria is not satisfied. Accessing to patient may not be possible.	No access controllability.
10	Decomposing bloods	No interoperability	Access to decompose machines is not under control.
11	Sending decomposed bloods to related labs	Interoperability with related lab personnel.	No access controllability.
12	Running tests	Interoperability with test machines.	Access to test machines is not under control.
13	Checking test results	No interoperability	No access controllability.
14	Reruning tests	Interoperability with test machines.	Access to test machines is not under control.
15	Checking panic result	No interoperability	No access controllability.
16	Calling physician	Interoperability with physician.	No access controllability.
17	Approving results	No interoperability	No access controllability.

Table 4.6 Process Evaluation Matrix of Laboratory Process-OA-R

No	Activity	**Operation Audibility (OA)**	**Restorability(R)**
1	Entering orders	Who entered orders is auditable.	Orders are recorded into LIS and restorability of this data is possible.
2	Entering cost information	Who entered cost information is auditable.	Cost information is recorded into HIS and restorability of this data is possible.
3	Sending patient to blood drawing section	No operation audibility.	No restorability.
4	Checking LIS for new orders	Who checked LIS is not auditable.	No restorability.
5	Drawing blood	Who draw blood is not auditable.	No restorability.
6	Printing barcodes for tubes	Who printed barcodes is not auditable.	Barcodes are written to LIS and restorability of this data is possible.
7	Transporting bloods to Central Lab.	Who sent bloods is auditable.	No restorability.
8	Applying blood acceptance criteria	Who applied acceptance criteria is not auditable.	No restorability.
9	Calling department secretary	Who called department secretary is not auditable.	No restorability.
10	Decomposing bloods	Who sent bloods to decompose section is not auditable.	No restorability.
11	Sending decomposed bloods to related labs	Who decomposed bloods is not auditable.	No restorability.
12	Running tests	Who run tests is auditable.	Test results are recorded into LIS and restorability of this data is possible.
13	Checking test results	Who checked results is auditable.	No restorability.
14	Reruning tests	Who run tests is auditable.	Test results are recorded into LIS and restorability of this data is possible.
15	Checking panic result	Who checked results is auditable.	No restorability.
16	Calling physician	Who called physician is not auditable.	No restorability.
17	Approving results	Who approved results is auditable.	Approved results are recorded into LIS and restorability of this data is possible.

Table 4.7 Process Evaluation Matrix of Laboratory Process-PA

No	Activity	Physical Accessibility(PA)
1	Entering orders	Physical accessibility to HIS.
2	Entering cost information	Physical accessibility to HIS.
3	Sending patient to blood drawing section	No physical accessibility.
4	Checking LIS for new orders	Physical accessibility to LIS.
5	Drawing blood	No physical accessibility.
6	Printing barcodes for tubes	Physical accessibility to devices.
7	Transporting bloods to Central Lab.	No physical accessibility.
8	Applying blood acceptance criteria	No physical accessibility.
9	Calling department secretary	No physical accessibility.
10	Decomposing bloods	No physical accessibility.
11	Sending decomposed bloods to related labs	No physical accessibility.
12	Running tests	Physical accessibility to reagents
13	Checking test results	No physical accessibility.
14	Reruning tests	Physical accessibility to reagents
15	Checking panic result	No physical accessibility.
16	Calling physician	No physical accessibility.
17	Approving results	No physical accessibility.

4.3.3.1.2 JCIAS Evaluation Matrix (JEM)

The JCIAS evaluation matrix of laboratory process is provided in below tables.

Table 4.8 JCIAS Evaluation Matrix of Laboratory Process-FC-FA-A

No	Measurable Elements	Suitability		Accuracy
		Func.Comp	Functional Adequacy	Accuracy
1	A laboratory safety program is in place and is appropriate to the risks and hazards encountered.			
	The program is coordinated with the organization's safety management program.	√	√	
	Written policies and procedures address the handling and disposal of infectious and hazardous materials.	√	√	
	Appropriate safety devices are available.	√	√	
	Laboratory staffs are oriented to safety procedures and practices.	√	√	
	Laboratory staff receive education for new procedures and newly acquired or recognized hazardous materials.	√	√	
2	Individuals with adequate training, skills, orientation, and experience administer the tests and interpret the results.			

Table 4.8 JCIAS Evaluation Matrix of Laboratory Process-FC-FA-A (Cont.)

	Those individuals who perform testing and those who direct or supervise testing are identified.	√	√	
	Appropriately trained and experienced staffs administer tests.	√	√	√
	Appropriately trained and experienced staffs interpret tests.	√	√	√
	There is an adequate number of staff to meet patient needs.	√	√	
	Supervisory staff have appropriate training and experience.	√	√	
3	Laboratory results are available in a timely way as defined by the organization.			
	The organization has established the expected report time for results.	√	√	
	The timeliness of reporting of urgent/emergency tests is monitored.	√	X	X
	Laboratory results are reported within a time frame to meet patient needs.	√	√	
4	There is a laboratory equipment management program and it is implemented.			
	The program includes selecting and acquiring equipment.	√	√	
	The program includes inventorying equipment.	√	√	
	The program includes inspecting and testing equipment.	√	√	
	The program includes calibrating and maintaining equipment.	√	√	
	The program includes monitoring and follow-up.	√	√	
	All testing, maintenance, and calibration of equipment are adequately documented.	√	√	√
5	Essential reagents and other supplies are regularly available.			
	Essential reagents and supplies are identified.	√	√	
	Essential reagents and supplies are available.	√	√	
	All reagents are stored and dispensed according to guidelines.	√	√	
	All reagents are periodically evaluated for accuracy and results.	√	√	
	All reagents and solutions are completely and accurately labeled according to guidelines.	√	√	
6	Procedures for collecting, identifying, handling, safely transporting, and disposing of specimens are followed			
	Procedures guide the ordering of tests.	√	√	
	Procedures guide the collection and identification of specimens.	√	√	
	Procedures guide the transport, storage, and preservation of specimens.	√	√	
	Procedures guide the receipt and tracking of specimens.	√	√	
	The procedures are implemented.	√	√	

Table 4.8 JCIAS Evaluation Matrix of Laboratory Process-FC-FA-A (Cont.)

	The procedures are observed when outside sources or services are used.	X		
7	The laboratory has established reference ranges for each test performed.			
	The range is included in the clinical record at the time test results are reported.	√	√	√
	Ranges are furnished when tests are performed by outside sources.	X		X
	Ranges are appropriate to the organization's geography and demographics.	√	√	√
	Ranges are reviewed and updated as needed.	√	√	√
8	The clinical laboratory, and other laboratory services throughout the organization, are under the direction and oversight of one or more qualified individuals responsible for carrying out the responsibilities identified in the intent statement.			
	Responsibilities include developing, implementing, and maintaining policies and procedures.	√	√	
	Responsibilities include administrative oversight.	√	√	
	Responsibilities include maintaining quality control programs.	√	√	
	Responsibilities include recommending outside sources of laboratory services.	X		
	Responsibilities include monitoring and reviewing all laboratory services within and outside of the laboratory.	√	√	√
9	There is a quality control program for the clinical laboratory.			
	The program includes the validation of test methods.	√	√	√
	The program includes the daily surveillance of test results.	√	√	√
	The program includes rapid correction of deficiencies.	√	√	√
	The program includes the documentation of results and corrective actions.	√	√	√
10	The organization regularly reviews quality control results for all outside sources of laboratory services.			
	Quality control results from outside sources are regularly reviewed.	X		
	Qualified individuals review the quality control results.	X		
11	The organization has access to experts in specialized diagnostic areas when necessary			
	A roster of experts for specialized diagnostic areas is maintained.	√	√	
	Experts in specialized diagnostic areas are contacted when needed.	√	√	

Table 4.9 JCIAS Evaluation Matrix of Laboratory Process-SD-ED

No	Measurable Elements	Understandability	Learnability
		Sufficiency of Documentation	Effectiveness of the User Documentation
1	A laboratory safety program is in place and is appropriate to the risks and hazards encountered.		
	The program is coordinated with the organization's safety management program.		
	Written policies and procedures address the handling and disposal of infectious and hazardous materials.	√	√
	Appropriate safety devices are available.		
	Laboratory staff are oriented to safety procedures and practices.		
	Laboratory staff receive education for new procedures and newly acquired or recognized hazardous materials.		
2	Individuals with adequate training, skills, orientation, and experience administer the tests and interpret the results.		
	Those individuals who perform testing and those who direct or supervise testing are identified.		
	Appropriately trained and experienced staff administer tests.		
	Appropriately trained and experienced staff interpret tests.		
	There is an adequate number of staff to meet patient needs.		
	Supervisory staff have appropriate training and experience.		
3	Laboratory results are available in a timely way as defined by the organization.		
	The organization has established the expected report time for results.	√	√
	The timeliness of reporting of urgent/emergency tests is monitored.		
	Laboratory results are reported within a time frame to meet patient needs.		
4	There is a laboratory equipment management program and it is implemented.		
	The program includes selecting and acquiring equipment.		
	The program includes inventorying equipment.		
	The program includes inspecting and testing equipment.		
	The program includes calibrating and maintaining equipment.		
	The program includes monitoring and follow-up.		
	All testing, maintenance, and calibration of equipment are adequately documented.	√	√

Table 4.9 JCIAS Evaluation Matrix of Laboratory Process-SD-ED (Cont.)

5	Essential reagents and other supplies are regularly available.		
	Essential reagents and supplies are identified.		
	Essential reagents and supplies are available.		
	All reagents are stored and dispensed according to guidelines.		
	All reagents are periodically evaluated for accuracy and results.		
	All reagents and solutions are completely and accurately labeled according to guidelines.		
6	Procedures for collecting, identifying, handling, safely transporting, and disposing of specimens are followed		
	Procedures guide the ordering of tests.	√	√
	Procedures guide the collection and identification of specimens.	√	√
	Procedures guide the transport, storage, and preservation of specimens.	√	√
	Procedures guide the receipt and tracking of specimens.	√	√
	The procedures are implemented.		
	The procedures are observed when outside sources or services are used.		
7	The laboratory has established reference ranges for each test performed.		
	The range is included in the clinical record at the time test results are reported.		
	Ranges are furnished when tests are performed by outside sources.		
	Ranges are appropriate to the organization's geography and demographics.		
	Ranges are reviewed and updated as needed.		
8	The clinical laboratory, and other laboratory services throughout the organization, are under the direction and oversight of one or more qualified individuals responsible for carrying out the responsibilities identified in the intent statement.		
	Responsibilities include developing, implementing, and maintaining policies and procedures.		
	Responsibilities include administrative oversight.		
	Responsibilities include maintaining quality control programs.		
	Responsibilities include recommending outside sources of laboratory services.		
	Responsibilities include monitoring and reviewing all laboratory services within and outside of the laboratory.		

Table 4.9 JCIAS Evaluation Matrix of Laboratory Process-SD-ED (Cont.)

9	There is a quality control program for the clinical laboratory.		
	The program includes the validation of test methods.	√	√
	The program includes the daily surveillance of test results.	√	√
	The program includes rapid correction of deficiencies.	√	√
	The program includes the documentation of results and corrective actions.	√	√
10	The organization regularly reviews quality control results for all outside sources of laboratory services.		
	Quality control results from outside sources are regularly reviewed.		
	Qualified individuals review the quality control results.		
11	The organization has access to experts in specialized diagnostic areas when necessary		
	A roster of experts for specialized diagnostic areas is maintained.		
	Experts in specialized diagnostic areas are contacted when needed.		

4.3.3.1.3 Efficiency Indicator Record (EIR)

Organizational efficiency information is given below:

Number of performed tests(daily)	:	19000
Number of rejected tests(daily)	:	0
Number of faulty performed tests(daily)	:	40/30
Number of staff	:	81
Number of machines	:	51

4.3.3.1.4 Attractiveness Indicator Record (AIR)

Total score of 1 SSQ is 25 and it was applied to 10 staff. Total score got from 10 staff was 173.Total score of 1 PSQ is 25 and it is applied to 13 patients. Total score got from 13 patients was 254.

4.3.3.1.5 Measurement Results

Measurement results of laboratory process are given in Table 4.10.

Table 4.10 Measurement Results of Laboratory Process

	Quality Attribute	Measured From		Result
FC	Functional completeness	JEM	1-5/47	0.89
FA	Functional adequacy	JEM	1-1/42	0.98
A	Accuracy	JEM	11/13	0.85
IO	Interoperability	PEM	8/9	0.89
AC	Access controllability	PEM	3/6	0.50
OA	Operation audibility	PEM	8/16	0.50
R	Restorability	PEM	5/5	1.00
SD	Sufficiency of documentation	JEM	11/11	1.00
ED	Effectiveness of the documentation	JEM	11/11	1.00
PA	Physical accessibility	PEM	5/5	1.00
US	User satisfaction	AIR	173/250	0.69
PS	Patient satisfaction	AIR	254/325	0.78
RT	Response time(daily)	EIR	19000/19000	1.00
PA	Staff adequacy level	EIR	81/81	1.00
AR	Acceptance ratio(daily)	EIR	(19000-0)/19000	1.00
	Quality Attribute			Result
FR	Fault ratio(Faulty performed tests(daily))	EIR	(40/30)/19000	0.0000
SR	Staffing ratio(daily)	EIR	81/19000	0.0043
MU	Machine utilization(daily)	EIR	51/19000	0.0027

4.3.3.1.6 Measurement Details

In this section details of each measure will be given in formula, result, and not performed activities/measurable elements headings.

1. Functional Completeness

$$\text{FC} = 1 - \frac{\text{Number of missing measurable elements detected in evaluation}}{\text{Number of measurable elements described in JCIAS}}$$

$$\text{FC} = 1 - 5/47 = 0.89$$

Number of measurement elements described in JCIAS is 47 and, missing measurable elements detected in evaluation is 5. These measurable elements are listed below:

1. Procedures for collecting, identifying, handling, safely transporting, and disposing are observed when outside sources or services are used.
2. Ranges are furnished when tests are performed by outside sources.
3. Responsibilities include recommending outside sources of laboratory services.
4. Quality control results from outside sources are regularly reviewed.
5. Qualified individuals review the quality control results.

2. Functional Adequacy

$$1 - \frac{\text{Number of measurable elements in which problems are detected in evaluation}}{\text{Number of measurable elements reviewed}}$$

FA=1-1/42=0.98

Number of measurable elements reviewed (it is also the number of performed measurable elements) is 42 and, in these measurable elements only 1 of them is not performed adequately. This measurable element is:

1. The timeliness of reporting of urgent/emergency tests is monitored.

3. Accuracy

$$\frac{\text{Number of measurable elements in which specific accuracy req. had been implemented}}{\text{Number of measurable elements for which specific accuracy req. need to be implemented}}$$

A=11/13=0.85

Number of measurable elements in which specific accuracy requirement shad been implemented is 11, and the number of measurement elements for which specific accuracy requirements need to be implemented is 13. The 2 not implemented measurable elements are given below:

1. The timeliness of reporting of urgent/emergency tests is monitored.
2. Ranges are furnished when tests are performed by outside sources.

4. Interoperability

$$\frac{\text{Number of interoperable activities that have been implemented correctly}}{\text{Number of interoperable activities in the process}}$$

IO=8/9=0.89

Number of interoperable activities that have been implemented correctly is 8, and the number of interoperable activities in the process is 9. The interoperability activity that has NOT been implemented correctly is 1 and given below:

1. Interoperability with department secretary. When acceptance criteria is not satisfied. Accessing to patient may not be possible.

5. Access Controllability

$$\frac{\text{Number of access controllability requirements implemented correctly}}{\text{Number of access controllability requirements in the process}}$$

$$AC=3/6=0.50$$

Number of access controllability requirements implemented correctly is 3, and the number of access controllability requirements in the process is 6. The access controllability requirements NOT implemented correctly are:

1. Access to pneumatic system is not under control
2. Access to decompose machines is not under control.
3. Access to test machines is not under control.

6. Operation Audibility

$$\frac{\text{Number of activities actually recorded during operation}}{\text{Number of activities planned to be recorded}}$$

$$OA=8/16 = 0.50$$

Number of activities actually recorded during the operation is 8, and the number of activities planned to be recorded is 16. The number of activities NOT recorded during operation is 8 and listed below:

1. Who checked LIS is not auditable.
2. Who draw blood is not auditable.
3. Who printed barcodes is not auditable.
4. Who applied acceptance criteria is not auditable.
5. Who called department secretary is not auditable.
6. Who sent bloods to decompose section is not auditable.
7. Who decomposed bloods is not auditable.

8. Who called physician is not auditable.

7. Restorability

$$\frac{\text{Number of activities that are restorable during operation}}{\text{Total number of activities that need restorability in process execution}}$$

$$R=5/5= 1.00$$

Number of activities that are restorable during the operation is 5, and the total number of activities that need restorability in process execution is also 5. Therefore, it is determined that all the activities are restorable in the process.

8. Sufficiency Of Documentation

$$\frac{\text{Number of measurable elements documented sufficiently}}{\text{Number of measurable elements need to be documented}}$$

$$SD=11/11=1.00$$

Number of measurable elements documented sufficiently is 11, and the number of measurable elements that are needed to be documented is also 11. So, it can be inferred that the process is documented sufficiently.

9. Effectiveness Of The Documentation

$$\frac{\text{Number of documented measurable elements that are used effectively}}{\text{Number of measurable elements that are documented}}$$

$$ED=11/11=1$$

Value of ED is 1. It is determined that all the documentation related measurable elements are performed by the hospital.

10. Physical Accessibility

$$\frac{\text{Number of functions in which physical accessibility req. had been implemented}}{\text{Number of functions for which physical access. req. need to be implemented}}$$

$$PA=5/5 = 1$$

Number of functions in which physical accessibility requirements had been implemented is 5, and the number of functions for which physical accessibility requirements that are needed to be implemented is 5.

11. User/Staff Satisfaction

$$\frac{\text{Total points get from Staff Satisfaction Questionnaire}}{\text{Total points of Staff Satisfaction Questionnaire}}$$

US=173/250 = 0.69

Staff satisfaction questionnaire is applied to 10 staff, and each questionnaire has a total of 25 points. After applying questionnaire, it is specified that a total of 173 points get from 10 questionnaire forms.

12. Patient Satisfaction

$$\frac{\text{Total points get from Patient Satisfaction Questionnaire}}{\text{Total points of Patient Satisfaction Questionnaire}}$$

PS=254/325= 0.78

Patient satisfaction questionnaire is applied to 13 patients, and each questionnaire has a total of 25 points. After applying questionnaire, it is specified that a total of 254 points get from 13 questionnaire forms.

13. Response Time

$$\frac{\text{Number of tasks which are performed in specified time}}{\text{Number of tasks}}$$

RT=19000/19000 = 1.00

The number of tasks which are performed in specified time is 19000 (it is also the number of responded requests-daily), and the number of daily performed tasks is 19000. It is specified during the interviews that all the requests are responded by the hospital.

14. Staff Adequacy Level

$$\frac{\text{Number of staff who received required trainings}}{\text{Number of staff}}$$

SA=81/81 = 1.00

The number of staff who received required trainings is 81 (it is also the number of staff, and it is specified that all the staff must get the required trainings).

15. Fault Ratio

$$\frac{\text{Number of detected failures}}{\text{Number of performed cases during process execution}}$$

FR = (40/30)/19000 = 0.0000

Number of detected failures through a month is 40 and the number of performed tests daily is 19000. Thus the fault ratio is very small and it approaches to 0.

16. Staffing Ratio

$$\frac{\text{Number of staff}}{\text{Number of tasks}}$$

SR=81/19000 = 0.0043

Number of staff in Laboratory is 81, and the number of performed tests-daily is 19000.

17. Acceptance Ratio

$$\frac{\text{Number of daily accepted patients}}{\text{Number of daily applied patients}}$$

AR= 19000/19000 = 1.00

Number of NOT rejected tests-daily is 19000 and it is specified that, as the hospital is the biggest hospital in the region, all the requests are handled by the hospital.

18. Machine Utilization

$$\frac{\text{Number of unit related machines}}{\text{Average number of daily patients}}$$

MU=51/19000 = 0.0027

Number of unit related machines is 51, and the number of daily performed tests is 19000.

4.3.3.2 Assessment Services

In this section firstly, process description will be given briefly, secondly, activities and measurable elements of process will be presented. Next, assessment services process diagram is provided, and lastly measurement results and their details are given.

Process Description: A patient assessment process results in decisions about the patient's immediate and continuing treatment needs for emergency, elective or planned care, even when the patient's condition changes. Patient assessment is an ongoing, dynamic process that takes place in many inpatient and outpatient settings and departments and clinics. Patient assessment consists of three primary processes:

- Collecting information and data on the patient's physical, psychological, social status, and health history
- Analyzing the data and information, including the results of laboratory and imaging diagnostic tests, to identify the patient's health care needs
- Developing a plan of care to meet the patient's identified needs

Activities: The activities employed in the Assessment process are given in the following table.

Table 4.11 Activities Employed in the Assessment Process

No	Activity	Executed By
1	Checking medical history	Physician
2	Getting anamnesis	Physician
3	Physical assessment	Physician
4	Prediagnosing illness	Physician
5	Ordering tests	Physician
6	Ordering consultation	Physician
7	Sending patient to related clinic	Physician
8	Specifying illness	Physician
9	Planning treatment	Physician
10	Assessing operation needs	Physician
11	Giving prescriptions and suggestions	Physician
12	Assessing nutritional needs	Physician
13	Giving report to patient	Physician
14	Recording assessment results	Physician

JCIAS Measurable Elements:

Table 4.12 Measurable Elements Employed in the Assessment Process

No	Measurable Elements
1.1	The organization has determined the scope and content of assessments, based on applicable laws and regulations and professional standards.
	The scope and content of assessments by each clinical discipline are defined in policies.
	The scope and content of assessments performed in inpatient and outpatient settings are defined in policies.
1.2	Each patient's initial assessment(s) include an evaluation of physical, psychological, social, and economic factors, including a physical examination and health history.
	All inpatients and outpatients have an initial assessment(s) that meets organization policy.
	The medical assessment includes a health history and a physical examination consistent with the scope and content defined in hospital policy.
	Each patient receives an initial psychological assessment as appropriate to their needs.
	Each patient receives an initial social and economic assessment as appropriate to their needs.
	The initial assessment(s) results in understanding any previous care and the care the patient is currently seeking.
	The initial assessment(s) results in selecting the best setting for the care.
	The initial assessment(s) results in an initial diagnosis.

Table 4.12 Measurable Elements Employed in the Assessment Process (Cont.)

1.3	The patient's medical and nursing needs are identified from the initial assessments.
	The initial assessment results in the identification of patients' medical needs.
	Medical needs are identified based on the documented health history and physical examination as well as other assessments required in accordance with hospital policy.
	The initial assessment results in the identification of patients' nursing needs.
	The nursing care needs of the patient are identified based on the nurse's documented assessment, the medical assessment, as well as other assessments required in accordance with hospital policy.
1.4	Assessments are completed in the time frame prescribed by the organization.
	Appropriate time frames for performing assessments are established for all settings and services.
	Assessments are completed within the time frames established by the organization.
	The findings of all assessments performed outside the organization are reviewed and/or verified at the time of admission to inpatient status.
1.5	Assessment findings are documented in the patient's record and readily available to those responsible for the patient's care.
	Assessment findings are documented in the patient's record.
	Those caring for the patient can find and retrieve assessments as needed from the patient's record or other standardized accessible location.
	Medical assessments are documented in the patient's record within 24 hours of admission.
	Nursing assessments are documented in the patient's record within 24 hours of admission.
1.6	Patients are screened for nutritional status and functional needs and are referred for further assessment and treatment when necessary.
	Qualified individuals develop criteria to identify patients who require further nutritional assessment.
	Patients are screened for nutritional risk as part of the initial assessment.
	Patients at risk for nutritional problems according to the criteria receive a nutritional assessment.
	Qualified individuals develop criteria to identify patients who require further functional assessment.
	Patients are screened for their need for further functional assessment as part of the initial assessment.
	Patients in need of a functional assessment according to the criteria are referred for such an assessment.
1.7	The organization conducts individualized initial assessments for special populations cared for by the organization.
	The organization identifies those patient populations and special situations for which the initial assessment process is modified.
	These special patient populations, including those relevant populations noted in the intent statement, receive individualized assessments.
1.8	The initial assessment includes determining the need for additional specialized assessments.
	When the need for additional specialized assessments is identified, patients are referred within the organization or outside the organization.
	Specialized assessments conducted within the organization are completed and documented in the patient's record.

Table 4.12 Measurable Elements Employed in the Assessment Process (Cont.)

2	All patients are reassessed at appropriate intervals to determine their response to treatment and to plan for continued treatment or discharge.
	Patients are reassessed to determine their response to treatment.
	Patients are reassessed to plan for continued treatment or discharge.
	Patients are reassessed at intervals appropriate to their condition, plan of care, and individual needs or according to organization policies and procedures.
	A physician reassesses patients daily, including weekends, during the acute phase of their care and treatment.
	Organization policy defines the circumstances, types of patients or patient populations for which a physician's assessment may be less than daily and identifies the reassessment interval for these patients.
	Reassessments are documented in the patient's record.
3	Qualified individuals conduct the assessments and reassessments.
	Individuals qualified to conduct patient assessments and reassessments are identified by the organization.
	Only those individuals permitted by licensure, applicable laws and regulations, or certification perform patient assessments.
	Emergency assessments are conducted by individuals qualified to do so.
	Nursing assessments are conducted by individuals qualified to do so.
	Those qualified to conduct patient assessments and reassessments have their responsibilities defined in writing.
4	Medical, nursing, and other individuals and services responsible for patient care collaborate to analyze and integrate patient assessments.
	Patient needs are prioritized based on assessment results.
	The patient and his or her family are informed of the outcomes of the assessment process and any confirmed diagnosis when appropriate.
	The patient and his or her family are informed of the planned care and treatment and participate in the decisions about the priority needs to be met.

The process modeling of the Assessment process is given in Figure 4.2.

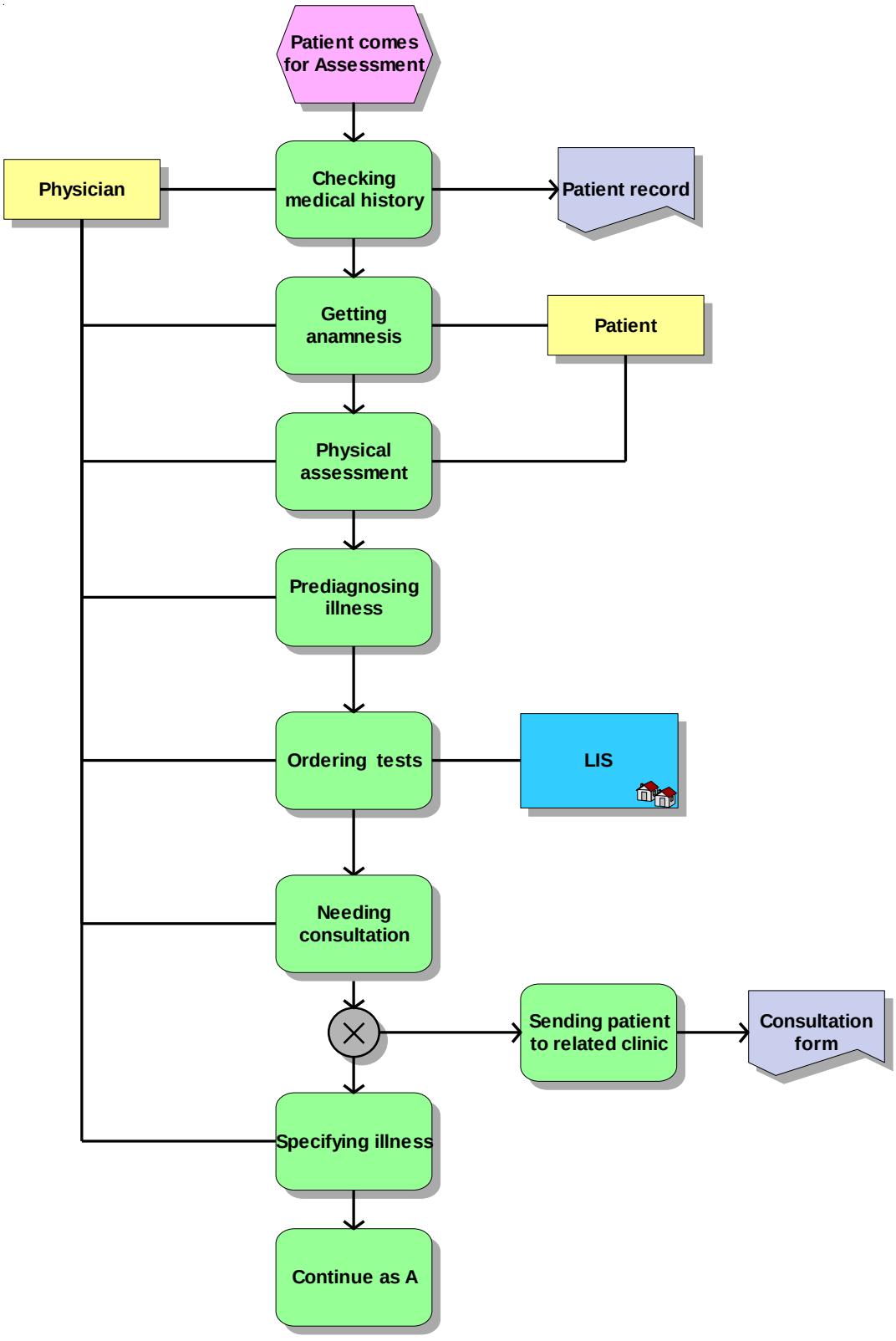

Figure 4.2 Assessment Process Diagram

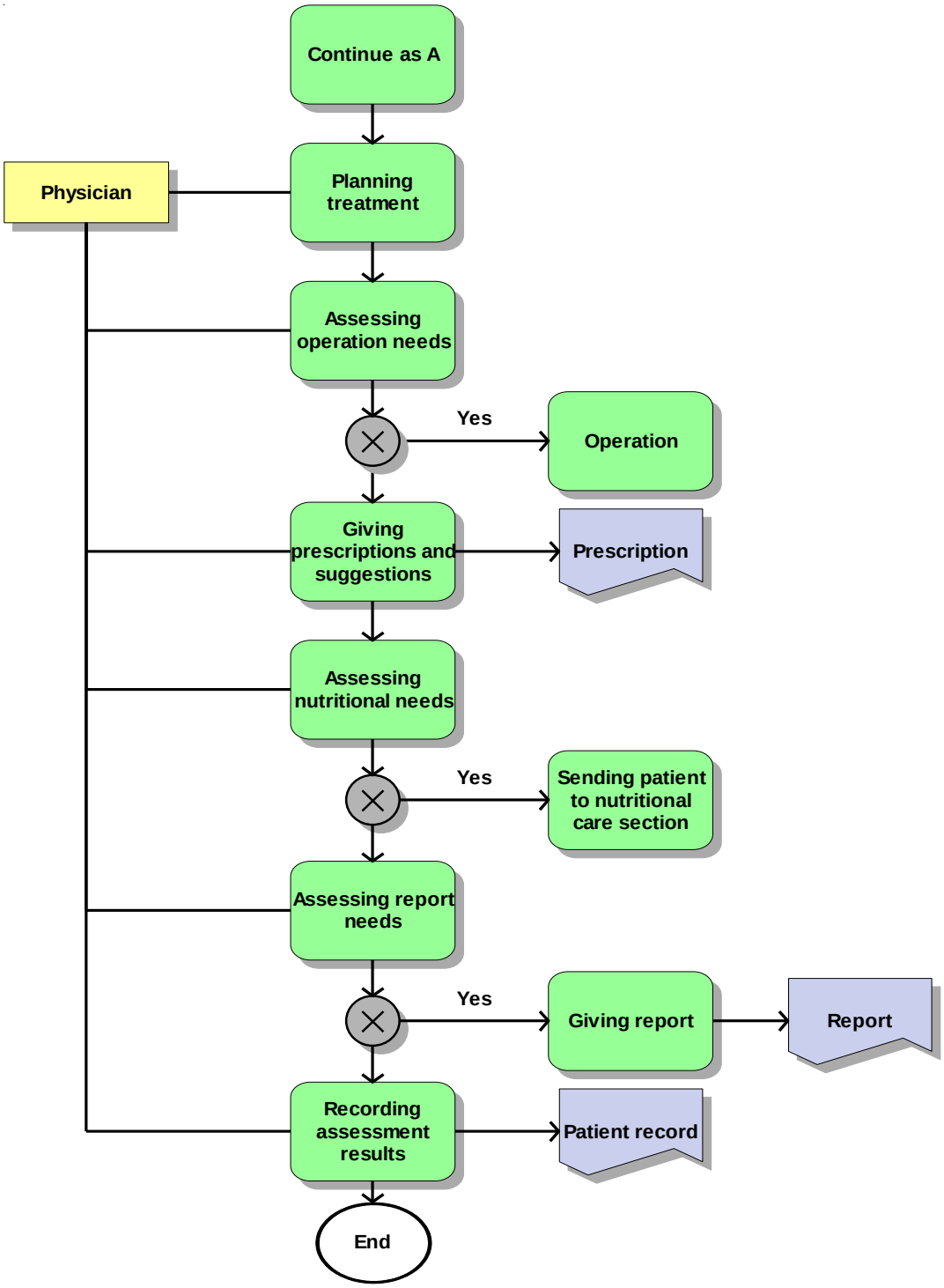

Figure 4.2 Assessment Process Diagram (Cont.)

In the next sections, the assets of assessment process measurement are provided in Process Evaluation Matrix, JCIAS Evaluation Matrix, Efficiency Indicator Record, and Attractiveness Indicator Record headings. After that, overall measurement result is provided.

4.3.3.2.1 Process Evaluation Matrix (PEM)

The process evaluation matrix of assessment process is provided in below tables.

Table 4.13 Process Evaluation Matrix of Assessment Process-IO-AC

No	Activity	Interoperability (IO)	Access Controllability(AC)
1	Checking medical history	Interoperability with the findings of all assessments performed outside the organization. These assessments are reviewed and/or verified at the time of admission.	Access of physician to Patient Record is not under control.
2	Getting anamnesis	Interoperability with patient.	No access controllability.
3	Physical assessment	No interaction.	No access controllability.
4	Prediagnosing illness	No interaction	No access controllability.
5	Ordering tests	Interoperability with LIS. Sometimes there are transmitting problems.	Access of physician to LIS is controlled.
6	Ordering consultation	No interaction.	No access controllability.
7	Sending patient to related clinic	Interoperability with related clinic.	No access controllability.
8	Specifying illness	No interaction.	No access controllability.
9	Planning treatment	No interaction.	No access controllability.
10	Assessing operation needs	No interaction.	No access controllability.
11	Giving prescriptions and suggestions	Interoperability with patient. There is no problem with the interaction.	No access controllability.
12	Assessing nutritional needs	No interaction.	No access controllability.
13	Giving report to patient	No interaction.	No access controllability.
14	Recording assessment results	No interaction.	No access controllability.

Table 4.14 Process Evaluation Matrix of Assessment Process-OA-R

No	Activity	Operation Audibility(OA)	Restorability(R)
1	Checking medical history	Whether medical history is checked or not is not auditable.	No restorability.
2	Getting anamnesis	Anamnesis is auditable.	No restorability.
3	Physical assessment	Physical assessment results are not auditable.	No restorability.
4	Prediagnosing illness	Which prediagnosed illness is specified is not auditable.	No restorability.
5	Ordering tests	Which tests are ordered is auditable.	No restorability.
6	Ordering consultation	Whether physician ordered consultation or not is auditable. Consultation information is recorded into Consultation Form.	Ordered tests are written to LIS and restoration of this data is possible.
7	Sending patient to related clinic	No operation audibility.	No restorability.
8	Specifying illness	Which illness is specified is auditable.	No restorability.
9	Planning treatment	Planned treatment is not auditable.	No restorability.
10	Assessing operation needs	Assessment results of operation needs are not auditable.	No restorability.
11	Giving prescriptions and suggestions	Given prescriptions are auditable.	No restorability.
12	Assessing nutritional needs	Assessment results of nutritional needs are not auditable.	No restorability.
13	Giving report to patient	Report details are auditable.	No restorability.
14	Recording assessment results	Who recorded assessment results is auditable.	Assessment results are recorded into patient record and restorability of this data is not possible.

Table 4.15 Process Evaluation Matrix of Assessment Process-PA

No	Activity	Physical Accessibility(PA)
1	Checking medical history	Physical accessibility to patient record is not always possible. Because, it can be in another department.
2	Getting anamnesis	No physical accessibility.
3	Physical assessment	No physical accessibility.
4	Prediagnosing illness	No physical accessibility.
5	Ordering tests	Getting test results on time is not always possible.
6	Ordering consultation	No physical accessibility.
7	Sending patient to related clinic	No physical accessibility.
8	Specifying illness	No physical accessibility.
9	Planning treatment	No physical accessibility.
10	Assessing operation needs	No physical accessibility.
11	Giving prescriptions and suggestions	No physical accessibility.
12	Assessing nutritional needs	No physical accessibility.
13	Giving report to patient	No physical accessibility.
14	Recording assessment results	No physical accessibility.

4.3.3.2.2 JCIAS Evaluation Matrix (JEM)

The JCIAS evaluation matrix of assessment process is provided in below tables.

Table 4.16 JCIAS Evaluation Matrix of Assessment Process FC-FA-A

No	Measurable Elements	Suitability		Accuracy
		Func. Comp	Functional Adequacy	Accuracy
1.1	The organization has determined the scope and content of assessments, based on applicable laws and regulations and professional standards.			
	The scope and content of assessments by each clinical discipline are defined in policies.	√	√	√
	The scope and content of assessments performed in inpatient and outpatient settings are defined in policies.	√	√	√

Table 4.16 JCIAS Evaluation Matrix of Assessment Process FC-FA-A (Cont.)

1.2	Each patient's initial assessment(s) include an evaluation of physical, psychological, social, and economic factors, including a physical examination and health history.			
	All inpatients and outpatients have an initial assessment(s) that meets organization policy.	√	√	√
	The medical assessment includes a health history and a physical examination consistent with the scope and content defined in hospital policy.	√	√	√
	Each patient receives an initial psychological assessment as appropriate to their needs.	√	√	
	Each patient receives an initial social and economic assessment as appropriate to their needs.	√	√	
	The initial assessment(s) results in understanding any previous care and the care the patient is currently seeking.	√	√	
	The initial assessment(s) results in selecting the best setting for the care.	√	√	
	The initial assessment(s) results in an initial diagnosis.	√	√	
1.3	The patient's medical and nursing needs are identified from the initial assessments.			
	The initial assessment results in the identification of patients' medical needs.	√	√	
	Medical needs are identified based on the documented health history and physical examination as well as other assessments required in accordance with hospital policy.	√	√	√
	The initial assessment results in the identification of patients' nursing needs.	√	√	
	The nursing care needs of the patient are identified based on the nurse's documented assessment, the medical assessment, as well as other assessments required in accordance with hospital policy.	√	√	√
1.4	Assessments are completed in the time frame prescribed by the organization.			
	Appropriate time frames for performing assessments are established for all settings and services.	**X**		
	Assessments are completed within the time frames established by the organization.	**X**		
	The findings of all assessments performed outside the organization are reviewed and/or verified at the time of admission to inpatient status.	√	√	

Table 4.16 JCIAS Evaluation Matrix of Assessment Process FC-FA-A (Cont.)

1.5	Assessment findings are documented in the patient's record and readily available to those responsible for the patient's care.			
	Assessment findings are documented in the patient's record.	√	√	
	Those caring for the patient can find and retrieve assessments as needed from the patient's record or other standardized accessible location.	√	X	
	Medical assessments are documented in the patient's record within 24 hours of admission.	√	√	
	Nursing assessments are documented in the patient's record within 24 hours of admission.	√	√	
1.6	Patients are screened for nutritional status and functional needs and are referred for further assessment and treatment when necessary.			
	Qualified individuals develop criteria to identify patients who require further nutritional assessment.	X		X
	Patients are screened for nutritional risk as part of the initial assessment.	√	√	
	Patients at risk for nutritional problems according to the criteria receive a nutritional assessment.	√	√	
	Qualified individuals develop criteria to identify patients who require further functional assessment.	X		X
	Patients are screened for their need for further functional assessment as part of the initial assessment.	√	√	
	Patients in need of a functional assessment according to the criteria are referred for such an assessment.	√	√	
1.7	The organization conducts individualized initial assessments for special populations cared for by the organization.			
	The organization identifies those patient populations and special situations for which the initial assessment process is modified.	√	√	√
	These special patient populations, including those relevant populations noted in the intent statement, receive individualized assessments.	√	√	
1.8	The initial assessment includes determining the need for additional specialized assessments.			
	When the need for additional specialized assessments is identified, patients are referred within the organization or outside the organization.	√	√	
	Specialized assessments conducted within the organization are completed and documented in the patient's record.	√	√	

Table 4.16 JCIAS Evaluation Matrix of Assessment Process FC-FA-A (Cont.)

2	All patients are reassessed at appropriate intervals to determine their response to treatment and to plan for continued treatment or discharge.			
	Patients are reassessed to determine their response to treatment.	√	√	
	Patients are reassessed to plan for continued treatment or discharge.	√	√	
	Patients are reassessed at intervals appropriate to their condition, plan of care, and individual needs or according to organization policies and procedures.	√	√	
	A physician reassesses patients daily, including weekends, during the acute phase of their care and treatment.	√	√	
	Organization policy defines the circumstances, types of patients or patient populations for which a physician's assessment may be less than daily and identifies the reassessment interval for these patients.	**X**		**X**
	Reassessments are documented in the patient's record.	√	√	
3	Qualified individuals conduct the assessments and reassessments.			
	Individuals qualified to conduct patient assessments and reassessments are identified by the organization.	√	√	√
	Only those individuals permitted by licensure, applicable laws and regulations, or certification perform patient assessments.	√	√	√
	Emergency assessments are conducted by individuals qualified to do so.	√	√	√
	Nursing assessments are conducted by individuals qualified to do so.	√	√	√
	Those qualified to conduct patient assessments and reassessments have their responsibilities defined in writing.	√	√	√
4	Medical, nursing, and other individuals and services responsible for patient care collaborate to analyze and integrate patient assessments.			
	Patient needs are prioritized based on assessment results.	√	√	
	The patient and his or her family are informed of the outcomes of the assessment process and any confirmed diagnosis when appropriate.	√	√	
	The patient and his or her family are informed of the planned care and treatment and participate in the decisions about the priority needs to be met.	√	√	

Table 4.17 JCIAS Evaluation Matrix of Assessment Process-SD-ED

No	Measurable Elements	Understandability	Learnability
		Sufficiency of Documentation	**Effectiveness of the User Documentation**
1.1	The organization has determined the scope and content of assessments, based on applicable laws and regulations and professional standards.		
	The scope and content of assessments by each clinical discipline are defined in policies.	√	√
	The scope and content of assessments performed in inpatient and outpatient settings are defined in policies.	√	√
1.2	Each patient's initial assessment(s) include an evaluation of physical, psychological, social, and economic factors, including a physical examination and health history.		
	All inpatients and outpatients have an initial assessment(s) that meets organization policy.		
	The medical assessment includes a health history and a physical examination consistent with the scope and content defined in hospital policy.		
	Each patient receives an initial psychological assessment as appropriate to their needs.		
	Each patient receives an initial social and economic assessment as appropriate to their needs.		
	The initial assessment(s) results in understanding any previous care and the care the patient is currently seeking.		
	The initial assessment(s) results in selecting the best setting for the care.		
	The initial assessment(s) results in an initial diagnosis.		
1.3	The patient's medical and nursing needs are identified from the initial assessments.		
	The initial assessment results in the identification of patients' medical needs.		
	Medical needs are identified based on the documented health history and physical examination as well as other assessments required in accordance with hospital policy.		
	The initial assessment results in the identification of patients' nursing needs.		
	The nursing care needs of the patient are identified based on the nurse's documented assessment, the medical assessment, as well as other assessments required in accordance with hospital policy.		

Table 4.17 JCIAS Evaluation Matrix of Assessment Process-SD-ED (Cont.)

1.4	Assessments are completed in the time frame prescribed by the organization.		
	Appropriate time frames for performing assessments are established for all settings and services.		
	Assessments are completed within the time frames established by the organization.		
	The findings of all assessments performed outside the organization are reviewed and/or verified at the time of admission to inpatient status.		
1.5	Assessment findings are documented in the patient's record and readily available to those responsible for the patient's care.		
	Assessment findings are documented in the patient's record.		
	Those caring for the patient can find and retrieve assessments as needed from the patient's record or other standardized accessible location.		
	Medical assessments are documented in the patient's record within 24 hours of admission.		
	Nursing assessments are documented in the patient's record within 24 hours of admission.		
1.6	Patients are screened for nutritional status and functional needs and are referred for further assessment and treatment when necessary.		
	Qualified individuals develop criteria to identify patients who require further nutritional assessment.	X	
	Patients are screened for nutritional risk as part of the initial assessment.		
	Patients at risk for nutritional problems according to the criteria receive a nutritional assessment.		
	Qualified individuals develop criteria to identify patients who require further functional assessment.	X	
	Patients are screened for their need for further functional assessment as part of the initial assessment.		
	Patients in need of a functional assessment according to the criteria are referred for such an assessment.		
1.7	The organization conducts individualized initial assessments for special populations cared for by the organization.		
	The organization identifies those patient populations and special situations for which the initial assessment process is modified.	√	√
	These special patient populations, including those relevant populations noted in the intent statement, receive individualized assessments.		

Table 4.17 JCIAS Evaluation Matrix of Assessment Process-SD-ED (Cont.)

1.8	The initial assessment includes determining the need for additional specialized assessments.		
	When the need for additional specialized assessments is identified, patients are referred within the organization or outside the organization.		
	Specialized assessments conducted within the organization are completed and documented in the patient's record.		
2	All patients are reassessed at appropriate intervals to determine their response to treatment and to plan for continued treatment or discharge.		
	Patients are reassessed to determine their response to treatment.		
	Patients are reassessed to plan for continued treatment or discharge.		
	Patients are reassessed at intervals appropriate to their condition, plan of care, and individual needs or according to organization policies and procedures.		
	A physician reassesses patients daily, including weekends, during the acute phase of their care and treatment.		
	Organization policy defines the circumstances, types of patients or patient populations for which a physician's assessment may be less than daily and identifies the reassessment interval for these patients.	X	
	Reassessments are documented in the patient's record.		
3	Qualified individuals conduct the assessments and reassessments.		
	Individuals qualified to conduct patient assessments and reassessments are identified by the organization.	√	√
	Only those individuals permitted by licensure, applicable laws and regulations, or certification perform patient assessments.		
	Emergency assessments are conducted by individuals qualified to do so.		
	Nursing assessments are conducted by individuals qualified to do so.		
	Those qualified to conduct patient assessments and reassessments have their responsibilities defined in writing.	√	√

Table 4.17 JCIAS Evaluation Matrix of Assessment Process-SD-ED (Cont.)

4	Medical, nursing, and other individuals and services responsible for patient care collaborate to analyze and integrate patient assessments.		
	Patient needs are prioritized based on assessment results.		
	The patient and his or her family are informed of the outcomes of the assessment process and any confirmed diagnosis when appropriate.		
	The patient and his or her family are informed of the planned care and treatment and participate in the decisions about the priority needs to be met.		

4.3.3.2.3 Efficiency Indicator Record (EIR)

Daily accepted patient number : 100

Number of staff : 12

Referred patients to other hospitals(daily) : 40

4.3.3.2.4 Attractiveness Indicator Record (AIR)

Total score of 1 SSQ is 25 and it was applied to 10 staff. Total score got from 10 staff was 207. Total score of 1 PSQ is 25 and it is applied to 10 patients. Total score got from 10 staff was 206.

4.3.3.2.5 Measurement Results

Measurement results of assessment process are given in Table 4.18.

Table 4.18 Measurement Results of Assessment Process

	Quality Attribute	Measured From		Result
FC	Functional completeness	JEM	1-5/44	0.89
FA	Functional adequacy	JEM	1-1/39	0.97
A	Accuracy	JEM	12/15	0.80
IO	Interoperability	PEM	4/5	0.80
AC	Access controllability	PEM	1/2	0.50
OA	Operation audibility	PEM	7/13	0.54
R	Restorability	PEM	1/2	0.50
SD	Sufficiency of documentation	JEM	5/8	0.63
ED	Effectiveness of the documentation	JEM	5/5	1.00
PA	Physical accessibility	PEM	1/2	0.50
US	User satisfaction	AIR	207/250	0.83
PS	Patient satisfaction	AIR	206/250	0.82
RT	Response time(daily)	EIR	100/100	1.00
PA	Staff adequacy level	EIR	12/12	1.00
AR	Acceptance ratio(daily)	EIR	(100-40)/100	0.60

	Quality Attribute			Result
FR	Fault ratio(Faulty performed tests(daily))	EIR	NA	NA
SR	Staffing ratio(daily)	EIR	12/100	0.1200
MU	Machine utilization(daily)	EIR	NA	NA

4.3.3.2.6 Measurement Details

In this section details of each measure will be given in formula, result, and not performed activities/measurable elements headings.

1. Functional Completeness

$$1 - \frac{\text{Number of missing measurable elements detected in evaluation}}{\text{Number of measurable elements described in JCIAS}}$$

$$FC = 1 - 5/44 = 0.89$$

Number of measurement elements described in JCIAS is44 and, missing measurable elements detected in evaluation is 5. These measurable elements are listed below:

1. Appropriate time frames for performing assessments are established for all settings and services.
2. Assessments are completed within the time frames established by the organization.
3. Qualified individuals develop criteria to identify patients who require further nutritional assessment.
4. Qualified individuals develop criteria to identify patients who require further functional assessment.
5. Organization policy defines the circumstances, types of patients or patient populations for which a physician's assessment may be less than daily and identifies the reassessment interval for these patients.

2. Functional Adequacy

$$1 - \frac{\text{Number of measurement elements in which problems are detected in evaluation}}{\text{Number of measurement elements reviewed}}$$

FA=1-1/39=0.97

Number of measurable elements reviewed (it is also the number of performed measurable elements) is 39 and, in these measurable elements only 1 of them is not performed adequately. This measurable element is:

1. Those caring for the patient can find and retrieve assessments as needed from the patient's record or other standardized accessible location.

3. Accuracy

$$\frac{\text{Number of measurement elements in which specific accuracy req. had been implemented}}{\text{Number of measurement elements for which specific accuracy req. need to be implemented}}$$

A=12/15=0.80

Number of measurable elements in which specific accuracy requirement shad been implemented is 12, and the number of measurement elements for which specific accuracy requirements need to be implemented is 15. The 3 not implemented measurable elements are given below:

1. Qualified individuals develop criteria to identify patients who require further nutritional assessment.

2. Qualified individuals develop criteria to identify patients who require further functional assessment.
3. Organization policy defines the circumstances, types of patients or patient populations for which a physician's assessment may be less than daily and identifies the reassessment interval for these patients.

4. Interoperability

$$\frac{\text{Number of interoperable activities that have been implemented correctly}}{\text{Number of interoperable activities in the process}}$$

IO=4/5=0.80

Number of interoperable activities that have been implemented correctly is4, and the number of interoperable activities in the process is5. The interoperability activity that has NOT been implemented correctly is 1 and given below:

1. Interoperability with archive staff - patient record cannot be accessible sometimes

5. Access Controllability

$$\frac{\text{Number of access controllability requirements implemented correctly}}{\text{Number of access controllability requirements in the process}}$$

AC=1/2=0.50

Number of access controllability requirements implemented correctly is 1, and the number of access controllability requirements in the process is 2. The access controllability requirement NOT implemented correctly is:

1. Access of physician to Patient Record is not under control.

6. Operation Audibility

$$\frac{\text{Number of activities actually recorded during operation}}{\text{Number of activities planned to be recorded}}$$

OA=7/13 = 0.54

Number of activities actually recorded during the operation is 7, and the number of activities planned to be recorded is 13. The number of activities NOT recorded during operation is 6 and listed below:

1. Whether medical history is checked or not is not auditable.
2. Physical assessment results are not auditable.
3. Which prediagnosed illness is specified is not auditable.
4. Planned treatment is not auditable.
5. Assessment results of operation needs are not auditable.
6. Assessment results of nutritional needs are not auditable.

7. Restorability

$$\frac{\text{Number of activities that are restorable during operation}}{\text{Total number of activities that need restorability in process execution}}$$

$$R=1/2 = 0.50$$

Number of activities that are restorable during the operation is 1, and the total number of activities that need restorability in process execution is 2. The NOT implemented restorability requirement is:

1. Assessment results are recorded into patient record and restorability of this data is not possible.

8. Sufficiency Of Documentation

$$\frac{\text{Number of measurable elements documented sufficiently}}{\text{Number of measurable elements need to be documented}}$$

$$SD=5/8=0.63$$

Number of measurable elements documented sufficiently is 5, and the number of measurable elements that are needed to be documented is 8. The number of measurable elements NOT documented during operation is 3 and listed below:

1. Qualified individuals develop criteria to identify patients who require further nutritional assessment.
2. Qualified individuals develop criteria to identify patients who require further functional assessment.

3. Organization policy defines the circumstances, types of patients or patient populations for which a physician's assessment may be less than daily and identifies the reassessment interval for these patients.

9. Effectiveness Of The Documentation

$$\frac{\text{Number of documented measurable elements that are used effectively}}{\text{Number of measurable elements that are documented}}$$

$$ED=5/5=1$$

Value of ED is 1. It is determined that all the documentation related measurable elements are performed by the hospital.

10. Physical Accessibility

$$\frac{\text{Number of functions in which physical accessibility req. had been implemented}}{\text{Number of functions for which physical access. req. need to be implemented}}$$

$$PA=1/2 = 0.50$$

Number of functions in which physical accessibility requirements had been implemented is 1, and the number of functions for which physical accessibility requirements that are needed to be implemented is 2.The number of functions in which physical accessibility requirement had NOT been implemented is 1 and given below:

1. Physical accessibility to patient record is not always possible. Because, it can be in another department.

11. User/Staff Satisfaction

$$\frac{\text{Total points get from Staff Satisfaction Questionnaire}}{\text{Total points of Staff Satisfaction Questionnaire}}$$

$$US=207/250 = 0.83$$

Staff satisfaction questionnaire is applied to 10 staff, and each questionnaire has a total of 25 points. After applying questionnaire, it is specified that a total of 207 points get from 10 questionnaire forms.

12. Patient Satisfaction

$$\frac{\text{Total points get from Patient Satisfaction Questionnaire}}{\text{Total points of Patient Satisfaction Questionnaire}}$$

PS=206/250 = 0.82

Patient satisfaction questionnaire is applied to 10 patients, and each questionnaire has a total of 25 points. After applying questionnaire, it is specified that a total of 206 points get from 10 questionnaire forms.

13. Response Time

$$\frac{\text{Number of tasks which are performed in specified time}}{\text{Number of tasks}}$$

RT=100/100 = 1.00

It is specified during the evaluations that the number of applied patients to department (Chest Diseases) daily is 100 and that all the requests are responded by the department.

14. Staff Adequacy Level

$$\frac{\text{Number of staff who received required trainings}}{\text{Number of staff}}$$

PA=12/12= 1.00

The number of staff who received required trainings is 12 (it is also the number of staff), and it is specified that all the staff must get the required trainings.

15. Fault Ratio

$$\frac{\text{Number of detected failures}}{\text{Number of performed cases during process execution}}$$

FR=NA

As the physicians do not keep any record about detected failures, this measure cannot be calculated.

16. Staffing Ratio

$$\frac{\text{Number of staff}}{\text{Number of tasks}}$$

SR=12/100 = 0.12

Number of staff in department is 12, and the number of daily accepted patient is 100.

17. Acceptance Ratio

$$\frac{\text{Number of daily accepted patients}}{\text{Number of daily applied patients}}$$

AR=60/100 = 0.60

Number of applied patient to department is 100 and number of accepted patient to department is 60. During the evaluations it is specified that due to restricted bed availability in the hospitals, 40% of the patients are not accepted or are given appointments for a future date.

18. Machine Utilization

$$\frac{\text{Number of unit related machines}}{\text{Average number of daily patients}}$$

MU=NA (Not Available)

As the complexity and diversity of used machines in the department, this measure cannot be calculated. It is also specified that because of different capacity and characteristics, using number of machines in calculations may be meaningless.

4.4 Analyzing the Case Study Measurements

The case study results were analyzed to specify candidate areas for process improvement. To do so, limits for the strong and weak aspects were determined based on consensus with process owners. In the current study, values greater than 0.85 were specified as strong aspects, values between 0.76 and 0.85 were neutral, values between 0.70 and 0.75 were specified as close to weak aspects, and 0.69 and lower values were specified as weak aspects.

4.4.1 Laboratory Services

Measurement results diagram of laboratory services was given in Figure 4.3 and weak, close to weak and strong aspects of laboratory process was given Table 4.19. FR, SR, and MU were not presented in the figure. Since, the formula of FR, SR, and MU are as follows: FR = (Number of detected failures/Number of performed cases during process execution), SR = (Number of staff/Number of tasks), and MU = (Number of department related machines/Average number of daily patients), and their results cannot be normalized to 1.

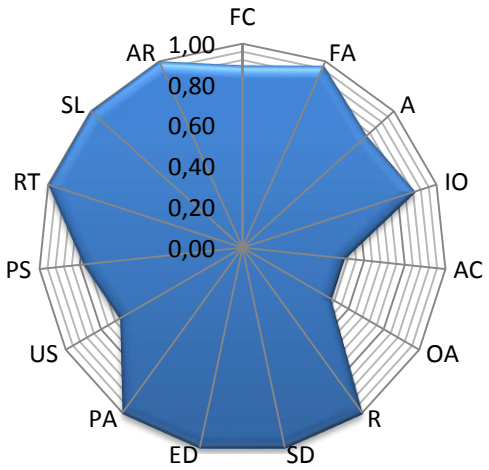

Figure 4.3 Laboratory Services Measurement Results

Table 4.19 Weak, Close to Weak, and Strong Aspects of Laboratory Process

	Quality Attribute	Result
FC	Functional completeness	0.89
FA	Functional adequacy	0.98
A	Accuracy	0.85
IO	Interoperability	0.89
AC	**Access controllability**	**0.50**
OA	**Operation audibility**	**0.50**
R	Restorability	1.00
SD	Sufficiency of documentation	1.00
ED	Effectiveness of the documentation	1.00
PA	Physical accessibility	1.00
SS	**Staff satisfaction**	**0.69**
PS	Patient satisfaction	0.78
RT	Response time(daily)	1.00
SL	Staff adequacy level	1.00
AR	Acceptance ratio(daily)	1.00

	Quality Attribute	Result
FR	Fault ratio(Faulty performed tests(daily))	0.0000
SR	Staffing ratio(daily)	0.0043
MU	Machine utilization(daily)	0.0027

4.4.1.1 Strong Aspects

Functional completeness, Functional adequacy, Accuracy, Interoperability, Restorability, Sufficiency of documentation, Effectiveness of the documentation, Physical accessibility, Response time, Staff adequacy level , Acceptance ratio, and Fault Ratio were the strong aspects. There are 47 activities in the JCIAS for laboratory process and except for 5 activities all the activities were implemented by the hospital. The activities that were not implemented by the hospital are observing procedures when outside sources or services are used, furnishing test ranges when tests are performed by outside sources, and reviewing quality control results from outside sources. The remaining 42 activities were performed by the hospital and as a result, value of Functional completeness is 0.89. Functional adequacy was also high.

Because it was seen that only 1 activity (monitoring the timeliness of reporting of urgent/emergency tests) was not performed adequately and all other activities were performed adequately. So the value of this measure was 0.98. By the usage of the pneumatic systems the value of interoperability measure was increased at the hospital. A pneumatic system provides an environment by which blood samples of patients in different wards can be sent in glass carriers through pipes to laboratories. This is to save time in obtaining test results and to speed up decisions on the mode of treatment. In that way interoperability problems decrease to low levels. In addition patients can access the laboratory test results from the internet and this also increases the value of interoperability. In addition it was observed that high importance was given the documentation and effectively used by the staff. All the process definitions were clearly documented and published at hospital's intranet. Effectiveness of the documentation was strong aspect in the laboratory process since written policies and procedures about handling and disposal of infectious and hazardous materials were used effectively. Furthermore, the hospital documented the expected report time for results and they were used effectively. In addition, all the testing, maintenance, and calibration of equipment were adequately documented and were used effectively. Physical accessibility was measured from the "Appropriate safety devices are available", "Essential reagents and supplies are available" and "Experts in specialized diagnostic areas are contacted when needed" requirements. During the assessment it was observed that all these requirements were met by the organization. In the hospital it was also specified that the responses to all requests were completed on time. Therefore, value of Response time was measured as 1. All the staff was hired according to qualification examinations and they had appropriate training. Thus, the value of Staff adequacy level was measured as 1. As for Acceptance ratio, it was specified that no laboratory order was rejected. Hence, number of rejected applications was zero and value of Acceptance ratio was 1. Number of detected failures through a month was 40 and the number of performed tests daily was 19000. Thus the fault ratio was very small and it was approximately zero.

4.4.1.2 Weak Aspects

Access controllability, Operation audibility, and Staff satisfaction were the weak aspects. For laboratory process, Access controllability was weak aspect in hospital. Further analysis of the causes of weak aspects in relation to Access controllability, we identified that there were 6 activities related to Access controllability and 3 were not managed. These were access to the pneumatic system, access to the decompose machines, and to the test machines. The Operation audibility measure was the second weak aspect since there were 16 Operation audibility related measures and only 8 were audited by the organization (who entered orders, who entered cost information, who sent bloods, who run tests, who checked results, who rerun tests, who checked results, who approved results). Staff satisfaction was determined as third weak aspect because the answer to "Does hospital management takes care of your problems? " is either "No" or "Sometimes". Thus, it can be concluded that hospital management does not give necessary importance to problems that staff may have. In addition some staff specified that they need extra time to complete their tasks and this results in lower staff satisfaction.

4.4.1.3 Pros and Cons of the Process

Pros and cons of laboratory process are given in Table 4.20.

Table 4.20 Pros and Cons of Laboratory Process

Pros	Cons
Pneumatic system	Inadequate training
Central Laboratory	No outside source usage
Good Documentation	Absence of methods which measure the quality of performed tests
Web access to laboratory results	Hospital management does not give necessary importance to staff's problems

4.4.1.4 Constraints

Response time was measured according to interview results. According to interviews it was specified that all the requests were responded on time. There was no statistic

which holds the number of requests not responded on time. Therefore this measure may have contained bias.

During the interviews it was specified that all of the staff were hired according to qualification examinations and all of them had appropriate trainings. Therefore measuring this metric may not be appropriate or other types of measuring techniques may be used to measure staff adequacy level.

Acceptance ratio was also measured according to interview results. At the interview it was specified that the hospital was the largest hospital of the region and there is no hospital which performs the laboratory tests that are not performed in the hospital. So the result of this metric was measured as 1.00.

In addition Machine utilization measure was not seen as an appropriate metric by the interviewers. Because there are complex machines in the laboratory and each machine's capacity change machine to machine so it is specified that number of machines may be meaningless.

4.4.2 Assessment Services

Measurement results diagram of assessment services is given in Figure 4.4 and weak, close to weak and strong aspects of assessment process is given Table 4.21.

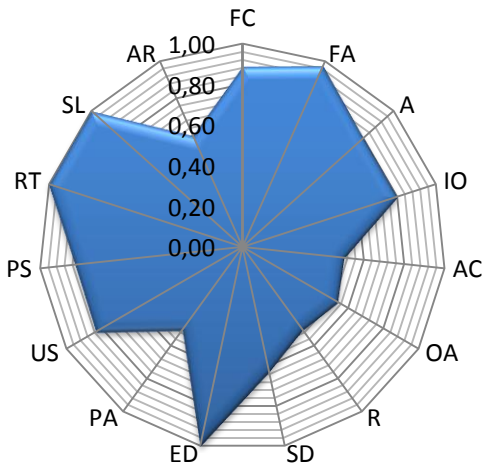

Figure 4.4 Assessment Services Measurement Results

Table 4.21 Weak, Close to Weak, and Strong Aspects of Assessment Process

	Quality Attribute	Result
FC	Functional completeness	0.89
FA	Functional adequacy	0.97
A	Accuracy	0.80
IO	Interoperability	0.80
AC	**Access controllability**	**0.50**
OA	**Operation audibility**	**0.54**
R	**Restorability**	**0.50**
SD	**Sufficiency of documentation**	**0.63**
ED	Effectiveness of the documentation	1.00
PA	**Physical accessibility**	**0.50**
SS	Staff satisfaction	0.83
PS	Patient satisfaction	0.82
RT	Response time(daily)	1.00
PA	Staff adequacy level	1.00
AR	**Acceptance ratio(daily)**	**0.60**

	Quality Attribute	Result
FR	Fault ratio(Faulty performed tests(daily))	NA
SR	Staffing ratio(daily)	0.1200
MU	Machine utilization(daily)	NA

4.4.2.1 Strong Aspects

Functional completeness, Functional adequacy, Effectiveness of the documentation, Response time, and Staff adequacy level were the strong aspects. There were 44 activities in the JCIAS for assessment process and except for 5 activities all the activities were implemented by the hospital. The activities that were not implemented by the hospital are defining appropriate time frames for performing assessments, completing assessment within the time frame defined definition of nutritional and functional assessments by the qualified individuals. It was observed that of the implemented 39 activities only 1 activity was not performed adequately. This activity is accessing patient record when needed. During the interview it was

specified that not all of the patient information was stored electronically (assessment results are recorded but other results such as test results that were performed in outside organizations, radiological test results etc.), but a great deal of information was kept in patient files and sometimes this file could be in another department and it was impossible to access it. Thus, value of Functional adequacy was high. During the evaluations it was specified that, in spite of having low value of sufficiency of documentation, existing documentation (rules and regulations, patient discharge forms etc.) was used effectively. In the hospital it was also specified that the responses to all requests were completed on time. Therefore, value of Response time was measured as 1. All the staff was hired according to qualification examinations and they had appropriate training. Thus, the value of Staff adequacy level was measured as 1.

4.4.2.2 Weak Aspects

For assessment process, Access controllability, Operation audibility, Restorability, Sufficiency of documentation, Physical accessibility, and Acceptance ratio were the weak aspects. There were 2 activities related to Access controllability. These were; access of physician to patient records and physician access to Laboratory Information System, during the evaluations it was specified that this access was not managed. In hospital, in spite of having Hospital Information System, it was not used effectively and patient records were completed manually. The Operation audibility measure was the second weak aspect with 13 activities related to Operation audibility and 6 were not audited by the organization (which tests are ordered, whether physician ordered consultation or not, which illness is specified, given prescriptions, resting report details, who recorded assessment results). The Restorability measure was the third weak aspect due to the fact that the assessment results were not correctly entered into patient records and restorability of this data was not always possible. The Sufficiency of documentation was the fourth weak aspect in the assessment process. The physician we interviewed specified that because of the nature of the assessment and lack of time it was impossible to document all the activities in the patient records, which resulted in a low usage of Hospital Information System. In addition, in spite of having a requirement to define and document the nutritional and functional

assessment criteria for the hospital, it was absent in the documentation. Furthermore, the reassessment intervals were not defined and documented in the hospital policies. The Physical accessibility measure was the fifth weak aspect due to problems of keeping patient records manually. In some cases (when patient record was in another department) it was not possible to access the patient's record. During the interview it was also specified that due to restricted bed availability in the hospital approximately 40% of the patients were not accepted or were given appointments for a future date. Therefore, the Acceptance ratio measure was also a low aspect in the hospital.

4.4.2.3 Pros and Cons of the Process

Pros and cons of assessment process are given in Table 4.22.

Table 4.22 Pros and Cons of Assessment Process

Pros	Cons
Anamnesis and other assessments are documented within detail.	During the assessments interferences are high and this extends the assessment time.
Medical, nursing, physical, and nutritional assessments are performed in the hospital	Test results that depends to other departments extends the assessment time.
Special assessment conditions are defined and special assessments are performed.	Awareness of documentation is low.
Reassessments are performed.	Acceptance ratio is low due to the bed availability.
Patient and their family are informed with patient information forms.	There is not any measurement activity
	Problems with accessing to patient files
	Inadequate trainings
	Too much patients for winter season
	Low usage of Hospital Information System

4.4.2.4 Constraints

Response time was measured according to interview results. According to interview it was specified that all the requests were responded on time. There was no statistic which holds the number of requests not responded on time. Therefore this measure may have contained bias.

During the interviews it was specified that all of the staff were hired according to qualification examinations and all of them had appropriate trainings. Therefore measuring this measure may not be appropriate or other types of measuring techniques may be used to measure staff adequacy level.

As in laboratory services Machine utilization measure was not seen as an appropriate measure by the interviewer.

4.4.3 Comparison among Hospitals

One of the major objectives of the HPQMM is providing comparisons among hospital processes. In this section comparison of laboratory processes of three hospitals will be given.

In terms of the results of laboratory processes the FC of hospital 1 was the weakest aspect in the three hospitals. This is because there were no written policies and procedures that guide ordering of tests, transport, storage, and preservation of specimens, collection and identification of specimens, and receipt and tracking of specimens. Thus, these activities were performed in ad-hoc manner and decrease process quality. The OA was a weak aspect in 3 hospitals. The details of causes indicate that approximately half the auditable operations were not recorded in these hospitals. The AC aspect was also a weak in the 3 hospitals due the fact that the access of laboratory staff to test machines was uncontrolled. The FR of hospital 1 was the weakest aspect in the three hospitals since there were more quality control activities in hospitals 2 and 3 and the checking of specimens was performed in more detail in these hospitals. On the other hand, the value of ED, PA, RT, SL, and AR were measured as 1 in 3 hospitals. ED was strong aspect in the laboratory processes

of all 3 hospitals since written policies and procedures about handling and disposal of infectious and hazardous materials were used effectively. Furthermore, all the hospitals had documented the expected report time for results and they were used effectively. In addition, all the testing, maintenance, and calibration of equipment were adequately documented and were used effectively. PA was also strong aspect in 3 hospitals since in the laboratory, physical access to reagents and devices were handled as physical accessibility issues, and all hospitals supervised these issues. In 3 hospitals it was also specified that the responses to all requests were completed on time. Therefore, value of RT is measured as 1 in the 3 hospitals. All the staff was hired according to qualification examinations and they had appropriate training. Thus, the value of SL was measured as 1. As for AR, it was specified in hospital 1 that only 2 of 1529 laboratory orders were rejected daily, in hospital 2 in spite of handling 4453 laboratory orders daily, only 46 were rejected in the whole year. In hospital 3, it was specified that no laboratory order was rejected. Hence, number of rejected applications was very small and value of AR was close to 1 in all 3 hospitals.

4.5 Answering the Research Questions

As the result of the case study, the research questions determined at the planning phase are answered as follows.

Question 1: Is it possible to measure health care process quality by using the HPQMM's quality indicators?

The quality measures of the HPQMM are derived from software quality measures and the quality of software is measured from functionality, reliability, usability, efficiency, maintainability, and portability characteristics. As specified earlier, software and process resemble to each other and the HPQMM also uses these characteristics. Thus, these characteristics not only provide quantifiable information about the health care processes, but also for all processes.

Question 2: Does the model measure health care processes comprehensively?

To answer this question the model was applied to both laboratory and assessment processes of hospitals. At the end of these applications, it was seen that the model successfully gave quality degrees of processes from functionality, reliability, usability, and efficiency characteristics. In addition, the model uses internationally accepted JCIAS measurable elements to determine functional suitability of processes and this standard handles all processes of hospitals. Thus, it can be concluded that the model has a baseline of handling comprehensive processes of hospitals.

Question 3: Does usage of these measures provide indications for process improvement?

To answering this question firstly, processes were assessed by using the HPQMM, and then, weak, close to weak and strong aspects were determined according to specified limits. With this method, a total of 79 improvement opportunities for laboratory processes and 76 improvement opportunities for assessment processes were provided to hospitals. After that, by using open ended interviews, weak and close to weak aspects were discussed. If there was a consensus about weak and close to weak aspects between process owners, then it was accepted that it was a process improvement opportunity.

Question 4: How can the model be refined and therefore improved?

To refine and improve the model the case studies are performed in an incremental fashion. According to feedbacks taken from the first two case studies, some measures were refined and some new measures were developed and included into the model. Quality attributes of measures were revised to become more understandable and more specific to health care processes.

4.6 Effort Spent in the Case Study

Measurement of laboratory processes took 58 person-hours on the average. The interview took 16 hours and 3 personnel took place in interviews, thus total effort for interview is 16*3=48 hours, the modeling took 5 hours, and the evaluating measures took 5 hours.

Each assessment process was completed in 42 person-hours on the average. The interview took 16*2 hours, the modeling took 5 hours, and the evaluating measures took 5 hours.

4.7 Validation of the Model

After the measurement of the processes, the validity of the HPQMM and measures were investigated with two rounds of studies. For each process 2 process owners, who is responsible from the process execution (for example laboratory chiefs for laboratory process, and physicians for assessment process), were responded the questions. The results of the first and the second round of the laboratory process are given in Table 4.23 and Table 4.24.

Table 4.23 Laboratory Process Model Assessment Results of Three Cases

MODEL ASSESMENT(5:Excellent 4:Very good 3:Good 2:Not bad 1:Bad)	
Do the measures identify opportunities for improvement	3
Do the measures give more detailed idea about the process quality	4
Do the measures add any contribution to JCI assessment	4
What is your general assessment about the model	4

Table 4.24 Laboratory Process Measure Assessment Results of Three Cases

MEASURE ASSESSMENT(5:Excellent 4:Very good 3:Good 2:Not bad 1:Bad)	
Functional implementation completeness	4
Functional adequacy	4
Accuracy	5
Interoperability	4
Access controllability	3
Operation audibility	4
Restorability	4
Sufficiency of documentation	5
Effectiveness of the documentation	4
Physical accessibility	4
User satisfaction	5
Patient satisfaction	5
Response time(monthly)	4
Personnel adequacy level	3
Acceptance ratio(daily)	4
Fault ratio(daily)	4
Staffing ratio(daily)	4
Machine utilization(daily)	3

The validation results of the assessment process are given in Table 4.25 and Table 4.26.

Table 4.25 Assessment Process Model Assessment Results of Three Cases

MODEL ASSESMENT(5:Excellent 4:Very good 3:Good 2:Not bad 1:Bad)	
Do the measures identify opportunities for improvement	4
Do the measures give more detailed idea about the process quality	4
Do the measures add any contribution to JCI assessment	3
What is your general assessment about the model	4

Table 4.26 Assessment Process Measure Assessment Results of Three Cases

METRIC ASSESSMENT(5:Excellent 4:Very good 3:Good 2:Not bad 1:Bad)	
Functional implementation completeness	4
Functional adequacy	3
Accuracy	3
Interoperability	4
Access controllability	3
Operation audibility	4
Restorability	3
Sufficiency of documentation	4
Effectiveness of the documentation	4
Physical accessibility	4
User satisfaction	4
Patient satisfaction	5
Response time(monthly)	4
Personnel adequacy level	4
Acceptance ratio(daily)	5
Fault ratio(daily)	4
Staffing ratio(daily)	3
Machine utilization(daily)	2

From the above tables it is seen that a median value of 4 was given to model, which refers to “Very Good”. In the second round, only the MU measure had not received an adequate score from the evaluators (median 2) and specifying that there were complex machines in the hospitals and the capacity of each one changes from machine to machine. Thus, number of machines may not be an appropriate criteria and this measure should be reviewed and redefined in the future.

On the other hand, there are some validity threats with the model and the model application. The first validity threat related to the model is that, whether an activity or measurable element is performed adequately is an abstract issue in some measures (FC, FA, etc.) and that decision changes from measurer to measurer. To decrease the effect of this threat an ordinal scale was defined and used to evaluate the subjective measures. The rating is defined as “fully performed”, “largely performed”, “partially performed” and “not performed”. The details of the measures and how to select an

appropriate rating were defined in the model and explained to the process owners. If an activity was completely or largely performed then it was accepted as performed, otherwise it was accepted as not performed. The second validity threat is related to the limits for the strong, weak, and close to weak aspects. Expert opinion was used to decrease the effect of this threat and the limits were specified according to a consensus between the process experts. However, as more data becomes available statistical methods can be used to define these limits. The third validity threat is related to the questionnaire that displayed the model validity. To decrease the effect of this threat, first the questionnaire was applied in a pilot study, and then according to the feedback it was modified and applied to other hospitals. In addition, the following limitations were observed related to the HPQMM. We found that due to different capacity and facilities of the hospital machines, using the number of machines in the measures may not be appropriate. Furthermore, during the interviews it was stated that all the staff were hired according to qualification examinations and all had appropriate training, but there was no list of the required trainings in the concept of the model. Therefore, measuring SL according to interview results may not be appropriate and other types of measuring techniques must be defined for the SL. In addition, the first threat with the model application is that the HPQMM was not applied to all hospital processes and constraints of other processes on the model were not analyzed. To decrease the effect of this threat we selected laboratory and assessment processes that were conceptually different from each other. However, application of the model considering all processes of a hospital may provide further insights about the measures. The second threat is related to the validity of the application results. To decrease the effect of this threat the compatibility of our findings in relation to the hospital's process improvement suggestions were investigated. The last validity threat is related to generalizability. In order to generalize the application results we selected hospitals that differed in size and type of quality initiatives already performed. The state public hospital was relatively small in size and university hospitals were large. Moreover, the latter had different quality initiatives, and in the former there was no quality initiative.

CHAPTER 5

CONCLUSIONS

In this chapter firstly, contributions of the study will be given. Following to these contributions, the limitations of the study are discussed and finally the chapter is concluded with recommendations for future research.

5.1 Contributions of the Study

In this thesis the details of a newly developed health care process quality measurement model is provided. Existing health care quality indicator models focus only a portion of process with limited number of quality indicators and they do not have a capability of measuring the quality across all health care processes. In addition, scope of existing models is limited with specific disease, clinic, or clinical areas and their indicators cannot be adoptable to other clinics and diseases. But, the HPQMM quality indicators are generic (functional completeness, accuracy, fault ratio etc.) and can be adoptable to all health care processes. Thus, the HPQMM provides significant contribution about measuring quality of activities and processes comprehensively.

Applicability of the model was investigated through applications in laboratory processes and assessment processes. By means of 18 measures, quality degrees of processes were depicted from different quality perspectives such as, completeness, adequacy, accuracy, reliability, and efficiency. In addition, weak aspects and not (properly) performed activities related to processes were determined, and efficiency

of processes was specified from staff and machine utilization perspectives. At last, a total of 79 improvement opportunities for laboratory processes and 76 improvement opportunities for assessment processes were provided to hospitals (Table 5.1) [45].

Table 5.1 Number of Improvement Opportunities for the Three Hospitals

Hospital	Laboratory	Assessment
1	32	34
2	27	20
3	20	22
Total	**79**	**76**

By using the model's provided improvement opportunities, hospitals were able to work on the causes of the weak aspects such as operation audibility, accuracy, restorability, staff and patient satisfaction, sufficiency of documentation, restorability, and acceptance ratio. In addition, quality measures of 3 hospitals were compared and weak aspects with respect to each other were specified. Thus, we conclude that the HPQMM enabled hospitals to make process comparisons internally and benchmark with other hospitals.

After the evaluation, interviews on measurement results were held with the staff and it was observed that the weak and strong aspects identified by the staff were also identified by the model. The staff also commented that these weak aspects were candidates for process improvement.

Furthermore, it was determined that application of the model did not require extensive effort (58 person-hours for the laboratory process and 42 person-hours for the assessment process) and it can be applied within all hospitals without the need to assign a large amount of resources and time.

Lastly, the applications of the HPQMM in public hospitals lead to an improved awareness of measurement and process improvement in hospitals. After applying the model in more hospitals and in more processes applicability and validity of the model will be increased and the value of health care process measurement and improvement will be understood more precisely in health care sector.

5.2 Limitations

The following limitations were observed related to the applications and the HPQMM. We found that due to different capacity and facilities of the hospital machines, using the number of machines in the measures may not be appropriate and this measure should be reviewed and redefined in the future. In addition, we were unable to fully utilize some measures, for example, Response time was measured according to the results of the interview. In the 3 hospitals it was specified that all requests were responded to, but there were no statistics that contained the number of requests that were not responded to on time. Therefore, the results of this measure may contain noise. Furthermore, obtaining the number of tasks that were not performed appropriately with the assessment process can be difficult. Physicians do not like to give the number of faulty performed tasks and there were no records of the number of these tasks. Therefore, fault ratio for the assessment processes cannot be measured. To measure these metrics, incompletely performed tasks must be recorded by hospitals. During the interviews it was stated that all the staff were hired according to qualification examinations and all had appropriate training, but there was no list of the required training in the concept of the model. Therefore, measuring staff adequacy level according to interview results may not be appropriate and other types of measuring techniques must be defined for the staff adequacy level.

5.3 Future Research

In the future, the model has to be applied in larger scope (more processes) and in more hospitals to generalize the validity of results. In addition, by adding some other process specific indicators to the model's scope, applicability can be increased.

In our study, validity of the measurement results was not assessed. Because there was no health care process quality measurement set which provides possibility to compare the HPQMM results. Thus in application level, validity of measurement results can be investigated by comparing the HPQMM measures with the existing health care quality indicators.

Moreover, a tool can be developed to automate application procedure. By means of this tool the application procedure can be standardized, automatic calculation of measures can be provided from process evaluation matrix, JCIAS evaluation matrix, and organizational efficiency records.

Lastly, in the model JCIAS measurable elements are used to standardize functional requirements related to process. The model specific standardized requirements can be determined in the future.

REFERENCES

[1] Mattke S, Epstein AM, Leatherman S. 2006. The OECD Health Care Quality Indicators Project: history and background. Int. J. for Quality in Health Care 9: 1-4.

[2] Kazandjian V, Wood P, Lawthers J. 1995. Balancing science and practice in indicator development: the Maryland Hospital Association Quality Indicator (QI) Project. Int. J. for Quality in Health Care7: 39–46.

[3] http://www.jointcommission.org/core_measure_set/, (2 September 2011, date last accessed).

[4] Thomson R, Taber S, Lally J, Kazandjian V. 2004. UK Quality Indicator Project(UK QIP) and the UK independent health care sector: a new development. Int. J. for Quality in Health Care16: i51–i56.

[5] Chiu WT, Yang CM, Lin HW, Chu TB. 2006 .Development and implementation of a nationwide health care quality indicator system in Taiwan. Int. J. for Quality in Health Care 19: 21-28.

[6] Thakur H, Chavhan S, Jotkar R, Mukherjee K. 2004. Developing clinical indicators for the secondary health system in India. Int. J. for Quality in Health Care 20: 297–303.

[7] Mainz J, Krog BR, Bjørnshave B, Bartels P. 2004. Nationwide continuous quality improvement using clinical indicators: the Danish National Indicator Project. Int. J. for Quality in Health Care16: i45–i50.

[8] Lawthers AG, Rozanski BS, Nizankowski R, Rys A. 1999. Using patient surveys to measure the quality of outpatient care in Krakow Poland. Int. J. for Quality in Health Care. Volume 11, Number 6: pp. 497–506.

[9] Donabedian A. 1980. Methods for deriving criteria for assessing the quality of medical care. Med Care Rev 37(7): 653–698, 1980.

[10] Pettersen IJ, Nyland K. 2006. Management and control of public hospitals-the use of performance measures in Norwegian hospitals. A case-study. Int J Health Plann Mgmt. 21: 133–149.

[11] Birch S, Maynard A. 1986. Performance indicators and performance assessment in the UK national health service: Implications for management and planning. Int J Health Plann Mgmt. 2: 143–156.

[12] Weng W, Hess BJ, Lynn LA, Holmboe ES, Lipner RS. 2010. Measuring Physicians' Performance in Clinical Practice: Reliability, Classification, Accuracy, and Validity. Evaluation & the Health Professions. 33: 302.

[13] Ketabi S. 2011. Efficiency Measurement of Cardiac Care Units of Isfahan Hospitals in Iran. Journal of Medical Systems. 35:143-150.

[14] Imperato PJ, Waisman J, Wallen M, Pryor V, Starr H, Rojas M, Terry K, Giardelli K. 2000. The use of quality indicators for assessing radical prostatectomy specimens. American Journal of Medical Quality. 15: 212-220.

[15] Watkins KD. 1999. Asthma Outcome Measures. Journal of Medical Systems. Vol. 23, No. 4.

[16] Osterweil, L. 1987. Software Processes are Software Too. Proceedings of the Ninth International Conference on Software Engineering, Monterey, CA, pp. 2-13.

[17] ISO/IEC 9126-3. 2000. Software Engineering– Product quality Part 3: Internal Metrics, ISO/IEC JTC1/SC7/WG6.

[18] ISO/IEC 25000, Software Engineering – Software Product Quality Requirements and Evaluation (SQuaRE) – Guide to SQuaRE, 2005.

[19] Güceğlioğlu S. 2006. A Pre-Enactment Model For Measuring Process Quality. PhD Thesis.

[20] Kaymakoğlu B,Yıldız Ö, Arıöz U. 2007. Assessment of laboratory and management information system processes of a hospital according to ISO 15504. Medical Informatics Turkey, Proceedings,145.

[21] Yıldız Ö., Demirörs O. 2009. Adopting Software Quality Measures for Healthcare Processes. Studies in Health Technology and Informatics Volume 150, pp: 394-398.

[22] Joint Commission on Accreditation of Health Care Organizations, Joint Commission International Accreditation Standards for Hospitals 3rd Edition, 2008.

[23] Medline Library: http://search.ebscohost.com (15 December 2009, date last accessed)

[24] Oxford Journals Library: http://www.oxfordjournals.org (15 December 2009, date last accessed)

[25] Thomson RG, McElroy H, Kazandjian VA. 1997. Maryland Hospital Quality Indicator Project in the United Kingdom: an approach for promoting continuous quality improvement. Quality in Health Care . 6:49-55

[26] Engels Y, Campbell S, Dautzenberg M, Hombergh P, Brinkmann H, Szécsényi J, Falcoff H, Seuntjens L, Kuenzi B, Grol R. February 2005. Developing a framework of, and quality indicators for, general practice management in Europe. Family Practice.

[27] Groene O, Klazinga N, Kazandjian V, Lombrail P, Bartels P. 2008. The World Health Organization Performance Assessment Tool for Quality Improvement in Hospitals (PATH): An Analysis of the Pilot Implementation in 37 Hospitals. International Journal for Quality in Health Care. Volume 20, Number 3: pp. 155–161.

[28] Kelley ET, Arispe I, Holmes J. 2006. Beyond the initial indicators: lessons from the OECD Health Care Quality Indicators Project and the US National Healthcare Quality Report. International Journal for Quality in Health Care, September

[29] Collopy BT. 2004. Clinical indicators in accreditation: an effective stimulus to improve patient care. International Journal for Quality in Health Care. Volume 12, Number 3: pp. 211–216.

[30] Campbell SM, Roland MO, Quayle JA, Buetow SA, Shekelle PG. 1998. Quality indicators for general practice: which ones can general practitioners and health authority managers agree are important and how useful are they. Journal of Public Health Medicine. Vol. 20, No. 4, pp. 414-421.

[31] Hickey A, Scott I, Denaro C, Stewart N, Bennett C, Theile T. 2004. Using clinical indicators in a quality improvement programme targeting cardiac care. International Journal for Quality in Health Care. Volume 16, Supplement 1: pp. i11–i25.

[32] Prys-Picard CO, Campbell SM, Ayres JG, Miles JF, Niven RM. 2006. Defining and investigating difficult asthma: Developing quality indicators. Respiratory Medicine. 100, 1254–1261.

[33] Pronovost PJ, Berenholtz SM, Ngo K, McDowell M, Holzmueller C, Haraden C, Resar R, Rainey T, Nolan T, Dorman T. September 2003. Developing and Pilot Testing Quality Indicators in the Intensive Care Unit. Journal of Critical Care. Vol 18, No 3: pp 145-155.

[34] Zimmerman DR. 2003. Improving nursing home quality of care through outcomes data: the MDS quality indicators, International Journal Of Geriatric Psychiatry. 18: 250–257.

[35] Kirchner JA, Funes VA, Adzet CB, Clar VD, Escuer MI, Girona JM, Barellas RP, Alsina CP, Aguila CG, Isern GT, Navarro CV. 2007. Quality indicators and specifications for key processes in clinical laboratories: a preliminary experience. Clinical Chemistry and Laboratory Medicine. 45(5):672–677

[36] Draskovic I, Dassen MV, Verhey F, Scheltens P, Rikkert MO. 2007. Development of quality indicators for memory clinics. International Journal of Geriatric Psychiatry. 23: 119–128.

[37] Fitch K, Bernstein SJ, Aguilar MD. The RAND/UCLA Appropriateness Method User's Manual, 2001: http://www.rand.org/publications/MR/MR1269/ (15 December 2009, date last accessed)

[38] Yıldız, Ö, Demirörs O. 2011. Health Care Process Quality Measurement Model (HPQMM). Technical Report, METU/II-TR-2011-29, Department of Medical Informatics, University of METU.

[39] Yin, R.K. 1984. Case Study Research Design and Methods. Second Edition, Applied Social Research Methods Series Volume 5, Sage Publications, ISBN 0-8039-5662-2.

[40] www.jcaho.org, (9 July 2011, date last accessed).

[41] www.iso.org, (9 July 2011, date last accessed).

[42] Yıldız, Ö, Demirörs O. 2011. HPQMM Application Results - Hospital 1. Technical Report, METU/II-TR-2011-26, Department of Medical Informatics, University of METU,

[43] Yıldız, Ö, Demirörs O. 2011. HPQMM Application Results- Hospital 2. Technical Report, METU/II-TR-2011-27, Department of Medical Informatics, University of METU.

[44] Yıldız, Ö, Demirörs O. 2011. HPQMM Application Results- Hospital 3. Technical Report, METU/II-TR-2011-28, Department of Medical Informatics, University of METU.

[45] Yıldız, Ö. Demirors O. 2012. Measuring Health Care Process Quality: Applications in Public Hospitals. Informatics for Health and Social Care. Minor revision April 2012.

APPENDICES

APPENDIX A: SUMMARY OF HEALTH CARE QUALITY MODELS

No	Model Name	Development Approach	Validation Approach	Scope	Type of Indicators	Geographic Implementation
1	MHAQI	Individual development. Pilot study. Deductive.	Case studies. Internal validity surveys.	Inpatient. Outpatient.	Process and outcome	USA, UK
2	UK QIP	Literature review. Peer review with an expert panel. Pilot study. Descriptive.	Case studies. Formal surveys.	Inpatient. Day case/ accident and emergency. Mental health. Long term care. Home care.	Process and outcome	UK
3		Individual development. Clinician interviews. Data reliability score. Indicator usefulness score. Pilot study. Deductive.	Expert opinion. Both indicator usefulness score and data reliability score for the indicators are high were found to be useful.	Clinical indicators.	Structure, process and outcome	India
4	THIS	Adopting HEDIS, ORXY, and CONQUEST. Descriptive.	Expert opinion. Consensus on selected measures.	Outpatient. Emergency. Inpatient. Intensive care.	Structure, process and outcome	Taiwan
5		Modified Delphi method. Deductive.	Expert opinion. Usefulness scale of 7, 8 or 9 without disagreement are considered face valid.	Infrastructure. Staff. Information. Finance Quality and Safety.	Structure, process and outcome	Belgium, France, Germany, The Netherlands, Switzerland and the United Kingdom
6		Two-stage Delphi process. Deductive.	Expert opinion. It is defined an indicator as face valid if it is rated with a median score of 8 or 9.	Access. Organizational performance. Preventive care. Care for a small number of chronic diseases. Prescribing.	Structure, process and outcome	UK and Wales
7	DNIP	Rand-modified-Delphi-three rounds. Nationwide pilot studies. Deductive.	Randomized controlled trials. Quasi- experimental studies. Case-control studies. Expert opinions.	Stroke. Hip fracture. Schizophrenia. Acute gastrointestinal surgery. Heart failure. Lung cancer.	Structure, process and outcome	Denmark
8	HCQI	Modified Delphi method. Deductive.	Expert opinion. Measures with high ratings(7 and above) are retained.	Diabetes. Mental health. Cardiac. Patient safety. Primary care.	Process and outcome	23 OECD Countries

9	NHQR	Individual Development. Priority condition areas identified, a framework that encompassed dimensions of quality is conceptualized. Descriptive.	Expert opinion. Consensus on measures.	Cancer. Diabetes. ESRD. Heart disease. HIV/AIDS. Maternal child health. Mental health. Respiratory disease. Nursing. Home health care.	Process and outcome	USA
10	PATH	Semi-structured interviews. Peer review. Standardized questionnaire (five-point Likert-type scale). Deductive.	Expert opinion. Major agreement (80% of the respondents) or disagreement (50%).	Clinical effectiveness safety. Patient centeredness. Efficiency. Staff orientation. Responsive governance.	Structure, process and outcome	A total of 37 hospitals in six regions/countries (Belgium, Ontario (Canada), Denmark, France, Slovakia, KwaZulu, Natal (South Africa))
11	BCC	Literature review. Adopting guidelines. Multidisciplinary panels. Descriptive.	Expert opinion. Indicators validated by independently reviewing charts of all seemingly eligible patients who failed to receive specific interventions in the first and last 6-month periods for those indicators that showed a failure rate of >20%. It surveyed a representative sample of hospital clinicians about the usefulness and impact of indicator feedback.	Acute coronary syndromes. Congestive heart failure.	Process and outcome	Three teaching hospitals [Royal Brisbane (800 beds), Princess Alexandra (700 beds) and Queen Elizabeth II Hospitals (260 beds)] and four Divisions of General Practice within metropolitan Brisbane
12	ACHS	Individual development. Literature review. The drafting of indicators field testing, refinement, confirmation. Survey. Deductive.	Expert opinion. As the indicators were provider-developed and generally 'evidence-based'. The ACHS was confident of face and content validity but uncertain of reliability.	Hospital wide medical indicators. Obstetrics and gynecology. Anesthesia. Day procedures. Emergency medicine. Internal medicine. Psychiatry. Ophthalmology. Pediatrics. Radiology. Rehabilitation medicine. Surgery. Intensive care. Dermatology. Pathology. Radiation oncology. Adverse drug reactions. Hospital in the home.	Process and outcome	Australia
13		Individual development. Patient surveys.	Expert opinion. Internal consistency was tested by using	Access. Patient experience. Clinical quality.	Structure, process and outcome	19 outpatient clinics in Krakow, Poland

		Pilot study. Deductive.	Cronbach's Alpha. Revision of questionnaire and actual survey.			
14		Modified RAND technique. Descriptive.	Expert opinion. Consensus was defined as existing where the median score from the overall panel was 7 or greater without disagreement.	Difficult asthma.	Process and outcome	UK
15		Literature review. Standardized data collection tools. Peer review. Pilot study. Interview with staff. Descriptive.	Expert opinion. Agreement about measures identified an important domain of ICU quality. Randomized clinical trials. For internal validity, both a physician and nurse in one ICU independently collect data for the process measures, and compare the results.	Outcome. Access. Complication. Process.	Structure, process and outcome	13 adult medical and surgical ICUs in urban community teaching and community hospitals
16	MDS	Literature review. Peer review. National clinical panels. Descriptive.	Expert opinion. Average facility accuracy rates for the Quality Indicators ranged from 72% to 95%.	Accidents. Behavioral and emotional patterns. Clinical management. Cognitive functioning. Elimination and continence. Infection control. Nutrition and eating. Physical functioning. Psychotropic drug use. Quality of life. Skin care.	Process and outcome	USA
17		Individual development. Peer review. Deductive.	Expert opinion. Consensus on measures.	Preanalytical steps. Analytical steps. Postanalytical steps.	Process and outcome	Primary care and hospital laboratories within the InstitutCatala` de la Salut (ICS); Catalonian Health Institute
18		RAND modified Delphi method. Descriptive.	Expert opinion. The face validity assessed by three expert panels. The internal consistency of the validity scale was tested by using Cronbach'sAlpha .	Memory clinics.	Structure, process and outcome	10 Memory clinics in Netherlands

APPENDIX B: LABORATORY PROCESS MEASUREMENT RESULTS-HOSPITAL1

MEASUREMENT RESULTS

	Quality Attribute	Measured From		Result
FC	Functional completeness	JEM	1-13/47	0.74
FA	Functional adequacy	JEM	1-5/34	0.86
A	Accuracy	JEM	10/13	0.77
IO	Interoperability	PEM	3/4	0.75
AC	Access controllability	PEM	2/3	0.67
OA	Operation audibility	PEM	7/11	0.64
R	Restorability	PEM	4/5	0.80
SD	Sufficiency of documentation	JEM	7/11	0.73
ED	Effectiveness of the documentation	JEM	7/7	1.00
PA	Physical accessibility	PEM	2/2	1.00
US	User satisfaction	AIR	186/250	0.74
PS	Patient satisfaction	AIR	206/250	0.82
RT	Response time(daily)	EIR	1529/1529	1.00
PA	Staff adequacy level	EIR	8/8	1.00
AR	Acceptance ratio(daily)	EIR	(1529-2)/1529	1.00

	Quality Attribute			Result
FR	Fault ratio(Faulty performed tests(daily))	EIR	4/1529	0.0026
SR	Staffing ratio(daily)	EIR	8/1529	0.0052
MU	Machine utilization(daily)	EIR	11/1529	0.0072

MEASUREMENT DETAILS

1. Functional Completeness

$$1 - \frac{\text{Number of missing measurable elements detected in evaluation}}{\text{Number of measurable elements described in JCIAS}}$$

Number of measurement elements described in JCIAS = 47

Missing measurable elements detected in evaluation = 13

1. Laboratory equipment management program includes selecting and acquiring equipment.
2. The program includes inventorying equipment.
3. Procedures guide the ordering of tests.
4. Procedures guide the transport, storage, and preservation of specimens.
5. Procedures guide the collection and identification of specimens.
6. Procedures guide the receipt and tracking of specimens.
7. The procedures are observed when outside sources or services are used.
8. Ranges are furnished when tests are performed by outside sources.
9. Responsibilities include recommending outside sources of laboratory services.
10. Quality control results from outside sources are regularly reviewed.
11. Qualified individuals review the quality control results.
12. A roster of experts for specialized diagnostic areas is maintained.
13. Experts in specialized diagnostic areas are contacted when needed.

$$FC = 1 - 13/47 = 0.72$$

2. Functional Adequacy

$$1 - \frac{\text{Number of measurement elements in which problems are detected in evaluation}}{\text{Number of measurement elements reviewed}}$$

Number of measurement elements in which problems are detected in evaluation = 5

1. Laboratory equipment management program is coordinated with the organization's safety management program.
2. There is an adequate number of staff to meet patient needs.
3. The timeliness of reporting of urgent/emergency tests is monitored.
4. Responsibilities include developing, implementing, and maintaining policies and procedures.

5. Responsibilities include monitoring and reviewing all laboratory services within and outside of the laboratory.

Number of measurement elements reviewed = 34

$$FA=1-5/34=0.85$$

3. Accuracy

$$\frac{\text{Number of measurement elements in which specific accuracy req. had been implemented}}{\text{Number of measurement elements for which specific accuracy req. need to be implemented}}$$

Number of measurement elements in which specific accuracy req.had been implemented :10

Number of measurement elements for which specific accuracy req.need to be implemented: 13

$$A=10/13=0.77$$

Number of measurement elements in which specific accuracy req.had NOT been implemented: 3

1. The timeliness of reporting of urgent/emergency tests is monitored.
2. Ranges are furnished when tests are performed by outside sources.
3. Responsibilities include monitoring and reviewing all laboratory services within and outside of the laboratory.

4. Interoperability

$$\frac{\text{Number of interoperable activities that have been implemented correctly}}{\text{Number of interoperable activities in the process}}$$

Number of interoperable activities that have been implemented correctly: 3

Number of interoperable activities in the process : 4

$$IO=3/4=0.75$$

Number of interoperable activities that have NOT been implemented correctly: 1

1. Interoperability with transmitting person. Procedures guide the transport, storage, and preservation of specimens is not defined.

5. Access Controllability

$$\frac{\text{Number of access controllability requirements implemented correctly}}{\text{Number of access controllability requirements in the process}}$$

Number of access controllability requirements implemented correctly :2

Number of access controllability requirements in the process : 3

AC=2/3=0.67

Number of access controllability requirements NOT implemented correctly: 1

1. Access to test machines is not under control.

6. Operation Audibility

$$\frac{\text{Number of activities actually recorded during operation}}{\text{Number of activities planned to be recorded}}$$

Number of activities actually recorded during operation: 7

Number of data planned to be recorded

OA=1-4/11 = 0.64

Number of activities NOT recorded during operation: 4

1. Who checked LIS is not auditable.
2. Who draw blood is not auditable.
3. Who transmitted specimens is not auditable.
4. Laboratory staff, who transmitted test results, is not auditable.

7. Restorability

$$\frac{\text{Number of activities that are restorable during operation}}{\text{Total number of activities that need restorability in process execution}}$$

Number of activities that are restorable during operation: 4

Total number of activities that need restorability in process execution: 5

R=4/5 = 0.80

Number of activities that are NOT restorable during operation:1

1. Check results of tests are not recorded. Restorability of this data is not possible.

8. Sufficiency Of Documentation

$$\frac{\text{Number of measurable elements documented sufficiently}}{\text{Number of measurable elements need to be documented}}$$

Number of measurable elements documented sufficiently: 7

Number of measurable elements need to be documented: 11

SD=7/11=0.64

Number of measurable elements documented sufficiently: 4

1. Procedures guide the ordering of tests.
2. Procedures guide the collection and identification of specimens.
3. Procedures guide the transport, storage, and preservation of specimens.
4. Procedures guide the receipt and tracking of specimens.

9. Effectiveness Of The Documentation

$$\frac{\text{Number of documented measurable elements that are used effectively}}{\text{Number of measurable elements that are documented}}$$

Number of documented measurable elements that are used effectively: 7

Number of measurable elements that are documented: 7

ED=7/7=1

10. Physical Accessibility

$$\frac{\text{Number of functions in which physical accessibility req. had been implemented}}{\text{Number of functions for which physical access. req. need to be implemented}}$$

Number of functions in which physical accessibility req.had been implemented:2

Number of functions for which physical access.req.need to be implemented:2

$$PA=2/2 = 1$$

11. User/Staff Satisfaction

$$\frac{\text{Total points get from Staff Satisfaction Questionnaire}}{\text{Total points of Staff Satisfaction Questionnaire}}$$

Total points get from Staff Satisfaction Questionnaire : 186

Total points of Staff Satisfaction Questionnaire: 25 (Total point of 1 questionnaire) ***10**(Number of applied questionnaire) **: 250**

$$SS=186/250 = 0.74$$

12. Patient Satisfaction

$$\frac{\text{Total points get from Patient Satisfaction Questionnaire}}{\text{Total points of Patient Satisfaction Questionnaire}}$$

Total points get from Patient Satisfaction Questionnaire: 206

Total points of Patient Satisfaction Questionnaire: 25 (Total point of 1 questionnaire) ***10** (Number of applied questionnaire)**: 250**

$$PS=206/250 = 0.82$$

13. Response Time

$$\frac{\text{Number of tasks which are performed in specified time}}{\text{Number of tasks}}$$

Number of tasks which are performed in specified time: 1529 (Number of responded requests-daily)

Number of tasks: 1529 (Number of performed tests-daily)

$$RT=1529/1529 = 1.00$$

14. Staff Adequacy Level

$$\frac{\text{Number of staff who received required trainings}}{\text{Number of staff}}$$

Number of staff who received required trainings: 8 (Number of staff)

Number of staff: 8 (Number of staff)

PA=8/8 = 1.00

15. Fault Ratio

$$\frac{\text{Number of detected failures}}{\text{Number of performed cases during process execution}}$$

Number of detected failures: 4 (Number of faulty performed tests-daily)

Number of performed cases during process execution: 1529 (Number of performed tests-daily)

FR=4/1529 = 0.0026

16. Staffing Ratio

$$\frac{\text{Number of staff}}{\text{Number of tasks}}$$

Number of staff: 8

Number of tasks: 1529 (Number of performed tests-daily)

SR=8/1529 = 0.0052

17. Acceptance Ratio

$$\frac{\text{Number of daily accepted patients}}{\text{Number of daily applied patients}}$$

Number of daily accepted patients: 1527 (Number of NOT rejected tests-daily)

Number of daily applied patients: 1529 (Number of performed tests-daily)

AR=1527/1529 = 1.00

18. Machine Utilization

$$\frac{\text{Number of unit related machines}}{\text{Average number of daily patients}}$$

Number of unit related machines: 11

Average number of daily patients: 1529 (Number of performed tests-daily)

MU=11/1529 = 0.0072

APPENDIX C: LABORATORY PROCESS MEASUREMENT RESULTS-HOSPITAL2

MEASUREMENT RESULTS

	Quality Attribute	Measured From		Result
FC	Functional completeness	JEM	1-6/47	0.87
FA	Functional adequacy	JEM	1-5/42	0.88
A	Accuracy	JEM	11/13	0.85
IO	Interoperability	PEM	8/9	0.89
AC	Access controllability	PEM	2/4	0.50
OA	Operation audibility	PEM	9/18	0.50
R	Restorability	PEM	4/6	0.67
SD	Sufficiency of documentation	JEM	11/11	1.00
ED	Effectiveness of the documentation	JEM	11/11	1.00
PA	Physical accessibility	PEM	3/3	1.00
US	User satisfaction	AIR	152/250	0.61
PS	Patient satisfaction	AIR	442/500	0.88
RT	Response time(daily)	EIR	16452/16452	1.00
PA	Staff adequacy level	EIR	137/137	1.00
AR	Acceptance ratio(daily)	EIR	1-(46/365)/4453	1.00

	Quality Attribute			Result
FR	Fault ratio(daily)	EIR	(20/30)/16452	0.0000
SR	Staffing ratio(daily)	EIR	137/16452	0.0083
MU	Machine utilization(daily)	EIR	32/16452	0.0019

MEASUREMENT DETAILS

1. Functional Completeness

$$1 - \frac{\text{Number of missing measurable elements detected in evaluation}}{\text{Number of measurable elements described in JCIAS}}$$

Number of measurement elements described in JCIAS = 47

Missing measurable elements detected in evaluation = 6

1. The timeliness of reporting of urgent/emergency tests is monitored.
2. Procedures for collecting, identifying, handling, safely transporting, and disposing are observed when outside sources or services are used.
3. Ranges are furnished when tests are performed by outside sources.
4. Responsibilities include recommending outside sources of laboratory services.
5. Quality control results from outside sources are regularly reviewed.
6. Qualified individuals review the quality control results.

FC =1- 6/47 = 0.87

2. Functional Adequacy

$$1 - \frac{\text{Number of measurement elements in which problems are detected in evaluation}}{\text{Number of measurement elements reviewed}}$$

Number of measurement elements in which problems are detected in evaluation = 5

1. There is an adequate number of staff to meet patient needs.
2. The timeliness of reporting of urgent/emergency tests is monitored.
3. Laboratory equipment management program includes inventorying equipment.
4. Procedures guide the collection and identification of specimens.
5. Procedures guide the transport, storage, and preservation of specimens.

Number of measurement elements reviewed = 42

FA=1-5/42=0.88

3. Accuracy

$$\frac{\text{Number of measurement elements in which specific accuracy req. had been implemented}}{\text{Number of measurement elements for which specific accuracy req. need to be implemented}}$$

Number of measurement elements in which specific accuracy req.had been implemented :11

Number of measurement elements for which specific accuracy req.need to be implemented: 13

A=11/13=0.85

Number of measurement elements in which specific accuracy req.had NOT been implemented: 2

1. The timeliness of reporting of urgent/emergency tests is monitored.
2. Ranges are furnished when tests are performed by outside sources.

4. Interoperability

$$\frac{\text{Number of interoperable activities that have been implemented correctly}}{\text{Number of interoperable activities in the process}}$$

Number of interoperable activities that have been implemented correctly: 8

Number of interoperable activities in the process : 9

IO=8/9=0.89

Number of interoperable activities that have NOT been implemented correctly: 1

1. Interoperability with department secretary. When acceptance criteria is not satisfied. Accessing to patient may not be possible.

5. Access Controllability

$$\frac{\text{Number of access controllability requirements implemented correctly}}{\text{Number of access controllability requirements in the process}}$$

Number of access controllability requirements implemented correctly :2

Number of access controllability requirements in the process : 4

AC=2/4=0.50

Number of access controllability requirements NOT implemented correctly: 2

1. Access to decompose machines is not under control.
2. Access to test machines is not under control.

6. Operation Audibility

$$\frac{\text{Number of activities actually recorded during operation}}{\text{Number of activities planned to be recorded}}$$

Number of activities actually recorded during operation: 9

Number of data planned to be recorded : 18

$$\mathbf{OA=9/18 = 0.50}$$

Number of activities NOT recorded during operation: 9

1. Who checked LIS is not auditable.
2. Who draw blood is not auditable.
3. Who printed barcodes is not auditable.
4. Who checked accuracy of forms is not auditable.
5. Who checked sufficiency of bloods is not auditable.
6. Who called department secretary is not auditable.
7. Who sent bloods to decompose section is not auditable.
8. Who decomposed bloods is not auditable.
9. Who called physician is not auditable.

7. Restorability

$$\frac{\text{Number of activities that are restorable during operation}}{\text{Total number of activities that need restorability in process execution}}$$

Number of activities that are restorable during operation: 4

Total number of activities that need restorability in process execution: 6

$$\mathbf{R=4/6 = 0.67}$$

Number of activities that are NOT restorable during operation:2

1. Orders are recorded into Lab.order form and restorability of this data is not possible.
2. Patient, physician information is recorded into Lab.order form and restorability of this data is not possible.

8. Sufficiency Of Documentation

$$\frac{\text{Number of measurable elements documented sufficiently}}{\text{Number of measurable elements need to be documented}}$$

Number of measurable elements documented sufficiently: 11

Number of measurable elements need to be documented: 11

SD=11/11=1.00

9. Effectiveness Of The Documentation

$$\frac{\text{Number of documented measurable elements that are used effectively}}{\text{Number of measurable elements that are documented}}$$

Number of documented measurable elements that are used effectively: 11

Number of measurable elements that are documented: 11

ED=11/11=1

10. Physical Accessibility

$$\frac{\text{Number of functions in which physical accessibility req. had been implemented}}{\text{Number of functions for which physical access. req. need to be implemented}}$$

Number of functions in which physical accessibility req.had been implemented:3

Number of functions for which physical access.req.need to be implemented:3

PA=3/3 = 1

11. User/Staff Satisfaction

$$\frac{\text{Total points get from Staff Satisfaction Questionnaire}}{\text{Total points of Staff Satisfaction Questionnaire}}$$

Total points get from Staff Satisfaction Questionnaire : 152

Total points of Staff Satisfaction Questionnaire: 25 (Total point of 1 questionnaire) *10(Number of applied questionnaire) : **250**

US=152/250 = 0.60

12. Patient Satisfaction

$$\frac{\text{Total points get from Patient Satisfaction Questionnaire}}{\text{Total points of Patient Satisfaction Questionnaire}}$$

Total points get from Patient Satisfaction Questionnaire: 442

Total points of Patient Satisfaction Questionnaire: 25 (Total point of 1 questionnaire) ***20** (Number of applied questionnaire)**: 500**

US=442/500= 0.88

13. Response Time

$$\frac{\text{Number of tasks which are performed in specified time}}{\text{Number of tasks}}$$

Number of tasks which are performed in specified time: 16452 (Number of responded requests-daily)

Number of tasks: 16452 (Number of performed tests-daily)

RT=16452/16452 = 1.00

14. Staff Adequacy Level

$$\frac{\text{Number of staff who received required trainings}}{\text{Number of staff}}$$

Number of staff who received required trainings: 137 (Number of staff)

Number of staff: 137 (Number of staff)

PA=137/137 = 1.00

15. Fault Ratio

$$\frac{\text{Number of detected failures}}{\text{Number of performed cases during process execution}}$$

Number of detected failures: 20/30 (Number of faulty performed tests-daily)

Number of performed cases during process execution: 16452 (Number of performed tests-daily)

FR=(20/30)/16452 = 0.0000

16. Staffing Ratio

$$\frac{\text{Number of staff}}{\text{Number of tasks}}$$

Number of staff: 137

Number of tasks: 16452 (Number of performed tests-daily)

SR=137/16452 = 0.0083

17. Acceptance Ratio

$$\frac{\text{Number of daily accepted patients}}{\text{Number of daily applied patients}}$$

Number of daily accepted patients: 16452-(46/365) (Number of NOT rejected tests-daily)

Number of daily applied patients: 16452 (Number of performed tests-daily)

AR= (16452-(46/365))/16452 = 1.00

18. Machine Utilization

$$\frac{\text{Number of unit related machines}}{\text{Average number of daily patients}}$$

Number of unit related machines: 32

Average number of daily patients: 16452 (Number of performed tests-daily)

MU=32/16452 = 0.0019

APPENDIX D: JCIAS ÖLÇÜLEBİLİR UNSURLARI VE ANKETLER

No	JCIAS Laboratuvar Ölçülebilir Unsurları
1	Bir laboratuvar güvenlik programı mevcuttur ve karşılaşılan risk ve tehlikeleri ele almaktadır.
	Program, organizasyonun güvenlik yönetim programı ile koordine edilmiştir.
	Yazılı politika ve prosedürler efektif ve tehlikeli materyallerin ele alınması ve imha edilmesini içerir
	Uygun güvenlik araçları mevcuttur
	Laboratuvar personeli güvenlik prosedürleri ve uygulamalarına uyum sağlamıştır
	Laboratuvar personeli, yeni prosedürler ve yeni kazanılmış veya fark edilmiş tehlikeli materyaller için eğitim almaktadır
2	Yeterli alıştırma, beceri, uyum ve tecrübeye sahip bireyler testi yönetir ve sonuçları yorumlar
	Testi gerçekleştiren bireyler, yönetenler ve denetleyenler belirlenmiştir
	Yeterince eğitimli ve tecrübeli personel testi gerçekleştirir
	Yeterince eğitimli ve tecrübeli personel testi yorumlar
	Hastaların ihtiyaçlarını karşılayacak yeterli sayıda personel mevcuttur
	Denetleyici personel yeterli eğitim ve tecrübeye sahiptir
3	Laboratuvar sonuçları organizasyon tarafından belirlenen zamanda hazır hale getirilir.
	Kurum, sonuçlar için beklenen raporlama zamanını belirler
	Acil testlerin zamanında raporlanıp raporlanmadığı takip edilir.
	Laboratuvar sonuçları hasta ihtiyaçlarını karşılayacak zaman dilimi içinde raporlanır.
4	Bir laboratuvar ekipmanı yönetim programı mevcuttur
	Program, ekipmanı seçmeyi ve tedarik etmeyi içerir
	Program envanter ekipmanını içerir
	Program ekipman tespiti ve test edilmesini içerir
	Program ekipmanın ayarlanmasını ve muhafaza edilmesini içerir
	Program izleme ve takip işlemlerini içerir
	Ekipmanın tüm test, muhafaza ve ayarlanma işlemleri uygun bir şekilde belgelenir.
5	Gerekli ayıraç ve diğer malzemeler düzenli bir şekilde mevcuttur

	Gerekli ayıraç ve malzemeler belirlenmiştir
	Gerekli ayıraç ve malzemeler mevcuttur
	Tüm ayıraçlar rehberlere göre saklanır ve tüketilir.
	Tüm ayıraçlar, sonuçlar ve tam doğruluk amacıyla periyodik olarak değerlendirilir.
	Tüm ayıraçlar ve solüsyonlar tam ve doğru bir şekilde titizlikle etiketlenir.
6	Örnekleri; bir araya getirme, belirleme, yönetme, güvenli bir şekilde taşıma ve dağıtma işlemi prosedürleri yerine getirilir.
	Prosedürler test isteğinde bulunmaya yol gösterir.
	Prosedürler, örneklerin bir araya getirilmesinde ve belirlenmesinde yol gösterir
	Prosedürler, örneklerin taşınmasında, saklanmasında ve korunmasında yol gösterir
	Prosedürler, örneklerin kayda geçilmesinde ve takibe alınmasında yol gösterir
	Prosedürler yerine getirilir
	Prosedürler, kurum dışı servis veya kaynak kullanıldığında gözlemlenir
7	Laboratuvar yürütülen her test için referans aralıkları saptamıştır
	Aralıklar, test sonuçları rapor edildiği anda klinik kayıtlarda yer almıştır
	Aralıklar, testler bir dış kaynak tarafından yapıldığında yayınlanmıştır.
	Aralıklar organizasyon hastalarına uygundur
	Aralıklar gerekli görüldüğünde yeniden gözden geçirilmiş ve güncellenmiştir
8	Klinik laboratuvar bir veya daha fazla nitelikli bireyin yönetimi altındadır
	Sorumluluklar; politika ve prosedürleri geliştirme yerine getirme ve muhafaza etmeyi içerir
	Sorumluluklar idari gözetimi içerir
	Sorumluluklar kalite kontrol programını uygulamayı içerir
	Sorumluluklar laboratuvar hizmetlerinin dış kaynaklarını tavsiye etmeyi içerir
	Sorumluluklar tüm laboratuvar hizmetlerinin izlenmesini ve yeniden gözden geçirilmesini içerir
9	Klinik laboratuvar için bir kalite kontrol programı vardır
	Program test metodlarının geçerliliğini içerir
	Program test sonuçlarının günlük gözlemlenmesini içerir
	Program aksaklıkların giderilmesini içerir
	Program sonuçların belgelenmesini ve düzeltici işlemleri içerir
10	Organizasyon, laboratuvar hizmetlerinin dış kaynak kullanımı kalite kontrol sonuçlarını düzenli olarakgözden geçirir
	Dış kaynaklardan alınan kalite kontrol sonuçları düzenli olarak yeniden gözden geçirilir
	Nitelikli bireyler kalite kontrol sonuçlarını yeniden gözden geçirirler
11	Organizasyon, gerek duyulduğunda, özelleşmiş tanı alanlarında uzmanlığı olan

	kişilere ulaşabilir
	Uzmanların özelleşmiş tanı alanlarına göre isim listesi mevcuttur
	İhtiyaç duyulduğunda özelleşmiş tanı alanlarındaki uzmanlarla bağlantı kurulur

No	JCIAS Muayene Ölçülebilir Unsurları
1.1	Kurum, yasa, düzenleme ve profesyonel standartlara dayanan, hasta değerlendirmesi içeriği ve konusunu belirler
	Değerlendirmenin konusu ve amacı her klinikçe politikalarda belirtilir
	Tüm hastalara uygulanacak muayenenin kapsam ve içeriği her klinik tarafından politikalarda tanımlanır.
1.2	Her hastanın başlangıç değerlendirmesi fiziksel, psikolojik, sosyal ve ekonomik faktörleri, fiziksel değerlendirme ve sağlık geçmişini içerir
	Tüm hastalar, kurum politikasıyla uyuşan bir başlangıç değerlendirmesi ile kabul edilir
	Tıbbi muayene, fiziksel değerlendirme ve anamnezi içerir
	Her hasta ihtiyaçları doğrultusunda bir başlangıç psikolojik değerlendirme alır
	Her hastaya bir başlangıç sosyal ve ekonomik değerlendirme yapılır
	Başlangıç değerlendirmesi geçmişte alınan tedavi durumunun belirlenmesini sağlar
	Başlangıç değerlendirmesi tedaviye uyan en uygun konumun seçimini sağlamalıdır.
	Başlangıç değerlendirmesi başlangıç tanısının konmasını sağlamalıdır
1.3	Hastanın tıbbi ve hemşirelik hizmetleri ihtiyaçları başlangıç değerlendirmesinden anlaşılır
	Başlangıç değerlendirmesinden hastanın tıbbi ihtiyaçları belirlenir.
	Tıbbi ihtiyaçlar dokümante edilen sağlık geçmişi, fiziksel değerlendirme ve hastane politikasına göre belirlenmiş diğer değerlendirmelere göre belirlenir.
	Başlangıç değerlendirmesinden hastanın hemşirelik ihtiyaçları belirlenir.
	Hastanın hemşirelik ihtiyaçları hemşirenin dokümantasyonu, tıbbi değerlendirmeler ve diğer değerlendirmelere göre belirlenir
1.4	Değerlendirme, kurumca belirlenen süre içerisinde tamamlanır
	Tüm tedavi rejimleri ve servisler için değerlendirme yapmada zaman aralıkları belirlenir.
	Değerlendirme kurumca belirlenen zaman aralığında tamamlanır
	Kurum dışında yapılan değerlendirme sonuçları hasta kabulünde doğrulanır
1.5	Değerlendirme sonuçları hasta kayıtlarında yer alır ve hastanın bakımından sorumlu kişinin kolayca ulaşabileceği yerde bulunur.
	Değerlendirme sonuçları hasta kayıtlarında yer alır

	Hastanın tedavisini yapanlar, ihtiyaç olduğunda değerlendirme sonuçlarını hasta kayıtlarından veya standart ulaşılabilir lokasyonlardan bulabilirler.
	Başlangıç tıbbi değerlendirme hastanın kuruma girmesini müteakip 24 saat içinde hastanın kayıtlarında yer alır
	Başlangıç hemşirelik ihtiyacı değerlendirmesi hastanın kuruma girmesini müteakip 24 saat içinde hastanın kayıtlarında yer alır
1.6	Hastalar beslenme durumları ve fonksiyonel ihtiyaçlarına göre incelenirler ve bunlar gerektiğinde daha ileri değerlendirme ve tedaviyle ilişkilendirilirler
	Yetkili kişiler, daha ileri besinsel değerlendirme ihtiyacı olan hastaları belirlemek için kriterler geliştirirler
	Hastalar, başlangıç değerlendirmesinin bir parçası olarak besinsel risklere karşı taranırlar
	Kriterlere göre beslenme problemleri ile ilgili risk altında olan hastalar, besinsel değerlendirmeye alınırlar
	Yetkili kişiler, daha ileri fonksiyonel değerlendirme gerektiren hastaları belirlemek için kriterler geliştirirler
	Hastalar başlangıç değerlendirmesinin bir parçası olarak daha ileri fonksiyonel değerlendirme ihtiyaçları için taranırlar
	Kriterlere göre fonksiyonel değerlendirme ihtiyacı olan hastalar bu tür bir değerlendirmeye yönlendirilirler
1.7	Kurum, kurumca tedavi edilen özel grup için bireysel başlangıç değerlendirmesi planlar
	Kurum, başlangıç değerlendirmesi değiştirilen özel durumları ve hasta gruplarını belirler
	Bu özel hasta grupları bireysel değerlendirmeye tabi tutulurlar
1.8	Başlangıç değerlendirmesi, ek özel değerlendirme durumlarını da belirler.
	İlave özel değerlendirme ihtiyacı saptandığında hastalar sevk edilirler.
	Eğer özel değerlendirme kurum içinde yapılır ise hasta kayıtlarına işlenir.
2	Tüm hastalar, tedaviye yanıtlarını tespit etmek ve sürmekte olan tedavi veya yürütülen görev için bir plan yapmak üzere uygun aralıklarla yeniden değerlendirilir
	Hastalar tedaviye verdikleri yanıtı tayin etmek üzere yeniden değerlendirilir.
	Hastalar sürmekte olan tedavi veya taburcu planları için yeniden değerlendirilir
	Hastalar; durumlarına, bakım planına ve bireysel htiyaçlarına uygun bir şekilde veya organizasyon politikası ve prosedürlere göre belli aralıklarla değerlendirilir
	Bir hekim, hastaları bakım ve tedavilerinin akut fazı boyunca günlük olarak (hafta sonlarını da içerecek şekilde) yeniden değerlendirir
	Organizasyon politikası, şartları veya hasta türlerini tanımlar (1günden daha az yeniden değerlendirme ve bu hastaların değerlendirilme aralıklarını belirler)
	Değerlendirmeler hasta kayıtlarına eklenir
3	Nitelikli bireyler değerlendirme ve yeniden gözden geçirmeleri yürütürler

	Hasta değerlendirme ve gözden geçirmelerini yürütecek nitelikteki bireyler, organizasyon tarafından belirlenir
	Sadece yasa ve düzenlemelere göre lisansı olan kişiler hasta değerlendirmesi yapabilir
	Acil değerlendirmeleri, bunu yapabilecek nitelikteki bireyler tarafından yapılır
	Hemşirelik değerlendirmeleri, bunu yapabilecek nitelikteki bireyler tarafından yapılır
	Hastaların değerlendirme ve gözden geçirme işlemlerini yürütecek niteliktekiler ve sorumluluklar tanımlanmış olmalıdır.
4	Tıbbi, hemşirelik ve diğer bireyler hasta bakımı ve değerlendirmesinin birlikte yürütülmesinden sorumludur
	Hasta ihtiyaçları değerlendirme sonuçlarına göre önceliklendirilir.
	Hasta ve yakınları değerlendirme sürecinin sonuçları ve istenen teşhis onayları hakkında bilgilendirilir.
	Hasta ve yakınları planlanan tedavi hakkında bilgilendirilerek ihtiyaçların önceliklendirilmesi ve karar süreçlerine katılmaları sağlanır.

Personel Değerlendirme Anketi

1. Hangi sıklıkla fazla mesaiye kalıyorsunuz?
    a) Sıklıkla
    b) Bazen
    c) Asla
2. Yazılı bir iş tanımınız var mı?
    a) Evet
    b) Hayır, iyi tanımlı değil
    c) Hayır
3. Hastane yönetimi sorunlarınızla yeterince ilgileniyor mu?
    a) Evet, kesinlikle
    b) Evet, kısmen
    c) Hayır
4. Biriminizde işlerin yürümesiyle ilgili genel değerlendirmeniz?
    a) Mükemmel
    b) Çok iyi
    c) İyi
    d) Orta
    e) Kötü

Hasta Değerlendirme Anketi

1. Birimle ilgili işlemlerinizin tamamlanması çok zaman alıyor mu?
    a) Evet, kesinlikle
    b) Biraz fazla
    c) Hayır
2. Tekrar gelmeyi tercih eder misiniz?
    a) Evet
    b) Belki
    c) Hayır
3. Tüm sorularınız ilgili personel tarafından cevaplandırıldı mı?
    a) Evet, kesinlikle
    b) Evet, kısmen
    c) Hayır
4. Birimle ilgili aldığınız hizmeti genel olarak nasıl değerlendirirsiniz?
    a) Mükemmel
    b) Çok iyi
    c) İyi
    d) Orta
    e) Kötü

VITA

ÖZKAN YILDIZ

He was born in Malatya on September 10, 1972. He received his B.S. degree in Computer Science Engineering from the Hacettepe University in 1994. He received his M.Sc. in Information Systems from the Middle East Technical University in December 2000.

He has been working in Turkish Prime Ministry as a software engineer since 1994. His main research areas are software process improvement, health care process improvement, process assessment, process measurement, and software development.

PUBLICATIONS:

Yıldız, Ö., Demirörs, O. 2010. A New Model for Measuring Healthcare Process Quality, *Medical Informatics Turkey,* Antalya, Türkiye.

Yıldız Ö., Demirörs O. 2009. Adopting Software Quality Measures for Healthcare Processes. *Studies in Health Technology and Informatics,* Volume 150, pp: 394-398.

Kaymakoğlu B, Ariöz U, Yıldız Ö, Coşkun G. 2008. Reliability And Correctness Measures For The Web Sites: A Diabetes Mellitus Case. *Health Informatics and Bioinformatics*, İstanbul, Türkiye

Yıldız, O., Demirörs, O. 2007. Applicability of ISO 9126 to Healthcare, *Medical Informatics Turkey,* Antalya, Türkiye.

Kaymakoğlu B.,Yıldız Ö., Arıöz U. 2007. Assessment of laboratory and management information system processes of a hospital according to ISO 15504. *Medical Informatics Turkey*, Proceedings, 145.

Kaymakoğlu B., Ariöz U., Yıldız Ö. 2006. An Evaluation of Data Errors and Losses During Transfer of ICD Codes to Electronic Media, *Medical Informatics Turkey*, Antalya, Türkiye.

Gül H., Kuru K.,Gürsel G., Yıldız Ö. 2005. Advantages of Electronic Prescription, Possible Problems in Its Use and Their Solutions, *Medical Informatics Turkey,* Antalya,Türkiye.

Yıldız, Ö., Demirörs, O. 2002. Software Maintenance Process Capability of Public Organizations: A Multiple Case Study", *SPICE 2002 Conference*, Venice, Italy from 14 -15 March 2002.

Demirörs, O., Yıldız, Ö., Güceğlioğlu, A.S. 2000. Using Cost of Software Quality for a Process Improvement Initiative, *26th EUROMICRO Conference*, Volume 2, September, pp. 2286.