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IMPLEMENTASI FUZZY-TIME DRIVEN ACTIVITY BASED COSTING (FUZZY-TDABC) UNTUK PENETAPAN BIAYA POKOK SERVIS LAYANAN KESEHATAN DI UNIT RAWAT JALAN

ELSA CAMELIA HARMADI
NRP 251.110.047

Dosen Pembimbing
Dyah Santhi Dewi, S.T.,M.Eng.Sc.,PhD
NIP.197705232000031002

JURUSAN TEKNIK INDUSTRI
FAKULTAS TEKNOLOGI INDUSTRI
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ELSA CAMELIA HARMADI
NRP 251.110.047

Supervisor
Dyah Santhi Dewi, S.T.,M.Eng.Sc.,PhD
NIP.197705232000031002

DEPARTMENT OF INDUSTRIAL ENGINEERING
FACULTY OF INDUSTRIAL TECHNOLOGY
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
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Written by:

ELSA CAMELIA HARMADI
NRP. 2511 100 047

Approved by
Final project supervisor

Dyah Santhi Dewi S.T., M.Eng.Sc.,PhD
NIP. 197705232000031002

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IMPLEMENTASI FUZZY-TIME DRIVEN ACTIVITY BASED COSTING (FUZZY-TDABC) DALAM PENETAPAN BIAYA POKOK LAYANAN KESEHATAN PADA UNIT RAWAT JALAN (STUDI KASUS: RUMAH SAKIT AL IRSYAD SURABAYA)

Nama : Elsa Camelia Harmadi

NRP : 2511100047

Dosen Pembimbing : Dyah Santhi Dewi, S.T., M.Eng. Sc., PhD

ABSTRAK

Salah satu pilar layanan kesehatan yang baik adalah penetapan tarif yang baik. Besarnya tarif dipengaruhi oleh biaya pokok layanan kesehatan. Fuzzy-TDABC dapat mengakomodasi kesulitan untuk estimasi biaya terkait tingginya variasi dan informasi biaya terkait pada proses layanan. Model fuzzy-TDABC memiliki informasi detail mengenai sumber daya ekonomis; alokasi biaya dan availibilitas dalam penyediaan layanan. Keunikan fuzzy-TDABC adalah memiliki persamaan waktu yang berisi informasi total waktu standar untuk mengerjakan satu siklus layanan. Pengukuran kerja secara langsung diperlukan untuk menghitung waktu standar, sehingga membutuhkan waktu yang cukup lama karena dipengaruhi oleh beberapa faktor ketidakpastian dari aktivitas yang beragam. Fuzzy set logic memiliki fungsi untuk meningkatkan akurasi dari perhitungan waktu standar dengan fungsi keanggotaan untuk setiap nilai waktu. Selanjutnya, estimasi biaya dihitung berdasarkan penggunaan CCR dan total waktu standar. Dengan adanya perbandingan overpricing dan underpricing, fuzzy-TDABC adalah salah satu pendekatan estimasi biaya yang direkomendasikan untuk memudahkan perhitungan biaya pokok dalam jenis layanan kesehatan yang beragam.

Kata kunci : biaya pokok layanan kesehatan, estimasi biaya, fuzzy-TDABC, klinik rawat jalan, pengukuran waktu kerja langsung

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IMPLEMENTATION OF FUZZY TIME DRIVEN ACTIVITY BASED COSTING (FUZZY-TDABC) TO ESTIMATE HEALTHCARE SERVICE COST IN OUTPATIENT UNIT (A CASE STUDY: AL IRSYAD HOSPITAL)

Name : Elsa Camelia Harmadi

Student ID : 2511100047

Supervisor : Dyah Santhi Dewi, S.T., M.Eng. Sc., PhD

ABSTRACT

One of healthcare pillars to provides an excellent services value is healthcare tariff. Healthcare tariff estimation is determined by service cost. This research is focus on implementation of cost estimation using fuzzy-TDABC in an outpatient unit. Fuzzy-TDABC can accommodates high various type of services and minimize the biased information related to the care processes. This model have detailed information about economic resources; its cost allocation and the practical capacity. The rate of economic resources usage is translated into capacity cost rate (CCR). The uniqueness of fuzzy-TDABC lies in time equation formulation which contains total standard time while performing a healthcare product. Since direct work measurement was performed to estimate standard working time, it can be concluded that it is requires long time to do and has high variations of heterogeneous activity that create data vagueness. Fuzzy set has a role to accommodate data vagueness since it contains logic set of membership functions. By then, service cost estimation is done by multiplying CCR with total standard time of a healthcare product. The research output is healthcare service cost in several care services in outpatient unit includes general clinic, antenatal clinic, hemodialysis clinic, and dental clinic. Based on the analysis of comparison with existing cost estimation, there are several evidences about the underpricing and overpricing of healthcare products. In conclusion, fuzzy-TDABC is recommended to be used in cost estimation of healthcare products since it can accommodate various types of services that shown in the form of packages.

Keywords : cost estimation, direct work measurement, fuzzy-TDABC, healthcare service cost, outpatient unit.

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PREFACE

Bismillahirrahmanirrahim.

Alhamdulillahirabbilalamin. In the name of Allah, the Most Gracious, the Most Merciful. Peace and blessings of Allah be upon His Messenger, Muhammad, and all his families and companions. Thanks to Allah who has gives much blessings and guidance for us. With His permissions, I able to complete the research that titled "Implementation of Fuzzy-Time Driven Activity Based Costing (Fuzzy-TDABC) to Estimate Healthcare Service Cost in Outpatient Unit (A Case Study: Al Irsyad Surabaya)". This research is submitted in fulfillment of the requirements of Bachelor Degree in Industrial Engineering of Institut Teknologi Sepuluh Nopember. It contains work done from March to July 2015.

Writing this research has been hard but in the process of writing the author have learned a lot and it is develop our way of thinking to solve a problem. Have dealt with a lot of threats and challenges, i would like to thank for all the guidance, support and motivation. Therefore I would like to give a deep gratitude to:

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9. Dear my future man and my future lovely kids, thanks for being my motivation to complete my bachelor degree with a good achievements. I hope that we will meet in our best moments when Allah has let us to do so.

No man without flaws, therefore the suggestions and questions are acceptable for the completion of further research. May Allah accept our good deeds and always bless us in every single step in our life.

Best regards,

Elsa Camelia Harmadi

Surabaya, Juli 2015

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CHAPTER I
INTRODUCTION

This chapter contains of research background, problem formulation, the purposes, and research benefits. Additionally, it also contains about the assumptions and limitations, and the outline of the research.

1.1 Research Background

As the fourth largest densely populated country in the world, Indonesia has a challenge to maintain a good healthcare service for its people. The provision of healthcare services has an important role to support the welfare of the community. As mentioned in Undang-Undang Negara Republik Indonesia no 39 year 2009 clause 5 that every people reserve a right to get a good healthcare services that provide safety, high quality, and affordable services. Based on the statement above, hospital as one of the healthcare services provider has a responsibility to provide good quality healthcare services with reasonable tariffs.

According to Health Research & Educational Trust (2013), there are five pillars to supports good provision of healthcare services in a hospital. Five pillars that support the provision of healthcare services are; (1) healthcare tariffs, (2) employee's dedication, (3) services delivery, (4) resource utilization, and (5) customer satisfaction. Based on Figure 1.1 about five pillars of healthcare services, those pillars are interconnected into each other. The integration of those pillars will improve hospital's value of competitiveness to gain customer satisfaction.

One indicator about good provision of healthcare services is the healthcare tariffs estimation. The value of tarrifs is determined by its service costs. There is a difference between the definition of tariffs and service costs. Tariffs is the amount of money that customer should pay include the estimation of company's profit margin. While the definition of service costs is the expenses related to resource usage to perform healthcare services.

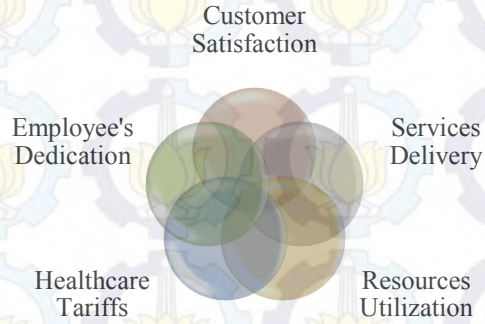

Figure 1.1 Five Pillars of Healthcare Services

Source: (Health Research & Educational Trust, 2013)

The component of service costs in healthcare includes direct labor costs, direct overhead costs, direct material costs, and indirect overhead costs (Setyawan, 2004). Direct labor cost contains of medical service, nursing service, and incentives. Direct overhead cost contains of dietary service, laundry service, diagnostic service, and rent cost of medical equipments, room usage, and healthcare facilities. Direct material cost contains of consumable drugs, medical equipments, and non medical equipments. Indirect overhead cost contains of medical outsourcing personnel salaries, non medical personnel salaries, director salary, environmental support cost, medical and non medical support cost.

A complex business process and high varieties of services become a challenge for hospital management to estimate healthcare service cost accurately. As mentioned before, service cost is used as the basis of tariffs estimations. The distortion of service cost lead to underprice and overprice that inflict a loss for the customer either hospital management (Demeree, 2009). If the tariffs exceed the service value, it will lead to customer dissatisfaction. But when the tariffs are set below the service value it will lead to financial loss of hospital management. This condition creates an urgency to use better service cost estimations, while it is used to manage willingness to pay and ability to pay of customer.

One of the methods to determine healthcare service cost is by using traditional approach. Traditional approach estimate the service cost based on the basic expenses to perform care activities. One of the hospitals that implemented

traditional approach is Al Irsyad Hospital in Surabaya. Service cost estimation is done by the authority of manager and director. Service cost is estimated by allocating direct material and direct labor to provide healthcare services. The component of services cost includes registration cost, doctors salaries, drugs usage, and medical treatment costs. The overhead is considered as direct cost and it is allocated through direct labor hours. To calculate overhead, the sum of the overhead expenses is divided by the sum of the direct labor. Direct labor hour is the cost driver that used in Al Irsyad Hospital.

Table 1.1 Sales Growth Rate of RS Al Irsyad Surabaya

No	Year	Annual Income	Sales Growth Rate
1	2011	IDR 36,444,082,796.00	-
2	2012	IDR 40,432,971,205.00	10.95%
3	2013	IDR 48,196,006,818.00	19.20%
4	2014	IDR 56,710,166,851.00	17.67%

Source: (Al Irsyad Hospital, 2014)

Based on the data from Table 1.1 from 2013 to 2014 there is a decreasing in sales growth rate from 19.20% to 17.67% which is 1.53%. The growth rate of sales can be affected by many factors such as customer satisfaction, the services punctuality, and others. To actualize the vision to be internationally recognized as an Islamic healthcare services provider that prioritizes quality and satisfaction for the customer, the hospital management needs to increase its quality with reasonable price.

When trying to provide a good quality services with reasonable price, hospital management faces some difficulties to set a price for its healthcare services. It is threaten by the competition among the other hospital that demanded to provide optimal services. The customer often dissatisfied with the services provided by the company that shown in the complaints report. The healthcare personnel team is not fully commit to build a team that has best performance, this can be affected by the salary system that not corresponding due to its workload.

Based on hospital's annual report, threats and weaknesses that faced by hospital management is high pressure toestimate patient fees. Hospital's source of fund is gathered from patients and it is not supported by government, thus the hospital management should manage their business by balancing the pricing system, usage of resources, expected qualities, customer and employee satisfaction. The information system that implemented in the existing system is not fully integrated, it means that the pricing system is not updated frequently and less accurate. It inferred the needs of a pricing system that provide high flexibility and more accurate than the existing system. One of the complaints that submitted is they are often pay the same patient fees although using different treatment and activities of care services. There is no difference based on severity rate to pay the patient fees, whether they get serious illness or not. Thus make the transparency of patient fees become important. In some cases, the patients frequently asks some reduction and discount in healthcare services fees, which implied that the pricing system is frequently underprice and overprice for customer.

Although traditional approach is easy to implement, this budgeting system has several weaknesses. The authority of manager and director as the consideration in determining the service cost will lead to underprice and overprice, since they're not have adequate information about the activities that caused expenses. Generally, the cost estimation is done based on the number of output, while in service industry the number of output is intangible. As the output is intangible, it is difficult to estimate the overhead cost accurately. Overhead cost component that should be considered contains electrical, water, and telephone expenses, director and non-medical personnel salaries, and maintenance expenses. Moreover, traditional approach is not accommodating high varieties of activites since it is not mention about the varieties of activities in healthcare services.

To overcome this problem in implementing traditional accounting system, healthcare management has an option to implement Activity Based Costing (ABC). ABC is a cost calculation technique that allocates resource cost to products based on resource consumption (Demeree, 2009). ABC has the ability of measuring real sources used by daily activities. Ghahramani (2008) stated that

activities done on the basis of costs are an important factor in analyzing the profitability of products. ABC allows the estimation of cost for each activity, since healthcare services is a system with high complexity, it needs multi driver activities model. To update the cost and do its maintenance regularly, the management should do re-survey and re-interviews which requires longer times and higher cost. The other consideration is the subjectivity when doing re-interviews that also questioned during the process.

A development of ABC that can be installed quickly and requires lower cost is developed by Kaplan and Anderson in 2007 called Time Driven Activity Based Costing (TDABC) (Szychta, 2010). It is estimating two parameters that consist of: (1) the unit cost of supplying capacity and (2) the time required to perform a transaction or an activity. Since it is relying on cost estimations based on cost equations from each activity on the basis of time, it helps to handle large cost informations and time proportions estimations accurately. The difference between ABC and TDABC lies in the usage of time equations when estimating time spent on each activity. It has special characteristics as it is consider standard time to perform an activity and it can cover high variations of service cost driver in that captured in time unit. TDABC offers a better way to calculate the cost component by using less complicated and less cost method to update the budgeting system frequently.

However, the variation of resource consumption is very high in healthcare services.The time needed on doing care service as the input parameter in TDABC model is estimated by its average value before inserted to the equation. If the hospital management implemented regular TDABC, each value of time in resource data set will be assumed and considered as it has same importance level. In a healthcare service, this assumption can not hold true. It will trigger inaccuracy in the cost analysis as it has different volume usage of economic resources. The usage of resources is depending on the number of medical treatment, which can be translated into the variations of time needed when doing care services. As the time needed is longer, the volume of resources usage will be larger. This condition will lead to a bias analysis since when the caused by the

demand of services can not be estimated such as in manufacturing industries. Nevertheless when some values are appear more frequent than the others, this assumption can not hold true.

Dealing with the uncertainties due to high variation and vagueness, Zadeh (1978) propose a fuzzy set theory to estimate value in an uncertain environment. Fuzzy set theory can cover a large data variation such as in healthcare services. Fuzzy-TDABC is the proposed version of TDABC that can be applied to perform a cost analysis in uncertain environment. There are many versions of fuzzy set theory. According to Chansaad (2012) one of the version that compatible with handling possible extreme cases of costs by distributing weights through membership functions is triangular fuzzy. Triangular fuzzy is the approach that can be used in fuzzy-TDABC since it has better intuitive than other types of fuzzy such as trapezoidal or bell shaped fuzzy numbers. By covering the uncertainties when estimating the costs, this research tries to capture possible costs estimation by provide additional information on the worst and best case result. Hopefully fuzzy-TDABC can provide better results on cost estimation and improve its accuracy.

1.2 Problem Formulation

The problem formulated through this research is how to estimate service costs in a high complexity and uncertain environment especially in healthcare services, which provides better accuration and easier to updated.

1.3 Research Objectives

The objectives of this research are:

1. To identify economic resources to perform healthcare services.
2. To calculate standard time in performing activites as the input for time equation deployment that used in fuzzy-TDABC.
3. To estimate service cost in a provision of healthcare services.

4. To analyze the application of fuzzy-TDABC to estimate healthcare service cost.
5. To give a recommendation based on the result of fuzzy-TDABC implementation.

1.4 Research Benefits

The benefits of this research are:

1. To improve pricing system accuracy by using time driver of care activities.
2. To improve pricing system flexibility by using simple and cheaper cost estimation.
3. To improve activities efficiency by propose a recommendation on work standard time.
4. To handle uncertainties data variations by avoiding intuitive judgement on cost estimations.
5. To enable a continuous improvements to increase customer and employees satisfaction.

1.5 Research Scope

Research scope is classified into the boundaries and the assumptions, which are shown as below:

1.5.1 The Boundaries

The boundaries that used in the research are:

1. The research is limited in the outpatient unit. The selection of outpatient unit is based on its high frequency of care services.
2. The care processes is limited to patient arrival, technical consultation, medical treatment, and payment process.

1.5.2 The Assumptions

The assumptions that used in the research are:

1. Healthcare personnel in outpatient unit were assumed healthy. It is implied that they do the care process correctly to reduce human error probability.
2. There are not any changes in process maps of healthcare activities. It is implied that the job description of healthcare personnel is not changes.

1.6 Research Outline

The outline of this research is classified into several chapters which are shown as below:

CHAPTER I INTRODUCTION

This chapter contains about the background of the research, followed by problem formulations, research benefit, the scope of the research, and the systematic writing.

CHAPTER II LITERATURE REVIEW

This chapter contains of literature review, includes the basic theory and academic background that used as references in completing the research. In this research will discuss about outpatient clinics, stopwatch time study, Time Driven Activity Based Costing (TDABC), fuzzy logic, continuous quality improvement, resources utilization, hospital revenue cycle, and business process improvement.

CHAPTER III RESEARCH METHODOLOGY

This chapter describe about the sequences in problem solving methods to do the research. The deployment of systematic scheme will directly support the research by systemic thinking process.

CHAPTER IV DATA COLLECTIONS AND PROCESSING

This chapter contains about the data collection and calculation to calculate service costs using fuzzy-TDABC. Time equation as the uniqueness of fuzzy-TDABC is constructed by the capacity cost rate for each resource and standard time to perform healthcare services. To reduce the uncertainties of bias and vagueness of information, the resource cost was developed into triangular fuzzy that is smallest possible, most promising, and largest possible value. Since then, a large variation of data of resource costs can be estimated better.

CHAPTER V DATA ANALYSIS

This chapter contains data analysis based on the data processing results. The analysis includes these following areas such as; (1) analysis of existing healthcare service estimation, (2) analysis of fuzzy-TDABC service cost estimation, and (3) analysis of possible recommendations based on fuzzy-TDABC implementation.

CHAPTER VI CONCLUSION AND SUGGESTION

This chapter contains the conclusion from the research regarding the objectives of the research. It is followed by the suggestions from the author for future research.

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CHAPTER II
LITERATURE REVIEW

This chapter contains of literature review, which includes the basic theory and academic background that used as references in completing the research. It is consists of service flow in a hospital, outpatient unit, healthcare budgeting system, service cost, service cost estimation, fuzzy set theory, work measurement methods, and fuzzy time-driven activity based costing (fuzzy-TDABC).

2.1 Service Flow in a Hospital

In provision of healthcare services, care activities are deployed in a process flow based on its functional units. There are pure supporting unit, supporting producing unit, and pure producing unit. Pure supporting unit defined as the department that provides information related to the support process of the hospital business; contains of administration support department and environmental support department. Semi supporting unit defined as the department that support the performance of producing unit; contains of facility support department, non medical support department, and medical support department. Pure producing unit is medical service department that provide care services for the patient.

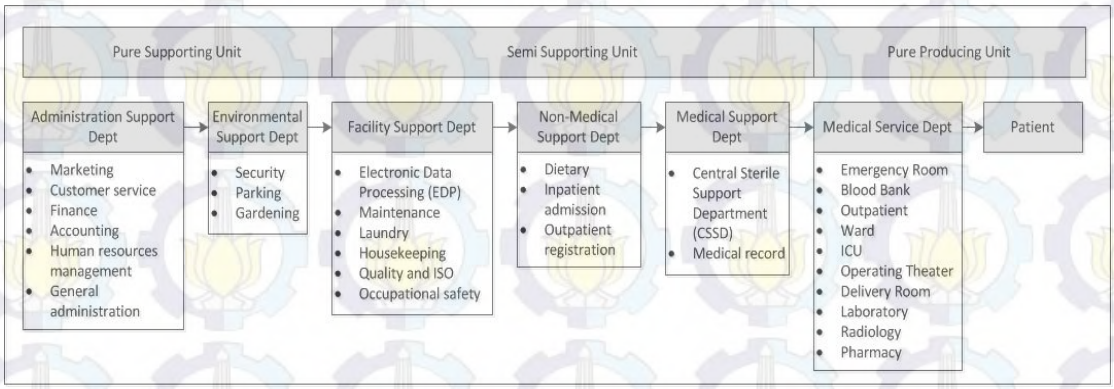

Figure 2.1 Healthcare Services Flow Process

Source: (Setyawan, 2004)

According to Figure 2.1 that shows the healthcare services flow process, administration department take a basic roles by perform managerial activities and provide informations for semi supporting department. The sub-units of administration department include marketing, customer services, finances and accounting, human resources management, and general administrations. Other pure supporting unit is the environmental support department which assures the technical activities ranging from security assurance, gardening, and parking.

Table 2.1 Classification of Unit in a Hospital

No	Type of Unit		Definition	Unit Name	The activities
1	Pure supporting unit		Supporting unit where it is difficult to identify the service cost allocation for the customer	Administration support department and environmental support department	Create database, enables sharing informations and data through hospital information system
2	Semi supporting unit		Supporting producing unit where the service cost is not the main reason why customer came to the hospital	Facilities support dept and non medical support dept	Accomodate supporting activities to provide healthcare services
3	Pure producing unit	One-step medical service unit	Pure producing unit that can perform individually	Medical support dept	Database maintainance of medical record of patient. This unit is used as information provider for the two-step medical service unit and three-step medical service unit
		Two-step medical service unit	Pure producing unit that can perform only when it is supported by one-step medical service unit	Emergency unit and outpatient unit	This unit provide healthcare activities that performed in some concise procedures, which prioritize services delivery time for the patients. It usually performs a small-medium medical treatments during care activities
		Three-step medical service unit	Pure producing unit that can perform only when it is supported by one-step medical service unit and two-step medical service unit	Inpatient unit and intensive unit	This unit needs an advance and continous treatment during care activities

Source: (Setyawan, 2004)

Based on Table 2.1 the information flows from pure supporting unit into semi producing unit. Semi producing unit perform operational supporting activities in

areas of facility support department, non medical support department, and medical support department. Sub-unit in facility support department provides maintenance, electronic data processing (EDP), laundry, housekeeping, quality and ISO, and occupational safety. Facility support department directly back up the needs of non-medical support department. The sub-unit in non-medical support departments are dietary, inpatient admission, and outpatient registration. Non-medical support department continues the informations and supports activities from the previous department into medical support department. Medical support department perform operational activities ranging from provide central sterile support department (CSSD) and medical record of patients.

Subsequently, the integration of pure supporting unit and semi producing unit is used to supports the operational in pure producing unit. Pure producing unit is medical service department that provide care activities for the patients. The sub-unit in this department is the services in emergency room, blood bank, outpatient unit, inpatient unit, ward care services, intensive care unit (ICU) services, operating theater, delivery room (antenatal services), laboratory, radiology unit, and pharmacy.

Pure producing unit is classified into three level of medical service unit. There were one-step, two-step, and three-step medical service unit. The classification is based on stratification of flow processes. One-step medical service unit is medical support department, consists of CSSD and medical record sub-unit which stored and maintains database of patient medical record. The unit is used as information provider for the upper medical service unit. Two-step medical service unit is emergency unit and outpatient unit. The technical operation of this unit is based on the data provided in medical support department as one-step medical service unit. The characteristics of two-step medical service unit is has basic healthcare treatments and activities that commonly used to heal patients.

2.2 Outpatient Unit

An outpatient unit is the department that provides medical procedures without any overnight care in the hospital (Healthwise, WebMD Medical Reference,

2013). In general, the care processes can be done in several hours. As shown in Table 2.1 about service type in a hospital, outpatient unit as two step medical service unit requires one step medical service unit to perform the care activities.

According to Southern Regional Health Authority (2014), based on the level and types of services offered there are four types of hospital; type A, type B, type C, and specialist. Specialist hospitals provide special healthcare treatments based on specific and distinctive treatment, such as psychiatric hospital, maternity hospital, etc. Type A hospitals provide multi-disciplinary institutions which provide both secondary and tertiary care, which is usually used as the final referral points for such services.

Different with type A hospital, type B hospitals provide inpatient and outpatient services in at least has five basic specialties, which are general surgery, general medicine, obstetrics and gynaecology, paediatrics and anaesthethics. It is also equipped with X-ray and several laboratory services to serve hospital patients. While type C hospital has basic primary healthcare services with outpatient and inpatient unit that provide general medicine, surgery, child and maternity care. Basic X-ray, laboratory services, and several specialist surgeons are also available to ensure the availability of emergency services.

Al Irsyad as type C hospital provides medical services and diagnostic services that ranging as below:

a. Medical clinic; includes general clinis, dental clinics, antenatal clinic, heart and lung clinic, neurology clinic, internal medicine clinic, ophtamology clinic, and nose-throat-ears (NTE) clinic. The other medical services provided are pregnancy clinic, child health clinic, general surgery, acupuncture clinic, and outpatient medical rehabilitation facilities.
b. Radiology; the unit that provides supporting diagnostic tests includes x ray, computer tomography (CT), magnetic resonance imaging (MRI), ultrasonography test, electrocardiogram test, and others.
c. Hemodialysis facilities; the hemodialysis unit provide care services for the people with dysfunctional kidney. The care process is replacing the functions

of kidney as it is cleaning and supports blood circulation through artificial kidney. An infusion was done through fistula that connects blood vessels with artificial kidney, while other infusion carrying clean blood returns to the blood vessels. The excess water and residual substances will be taken out during the care process. The time needed to perform full cycle of hemodialysis care is depending on the physical condition of the patient, which is usually takes four to five hours.

d. Pathology Clinical Laboratory; the unit that provides medical testing that provide a several packages such as hypertension care packages, kidney care packages, and diabetes care packages.
e. Dietary consultation; a nutrition counseling is provided to help patient to learn a healthy eating and lifestyle. Based on the consultations, the patient will receive clear nutritional guidance based on the personal needs. The service offered includes weight management, diabetes, nutritional support, vegetarian diets, cholesterol, etc.
f. Pharmacy unit; is a unit that supply medicine and drugs whether it is from prescriptions or other needs. It provide services ranging from dispense prescriptions, repeat dispensing, medicine use reviews, flu vaccinations, supervised drug administration, etc.
g. Medical rehabilitation facilities; rehabilitation unit has aims to increase physical capacities and functional abilities of a patient to improve its quality of life. The available treatments are ultrasonic therapy and electromagnetic therapy. It is also equipped with short wave diatermi (SWD) and ultra sound diatermi (USD) facilities.
h. Other facilities; the hospital management provides other activities such as spiritual guidance, pregnancy exercise, and others.

Figure 2.2 Patient Flow Process
Source: (Al Irsyad Hospital, 2014)

Based on main activities in the outpatient unit, the research is limited to several processes ranging from patient arrival, patient registration, medical consultation, medical treatment, and payment process. The common procedures in outpatient unit are explained as the following. In outpatient unit, patient arrival is checked based on its status whether it is already registered or not. The following activitiy is the recall of the previous medical record, and then they do consultation process with doctor or other medical personnel. Subsequently, the patient that already examined got medical recommendation treatment. They did the medical treatment based on the personal needs of healthcare services. By finishing the medical treatment, patient got suggestions and drugs prescription. The final process is the payment process.

2.3 Budgeting System in a Hospital

A hospital budgeting is a quantitative statement of a strategic planning. It is used as supporting tools to help the coordination and implementation of a regulation (Horngren & Foster, 1988). Silalahi (1989) stated that a budgeting is a management tools to helps information transferring and processing as the basis for decision making. The other function of a budgeting is become a monitoring agent and work standard measurement to achieve the organization goals.

According to Djuhaeni (2012), there are some general terms in hospital budgeting that shown as below.

1. Cost; it is the monetary value of input to be processed as an output. It identifies the monetary value of resources used to perform an activity. In healthcare services, the input includes doctor services, medical personnel services, drugs consumption, medical equipment, laundry, and building usage.
2. Cost driver; the factors that cause changes the cost of an activity.
3. Activity; what the stakeholder does in an organization.

4. Activity cost driver; a measure of the consumption of an activity by products, customers, or services. It is used as the basis of assigning activities to cost objects.
5. Resource cost driver; an indicator that helps to associate the costs of resources to corresponding activities and to distribute the costs of different resources between activities.
6. Cost object; an activity, output, or an item of which cost is to be measured.
7. Cost behavior; it is shown the relationship between cost and activities.
8. Cost estimation; it is the process to determine the cost behavior based on the historical data
9. Cost prediction; it is the activitiy to determine the tariff based on the analysis of cost estimation of a specific product or services.

Cost estimation is one of important process in a hospital budgeting system as the basis to do the cost prediction. This research focuses on the process to estimate a service cost while provide a healthcare services. To prepare the cost estimation it is needed a good understanding about the supporting components and non supporting components to provide healthcare services.

2.4 Healthcare Service Cost

The terminology of service costs is different with tariff. Service cost is the calculation of the expenses to perform the services, while tariff is the cost that should be covered include the desirable profit and other considerations (Setiaji, 2006).

Tariff determination needs a special considerations based on the unit cost that composed to create a product, with considering willingness to pay and ability to pay of the customer. Cost is the value estimations of input that used to produces an output. The input that used to perform a service called economic resources to produce the output. A good and an accurate budgeting system determine the total service cost based on right definitions of cost components variations. To determine a service cost, there is a term that describes the opportunity value to get

the services, called opportunity cost. Since a budgeting system is a quantitative analysis, it is needed to convert and insert a cost component in a numerical unit (Thabrany, 1999).

According to Setyawan (2004); based on the changes of production scale, a cost can be classified into variable cost and fixed cost.

a. Variable Cost

Variable costs are costs which amount is influenced by the amount of the generated service. There are 3 categories of expenses are included in the variable costs, namely:

1. Direct service costs; are costs incurred for direct patient care. In the outpatient unit, direct service costs include the costs of medical services, paramedics, the cost of stationery, and equipment used directly to support services.
2. Direct labor costs; the cost of which depends on the number of hours of work done, such as overtime pay. In addition to the benefit of planning, costs can also be used for purposes of the hospital employee motivation.
3. Direct overhead costs, ie costs that are not directly related to patient but can be changed directly with the size of the volume of activity. Indirect costs are included in the variable costs are laundry, use of electricity, and water.

b. Fixed costs

Fixed costs are costs that do not change directly with the volume of service provision. Components of the fixed costs are part of the indirect overhead costs such as depreciation on buildings, research, and development training for employee.

Gani (1993) stated that there are several principals to do the estimations of service cost in healthcare service.

1. Identification of type and variations of services. The unit cost identification that involved performing care activities should estimated accurately.
2. Cost estimation is used as the basis of tariff determinations, where it should consider the economical and social motivation. Tariff rate should consider

about the willingness to pay and abililty to pay, since it will affect the awareness of people about the importance of maintaining healthiness.

3. Utilization rate. The changing of healthcare service cost will affect the utilization rate of economic resources.
4. Willingness to pay (WTP) and ability to pay (ATP) of the patients. WTP and ATP patients affected by the condition underpricing and overpricing a health services. If a service happens underprice will bring surplus for these patients and overprice will reduce the level of consumer satisfaction. Therefore, to balance the WTP and ATP antaar patients required a financing system that is accurate.
5. Strategic planning of profit, adjusted with the vision and mission of the organization.
6. Performance of the level of quality and price comparisons of competitors.
7. The existence of a policy to give special subsidies in certain medical cases.

The cost calculation can be done by estimating the total cost and unit cost of service products. The total cost formula and unit costs are as follows.

$$TC = FC + VC \quad \text{.....(2.1)}$$

And the calculation of unit cost using the following formula;

$$UC = \frac{FC}{C} + \frac{VC}{Q} \quad \text{.....(2.2)}$$

Where:

TC = total cost (total cost)

FC = fixed costs (fixed cost)

VC = variable costs (variable cost)

UC = the unit cost (unit cost)

C = capacity in units of outpatient services

Q = amount of output (output) units in unit outpatient services

The unit cost is the cost that is calculated to provide one unit of product services. The definition of the unit cost is often equated with the average cost (Setiaji, 2006). At the hospital budgeting system, the unit costs of products are classified into the outpatient unit, medical action hemodialysis, radiology medical action, and so on. The amount of unit costs are not only determined by the total costs incurred, but also influenced by the level of capacity utilization. The higher utilization of capacity (Q) use will reduce the unit cost of a health services, otherwise the lower utilization of capacity will increase the unit cost of health care.

2.5 Service Cost Estimation Methods

According to Setiaji (2006) there are several methods that can be used to estimate a healthcare services cost. The alternatives are ranging from traditional approach, activity based costing, and time-driven activity based costing.

2.5.1 Traditional Approach

One of the alternatives in service cost estimation is by using traditional approach. Traditional approach set the cost distribution based on the cost centers of production cost. Cost center of production cost are consists of direct labor cost, direct material cost, and overhead cost. The overhead cost is also considered as direct costs that estimated by the cost driver that usually shown in direct labor hours.

According to Koswari (2013) the tariff of a service is calculated as follow:

1. Tracing; identify direct labor and direct material to provide a services.
2. Allocating overhead costs to products or services based on a rate.
3. Calculate tariff of a service.

In an outpatient unit of a hospital, to calculate the service cost it is consider about the registration ticket, medical personnel salaries, medical treatment costs,

and consumable resources costs. This approach is a simple method that easy to be implemented.

Although this approach is easy to be implemented, there are several weaknesses of traditional approach that are listed as below:

1. Traditional approach only present cost informations in organizations that provides small-medium various services to their customers. The special features of various activities were not detected; this will lead to distorted informations and reduced the accuracy of service costs.
2. There are not any separations of different cost domains. It uses common cost centers to gather the relevant costs and its overhead. This problem causes the allocation of unreal costs to the given services.
3. Traditional approach doesn't show about the real information about operational process and cost. This approach only considers the costs which are easily identifiable in calculating cost price, where the overhead cost is not included in the estimations.
4. The lack of preparations about cost price and other necessary information for decision making. This approach mainly uses direct costs to estimate the service costs.

2.5.2 Activity Based Costing (ABC)

Activity based costing (ABC) is developed by Kaplan and Anderson in 1985. It is one of the method that develop a costing system based on the activities that done to provide the services. ABC is an accounting information system to identify the costs inherent in the activity, and classifies expenses on the basis of existing properties in such activity.

ABC estimated costs based on two parameters, there are; (1) a source of cost driver is used to estimate the cost into different activities in health services, and (2) the allocation of costs made in the second stage using the activity cost driver, which can measure the demand of an object costs of an activity.

According to Blocher, Stout, and Cokins (2011) stages in the formulation of ABC model includes three phases, there are;

1. Identify resources and activities
2. To impose the cost of resources to activities
3. Imposing activity costs to cost objects

To estimate the percentage of time used for healthcare, the accuracy of the ABC method is questionable when there is subjectivity to the proportion of the activities undertaken. In this situation, the cost of services is distorted and leads to inaccuracies of cost makes underprice and overprice condition are charged for the patient. In healthcare, the implementation of the ABC method to face the challenges associated with determining the percentage of time estimation done on a health care process. Another challenge is the ABC method only estimate costs based on a cost driver while in health services, a combination of health services that may be done is very complex and thus require an accurate estimate which includes many triggers costs in calculating the cost of the service.

To assign indirect costs, note whether the expense is included in the cost component factory level or departmental level. Then with the classification of the activity cost driver, it can be concluded that the group overhead costs are charged to products using the drive unit level, the most commonly used is based on the number of direct labor hours.

Based on how the imposition of production costs, ABC is more suitable to be implemented in the manufacturing industry (Heru, 2010). In the manufacturing industry, the imposition of production costs do ddengan trace triggers cost (cost driver) in the activity. So it can be done loading cost drivers for products based on activity undertaken (Naraswari, 2013). While in the service industry, ABC Application of ABC in manufacturing industry estimates that the cost of a product by considering two parameters, namely; (1) the number of products with clear units, and (2) the activity of supporting production based on the proportion of working time. Compared with the traditional approach of using only a single cost

driver, ABC can formulate the difference supporting activities defined in the multi cost driver.

Similar with the determination of the cost of traditional approaches, the ABC method also has some drawbacks. Determination of the proportion of working time in each activity based on direct surveys and interviews conducted directly, so there is subjectivity factor of speakers. Besides the long time required for data collection considering the number of stakeholders involved, so it requires a considerable cost to formulate basic costs (Everaert P BW, 2008). This condition is the low frequency of renewal spur costing principal. In fact, the provision of health care services is a dynamic industry because of the development of a disease-related variation.Thus make increasing the needs of methods estimation that can be updated every time.

2.5.3 Time-Driven Activity Based Costing

Time Driven Activity Based Costing (TDABC) is the development of methods of activity based costing (ABC) conducted by Kaplan and Anderson (1985). This method of estimation noticed two parameters are: (1) Unit cost of supply capacity and (2) the time required to perform an activity (Natalie Demeree, 2009) by arranging the equation of time to calculate the time needed to perform an activity. TDABC capture and identify the shortcomings of the ABC method is the determination of the object that uses activity-based cost resource.

Table 2.2 Differences between ABC and TDABC

Sequences	ABC	TDABC
Step 1	Identify the different overhead activities	Identify the various resource groups
Step 2	Assign the overhead costs to the different activities using a resource driver	Estimate total costs of each resource group
Step 3	Identify the activity driver for each activity	Estimate the practical capacity of each resources group

Step 4	Determine the activity driver rate by dividing the total activity costs by the practical volume of the activity driver	Calculate the unit cost of each resource group by dividing the total cost of each resource group by the practical capacity
Step 5	Multiply the activity driver rate by the activity driver consumption to trace costs to orders, products, or customers	Determine the time estimation for each event, based upon the time equation for the activity and the characteristics of the event
Step 6		Multiply the unit cost of each resource group by the time estimate for the event

Sources: (Everaert P B. W., 2008)

As shown in Table 2.2 about the differences of ABC and TDABC, in ABC approach, cost of activity based on transaction drivers such as number of equipments used, service order, the delivery of services are allocated to the cost subject. In the same situation, TDABC offer better accuracy of ABC (Sarokolei & Saviz, 2013). TDABC determine the capacity cost rate, and determine the rate of capacity consumption in each transaction for each activity. It has objectives to not determine the exact time but the time approximation for predicting the model is sufficient (Kowsari, 2013). In TDABC there are some terms that are commonly used are listed in the following explanation.

Table 2.3 Common Terminology in TDABC

Terms	Definition
Economic Resources	Supporting resource that has economic value. Resources include health workers, medical equipment, supporting health facilities sharing.
Practical Capacity	The level of availability of time (capacity) of economic resources in their daily activities. Has units in unit time
Cost of Capacity Supplied	Costs necessary to economic resources
Capacity cost rate	The value of the economic cost of resources based on the capacity of time
Unit time of activity	The time required to perform the activity
Activity cost driver rate	A value whether there is activity cost driver

Terms	Definition
Number of activities	The activities performed by cost driver
Total cost of activities	The total cost required to perform the activity

According to Table 2.3 of the common terms used in the preparation of TDABC models, there are some vocabulary that are economic resources, cost of capacity supplied, capacity cost rate, unit time of activity, activity cost driver rate, number of activities, and total cost of activities.

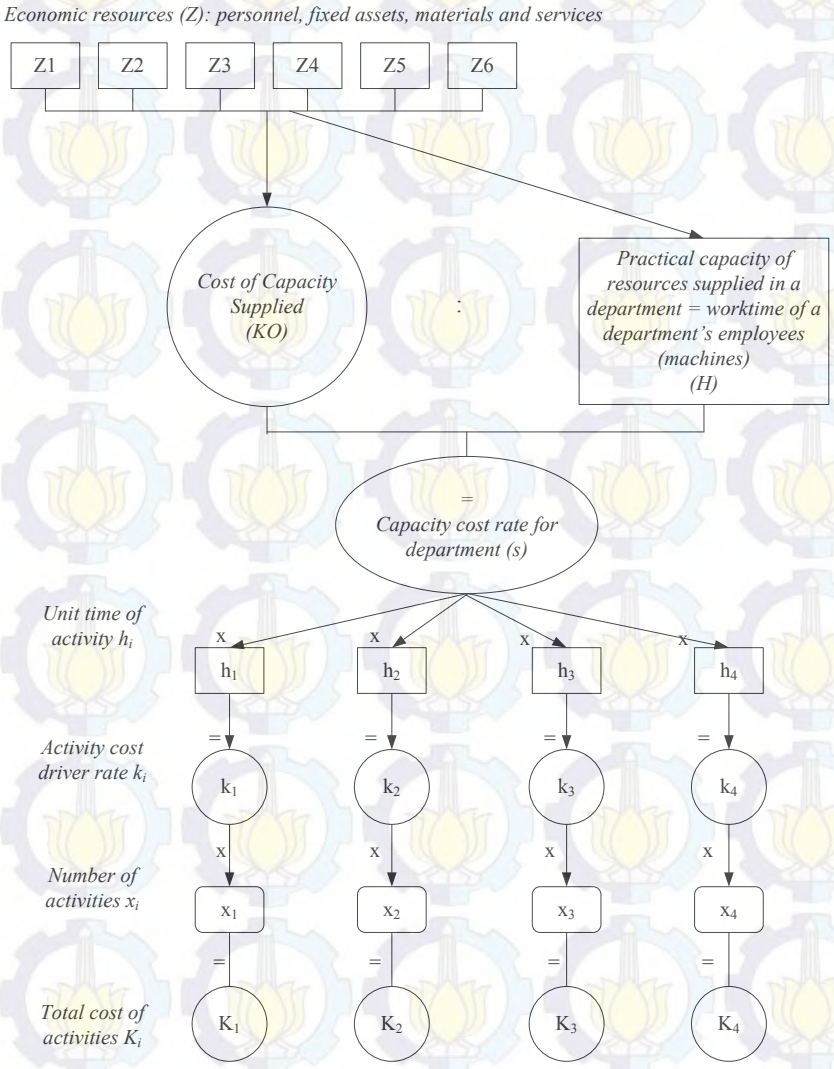

Figure 2.3 TDABC process

Source: (Szychta, 2010)

Based on Figure 2.3 about TDABC cost estimation processes, there are three main stages to formulate models TDABC;

First stage that includes evaluating the costs of different practiced capacity resource which every resource provides such as;

1. Identification of economic resources; identify the resource groups which perform the activities such as medical personnel, medical equipment used, laundry service, etc.
2. Evaluating the cost of each resource group. In healthcare organization which has uncertain demand and cost allocation of a resource, this information has a large data variance.
3. Evaluating practical capacity of resources of resource supplied; identify the capacity time of resource.
4. Estimation of capacity cost rate; calculating cost of each supplied capacity unit for each resource group through dividing the total cost of each resource.

Second stage that includes evaluating the time necessary for different activities such as;

5. Identifying the factors that affect the time of doing each activity; develop process maps and drivers for the healthcare cycle.
6. Formulate a time equation which show the dependence of time of doing the activity to all driver; estimate unit time for process step.

Third stage is the multiplication process on cost of each supplied capacity unit of each group of resources by the time of doing each activity (Soltani & Kalani, 2010)

2.6 Fuzzy Time-Driven Activity Based Costing (Fuzzy TDABC)

As the development of TDABC gives better accuracy to estimate healthcare service cost, several project has developed to know its implementation in a service industries. Service industries has high complexity and offer more variationsof product compared to manufacturing industries. Since then, there is a large data

variation that can be found in service cost estimation. The general TDABC handle the data variation with an assumption based on its average value. This assumptions work well if the data set is minimal. Such as in the real implementation of a healthcare service, a cost allocation for examining patient in hemodialysis unit has the same value trough time by time. Whereas, the costs allocation can be different depending on the recent market price and other external issues that can affects the cost of resources.

2.6.1 Fuzzy Set Theory

Handling the bias and uncertain factors, Zadeh (1965) develop a fuzzy set theory, which was based on the rationality of uncertainty due to imprecision or vagueness. A fuzzy application was developed from image processing, automated control, and other fields.

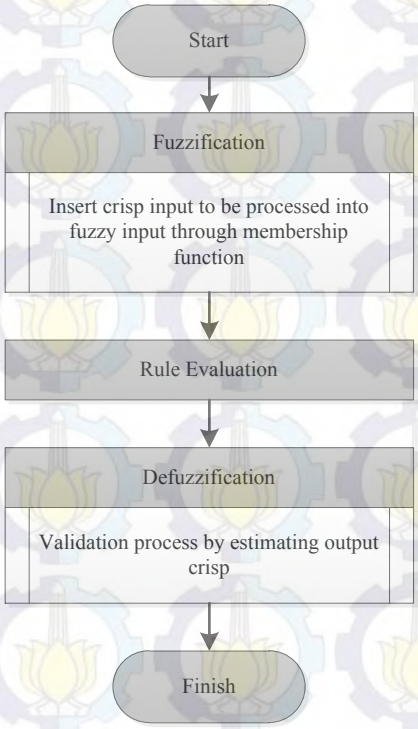

Figure 2.4 Fuzzy Logic Sequences

It is used to handle vagueness of information in real life situations. A set containing elements that have varying degrees of membership is called a fuzzy set. A fuzzy set as the foundation of the formation of fuzzy logic makes it to the

degree of membership of a data element. A membership function μ_x consists of real numbers in the interval [0 1] that shows the degree of membership of a fuzzy number within the set.

Generally there are three stages of fuzzy logic. The system starts from fuzzyfication membership, which includes crisp inputs into the fuzzy function through membership functions. The input that already processed through several parameters is converted into crisp output in defuzzification process.

A triangular fuzzy is a special type of fuzzy numbers that is defined by a triplet; smallest value (a_1), most possible value (a_M), and largest value (a_2) (Kaufmann & M.M, 1988). The triangular fuzzy attempts to handle with the uncertainties by provide the possibility of each fuzzy number.

The fuzzification stage shows the precise (crisp) value that ready to be processed into fuzzy number. Such as mentioned above, (a_1 , a_M , a_2) is the smallest value, most promising value, and largest value. In rule evaluation stage the triangular fuzzy number A or triangular number with a membership function $\mu_A(x)$ is defined by;

$$A = \mu_A(x) = \frac{X-a1}{aM-a1} \text{ for } a_1 \leq x \leq a_M$$

$$\frac{X-a2}{aM-a2} \text{ for } a_M \leq x \leq a_2$$

0, otherwise ……(2.3)

Where [a_1 a_2] is the interval of possible numbers and the point (a_M , a_1) is the peak that shown in Figure 2.5 about triangular fuzzy number. Triangular fuzzy number used to represent uncertainty of TDABC parameters in this analysis because of its simplification to formulate in a fuzzy environment, and it is considered has more intuitive method compared to trapezoidal or bell-shaped fuzzy numbers (Chou & Chang, 2008).

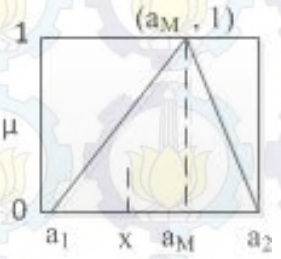

Figure 2.5 Triangular Fuzzy Number
Source: (Chansaad, 2012)

The following step after rule evaluation process is the defuzzification. Defuzzification is the opposite process of fuzzification, which it transform a fuzzy quantity become crisp output. There are several techniques includes; (1) max-membership principle, (2) centroid method or center of gravity, (3) weighted average, (4) mean-max membership, (5) center of sums, (6) center of largest area, and (7) first maxima or last maxima (Ibrahim, 2004). The most prevalent and physically appealing method that suitable with triangular fuzzy is centroid method (Lee, 1990). By using centroid method, a crisp value (x*) from a membership function $\mu_A(x)$ can be obtained from the formula below.

$$X^* = \int \frac{\mu A\,(x)\;x dx}{\mu A\,(x)\;dx} \qquad \text{.....(2.4)}$$

Crisp value is used as the input of defuzzification process. Defuzzification will show the result of fuzzification process by resulting output crisp. Output crisp implied the final value from overall fuzzy process.

2.6.2 Proposed Fuzzy-TDABC Model

In TDABC model, if variation exists, the input parameters would have to be averaged out before being inserted to the equation. By estimate the average data as the precise value, this will assume that each data value is equally important. According to Chansaad (2012), nevertheless when some values are appear more frequent than the others, this assumption can not hold true. A fuzzy set is

proposed in the research to represent imprecision and vagueness of resource data. In this sub chapter consists of the flow process of fuzzy-TDABC and its comparison with the previous study, such as ABC and general TDABC implementation. Below Table 2.4 shows the difference between ABC and fuzzy-TDABC.

Table 2.4 The Difference Between ABC and fuzzy-TDABC

No	Comparing Factor	ABC	Fuzzy-TDABC
1	Kind of drivers for cost allocation	Transaction drivers such as the number of initiation times	Time drivers like time needed for initiation activity
2	The number of time drivers	One driver is only used with each activity	Infinite drivers can be used with each activity
3	Model accuracy	The model does not consider all activity features and it affects the costing accuracy	The model considers activity features in allocation time efficiently, it has better accuracy
4	System dimensions	Every difference in activities requires using a new activity	For each activity a time equation is used which has all activity features
5	Model updating	The model has many details and it is time-consuming to be updated	The model has less details and it is easier to be updated
6	The ability to calculate unused capacity	The model cannot calculate the unused capacity	The model can calculate the unused capacity
7	The ability to handle data variation	The model can handle limited data variation	The model can handle large data variation
8	The ability to handle uncertainties	The model has less ability to handle uncertainties	The model has better ability to handle uncertainties

Source: (Kowsari, 2013)

Based on the Table 2.4 that shows the differences of ABC and fuzzy-TDABC, there are several comparing factors such as kind of drivers for cost allocation, the number of time drivers, model accuracy, system dimensions, model updating, the

ability to calculate unused capacity, the ability to handle data variation, and the ability to handle uncertainties.

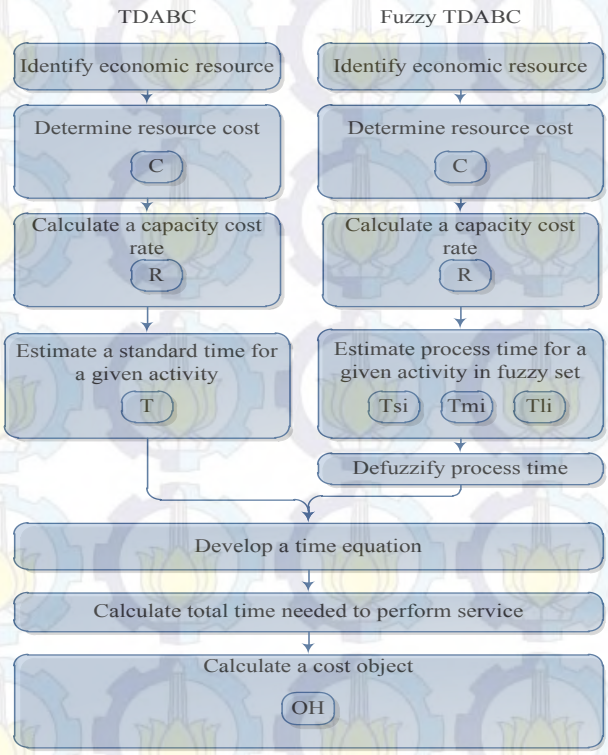

Figure 2.6 Difference of TDABC and Fuzzy-TDABC

Sources: (Chansaad, 2012)

The decision about which method is the best is depending on the organization needs. Nonetheless, it is concluded that fuzzy-TDABC can offers better solution based on the drawbacks of ABC implementation, especially when it is applied in a high complexity and large data varieties such as in healthcare services. Figure 2.6 below shows the difference between sequences of TDABC and fuzzy-TDABC implementation to calculate service costs.

Based on Figure 2.6, the flow process of fuzzy-TDABC is also classified into three stages as shown in TDABC. The first stage is estimation of process time while performing an activity. Since healthcare services shows the uncertainty and high variation of process time, a fuzzy method is the most appropriate method to accommodate the variations. The value of fuzzy that collected is based on direct observation and from expert judgement.

1. Identify fuzzy set of process time; in a fuzzy-TDABC process time of each activity are represented in triangular fuzzy number. As shown in the previous discussion above, the triangular fuzzy number consists of smallest value (T_{si}), most possible value (T_{mi}), and largest value (T_{li}). Each of process time for a care services is plotted into three values. The smallest value show the fastest time that likely occur during care process. The most possible value is the most frequent value process time to be detected, while the largest value is the process time that has higher deviation from the average value. The equation of process time in fuzzy set was shown in the equation below.

$$\text{Process time in fuzzy set } (T_i) = (T_{si}, T_{mi}, T_{li}) \quad \ldots\ldots\ldots\ldots\ldots\ldots (2.5)$$

Where:

T_{si} = value of fast process time

T_{mi} = value of average process time

T_{li} = value of slow process time

2. The following process is the calculation of membership function of each value of T. Since the crisp input is represented in three values, it is needed to calculate its average value. The formula to calculate the average value is using the formulation below.

$$T_{si} = ((T_{si1} + T_{si2} + \ldots\ldots + T_{sin}) / n)) \quad \ldots\ldots\ldots\ldots\ldots\ldots (2.6)$$

Where:

$T_{si\ average}$ = average value of fast process time

T_n= process time for n activity

n = number of data taken

3. The following process is the estimation of membership value by doing the interpolation process. Where (T_{si} , T_{mi} , T_{li}) are the average value of smallest, average value of most frequent value, largest value of largest process time of an activity.

$$\mu_T(x) = \frac{Tli - Tmi}{Tli - Tsi} \text{ for } T_{si} \leq T_{mi} \leq T_{li} \quad \ldots\ldots\ldots (2.7)$$

Where:

$\mu_T(x)$ = membership function

T_{si} = average value of fast process time

T_{mi} = average value of average process time

T_{li} = average value of slow process time

4. Defuzzified the process time; a fuzzy set is transformed to create crisp output. The fuzzy set of process time is defuzzified to obtain a crisp value of T using the equation below.

$$T = \frac{Tli\ \mu Tli + Tmi\ \mu Tmi}{2} \quad \ldots\ldots\ldots\ldots\ldots (2.8)$$

Where:

T = crisp output, standard time result

T_{li} = value of slow process time

T_{mi} = value of average process time

μTli = value of membership function of slow process time

μTmi = value of membership function of average process time

2.7 Work Measurement Methods

According to Wignjosoebroto (1995) there are two types of work measurement methods, which are direct work measurement and indirect work measurement. Indirect work measurement can be done by through standard data methods, regression analysis method, and through predetermined method time measurement (MTM). In indirect work measurement, the method that easy to be implemented is MTM. MTM method use video observation as the media to estimate standard time to perform an activity.

Direct work measurement consists of stopwatch time study (STS) and work sampling. In the application of healthcare services, the direct work measurement is more suitable as it is observed the working system in a larger perspectives rather than observing through video. The output standard and standard time while perform an activity are also easier to estimate by direct work measurement.

Furthermore, the estimation of proportions in working and non working time of the operator is done by identifying its personal time and allowances.

The direct work measurement is done by direct observation of medical personnel while they are pesrforms care activities and medical treatments. In this research it is needed the data of standard time for one cycle of healthcare services, where it can be gained from the implementation of STS. Besides the usage of STS, it is also needed to know the proportions and the number of output in certain period of time. Work sampling implementation can fulfill the demand of number of output, since it shows the time distributions and time usage during a random working time of medical personnel.

2.7.1 Stopwatch Time Study (STS)

Stopwatch time study (STS) is one of the methods to estimate the standard time to perform a specific activity in a work cycle. In this method, the work identification is done by break down of work operations into some specific work elements. The characteristics of work measurement using this method are for repetitive and homogenous operations.

STS enables breaking down of the working operations become working elements. The technical operations of STS through the record of each element working in a cycle using stopwatch time study. The advantages direct measurement is easier to calculate the output of the cycle, depends the type of the work operations. The determination which one is the better method can not be done, as it has each special uniqueness and speciality based on the type and variations of various activities during the process.

Based on Figure 2.7 about the sequences of stopwatch time study, the process is initiated by the breaking down of working operations into working elements. The standard time is calculated in a one cycle of observations.

Subsequently, the following process is the data uniformity test. This test is used to identify the data deviations among the working time of each activity, and then deployed it according on its upper limit and lower limit. The software that

used in this stage is minitab. After the deployment ofdata in its upper limit and lower limit, the outlier data is eliminated.

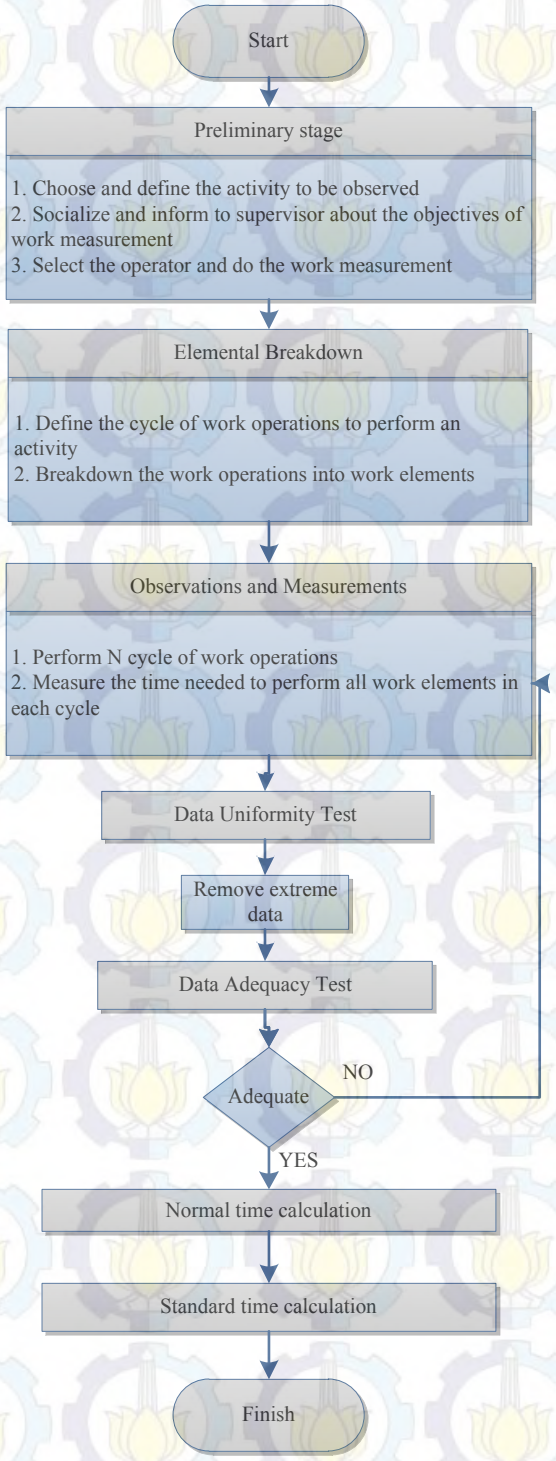

Figure 2.7 Sequences of Stopwatch Time Study

Sources: (Wignjosoebroto, 1995)

After the data is uniform and fulfilled the standard number, the following process is the estimation of performance rating of the medical personnel, defines its allowance time, and handling time between the processes. Performance rating was identified by Westinghouse rating system. It use several parameters that ranging from skill, effort, conditions, and consistency.

The rating system is differ into several level that shown in the Table 2.5 about Westinghouse rating system, ranging from superskill, excellent, good, average, fair and poor parameter. The rating is done by direct observations of the medical personnel.

Table 2.5 Westinghouse Rating System

Skill		Effort	
+ 0.15 A_1 - Superskill	- 0.05 E_1 - Fair	+ 0.13 A_1 - Excessive	- 0.04 E_1 - Fair
+ 0.13 A_2	- 0.10 E_2	+ 0.12 A_2	- 0.08 E_2
+ 0.11 B_1 - Excellent	- 0.16 F_1 - Poor	+ 0.10 B_1 - Excellent	- 0.12 F_1 - Poor
+ 0.08 B_2	- 0.22 F_2	+ 0.08 B_2	- 0.17 F_2
+ 0.06 C_1 - Good		+ 0.05 C_1 - Good	
+ 0.03 C_2		+ 0.02 C_2	
0.00 D - Average		0.00 D - Average	
Conditions		**Consistency**	
+ 0.06 A - Ideal		+ 0.04 A - Perfect	
+ 0.04 B - Excellent		+ 0.03 B - Excellent	
+ 0.02 C - Good		+ 0.01 C - Good	
0.00 D - Average		0.00 D - Average	
- 0.03 E - Fair		- 0.02 E - Fair	
- 0.07 F - Poor		- 0.04 F - Poor	

Source: (Wignjosoebroto, 1995)

The allowance determinations use the formula that shown as below.

$$\% \text{ Allowance} = \frac{\sum \text{Allowance}}{\sum \text{Allowance} + \sum \text{Operasi} + \sum \text{Handling Time}} \text{ x } 100\% \text{.....2.9}$$

After the estimation of performance rating and allowance level, the subsequent activities is the normal time and standard time calculation. Normal time is the actual time to perform an activity by considering the total performance rating.

While standard time is the value of normal time that consider the allowance of operator. The formula to calculate normal time is shown as below.

$$Tn = Ta \times PR \ldots\ldots\ldots\ldots\ldots 2.10$$

Where:

Tn = normal time

Ta = uniformed actual time

PR = performance rating

The formula to calculate standard time is shown as below.

$$\text{Standard time} = \frac{\text{Normal time x } 100\%}{100\% - \%\ Allowance}(\text{hour/unit}) \ldots\ldots\ldots\ldots\ldots\ldots 2.9$$

By using STS, it will help to determine the standard time to perform a care cycle. Which is the standard time is used to develop the time equation of fuzzy-TDABC.

2.7.2 Work Sampling Method

In work sampling, the initial process is determined the number of data needed in certain interval in period of time. For example the sampling is done by 100 data prework sampling, for two hours observations.

The time determination of random data is get from random number in Ms. Excel for two hours long observations to know the standard output in that time.

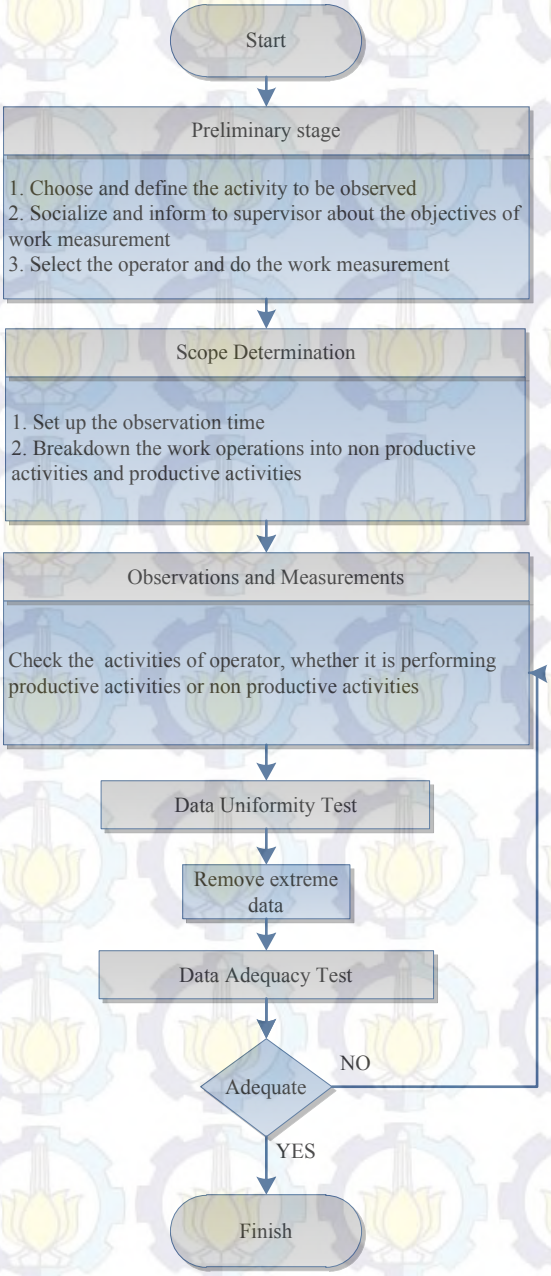

Figure 2.8 Sequences of Work Sampling

Sources : (Wignjosoebroto, 1995)

Based on Figure 2.8 that shows the sequences of work sampling, the direct observations is done right after generate the random time during the interval. The observations are done based on what the operator did in their working and not working activities. Data adequacy test is performed in the same procedures as the STS method. The objectives in doing work sampling is to know the time

effectiveness while performing actual woking time compared to standard working time.

2.8 Previous Researches

Based on Figure 2.9 the development of cost estimation methods is intitiated with traditional approach. The implementation of traditional approach in service industries has founded some weaknesses that already stated in the research background.

To overcome the drawbacks of traditional costing, in 1998 Kaplan and Cooper develop ABC that uses activities to perform the services as the cost allocation basis. While the time proportions to perform activities can not estimated accurately, TDABC offers better methods by using time equation to allocate costs. The gap of large data varieties in allocating resource cost leads to undistorted information that can affect time equation accuration.

This research tries to reduce the gap of large data variation in costs estimation by using fuzzy set to provide additional information on the worst and best case result.

Previous study of service costs estimation is using TDABC in outpatient clinic that conducted by Natalie Demeree et al., where the scope of this research are limited to non-technical consultation and technical consultation. This study is continued by Francisca Vidya in 2013 that using TDABC to calculate service costs in outpatient unit.

The efforts to captures the large data variation in TDABC is initiated by Annaruemon Chansaad in 2012, using approach of fuzzy-TDABC. The aim of this study is implemented in manufacturing industries which focuses on production department.

Based on figure 2.9 the development of service costing methods is initiated from traditional costing to activity based costing to time driven activity based costing to fuzzy time driven activity based costing.

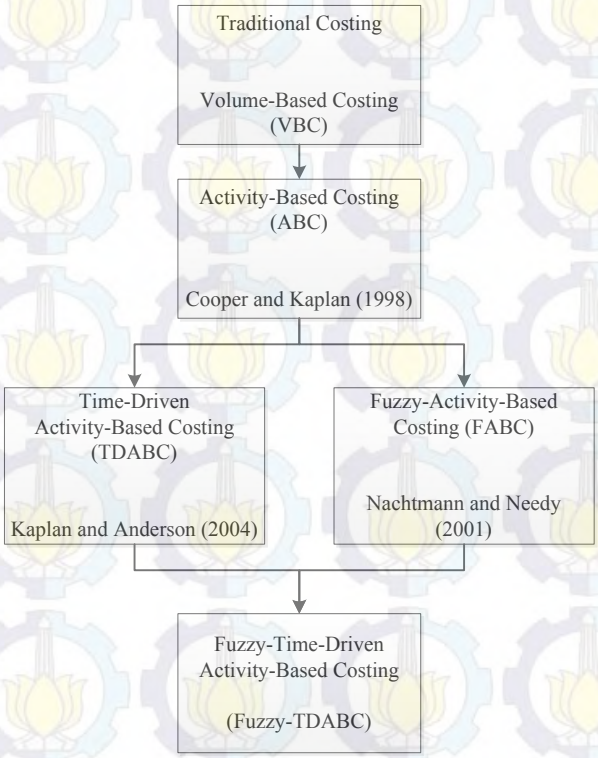

Figure 2.9 Development of Costing Methods

Source: (Chansaad, 2012)

According to Table 2.6 this research proposes a method that can estimate service costs that ables to handle large data variation in high complexity organizations especially in healthcare services.

Table 2.6 Research Position

Year	Author (s)	Research Title	Scope	Methods
2009	Natalie Demeere et al.	Time Driven Activity Based Costing in an Outpatient Clinic Environment	Outpatient Clinic; Service Industries	Time Driven Activity Based Costing
2012	Annaruemon Phoonsiri Chansaad	A Fuzzy Time Driven Activity Based Costing Model in an Uncertain Manufacturing Environment	Production Dept; Manufacturing Industries	Fuzzy Time Driven Activity Based Costing
2013	Francisca Vidya Adata Naraswari	Penerapan Time Driven Activity Based Costing dalam Perhitungan Biaya Instalasi Radiologi di Rumah Sakit Yakkum Purwodadi	Radiology Unit; Service industries	Time Driven Activity Based Costing
2015	Elsa Camelia Harmadi	Implementation of Healthcare Service Cost by Fuzzy Time Driven Activity Based Costing	Outpatient Unit; Service industries	Fuzzy Time Driven Activity Based Costing

Since the previous study of Chansaad (2012) already tried to propose a research that can be implemented, in this research the gap is there is not yet developed a study that tries to handle data variation in service industries using fuzzy-TDABC. The method that used in the research is fuzzy-TDABC that concern on the scope of outpatient unit. Consideration in outpatient unit selection is based on the number of patient arrival that is more frequent than any other pure producing unit in a hospital.

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CHAPTER III
RESEARCH METHODOLOGY

This chapter describe about the sequences in problem solving methods to done the research. The deployment of systematic scheme will directly support the research by systemic thinking process.

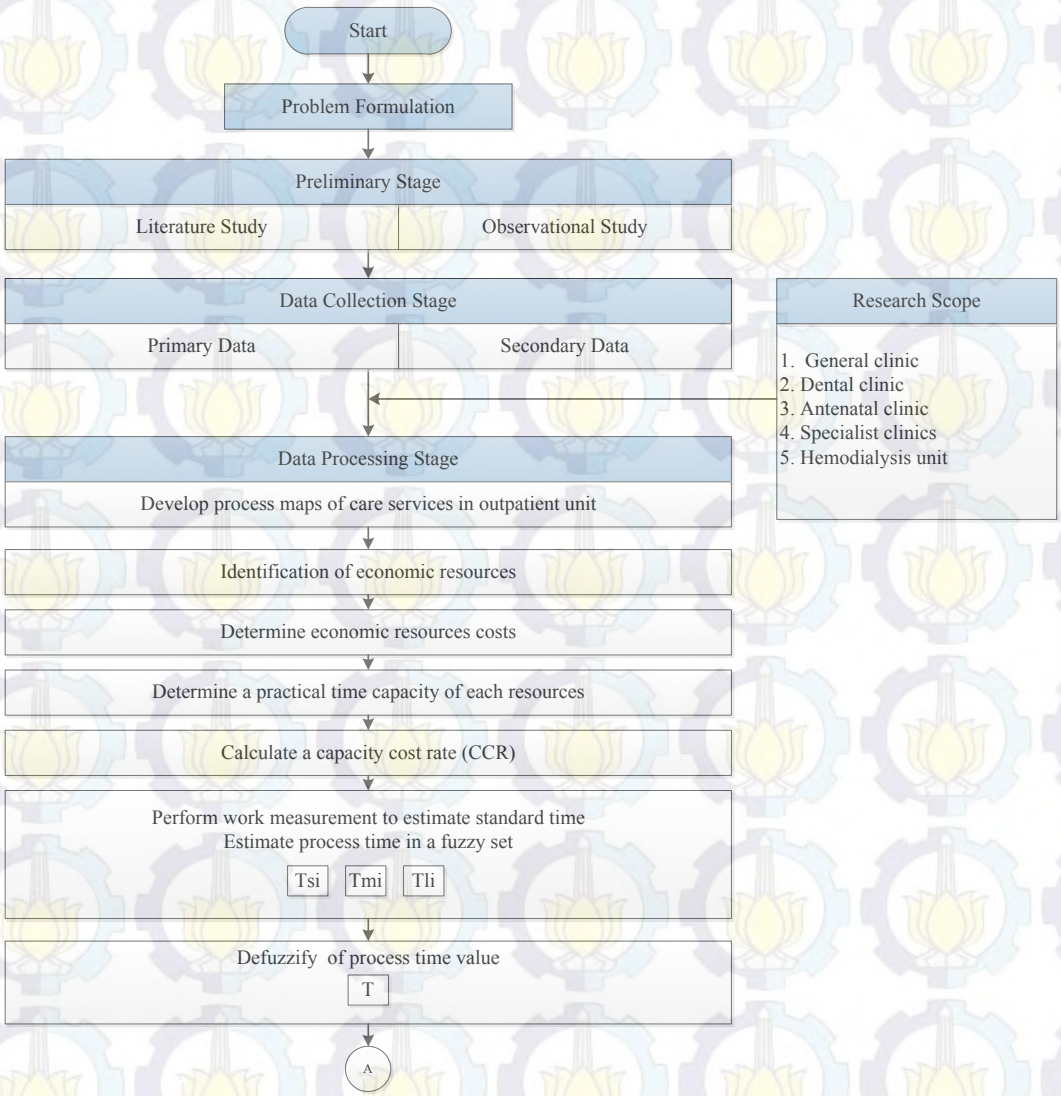
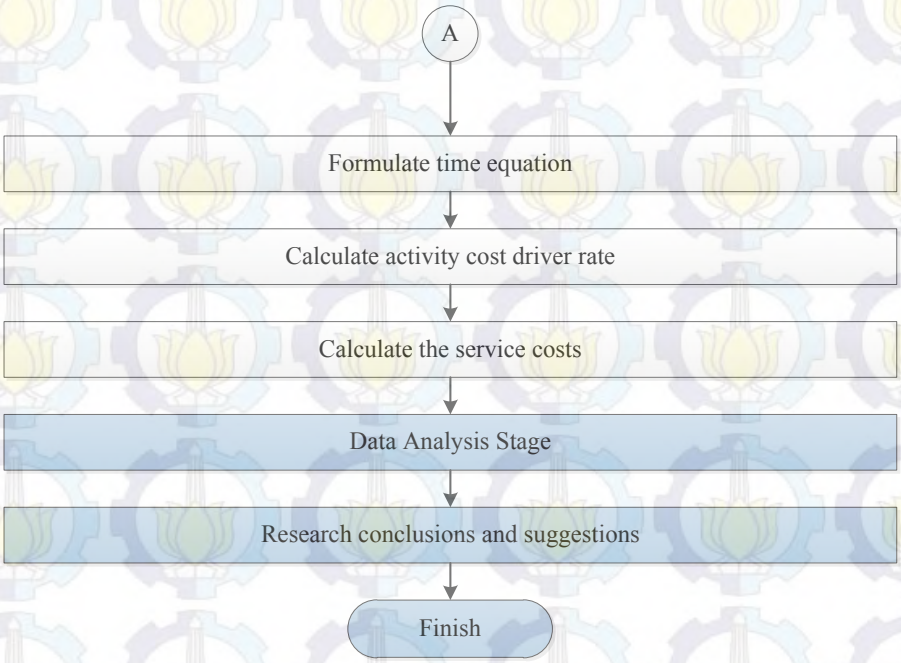


Figure 3.1 Research Methodology



Based on the Figure 3.1 that shows the research methodology, there are five main stages in order to complete the research. The five stages are; (1) preliminary stage, (2) data collection stage, (3) data processing stage, (4) data analysis stage, and (5) research conclusion and suggestion. The description of the processes will be shown in the sub-chapter below.

3.1 Preliminary Stage

Preliminary stage is initiated with problem formulation deployment. The problem formulation is existed since there is a gap between this research and previous research. The previous study is about the implementation of TDABC to estimate service cost in an inpatient unit of a hospital. The other research is done by estimate service cost in an outpatient clinic using TDABC. This research took the previous gap by estimate service cost using Fuzzy-TDABC in an outpatient unit of a hospital to improve the involvement of uncertainty factors.

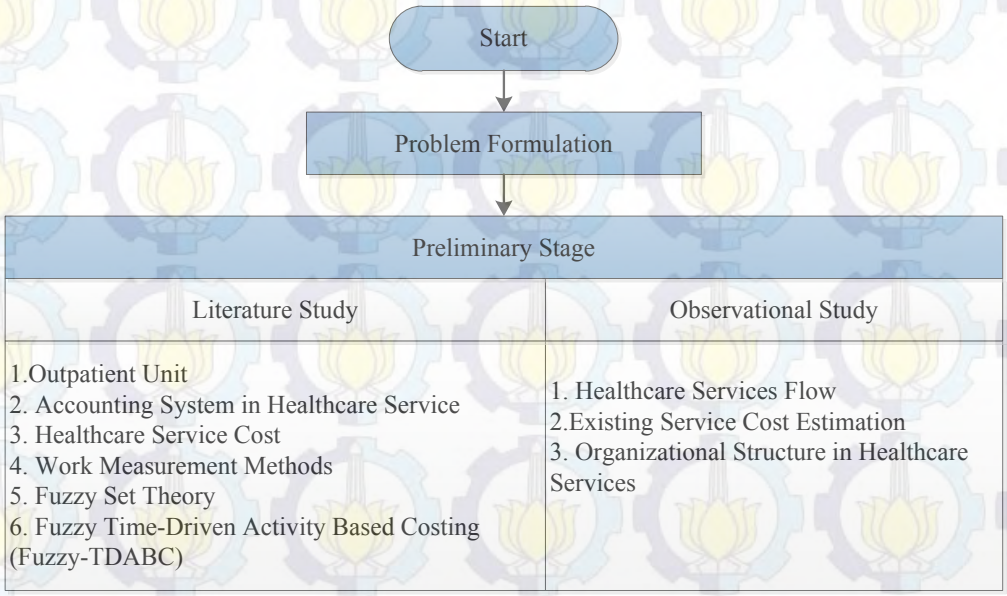


Figure 3.2 Preliminary Stage

Based on the Figure 3.2 about the preliminary stage of the research, the deployment of problem formulation is followedby literature study and observational study. The theoretical issues that used in the research ranging from outpatient unit, accounting system in healthcare services, healthcare service cost, work measurement methods, fuzzy set theory, and fuzzy-TDABC. The observational study consists of study about healthcare services flow, existing service cost estimation, and organizational structure in healthcare services.

The expected output of this stage is to identify the informations and data needed for data collection stage.

3.2 Data Collection Stage

Data collection stage consists of collection of primary data and secondary data. Primary data is collected through direct observation, discussion, either through direct interview. The data collected through direct observation and interview are listed as following; (1) type of care services in the outpatient unit, (2) sub-activities in care services, (3) economic resources identifications, (4) economic resource cost, (5) standard time of sub-activities, and (6) existing service cost estimation.

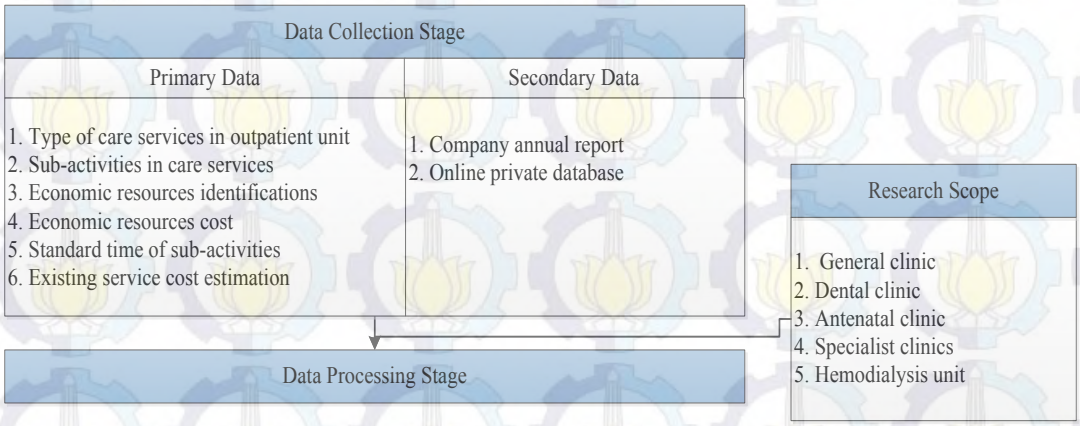


Figure 3.3 Data Collection and Processing Stage

Based on the Figure 3.3 about data collection stage, the secondary data were also collected. The secondary data is collected based on credible sources such as internal database of company, and historical data through company annual report.

The observation was limited in outpatient unit of a hospital. An outpatient unit provides care services through medical clinics and medical support treatments. The research scope are; (1) general clinic, (2) dental clinic, (3) antenatal clinic, (4) specialist clinics (5) hemodialysis clinic.

The sequences of care services in an outpatient unit are started from patient arrival, patient registration, technical consultation, medical treatment, drugs prescriptions, and payment process. The sub-activities data observations used as basis to developed process maps of care services in outpatient unit that will be discussed further in the next sub-chapter.

3.3 Data Processing Stage

Data processing stage consists of several methods that used to develop fuzzy-TDABC model. As mentioned above, the methodological approach that used in this research is consists of work measurement methods, fuzzy set theory, and fuzzy-TDABC.

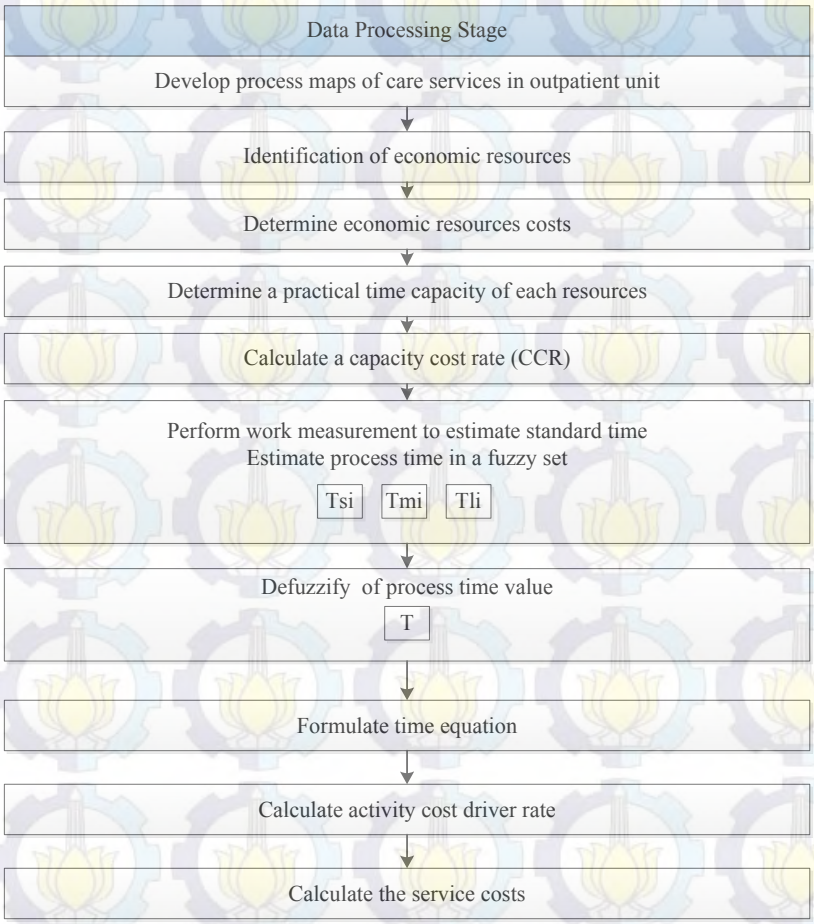


Figure 3.4 Data Processing Stage

As shown at Figure 3.4 about data processing stage, this stage is consists of several sequences in order to develop fuzzy-TDABC model of service cost estimations in outpatient unit in a hospital.

Data processing stage is initiated with direct observation to know the most frequent care services in the outpatient unit. By understanding the business process within the unit the next step is by developing a process maps. The process maps is make easier about the identification about the time needed and what are the resources that related to each activity. The next step is about identification process of economic resources costs, consists of direct labor cost, direct material cost, and overhead cost. To calculate capacity cost rate (CCR), the economic resources costs are divided by its practical time. Practical time is the available time of an economic resource to support the provision of care services.

The following step of cost estimation is by calculating standard time while performing an activity. Calculation of standard time is going to use in the time equation formulation. In the care services, the work measurement is difficult to measure completely, as it requires a long time to collect the whole data. The work measurement that applied in the research is based on work sampling and stopwatch time study. The differences between one medical case with the other is accommodated in the fuzzy set theory. Fuzzy set enable the variations between the process times while performing care activities.

The process time is divided into three categories; includes fast process time, average process time, and slow process time. The difference of process time is affected by the severity of illness, skill of medical personel, resources availability, and other external factors. By using fuzzy set, the defuzification process will result the crisp output that implied the average value of the data possibility. The output of defuzification is standard process time. This is going to be used in the formulation of time equation.

Following the formulation of time equation, the cost estimation is done by multiplying the combination of a care services with its capacity cost rate. By then, the service cost for each probability will be known. This is the final result of cost estimation, which shown the resources consumption on each activity.

3.4 Data Analysis Stage

Data analysis stage consists of the discussion about the analysis of existing service cost estimation in Al Irsyad Hospital, as mentioned in the sub-chapter above that there are several drawbacks of traditional implementation. Thus the analysis will lead to a research gap about the improvement method of service cost estimation using fuzzy-TDABC method. Furthermore it will also discuss about the implementation of fuzzy-TDABC method.

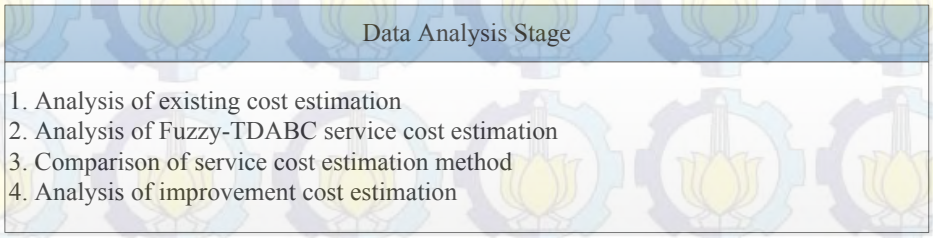


Figure 3.5 Data Analysis Stage

Based on Figure 3.5 about data analysis stage, other analysis is discussing the implementation of fuzzy-TDABC method to estimate the healthcare service cost. Furthermore, it will also discuss about the comparison between existing cost estimation with fuzzy-TDABC result. By knowing the difference between existing cost estimation with the fuzzy-TDABC result, overprice and underprice of a healthcare service will be detected early. Furthermore, it will gain a better profitability for the hospital management.

3.5 Final Stage

After the data analysis stage, the following step to complete the research is the formulation of research conclusions. The conclusions are formulated by recall the objectives that want to be achieved which are deployed in preliminary stage of the research.

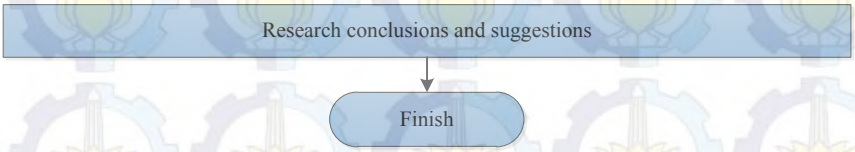


Figure 3.6 Final Stage

Based on Figure 3.6 besides the formulation of conclusions of the research, it is also needed to formulate the suggestions for the research. The suggestions that can be made are helpful for the hospital management and for the development of further research.

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CHAPTER IV
DATA COLLECTING AND PROCESSING

This chapter contains about data collection recap from outpatient unit in Al Irsyad Hospital, as it is going to be used in data processing stage to estimate healthcare service cost using fuzzy-TDABC.

4.1 Al Irsyad Hospital Profile

Al Irsyad Hospital is one of the private hospitals that located in northern part of Surabaya. It is established in 4th December 1978. As a type C hospital, Al Irsyad Hospital provides basic primary healthcare services with outpatient and inpatient unit includes general medicine, surgery, child and maternity care. The other facilities such as basic x-ray, hemodialysis clinic, laboratory facilities, and specialist surgery are also available to support medical treatment for its patient. To enhance customer satisfaction, hospital management is prioritizing on excellent value healthcare services. As mentioned in research background, a key of customer satisfaction is the integration and supports from other healthcare services pillars such as employee's dedication, services delivery, resources utilization, and healthcare tariffs.

4.1.1 Hospital History

The history of hospital began in 1965, there were a big casualties that caused by the occurrence of colonial wars in Surabaya. The beginning to make an emergency hospital is initiated from youth generation, Al Irsyad, and doctor's initiation. The emergency hospital began their medical operation in Al Irsyad Foundation School. It is provides emergency care and other medical treatment; a policlinic for primary illness. During the development of the emergency hospital, the location of care services is moved to Jalan Danakarya Surabaya. As time goes by the services types are developed, it is shown by the establishment of medical rehabilitation clinic on 2001. In addition, by an increasing demand of kidney

failure care services, a hemodialysis clinic was established in 2002. By providing an excellent care services, hemodialysis unit receive an award as the best hemodialysis service in 2014. This hospital has its claim as the first and the oldest Islamic hospital in East Java, makes it has a big responsibility to maintain and improve healthcare services provision during time by time.

4.1.2 Hospital Vision, Mission, and Motto

Hospital management has a vision to have an international recognition of its healthcare services by providing excellent values and creates an Islamic environment for the patient. To support the realization of vision, there are some missions to accelerate the achievement. The mission is deployed into the following points; (1) to support government and society to support healthcare and welfare system, (2) to provide an Islamic and professional healthcare service, (3) to develop a corporate social responsibility, and (4) to provide the best services to the whole society. The motto of the hospital is "Layananku adalah Ibadahku", which has the same meaning as "My services are My Charity".

4.1.3 Hospital Organization Structure

The organization structure of Al Irsyad Hospital is shown in Figure 4.1 below. Highest authorization in organization structure belongs to Al Irsyad foundation. Al Irsyad founder has subsidiaries that consist of board of trustees and executive director; which has a responsibility for overall strategic and operational responsibilities.

The director has subsidiaries that consist of medical committee, KPRS committee, and SMF manager. Parallel with SMF, there are medical vice director, manager of media services, and General & Finance Vice Director. Medical vice director has the authority to manage pharmacy installation, and medical support services.

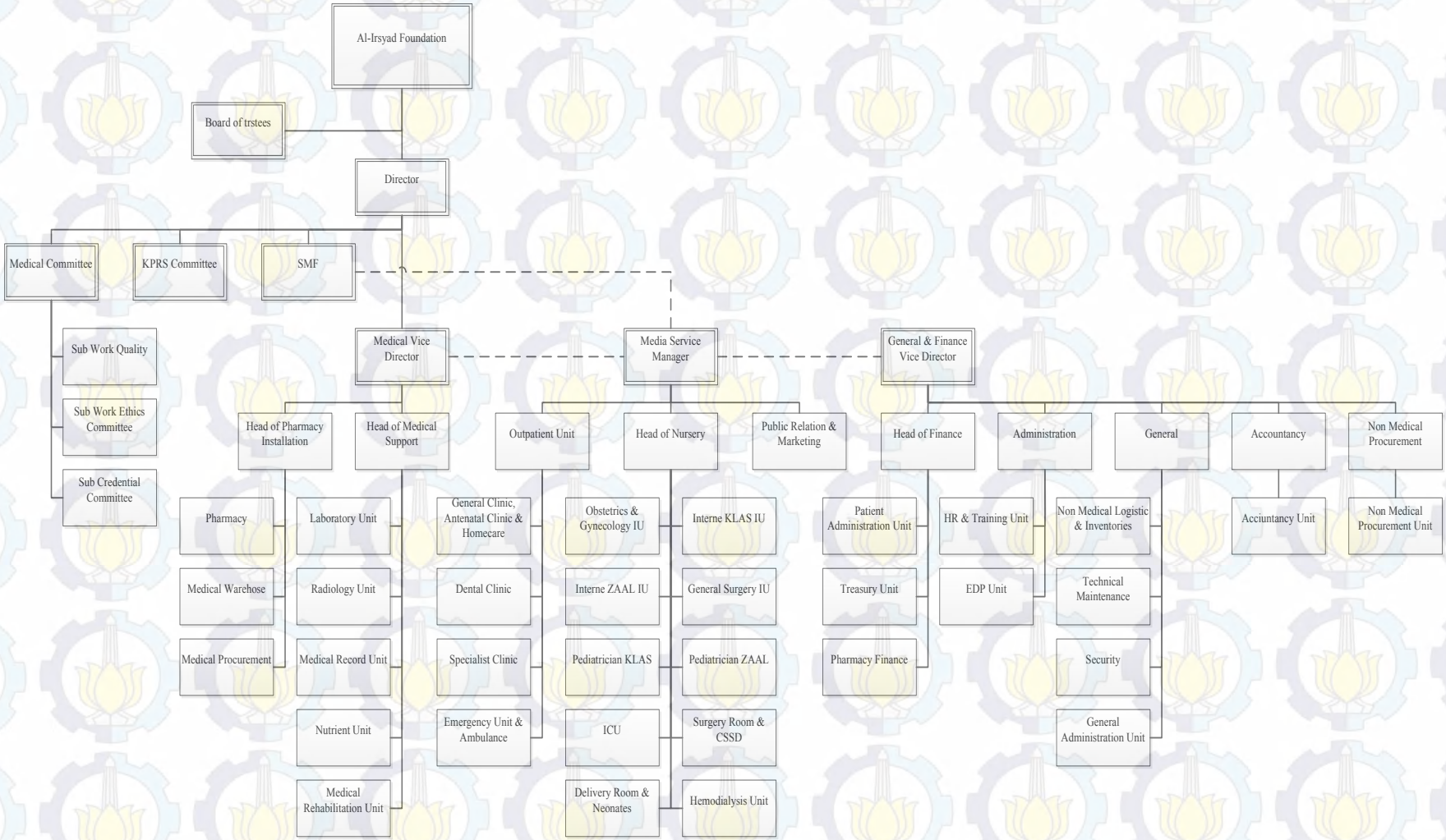


Figure 4.1 Hospital Organization Structure

Sources: Hospital documentation

The department that includes below the authority of medical vice director is medical procurement, medical warehouse, pharmacy services, laboratory unit, radiology unit, medical record unit, nutritional unit, and medical rehabilitation unit.

The director has subsidiaries that consist of medical committee, KPRS committee, and SMF manager. Parallel with SMF, there are medical vice director, manager of media services, and General & Finance Vice Director. Medical vice director has the authority to manage pharmacy installation, and medical support services. The department that includes below the authority of medical vice director is medical procurement, medical warehouse, pharmacy services, laboratory unit, radiology unit, medical record unit, nutritional unit, and medical rehabilitation unit.

The manager of media services has the authority to manage the nursery unit (outpatient unit), inpatient unit, and human resources & public relations unit. Inpatient unit has several departments such as; (1) general clinic, antenatal clinic, and home care, (2) dental clinic, (3) specialist clinic, and (4) emergency installation and ambulance. Besides the provision of care in outpatient unit, media services department also has subsidiaries that include human resources and marketing department.

The other entity of the hospital organization structure is general and finance department which do the activities related to the hospital accounting, patient administration, treasury unit, and pharmacy accounting unit. This department is also taking care of general issues of the hospital management such as non-medical logistics, maintenance and technical unit, and security services.

4.1.4 Hospital Medical Personnel

The medical personnel that supports healthcare provision in Al Irsyad Hospital are divided into several categories which are listed as follow; (A) basic medical personnel, (B) basic specialist medical personnel, (C) medical support specialist,

(D) other specialist medical personnel, (E) dental specialist medical personnel, (F) paramedic and other medical personnel, and (G) non-medical and other personnel.

Table 4.1 Medical Personnel in Al Irsyad Hospital

No	Healthcare Personnel	Number of Personnel	Status	
			Full time	Part time
A	Basic Medical Personnel			
1	General practitioner	20	11	9
2	Dentist	3	2	1
B	Basic Specialist Medical Personnel			
1	Surgeon	4		4
2	Internal medicine specialist	3		3
	Liver specialist	2		2
3	Pediatrician	3		3
4	Obstetrician	4		4
C	Medical Support Specialist			
1	Anesthesiology specialist	3		3
2	Radiology specialist	2		2
3	Medical rehabilitation specialist	4		4
4	Clinical pathology specialist	1		1

Based on the Table 4.1 above, the hospital is supported by 23 basic medical personnel, 16 medical personnel, and 10 medical support specialist. The basic medical personnel is consists of 11 full time and nine part time general practitioners. There are also two full time dentists and one part time dentist that give healthcare services daily.

Basic specialist medical personnel is supported by part time employees consists of four surgeons, three internal medicine specialists, two liver specialists, three pediatricians, and four obstetricians.

Medical support specialist is supported by part time employees consists of three anesthesiology specialist, two radiology specialist, four medical rehab specialist, and one clinical pathology specialist.

Table 4.1 Medical Personnel in Al Irsyad Hospital (con't)

No	Healthcare Personnel	Number of Personnel	Status	
			Full time	Part time
D	Other Specialist Medical Personnel			
1	Ophthalmologist	2		2
2	Nose-throat-ear (NTE) specialist	2	1	1
3	Neurology specialist	3		3
4	Heart and blood vessels specialist	3		3
5	Dermatologist	2		2
6	Psychiatric specialist	1		1
7	Lung specialist	3		3
8	Orthopedic specialist	4		4
9	Urology specialist	1		1
10	Plastic surgeon	1		1

Based on the Table 4.1 there are 22 supporting medical personnel that consists of two part time ophthalmologists, one part time and one full time NTE specialist, three part time neurology specialists, three part time heart and blood vessels specialists, two part time dermatologists. Other than that, there are also one part time psychiatric specialist, three part time lung specialists, four part time orthopedic specialists, one part time urology specialist, and one plastic surgeon.

Table 4.1 Medical Personnel in Al Irsyad Hospital (con't)

No	Healthcare Personnel	Number of Personnel	Status	
			Full time	Part time
E	Dental Specialist Medical Personnel			
1	Oral surgery dentist	3		3
2	Endodontic specialist dentist	3		3
3	Orthodontic specialist dentist	1		1
F	Paramedic and Other Medical Personnel			
1	Nurse	134	96	38

No	Healthcare Personnel	Number of Personnel	Status	
			Full time	Part time
2	Topologist	10	10	
	Pharmacist	3	2	1
3	Nutritionist	2	1	1
4	Medical record personnel	3		3
5	Medical engineer	1		1
6	Medical analyst	8	7	1
7	Radiologist	5	1	4
8	Physiotherapist	3	2	1
G	Non-medical and other personnel			
1	Bachelor of public health	2	2	
2	Other personnel	170	112	58
Total healthcare personnel		419	247	172

Based on the Table 4.1, the last of the categories are dental specialist medical personnel, paramedic and other medical personnel, and non-medical personnel. Dental specialist are supported by part time employees which are consists of three oral surgery dentist, three endodontic specialist dentist, and one orthodontic specialist dentist.

Paramedic and other medical personnel category is supported by 169 employees who is consists of nurses, topologists, pharmacist, nutritionist, medical record personnel, medical engineer, medical analyst, radiologist, and physiotherapists. The last category of medical personnel is non-medical personnel that consist of two full time public health bachelor and 170 other personnel.

4.2 Identification of Process Maps in Outpatient Unit

The research is focused in an outpatient unit which is consists of several departments such as general clinics, specialist clinic, antenatal and child care clinic, dental clinic, and hemodialysis unit. The patient arrival in outpatient unit has highest rate among other care unit in Al Irsyad Hospital. The departments were chosen based on several criteria; the first criterion is high proportion of patient compared to the other department based on the evaluation of medical expert. A better estimation on healthcare service cost in the department with high

patient rate hopefully will boost the profitability, as the multiplier of the profit is higher. The second criterion is these departments have the same predecessor and the post treatment activities. This condition will ease the healthcare financial team to develop a cost estimation method in high varieties services.

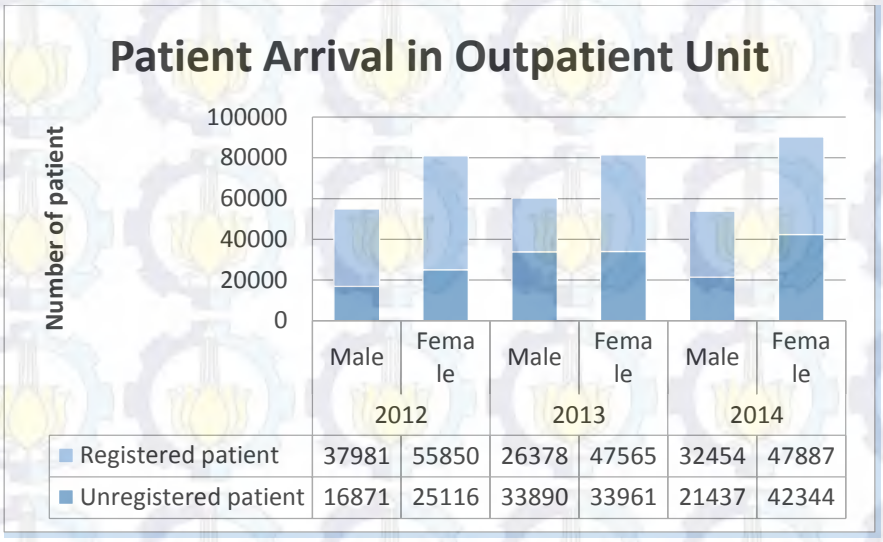


Figure 4.2 Patient Arrival in Outpatient Unit

Figure 4.2 shows the patient arrival rate in outpatient unit. The data shows about the number of registered patient and unregistered patient during 2012 to 2014. Generally female patient has higher proportion rather than male patient to get a healthcare service. There is an increasing of the patient arrival during year to year which shown 135.818 patient in 2012, followed by 141.794 patient in 2013, and 144.122 patient in 2014. This increase the needs of a better quality services to the patients includes the care delivery with affordable tariff that are also profitable for the hospital management to provide a better facilities for them.

Table 4.2 show the information about annual patient arrival in outpatient clinics. The general clinic has highest rate 24,144 patients/year, antenatal clinic that has 14,376 patients/year, dental clinic that has 12,576 patients/year, and 6,588 patients/year in hemodialysis clinic. The research scope is limited to these four clinics based on the data availability in the field.

Table 4.2 Annual Patient Arrival in Outpatient Clinics

Department	Annual Patient Arrival Rate
General clinic	24,144
Antenatal clinic	14,376
Dental clinic	12,576
Hemodialysis clinic	6,588

The research scope is limited into several departments that are; (1) general clinic, (2) dental clinic, (3) hemodialysis unit, and (4) antenatal clinic.

Between those departments, there are similar predecessor and post examination activities that related to patient registration process, post treatment process, and payment process. The registration of patients between the whole departments remains the same, with the submission of personal data and medical history. In the registration, the patient has to buy a healthcare card. Healthcare card is used as the ticket to get a care services in a unit, which stated the treatment that the patient get during the examination process as well as the bill for the whole care services.

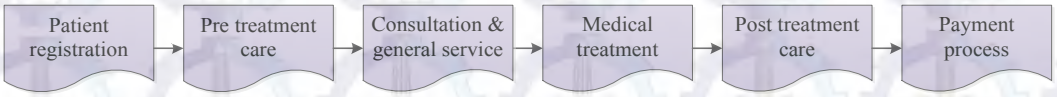


Figure 4.3 General process maps

As shown in Figure 4.3, general flow process in outpatient unit consists of patient arrival, followed by the patient registration, then the patient come into the examination room, then the patient leave the examination room to do the payment process. The details of the activity will be discussed further in the next sub-chapter.

The patient registration is done in the registration desk, which is located in the first floor of the hospital. There are two ways of registration based on the service

type, the first registration desk is located in the hospital main lobby which serves the patient that needs healthcare services from general clinic, antenatal clinic, dental clinic, and hemodialysis unit. While the other registration desk that located in the left wing of the hospital is used to serves patients that are registered to get specialist healthcare services as well in obstetrician and gynecology clinic, ophthalmology clinic, NTE clinic, and interne clinic. The main healthcare services are medical consultation and medical treatment. Basically medical consultation has the same characteristics from one department to another department. In other side, the medical treatment is different between one department to another as it is provides several services based on its specialties. This research is focus on the services that most frequently faced by the healthcare personnel.

Followed by post treatment activities, as the patient get the healthcare service, the payment process is also done differently while the general clinic, antenatal clinic, dental clinic, and hemodialysis unit is processed in the main lobby. While the patients from specialist clinic paying their bill in the specialist clinic cashier.

4.2.1 General Clinic Process Maps

General clinic as one of the department in outpatient unit in Al Irsyad Hospital operated daily from 07.00 am until 09.00 pm. The general clinic provides primary services which serve basic medical treatment such as physical check-up and drug prescription. There is also optional treatment such as giving anesthesia if there are any advance needs for the patients. The clinic is supported by four healthcare personnel from patient arrival until they submit the payment coupon in the cashier. The medical personnel that support healthcare provision in general clinic are one registration staff, one general doctor, one nurse, and one cashier.

As mentioned above that there are four medical personnel called registration staff, general doctor, nurse, and cashier. The flow of the patient in general clinic is shown in the Figure 4.4.

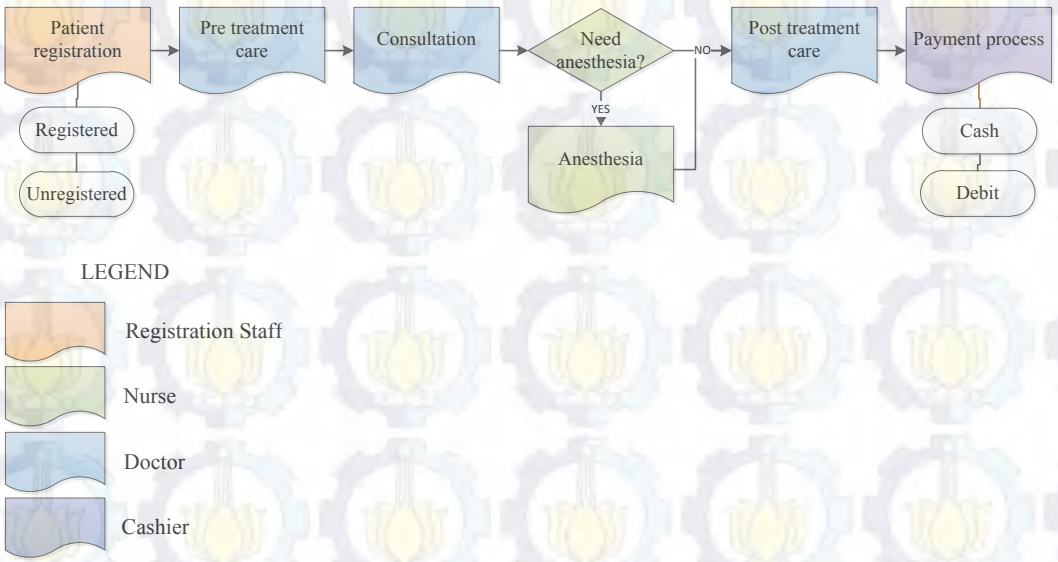


Figure 4.4 General clinic process maps

Based on the Figure 4.4 the healthcare service is distinguished into routines and non-routine activities. Routine activities or as known as main activities in general clinic are patient registration, doctor consultation, physical check-up, post treatment care, and payment process. Non-routine activity is defined as the optional activities where not all the patients that arrive into general clinic are needs the medical treatment. The non-routine activity in general clinic is give anesthesia. This clinic also has unique characteristics that the medical services in this department is limited rather than other department in outpatient unit such as antenatal clinic and dentist clinic. The limited services that provided in the general clinic caused it creates more referral letter rather than other clinic.

Generally, patient that registered in general clinic is the patient with unknown illness and suffering general symptoms or disease that they have not discovered before. If the illness is already detected by the analysis of general doctor, they will give referral letter for other doctor that has specialized area in those illness. Moreover, the doctor also has authorization to give referral letter for advance medical treatment that needed by the patients depending on the illness severity rate.

The flow process of patient in the general clinic is started with the patient arrival. Generally the patient that comes to general clinic is never been there before, called unregistered patient. The unregistered patient collects the required documents for the administration process that held by registration staff. The registration process includes submission of personal data and information, medical history, and providing care ticket for each patient. A healthcare ticket is a predecessor instruments that needed by patient in any visitation services in Al Irsyad Hospital. After the registration staff is inputting the personal medical data, the patient will receive queue number, care ticket, and personal care card.

Subsequently, the patient will have to wait for the calling from the nurse in general clinic. If there are not any previous patient in general clinic, the patient do not have to wait as the nurse will direct them to enter the examination room. In the examination room, the patient will give their queue number as they are also show their care ticket to the nurse. The medical treatment is initiated with consultation with the doctor. The time needed to do the medical consultation is depending on the patient. By determining healthcare services standard time using fuzzification techniques, the accuracy will increase as it is accommodating an accurate ranging from the most likely occur, the largest and smallest value of time needed.

The doctor consultation is followed by the personal condition check-up for the patient that done in various ways such as heart rate checking process and respiration checking process using stethoscope, tension checking and other physical checking. By observing the patient physical condition, the doctor can determine what is the treatment that patient needs. If the patient is need an anesthesia, the nurse as the doctor's assistant will prepare the materials and equipment such as spet and liquid for the injection process. The injection given is used as the neutralization phase for their recent illness while waiting for the advance medical treatment in their next visitation. The injection process is the last treatment that can give to the patient in general clinic. For further medical treatment, the doctor will make a referral letter whether they need advance consultation with the specialist doctor based on their illness or they need an

advance medical treatment such as laboratory testing or radiology services. If those instructions are unnecessary for the patient, probably the doctors use their authorization to recommend the drug usage in the form of doctor's prescription.

Before the patient leave the examination room, they will get their patient care card back as it is shows their medical bill.

4.2.2 Dental Clinic Process Maps

Dental clinic as one of the clinic in outpatient unit in Al Irsyad Hospital has operational hours from 07.00 am until 09.00 pm daily. Dental clinic provides primary and advance services for its patients. This research will focus on primary service that includes dental filling, dental extraction, and dental care. The clinic is supported actively by full time two dentists and one part time specialist dentist.

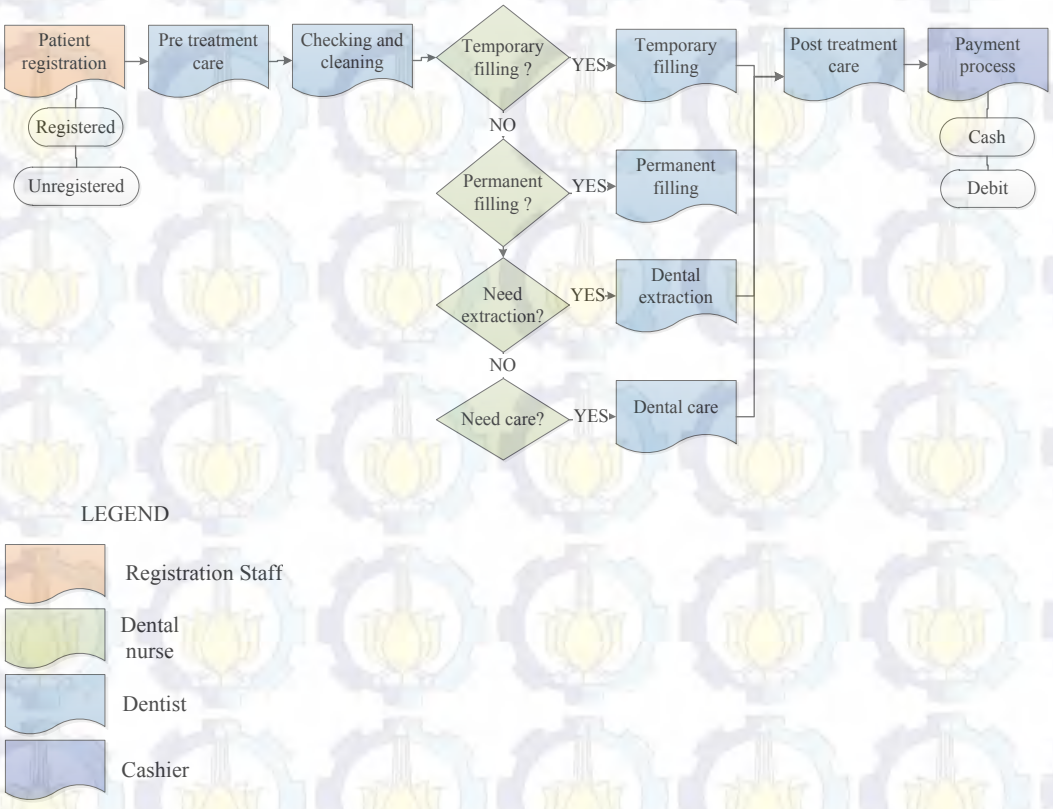


Figure 4.5 Dental clinic process maps

The patient flow process of dental clinic is shown in the Figure 4.5. As the patient arrives, they will check-in into centralized registration desk that are also serves the patient for general clinic and antenatal clinic. In the registration desk, the administration staff will record their medical data and history for each patient, as well as provide a healthcare card that should be bought by them.

The patients that enter the examination room bring in the queue number and their card. By then, the pre-treatment check-up is started. The pre-treatment that occur in the dental clinic is quite different with the other clinic in the outpatient unit. Pre-treatment activity in dental clinic consists of medical consultation, sometimes the medical consultation was held as dental physical check-up is take place.

Based on work sampling and direct observation, the most frequent services that provided by hospital management are dental filling, dental extraction, and dental care for decay. As the services that given are varies, the resources that used were also different. While the resources usage is different, the healthcare services estimation needs a better approach to calculate the each resource consumption. Since the resource consumption is depending on the severity rate of an illness, time needed to perform care service can be used as the variable to calculate service cost. Fuzzy-TDABC method try to accommodate the various services in healthcare industry based on time fuzziness, as it has different time while performing an activity.

Dental filling is the activity to fill up the dental cavities. The case that will discuss in this research is limited in two types of service; those are temporary filling and permanent filling. Since the material of filling is different, the service cost is also different. The other services that observed are dental extraction. Unlikely dental filling, the service cost for dental filling is the same from one case to another, it is shown by the resources that are going to use for dental extraction is inconsumable equipment such as electric anesthesia and dental pin set. The last services that are observed is dental care. Dental care that observed is limited for pulpectomy. Pulpectomy is the activity to monitor and maintain the root of the

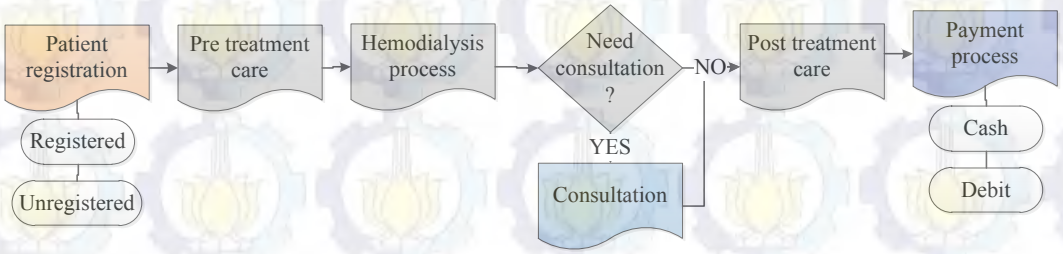
teeth for adult. Actually, there are also available dental services for the kids, but the cases are not frequently during the daily operation.

Following medical treatment activities, post treatment activities are performed by the nurse. The activities related consists of make another appointment, make a referral to another dentist or referral for other advance treatment. Besides, nurse is also preparing for the payment notes. When the post treatment was finished, the patient leaving the examination room and go to the cashier to pay their medical bill.

4.2.3 Hemodialysis Clinic Process Maps

Hemodialysis unit is the clinic that developed recently in 2002. Although the clinic was already run for 13 years, it has a fast development and the care services are improved day by day. This result that hemodialysis clinic was known as one of the best hemodialysis care provider in Surabaya. There are 13 units of hemodialysis that available daily from 06.00 am until 02.00 pm. Since the duration of the care services is four hours, hemodialysis process is divided into two sections. The first section is started in 06.00 am and the second set is started at 10.00 am.

Unlikely other clinic, in this unit the services are directly supported by hemodialysis nurses whose are usually called hemodialysis assistant. There are six active assistant in a day, which are works for eight hours per day. The other medical personnel that support the care services is the part time doctor that are usually outsourced from other clinic, just in case whether the patient has some serious illness during or after hemodialysis process.



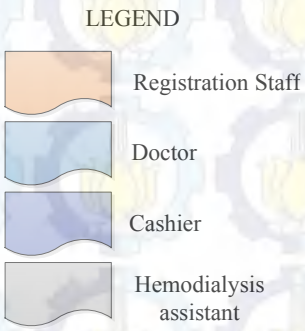


Figure 4.6 Hemodialysis process maps

Based on the Figure 4.6, hemodialysis patient is responsible to register themselves in the centralized registration desk that also serving another patient from general and dental clinics. The registration process was served by two administration staff that helps them with their document requirements, such as the previous healthcare card for those who already come for second or more visit. While unregistered patient have to submit their previous medical record, laboratory result, and other supporting documents. After their data was recorded, the patients will receive and pay for their healthcare card which value IDR 15,000.00.

Subsequently, the patient are enter the hemodialysis unit that located in the second floor of the hospital. Pre-treatment activities that are done before hemodialysis process are personal bathroom time and body weighing. After the patient already finished with physical check-up, they are directed to go on their ward by hemodialysis assistant. Before the hemodialysis process was started, the patient are requires doing fistula installation on their left hand. Fistula is consists of two selang; the first selang has functions to transferred pre-hemodialysis blood into the dialyzer machine. As the dialyzer machine is processing oxygenated blood, the second selang is transferring the clean blood from dialyzer machine into the body.

Hemodialysis process is approximately needs four hours for each patient, which is longer than usual clinic. High equipment cost and longer service time was also the trigger that service cost in this clinic is also high. During four hours

of care services, the patient are doing their personal activities such as reading a book, sleeping, moreover they are also chatting with other hemodialysis patient. If there is any anomaly of the physical condition, the nurses will check their tension, body respiration, iris checking, and other evidences that supporting the diagnosis of doctor. Fortunately, the patients are having good services as the number of emergency cases of can be minimized.

The following services are the post treatment activities. After four hours of hemodialysis process, the dialyzer will give a signal that shown the process was completed. The hemodialysis assistant will help the patient to uninstall their fistula and turn-off the dialyzer machine. The following process that known as post physical activities includes respiration and tension checking and giving vitamin. By then, the overall care service in hemodialysis clinic is done. Subsequently, the patient leaves the examination room and pay for their bill.

4.2.4 Antenatal Clinic Process Maps

Antenatal clinic as one member of the outpatient unit has operational hours from 07.00 am until 02.00 pm. Antenatal clinic provides several care services for babies, infants, and women such as immunization, child care, and contraception installation. This research focusing on immunization for the most frequent care service that done by medical personnel.

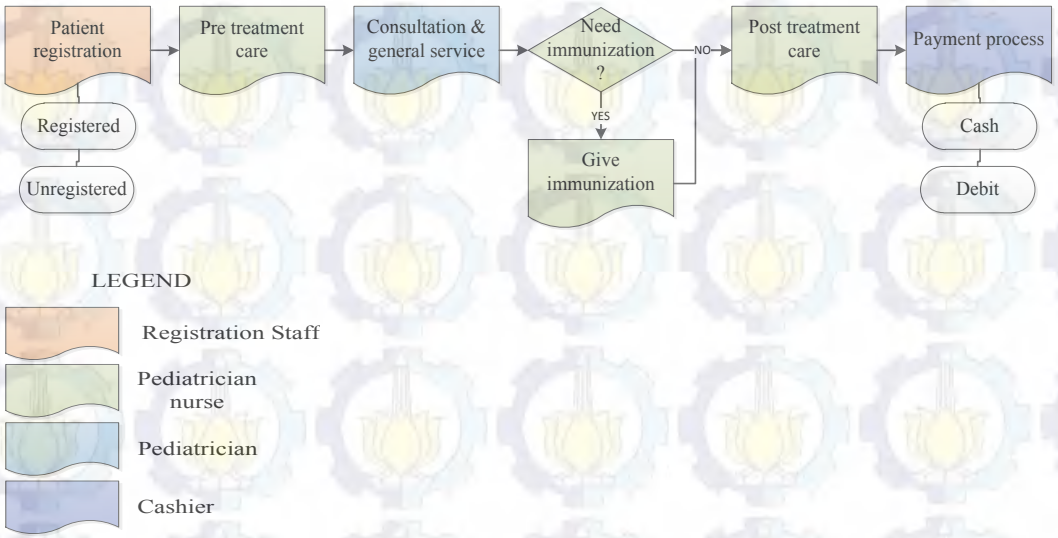


Figure 4.7 Antenatal Clinic Process Maps

Based on Figure 4.7 antenatal clinic process maps generally have the same sequences with other general clinic. As the patients arrive, they regist themselves into centralized registration desk, which is located in the main lobby of Al Irsyad Hospital. After the patient gets their queue number and healthcare card, they tend to wait in the main lobby until the nurse is calling for their queue number. As the patient enters the examination room, they will get physical check up by pediatrician. There are two conditions of patient; (1) the unregistered patient (newly arrived) needs the physical check up by the pediatrician, and (2) registered patient from Care Clinic didn't need the physical check up as their medical history is known.

Subsequently, the medical treatment is held by giving immunization if needed. If it is not, the patient will get doctor's prescription in post-treatment activities. Post treatment activities also includes of personal medical history recording by nurse. As the overall medical process is finished, patient leave the examination room and pay their medical bills in the cashier.

4.3 Fuzzy TDABC on Outpatient Unit

This sub chapter consists of data collecting and data processing to estimate healthcare services cost using fuzzy-TDABC. A process input is the identification of economic resources; cost allocation of economic resources and its practical capacity to calculate capacity cost rate (CCR). CCR values represent the expenses per minutes. Subsequently, economic resources are assigned based on its utilization during care activities. The resources consumption of each activity is accomodated in time equation model. Time equation model allocate resources consumption by using basis of process time and activity volume for certain activities. In last, the cost estimation can be done by multiplying total CCR per resources with process time as it is accommodates in time equation model. Fuzzy-TDABC model can accommodate large data varieties by doing details process mapping based on time usage and its volume.

This session discuss about the architecture of fuzzy-TDABC model, which represents the integrated view of economic resources into departmental views to assign cost objects.

General healthcare services in outpatient unit include general clinic, antenatal clinic, hemodialysis unit, and dental clinic. Figure 4.8 show mapping process of cost allocation from economic resources through departmental processes.

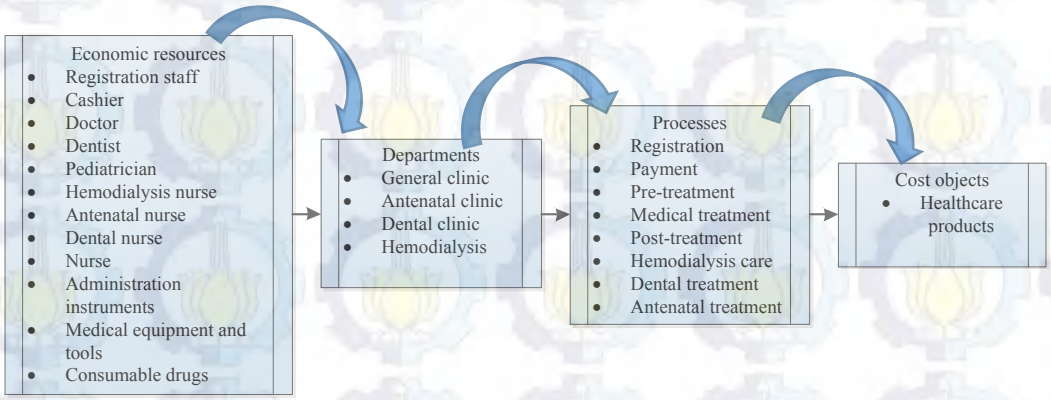


Figure 4.8 Mapping Process in Outpatient Unit

The resources are allocated into the departments that are provides healthcare services, which show a probability of a resource that can be used in several departments. For example general doctor's clinical hours are 14 hours daily, which is allocated mainly in general clinic. There is a probability that general doctor is give a consultation session and medical treatment in hemodialysis unit where its services is needed. This condition creates an urgency to develop a cost estimation that accommodates the proportion of economic resources usage between departments. Since then, a better cost estimation can provide better results.

4.3.1 Identification of Economic Resources

The first step to estimate healthcare cost is identification of economic resources. Economic resources are the subject that causes expenses. Economic resources mainly categorized into operational activity, medical personnel, and medical equipment.

General Clinic

The recap of economic resources in general clinic is shown in Table 4.3. There are several cost pools that identified in outpatient unit; administration instruments, medical personnel, and medical instruments.

Table 4.3 Economic Resources of General Clinic

Economic Resources		Quantity	Unit
Administration instruments	Computer, office equipment, and cash register	2	Set
Medical personnel	Registration staff	4	Person
	Doctor	2	Person
	Nurse	3	Person
	Cashier	4	Person
Medical instruments	Medical equipments and tools	1	Set
	Consumable drugs	30,000	Set

Administration instruments are economic resources that are going to be used in the administration process; patient registration and patient payment process. It is consists of office equipment usage, the computer usage, and cash register machines. The overhead costs of the economic resources are calculated includes in cost allocations of instruments.

The medical personnel that support the healthcare provision are registration staff, doctor, nurse, and cashier. The quantity of personnel is represents the total number of medical employee in two shifts. The facilities that used for medical treatment is categorized as medical equipment and tools and consumable drugs.

Table 4.4 Medical Personnel in General Clinic

Economic Resources		Description	General doctor	Administrative staff	Nurse
Medical Personnel	Primary salary	Salary, bonus	IDR 6,500,000.00	IDR 3,500,000.00	IDR 4,500,000.00

Economic Resources		Description	General doctor	Administrative staff	Nurse
	Malpractice Insurance		IDR 750,000.00	-	-
	Other expenses	Safety insurance, consumptions, utilities	IDR 400,000.00	IDR 245,000.00	IDR 175,000.00
	Total Expenses		IDR 7,650,000.00	IDR 3,745,000.00	IDR 4,675,000.00
	Morning, research, training		15%	10%	10%
	Clinical time		85%	90%	90%
	Annual Medical Personnel cost		IDR 78,030,000.00	IDR 40,446,000.00	IDR 50,490,000.00

Based on Table 4.4 general doctor's primary salary is IDR 6,500,000. The primary salary of doctor is added with malpractice insurance which has value of IDR 750,000,000. Other than primary salary, medical personnel have additional expenses such as personel consumptions, safety insurance, and utilities. To calculate annual medical personnel cost, percentages of clinical time of medical employee were considered in net salary calculation.

Refer to Table 4.4 it is known that doctor has higher non-clinical hours rather than other medical personnel. Non-clinical time for doctor is allocated for morning activities, research and discussion, or meeting session. Non-clinical time for administrative staff is allocated for discussion and meeting. Same with administrative staff, non-clinical time of medical nurse is allocated for visite activities into other department, meeting, etc. Here is the calculation example to calculate annual salary of medical personnel shown in Formula 4.1.

$$\text{Annual net salary} = gross\ salary\ x\ \%\ clinical\ time\ x\ 12 \quad \text{.....(4.1)}$$

Here is an example about how to calculate annual net salary for one doctor.

$$\text{Annual net salary for a doctor} = 7{,}650{,}000\ x\ 85\%\ x\ 12$$

$$\text{Annual net salary for one doctor} = IDR\ 78{,}030{,}000$$

Based on the formula above, doctor's annual net salary is IDR 78,030,000.00 per person. Subsequently, annual net salary for administration staff (registration and cashier staff) is IDR 40,446,000.00 and IDR 50,490,000.00 for medical nurse.

Table 4.5 Medical Instruments in General Clinic

Economic Resources		Description	Qty	set
Medical instruments	Medical equipments and tools	Medical set	1	set
	Consumable drugs	Anesthesia		
		Vaccine dipenhidramin	30,000	set
		Vaccine antalgin	30,000	set
		Syringe (s)	30,000	set
		Syringe (m)	30,000	set
		Basic medical packages	30,000	set
		Stationery stuff	30,000	set

Table 4.5 shows the details about the medical instruments that are going to be used to give care services to the patients. Medical instruments are differs into medical equipments and consumable drugs. Since in general clinic the options of care services is limited only on anesthesia care, the consumable drugs that are purchase in every period includes vaccine dipenhidramin, vaccine antalgin, medical syringes, basic medical packages, and stationery stuffs.

The number of consumable drugs is calculated as 30,000 set which represent annual patient arrival rate in general clinic. Recall from Table 4.2 that arrival rate of general clinic is 24,144 patients, and hospital management should store some additional drugs set that rounded into 30,000 set.

Dental Clinic

The recap of economic resources in dental clinic is shown in Table 4.6.

Table 4.6 Economic Resources of Dental Clinic

No	Economic Resources		Quantity	Unit
1	Administration instruments	Computer, office equipment, and cash register	2	Set
2	Medical personnel	Registration staff	4	Person
		Dentist	4	Person
		Dental nurse	4	Person
		Cashier	4	Person
3	Medical instruments	Medical equipments and tools	1	Set
		Consumable drugs	18,000	Set

As shown in Table 4.6 the economic resources in dental clinic mainly using same economic resources with general clinic, those are administration instruments, registration staff, and cashier. The other economic resources such as dentist, dental nurse, and dental instruments are a unique distinguisher with other clinics. This implied a unique distinguisher resource usage can not be shared with other departments. There are four dentists and four dental nurses which supports care activities.

Table 4.7 Medical Personnel in Dental Clinic

Economic Resources		Description	Dentist	Administrative staff	Nurse
Medical Personnel	Primary salary	Salary, bonus	IDR 7,700,000.00	IDR 3,500,000.00	IDR 4,900,000.00
	Malpractice Insurance		IDR 750,000.00	IDR 0.00	IDR 0.00
	Other expenses	Safety insurance, consumptions, utilities	IDR 400,000.00	IDR 245,000.00	IDR 175,000.00
	Total Expenses		IDR 8,850,000.00	IDR 3,745,000.00	IDR 5,075,000.00
	Morning, research, training		15%	10%	10%
	Clinical time		85%	90%	90%
	Annual Medical Personnel cost		IDR 90,270,000.00	IDR 40,446,000.00	IDR 54,810,000.00

Based on Table 4.7 it is shown that the cost component of medical personnel is same with other clinic which consists of malpractice insurance for dentist, safety insurance, personal consumptions, and utilities.

Table 4.8 Consumable Drugs in Dental Clinic

Economic Resources	Description	Qty	Set
Consumable drug	Medical treatment: Dental exctraction		
	Anesthesia THKin	6,000	Set
	Syringe 5 putt	6,000	Set
	Dental pliers	6,000	Set
	Dental drill	6,000	Set
	Dental screwdrivers	6,000	Set
	Medical treatment: Dental care		
	Dental mirror	4,000	Set
	Syringe	4,000	Set
	Mur	4,000	Set
	Sonde	4,000	Set
	Dental pin set	4,000	Set
	Escavator	4,000	Set
	Medical treatment: Dental filling		
	Ekeno	10,000	Set
	THF	10,000	Set
	Epoperil	10,000	Set
	Purperil	10,000	Set
	Cement	10,000	Set
	Basic medical packages	10,000	Set
	Stationery stuff	10,000	Set
	Total consumable drug	10,000	Set

Table 4.8 shows the details of consumable drugs in dental clinic which is categorized based on the services types. Primary services types that are provided in dental clinic consist of dental filling, dental care, and dental extraction.

The component of medical drugs for dental extraction is consists of anesthesia THKin, syringe 5 putt, dental pliers, dental drill and dental screwdrivers. The component of medical drugs for dental care is consists of dental mirror, syringe, mur, sonde, dental pin set and escavator. The component of medical drugs for dental filling is consists of ekeno, THF, epoperil, purperil, etc.

Total number of consumable drugs is calculated as 20,000 set which represent annual patient arrival rate in dental clinic. Recall from Table 4.2 that arrival rate of dental clinic is 12,576 patients, and hospital management should store some additional drugs set that rounded into 20,000 set.

Hemodialysis Clinic

The recap of economic resources in hemodialysis clinic is shown in Table 4.9.

Table 4.9 Economic Resources of Hemodialysis Unit

No	Economic Resources		Quantity	Unit
1	Administration instruments	Computer, office equipment, and cash register	2	Set
2	Medical personnel	Registration staff	4	Person
		Doctor	2	Person
		Hemodialysis assistant	5	Person
		Cashier	4	Person
3	Medical instruments	Medical equipments and tools	1	Set
		Consumable drugs	10,000	Set

Economic resources in hemodialysis clinic are differs into two, which are the centralized economic resources and special economic resources. Centralized economic resources in hemodialysis unit are administration instruments, registration staff, and cashier. There are unique economic resources that are not available in any other clinic in outpatient unit such as hemodialysis assistant and hemodialysis instruments. There are shared economic resources, as mentioned

above that this clinic is also supported by general doctor in general clinic just in case that there are some special cases that related to the changing of patient condition.

Table 4.10 Medical Personnel in Hemodialysis Clinic

Economic Resources		Description	General doctor	Administrative staff	Hemodialysis assistant
Medical Personnel	Primary salary	Salary, bonus	IDR 6,500,000.00	IDR 3,500,000.00	IDR 5,200,000.00
	Malpractice Insurance		IDR 750,000.00	IDR 0.00	IDR 0.00
	Other expenses	Safety insurance, consumptions, utilities	IDR 400,000.00	IDR 245,000.00	IDR 175,000.00
	Total Expenses		IDR 7,650,000.00	IDR 3,745,000.00	IDR 5,375,000.00
	Morning, research, training		15%	10%	10%
	Clinical time		85%	90%	90%
	Annual Medical Personnel cost		IDR 78,030,000.00	IDR 40,446,000.00	IDR 58,050,000.00

Based on the Table 4.10, the medical personnel that directly involved in hemodialysis care is hemodialysis assistant, while the role of general doctor is limited as outsourcing employees in some special cases. The cost estimation of an outsourcing personnel will described further in following sub-chapter.

Table 4.11 Hemodialysis Medical Instruments

Economic Resources		Description	Qty	Set
Medical instruments	Medical equipments and tools	Medical set	1	Set
	Consumable drug	Medical treatment: Hemodialysis process		
		Dialiser tube	10,000	Set
		Blood line tubing system	10,000	Set
		AV fistula	10,000	Set
		GA fistula	10,000	Set
		Bicarbonate substances	10,000	Set
		Hemosulphate A	10,000	Set
		Basic medical packages	10,000	Set

Economic Resources		Description	Qty	Set
		Stationery stuff	10,000	Set
		Total consumable drug	10,000	Set

Based on Table 4.11 medical instruments that used in hemodialysis unit consists of dialiser tubes, blood line tubing system, AV fistula, GA fistula, bicarbonate substances, hemosulphate A, basic medical packages, and stationery stuffs. The equipment and tools that are used in this clinic includes wards, weighing scale, hemodialiser machines, and other medical equipments.

Total number of consumable drugs is calculated as 10,000 set which represent annual patient arrival rate in dental clinic. Recall from Table 4.2 that annual arrival rate of dental clinic is 6,588 patients, and hospital management should store some additional drugs set that rounded into 10,000 set.

Antenatal Clinic

The recap of economic resources in antenatal clinic is shown in Table 4.12.

Table 4.12 Economic Resources of Antenatal Clinic

No	Economic Resources		Quantity	Unit
1	Administration instruments	Computer, office equipment, and cash register	2	Set
2	Medical personnel	Registration staff	4	Person
		Pediatrician	1	Person
		Pediatrician nurse	2	Person
		Cashier	4	Person
3	Medical instruments	Medical equipments and tools	1	Set
		Consumable drugs	20,000	Set

As shown in Table 4.12 the centralized economic resources in antenatal clinic includes administration instruments, registration staff, and cashier. While other

resources such as pediatrician, pediatrician nurse, and antenatal medical instruments are defined as non-shareable economic resources as it has specific job description in this clinic.

Table 4.13 Medical Personnel in Antenatal Clinic

Economic Resources		Description	Pediatrician	Administrative staff	Pediatrician Nurse
Medical Personnel	Primary salary	Salary, bonus	IDR 7,000,000.00	IDR 3,500,000.00	IDR 5,000,000.00
	Malpractice Insurance		IDR 750,000.00	IDR 0.00	IDR 0.00
	Other expenses	Safety insurance, consumptions, utilities	IDR 400,000.00	IDR 245,000.00	IDR 175,000.00
	Total Expenses		IDR 8,150,000.00	IDR 3,745,000.00	IDR 5,175,000.00
	Morning, research, training		15%	10%	10%
	Clinical time		85%	90%	90%
	Annual Medical Personnel cost		IDR 83,130,000.00	IDR 40,446,000.00	IDR 55,890,000.00

As shown in Table 4.13 medical personnel that directly supports care services in antenatal clinic is pediatrician and pediatrician nurse. The clinical time of pediatrician nurse is larger than the clinical time of pediatrician, since nurses are doing more activities related to the medical treatment and document processing for the patients. While pediatrician activities are limited to physical check up and give a prescription.

Table 4.14 Antenatal Medical Instruments

Economic Resources		Description	Qty	Set
Medical instruments	Medical equipments and tools	Medical set	1	Set
	Consumable drugs	Immunization		
		Vaccine BCG	20,000	Set
		Spet 3 cc	20,000	Set
		Syringe	20,000	Set
		Alcohol SWAB	20,000	Set

Economic Resources		Description	Qty	Set
		Vaccine E	20,000	Set
		Hand sanitizer	20,000	Set
		Basic medical packages	20,000	Set
		Stationery stuff	20,000	Set
		Total consumable drug	20,000	Set

Based on direct observation in antenatal clinic, the research scope of care services is limited into BCG immunization care process. The medical instruments that are used in antenatal clinic are shown in the Table 4.14, which is includes vaccine BCG, medical spet, medical syringes, alcohol SWAB, vaccine E, hand sanitizer, basic medical packages, and stationery stuffs.

Total number of consumable drugs is calculated as 20,000 set which represent annual patient arrival rate in dental clinic. Recall from Table 4.2 that annual arrival rate of dental clinic is 14,376 patients, and hospital management should store some additional drugs set that rounded into 20,000 set.

4.3.2 Cost Allocation of Economic Resources

This sub chapter discuss about the cost allocation of economic resources in each clinic. The data of cost allocation is deployed based on the interview with vice director of financial department, hospital senior accountant, and head of nurses in outpatient unit.

In this stage, cost determinator may faced some problems related to the value of annual cost for specific economic resources, such as cost allocation for administration instruments since it is centralized and shareable resources with other departmetns. The solution of this problem is by determinig a proportion for specific resources to allocate its annual cost. Cost allocation for administration instruments includes the overhead cost while using electronic devices such as cash register, computer, and others. The data collection about medical personnel salaries are disguised related to the work ethics of medical personnel. Cost allocation for medical equipments consists of maintenance costs, rent, and utilities

cost. Other than that, consumable drugs cost allocation is based on the volume of stock keeping unit that are stored in pharmacy department.

General Clinic

Recap of cost allocation for each economic resource is shown in Table 4.15.

Table 4.15 Recap of Cost Allocation in General Clinic

Economic Resources		Quantity	Unit	Annual Cost	Total Annual Cost
Administration instruments	Computer, office equipment, and cash register	1	Set	IDR 350,000,000.00	IDR 350,000,000.00
Medical personnel	Registration staff	4	Person	IDR 40,446,000.00	IDR 161,784,000.00
	Doctor	2	Person	IDR 78,030,000.00	IDR 156,060,000.00
	Nurse	3	Person	IDR 50,490,000.00	IDR 151,470,000.00
	Cashier	4	Person	IDR 40,446,000.00	IDR 161,784,000.00
Medical instruments	Medical equipments and tools	1	Set	IDR 30,000,000.00	IDR 30,000,000.00
	Consumable drugs	30,000	Set	IDR 45,000,000.00	IDR 45,000,000.00

As shown in Table 4.15, cost allocation for administration instruments has a value of IDR 350,000,000. The cost allocation for centralized economic resources has the same value among all clinics in outpatient unit, while some specific economic resources have different value within departments. For example, consumable drugs are allocated IDR 45,000,000 annually for 30,000 set.

Dental Clinic

The recap of cost allocation in general clinic is shown in Table 4.16, which consists of operational activity cost, medical personnel cost, and medical equipment cost. Since it has different number of consumable drugs set, cost allocation for each service types are also has different value. The basis of cost determination is by using proportions of service types that has most frequent treatments.

Table 4.16 Recap of Cost Allocation in Dental Clinic

Economic Resources		Quantity	Unit	Annual Cost	Total Annual Cost
Administration instruments	Computer, office equipment, and cash register	1	set	IDR 350,000,000.00	IDR 350,000,000.00
Medical personnel	Registration staff	4	person	IDR 40,446,000.00	IDR 161,784,000.00
	Dentist	4	person	IDR 90,270,000.00	IDR 361,080,000.00
	Nurse	4	person	IDR 54,810,000.00	IDR 219,240,000.00
	Cashier	4	person	IDR 40,446,000.00	IDR 161,784,000.00
Medical instruments	Medical equipments and tools	1	set	IDR 80,000,000.00	IDR 80,000,000.00
	Temporary filling drugs	6,000	set	IDR 125,000,000.00	IDR 125,000,000.00
	Permanent filling drugs	4,000	set	IDR 250,000,000.00	IDR 250,000,000.00
	Dental extraction drugs	4,000	set	IDR 70,000,000.00	IDR 70,000,000.00
	Dental care drugs	4,000	set	IDR 155,000,000.00	IDR 155,000,000.00

As shown in Table 4.16 cost allocation for temporary filling drugs is IDR 125,000,000 annualy for 6000 set. Permanent filling drugs expense is allocated as IDR 250,000,000 for 4000 set since it has more expensive drugs. The proportion of 6:4 of resources set is done based on the number of frequent cases that usually occur during daily operation. For dental extraction it is allocated IDR 70,000,000 for 4,000 set of consumable drugs. Other than that, IDR 155,000,000 is allocated for 4,000 set dental care drugs.

Hemodialysis Clinic

The recap of cost allocation that used in hemodialysis clinic is shown in Table 4.17. Medical equipments and tools is allocated for IDR 325,000,000 for operational costs, maintenance cost, repairment costs, and rent costs. Total number of dialiser machines in hemodialysis unit is 18 machines. Hence, the calculation of annual costs is recapped into 1 set of medical equipments to calculate the aggregate cost.

Table 4.17 Recap of Cost Allocation in Hemodialysis Clinic

Economic Resources		Quantity	Unit	Annual Cost	Total Annual Cost
Administration instruments	Computer, office equipment, and cash register	1	set	IDR 350,000,000.00	IDR 350,000,000.00
Medical personnel	Registration staff	4	person	IDR 40,446,000.00	IDR 161,784,000.00
	Doctor	2	person	IDR 78,030,000.00	IDR 156,060,000.00
	Hemodialysis assistant	5	person	IDR 58,050,000.00	IDR 290,250,000.00
	Cashier	4	person	IDR 40,446,000.00	IDR 161,784,000.00
Medical instruments	Medical equipments and tools	1	set	IDR 325,000,000.00	IDR 325,000,000.00
	Consumable drugs	10,000	set	IDR 325,000,000.00	IDR 325,000,000.00

Consumable drugs that used in hemodialysis clinic include of medical equipment and hemodialysis consumable drugs. The expenses are consists of dialiser tube, blood line tubing system, AV fistula, GA fistula, bycarbonate substances, hemosulphate A, basic medical packages, and stationery stuff. Cost allocation for hemodialysis consumable drugs has value of IDR 325,000,000.

Antenatal Clinic

Table 4.18 provided recap of cost allocation in antenatal clinic. It is known that annual salary of pediatrician is IDR 67,830,000, a value of IDR 40,446,000 is allocated for administrative staff, and IDR 45,090,000.00 for nurse.

Table 4.18 Cost Allocation in Antenatal Clinic

Economic Resources		Quantity	Unit	Annual Cost	Total Annual Cost
Administration instruments	Computer, office equipment, and cash register	1	set	IDR 350,000,000.00	IDR 350,000,000.00
Medical personnel	Registration staff	4	person	IDR 40,446,000.00	IDR 161,784,000.00
	Doctor	1	person	IDR 83,130,000.00	IDR 83,130,000.00
	Nurse	2	person	IDR 55,890,000.00	IDR 111,780,000.00
	Cashier	4	person	IDR 40,446,000.00	IDR 161,784,000.00
Medical instruments	Medical equipments and tools	1	set	IDR 30,000,000.00	IDR 30,000,000.00
	Consumable drugs	20,000	set	IDR 45,000,000.00	IDR 45,000,000.00

Based on Table 4.18 the resources consumption includes the medical treatment tools, equipment, and consumable drugs. The drugs and medical tools consumption includes vaccine BCG, spet 3 cc, syringe, alcohol SWAB, hand sanitizer, basic medical packages (plaster and vitamin), and stationery stuff. Total cost allocation for consumable drug is IDR 45,000,000 for 20,000 set.

4.3.3 Economic Resources Practical Capacity

Practical capacity represents the available time to perform care activities. It is used as the input to calculate capacity cost rate (CCR). The aim to do practical capacity calculation is to know the available time or volume of economic resources. This increasing the accuracy of cost estimation while considering time-based and volume-based while assigning economic resources to each activity. This research distinguished the calculation of practical capacity into volume based and time based economic resources. Time based economics resources is consists of operational activity, the availability of medical personnel, and the availability of medical equipment. While volume based economics resources is consist of consumable drugs.

Table 4.19 Practical Capacity of Time Based Economics Resources

Practical Capacity	Operational Activity	Medical Personnel	Medical Equipment
Weeks per year	52	52	52
Weeks unavailable	8	8	8
Working weeks	44	44	44
Working days in a week	6	6	6
Hours per day	14	14	14
Breaks, discussion, morning activity	-	2.1	-
Clinical hours per day	14	11.9	8
Annual Practical Capacity (minutes)	221,760 minutes	188,496 minutes	126,720 minutes

To calculate capacity time for medical peronnel, the data needed is total available minutes during a year for each personnel type. Available time that calculated is net time from clinical time per resources, and it is included with the reduction of non-clinical time. In this research active clinical hours for all medical personnel is assumed the same.

As shown in Table 4.19, there are 44 available weeks during a year. In the example of medical personnel capacity time, since there are two shifts in a day, the available hours for medical personnel is 14 hours. As mentioned above, non-working time of medical personnel is allocated for personal activities and breaks. Non-working activities from medical personnel is 2.1 hours per day. Hence, using Formula 4.2 the annual practical capacity is 188,496 minutes/year.

$$\text{Practical capacity} = Working\ weeks\ x\ working\ hours/ day\ x\ (clinical\ hours) x\ 60 \quad \text{.....(4.2)}$$

Here is an example how to calculate practical capacity of medical personnel.

$$\text{Practical capacity of medical personnel} = 44\ x\ 6\ x\ (14 - 2.1) x\ 60$$

$$\text{Practical capacity of medical personnel} = 188{,}496\ minutes\ per\ year$$

The calculation of consumable drug's practical capacity is by using volume basis. Thus the calculation of consumable drug's practical capacity

The calculation of practical capacity for other economic resources is using the same formula with the medical personnel practical capacity time calculation. Administration instruments that going to used for operational activities have available time 14 hours. Other than that, practical capacity calculation for medical instruments is allocated for 8 hours per day. It is based on the assumptions that there are four non-active hours which show the probability of services that is not using those medical instruments.

4.3.4 Calculate Capacity Cost Rate (CCR)

After the economic resources cost allocation and practical capacity is known, then the following step to build a fuzzy-TDABC method is by calculation of capacity cost rate (CCR). CCR shows the cost per minutes for each economic resource.

CCR calculation is using the equation in Formula 4.3.

$$\text{CCR} = \frac{annual\ cost\ of\ economic\ resources}{practical\ capacity} \text{.....(4.3)}$$

Here an example about how to calculate the CCR of doctor.

$$\text{CCR of doctor} = \frac{125{,}460{,}000}{188{,}496} = IDR\ 665.58\ per\ minutes$$

The detail about recap of capacity cost rate in general clinic is shown in Table 4.20.

Table 4.20 CCR Calculation in General Clinic

Economic Resources	Economic Resources	Practical Capacity	Total Annual Cost	CCR
Administration instruments	Computer, office equipment, and cash register	221,760	IDR 350,000,000.00	IDR 1,578.28
Medical personnel	Registration staff	188,496	IDR 161,784,000.00	IDR 858.29
	Doctor	188,496	IDR 156,060,000.00	IDR 827.92
	Nurse	188,496	IDR 151,470,000.00	IDR 803.57
	Cashier	188,496	IDR 161,784,000.00	IDR 858.29
Medical instruments	Medical equipments and tools	126,720	IDR 30,000,000.00	IDR 236.74
	Consumable drugs	30,000	IDR 45,000,000.00	IDR 1,500.00

The detail about recap of capacity cost rate in dental clinic is shown in Table 4.21.

Table 4.21 CCR Calculation in Dental Clinic

Economic Resources		Practical Capacity	Total Annual Cost	CCR
Administration instruments	Computer, office equipment, and cash register	221,760	IDR 350,000,000.00	IDR 1,578.28
Medical personnel	Registration staff	188,496	IDR 161,784,000.00	IDR 858.29
	Dentist	188,496	IDR 361,080,000.00	IDR 1,915.58
	Nurse	188,496	IDR 219,240,000.00	IDR 1,163.10
	Cashier	188,496	IDR 161,784,000.00	IDR 858.29
Medical instruments	Medical equipments and tools	126,720	IDR 80,000,000.00	IDR 631.31
	Temporary filling drugs	6,000	IDR 125,000,000.00	IDR 20,833.33
	Permanent filling drugs	4,000	IDR 250,000,000.00	IDR 62,500.00
	Dental extraction drugs	4,000	IDR 70,000,000.00	IDR 17,500.00
	Dental care drugs	4,000	IDR 155,000,000.00	IDR 38,750.00

The detail about recap of capacity cost rate in hemodialysis clinic is shown in Table 4.22.

Table 4.22 CCR Calculation in Hemodialysis Clinic

Economic Resources	Economic Resources	Practical Capacity	Total Annual Cost	CCR per resources / minutes
Administration instruments	Computer, office equipment, and cash register	221,760	IDR 350,000,000.00	IDR 1,578.28
Medical personnel	Registration staff	188,496	IDR 161,784,000.00	IDR 858.29
	Doctor	188,496	IDR 156,060,000.00	IDR 827.92
	Hemodialysis assistant	188,496	IDR 290,250,000.00	IDR 1,539.82
	Cashier	188,496	IDR 161,784,000.00	IDR 858.29
Medical instruments	Medical equipments and tools	126,720	IDR 325,000,000.00	IDR 2,564.71
	Hemodialysis drugs	10,000	IDR 325,000,000.00	IDR 32,500.00

The detail about recap of capacity cost rate in dental clinic is shown in Table 4.23.

Table 4.23 CCR Calculation in Antenatal Clinic

Economic Resources	Economic Resources	Practical Capacity	Total Annual Cost	CCR per resources / minutes
Administration instruments	Computer, office equipment, and cash register	221,760	IDR 350,000,000.00	IDR 1,578.28
Medical personnel	Registration staff	188,496	IDR 161,784,000.00	IDR 858.29
	Doctor	188,496	IDR 83,130,000.00	IDR 441.02
	Nurse	188,496	IDR 111,780,000.00	IDR 593.01
	Cashier	188,496	IDR 161,784,000.00	IDR 858.29
Medical instruments	Medical equipments and tools	126,720	IDR 80,000,000.00	IDR 631.31
	Consumable drugs	20,000	IDR 65,000,000.00	IDR 3,250.00

In this stage, medical personnel have different annual cost between one another. Thus, the CCR of registration staff, doctor, nurse, and cashier is also has different value. The aims of CCR calculation is to breaking down into details what are the cost components for each activities that cause expenses based on its available time.

4.3.5 Time Equation Formulation Based on Fuzzy Set

This sub-chapter has aims to develop a time equation within care activities that shown in process maps. Developing a time equation requires data of standard time to perform care process. This research has implemented several methods to estimate the process time of an activity; stopwatch time study and fuzzy set method.

As shown in Table 4.24, based on the type of activities, there are two different types of work measurement that conducted to estimate standard time. To calculate working standard time, the healthcare activities is distinguished into two; the activities that has homogenous work elements and the activities that has heterogenous work elements. The heterogenous work elemets is not suitable with the usage stopwatch time study as it is accommodates cyclical and homogenous work elements. Hence, a fuzzy set method is developed to accommodate variations in heterogenous activity

Table 4.24 Work Measurement Methods

Process	Activity	Homogenous Activity	Heterogenous Activity	Data Collection Process
Patient registration	Call for patient number	V		Stopwatch Time Study
	Receiving patient document	V		
	Create clinical notes	V		
Pre-treatment	Call in the patient	V		Stopwatch Time Study
	Check the patient number	V		
	Check the patient medical histories	V		
Consultation	Consultation		V	Fuzzy Set Method
	Physical check up		V	
Medical treatment			V	Fuzzy Set Method
Post-treatment	Post consultation	V		Stopwatch Time Study
	Make another appointment	V		
	Make a referral	V		
	Make a drug prescription	V		
	Make a payment notes	V		

Process	Activity	Homogenous Activity	Heterogenous Activity	Data Collection Process
Payment process	Take the payment notes	V		Stopwatch Time Study
	Input patient data	V		
	Give the payment notes	V		
	Check the payment notes	V		
	Accept the money	V		
	Give money changes	V		

Based on Table 4.24, the processes that use stopwatch time study is patient registration, pre-treatment process, post-treatment process, and payment process. The processes that use fuzzy set method include consultation and medical treatment. Medical treatment and consultation process is different between one to another, in general clinic the medical treatment is in the form of anesthesia. In dental clinic the type of services is ranging from dental care, dental filling, and dental extraction. In hemodialysis clinic the type of services is ranging from hemodialysis care and hemodialysis care plus consultation. In antenatal clinic the type of services is ranging from consultation and coTensultation plus immunization. The selection of services types is based on direct interview with the experts about what are the healthcare products that most frequently perform.

Stopwatch Time Study

As mentioned above, stopwatch time study is conduct when there are cyclical activities in a process. The study was initiated by estimating actual time of n-cycle process.

Table 4.25 Stopwatch Time Study in Homogenous Process

Work Operation	Work Element	Working time n-cycle (second)								Actual Time (second)
		1	2	3	4	5	6	…	20	
Patient registration	Call for patient number	52	41	40	44	54	50	54	60	45
	Input patient documents	62	64	68	56	60	64	72	64	65
	Create clinical notes	9	17	12	10	14	14	11	14	12.35

As shown in Table 4.25, actual time is the average value of working time. Actual time is the process time that is collected based on the real observations. The value of actual time then is processed with performance rating. Recall from Chapter II that performance rating is determined based on the skills and competences of medical personnel, the rating that is used in this research is 1,11% which has good skills and competences. The allowance of personnel is set in 9%, it is used to determine standard time calculation. The allowance of medical personnel should be different from doctor, nurses, hemodialysis assistant, administration personnel, as well as they have different job description. But in this research the allowances of medical personnel is using the same number due to limited informations during data collection process.

Table 4.26 Standard Time Calculation

Process	Activity	Actual Time (second)	Performance Rating	Normal Time (second)	Allowance	Standard Time (second)	Activity Total Time (minutes)
Patient registrati on	Call for patient number	18	1.11	19.98	0.09	21.7782	
	Receiving patient document	17	1.11	18.87	0.09	20.5683	1.915675
	Create clinical note	60	1.11	66.6	0.09	72.594	

Table 4.26 shows that normal time is the multiplication of actual time with performance rating. To calculate standard time of 'calling for patient number' activity here is the sample of calculation in Formula 4.4.

$$\text{Standard time} = \frac{\text{Normal time x } 100\%}{100\% - \%\ Allowance}\,(\text{second}) \ldots\ldots (4.4)$$

$$\text{Standard time of } 'calling\ for\ patient\ number' = \frac{19.98 \text{ x } 100\%}{100\% - 9\%}$$

$$= 21.77 \text{ second}$$

Subsequently, it is needed a sum of total time needed for all work elements and recap it by using unit minutes.

Fuzzy Set Method

The work measurement method is initiated with direct observation and work sampling. Research scope is determined based on the most frequent activities. For example, direct observation is conducted to know what the primary activity in dental clinic is. By observing care activities, a stopwatch time study was conducted as one supporting process to determine work elements of an activity. Furthermore it has aim to know the standard time that done by medical personnel. Since there are large data needed to complete the data adequacy test, there is an option to estimate work standard time.

Since standard time measurement for medical treatment has high varieties based on its influencing factor, a fuzzy set was developed to accommodate data uncertainties. Fuzzy set method is the most appropriate option since it can accommodates high uncertainty factors while performing an activity. There are high varieties of process time influenced by external factors; personnel skill, external environment, illness severity, and other considerations.

There are several processes in general clinic includes patient registration, pre-treatment care, consultation, anesthesia care (optional), post treatment care, and payment process. It is also contains information the employee that perform the activity includes its standard time.

Here is the sample of standard time calculation using fuzzy set theory while performing an anesthesia activity. Fuzzy set data were gathered from three different expert judgements. The expert criteria are determined based on the job position, which also represents their working duration and adequate job knowledges. Or even, the interview process is done based on the available employee if it has limited expert resources.

Table 4.27 Fuzzy Set on Anesthesia Treatment

Department	Work Operation	Fuzzy Level	Fuzzy Value (minutes)			Average Value	Membership value	Defuzzification
			1	2	3			

General clinic	Anesthesia	Slow	3	3	4	3.33	0.60	2.47
		Average	2	2	3	2.33	0.40	
		Fast	2	1	2	1.67	-	

Table 4.27 shows different process time between medical personnel that is shown in Fuzzy Value column. It has three columns which implied the number of expert judgement is gathered from three different employees. In Fuzzy Level column, time needed to prepare anesthesia is categorized into three values, most frequent process time (average process time), possible value of maximum process time (slowest process time), and possible value of minimum process time (fastest process time).

The average value in Crisp Input column is used as the crisp input to be translated into membership value. Membership value is data processing stages by using interpolation method to give the proportion of each fuzzy level. As shown in Table 4.27, the fuzzy level that has membership value is Slow and Average level. The membership value estimation is using Formula 4.5 and 4.6.

$$\text{Membership value of Slow level} = \frac{crisp\ input\ of\ slow - crisp\ input\ of average}{crisp\ input\ of\ slow - crisp\ input\ of\ fast} \quad ...(4.5)$$

$$\text{Membership value of Average level} = \frac{crisp\ input\ of\ average - crisp\ input\ of fast}{crisp\ input\ of\ slow - crisp\ input\ of\ fast} \quad ...(4.6)$$

The example of membership value calculation in anesthesia preparation is shown in the equation below.

$$\text{Membership value of Slow level} = \frac{3.33 - 2.33}{3.33 - 1.67} = 0.6$$

$$\text{Membership value of Slow level} = \frac{2.33 - 1.67}{3.33 - 1.67} = 0.4$$

As crisp input is translated into membership value, it is ready for the defuzzification process. Defuzzification process is the processing stage of fuzzy value into crisp output. Crisp output is use as the final resulf of fuzzy set stages. The formula of defuzzification is solved with the equation in Formula 4.7.

$$\text{Crisp output} = \frac{\sum(crisp\ input\ x\ membership\ value)}{2} \ldots . (4.7)$$

The example of crisp output calculation in anesthesia preparation is shown as the equation below.

$$\text{Crisp output} = \frac{(3.33\ x\ 0.6)+(2.33\ x\ 0.4)}{2} = 2.47 \text{ minutes}$$

From the equation above, it is shown that crisp output for anesthesia preparation is 2.47 minutes. Thus, the standard time for anesthesia preparation is 2.47 minutes.

Time Equation Model

Beside fuzzy set theory, time equation is the unique character to allocate services cost in fuzzy-TDABC method. The general formula to build a time equation in this research is shown in Formula 4.8.

$$T = \sum T_i + (A_i \times X_i) \text{ (minutes)}\ldots.(4.8)$$

Where;

T = time equation of process, total time to perform a service

T_i = time in process i

A_i = additional time in process I (if there are any additional time)

X_i = binary code for additional time i (0 or 1)

General time equation is formulated based in the additional time of a process that may occur in care processes. It is accommodates the probabilities and high varieties service types in a complex organization such as in outpatient unit. This session discuss about standard process time in each activities followed by time equation for each clinic.

General Clinic

Table 4.28 shows the recap of standard time using STS calculation in general clinic. The standard time for patient registration is 1.9 minutes, pre-treatment process is 2.4 minutes, post-treatment is 2.7 minutes, and payment process is 2.4 minutes.

Table 4.28 STS calculation in general clinic

Process	Activity	Actual Time	Performance Rating	Normal Time	Allowance	Standard Time	Activity Total Time (minutes)
Patient registration	Call for patient number	18	1.11	19.98	0.09	21.7782	1.915675
	Receiving patient document	17	1.11	18.87	0.09	20.5683	
	Create clinical note	60	1.11	66.6	0.09	72.594	
Pre-treatment	Call in the patient	20	1.11	22.2	0.09	24.198	2.4198
	Check the patient number	18	1.11	19.98	0.09	21.7782	
	Check the patient medical histories	82	1.11	91.02	0.09	99.2118	
Post-treatment	Post consultation	50	1.11	55.5	0.09	60.495	2.78277
	Make another appointment	20	1.11	22.2	0.09	24.198	
	Make a referral	20	1.11	22.2	0.09	24.198	
	Make a drug prescription	25	1.11	27.75	0.09	30.2475	
	Make a payment notes	23	1.11	25.53	0.09	27.8277	
Payment process	Take the payment notes	15	1.11	16.65	0.09	18.1485	2.4198

Process	Activity	Actual Time	Performance Rating	Normal Time	Allowance	Standard Time	Activity Total Time (minutes)
	Input patient data	30	1.11	33.3	0.09	36.297	
	Give the payment notes	15	1.11	16.65	0.09	18.1485	
	Check the payment notes	20	1.11	22.2	0.09	24.198	
	Accept the money	15	1.11	16.65	0.09	18.1485	
	Give money changes	25	1.11	27.75	0.09	30.2475	

Based on Table 4.29 it is shown that there is defuzzification column. It is represent the crisp output of fuzzy set that translated into standard working time. The standard time for consultation is 5.13 minutes and anesthesia is 2.4 minutes.

Table 4.29 Fuzzy set in general clinic

Department	Work Operation	Fuzzy Level	Fuzzy Value (minutes)			Defuzzification
			1	2	3	
General clinic	Consultation	Slow	7	8	9	5.13
		Average	5	5.5	5.3	
		Fast	1.5	1.9	3	
	Anesthesia	Slow	3.9	4.2	4	2.40
		Average	3	2.5	3	
		Fast	1	0.5	1	

The details about mapping process is shown in Figure 4.9 that contains the standard time to perform basic service in general clinic, and also show standard time to perform additional services such as anesthesia. This session will discuss about the time equation model in general clinic. Time equation can accommodates the probability of different service types that lead to different resources usage. Recall that activities related to each processes has already discuss in Sub-Chapter 4.2.

As shown in Figure 4.9 that basic standard time to do patient registration is 1.9 minutes, added with 1.9 minutes if it is registered patient or 2.3 minutes if it is unregistered patient. The standard time in additional services is determined based on the proportion of activities needed in each condition. Basic activities for

patient registration include receiving patient arrival, and receive patient documents. There is a difference while serving registered and unregistered patient. Registered patient requires smaller process time as it is only checking patient status and its medical histories, no need to processing new documents such as for unregistered patient. Patient registration time within the clinics is different since the document required is also different.

Other than that, payment process is also has basic primary activities includes receiving patient, input and processing the medical bills. The basic activity needs 2.4 minutes, while there is an additional 1.1 minute needed to perform receiving money and give the changes for cash payment; and there is an additional 2.4 minute needed to perform preparing card machine, input the bill, and processing the bill for debit payment. Payment process standard time is same within the clinics since the job descriptions of cashier is same for all clinics in outpatient unit.

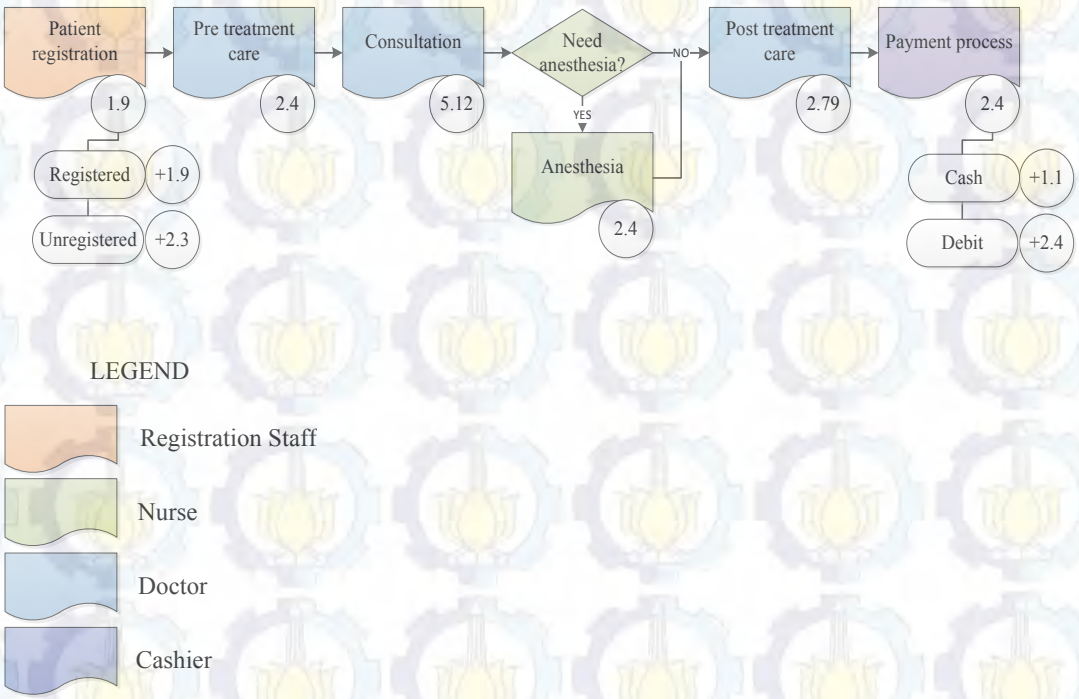


Figure 4.9 General Clinic Mapping Process

Figure 4.9 shows about mapping process in general clinic contains with information about its standard time. Standard time calculation is done by using several work methods measurement. Stopwatch time study is conducted when the measurement of working time has homogenous, cyclical, and repetitive activities in patient registration, pre-treatment care, post treatment care, and patient payment process. Other than that, consultation process and anesthesia care needs different time between one case and another.

Here are the details about time equation that represents total time to perform a service product in general clinic shown in Formula 4.9.

$$Tg = 1.9 + (1.9Xg_1 + 2.3Xg_2) + 2.4 + 5.12 + (2.4Xg_3) + 2.79 + 2.4 + (1.1Xg_4 + 2.4Xg_5)\ (\text{minutes}) \ldots..(4.9)$$

Subject to;

$Xg_1 + Xg_2 = 1$

$Xg_4 + Xg_5 = 1$

$Xg_1, Xg_2, Xg_3, Xg_4, Xg_5 = 0$ or 1 (binary)

Where;

Tg = time equation of process, total time to perform a service in general clinic

Xg_1 = registered patient

Xg_2 = unregistered patient

Xg_3 = anesthesia care

Xg_4 = cash payment

Xg_5 = debit payment

Here is the case A as an example of total time to perform a care services in general clinic. Rahman has already come to the general clinic twice; this implied that Rahman is a registered patient. He got consultation and anesthesia care based

on the doctor's diagnosis. After the medical treatment, he leaves the examination room and pay the medical bill with debit payment.

$$Tg \text{ of case A} = 1.9 + (1.9(1) + 2.3(0)) + 2.4 + 5.12 + (2.4(1)) + 2.79 + 2.4 + (1.1(0) + 2.4(1)) \text{ (minutes)}$$

$$Tg \text{ of case A} = 21.32 \text{ minutes}$$

Hence, total time to perform case A in general clinic is 21.32 minutes.

Dental Clinic

Table 4.30 shows the recap of standard time using STS calculation in general clinic. The standard time for patient registration is 1.9 minutes, pre-treatment process is 2.4 minutes, post-treatment is 2.1 minutes, and payment process is 2.4 minutes.

Table 4.30 STS calculation in dental clinic

Process	Activity	Actual Time (second)	Performance Rating	Normal Time (second)	Allowance	Standard Time (second)	Activity Total Time (minutes)
Patient registration	Call for patient number	18	1.11	19.98	0.09	21.7782	1.915675
	Receiving patient document	17	1.11	18.87	0.09	20.5683	
	Create clinical note	60	1.11	66.6	0.09	72.594	
Pre-treatment	Call in the patient	20	1.11	22.2	0.09	24.198	2.4198
	Check the patient number	18	1.11	19.98	0.09	21.7782	
	Check the patient medical histories	82	1.11	91.02	0.09	99.2118	
Post-treatment	Post consultation	38	1.11	42.18	0.09	45.9762	2.13749
	Make another appointment	20	1.11	22.2	0.09	24.198	
	Make a referral	15	1.11	16.65	0.09	18.1485	
	Make a drug prescription	18	1.11	19.98	0.09	21.7782	

Process	Activity	Actual Time (second)	Performance Rating	Normal Time (second)	Allowance	Standard Time (second)	Activity Total Time (minutes)
	Make a payment notes	15	1.11	16.65	0.09	18.1485	
Payment process	Take the payment notes	15	1.11	16.65	0.09	18.1485	2.4198
	Input patient data	30	1.11	33.3	0.09	36.297	
	Give the payment notes	15	1.11	16.65	0.09	18.1485	
	Check the payment notes	20	1.11	22.2	0.09	24.198	
	Accept the money	15	1.11	16.65	0.09	18.1485	
	Give money changes	25	1.11	27.75	0.09	30.2475	

Based on Table 4.31 it is shown that there is defuzzification column. It is represent the crisp output of fuzzy set that translated into standard working time. The standard time for checking and cleaning is 3.2 minutes, temporary filling is 2.33 minutes, permanent filling is 19.99 minutes, dental extraction is 2.5 minutes, and dental care 7.6 minutes.

Table 4.31 Fuzzy set in dental clinic

Department	Work Operation	Fuzzy Level	Fuzzy Value (minutes)			Defuzzification
			1	2	3	
Dental clinic	Checking & cleaning	Slow	4.5	5	5	3.20
		Average	3	3	3.8	
		Fast	1.9	1.5	1.5	
	Temporary filling	Slow	3.9	4.1	4	2.33
		Average	3	2.7	3.1	
		Fast	1	0.5	1.1	
	Permanent filling	Slow	28	27	26	19.99
		Average	20	21	21	
		Fast	16	16.8	15.4	
	Dental extraction	Slow	3.5	4.5	4	2.50
		Average	2.5	3.1	2.5	
		Fast	1	1	1	
	Dental care	Slow	9.5	9	9	7.60
		Average	4	5	5	

Department	Work Operation	Fuzzy Level	Fuzzy Value (minutes)			Defuzzification
			1	2	3	
		Fast	3	3	4	

The details about mapping process is shown in Figure 4.10 that contains the standard time to perform basic service in dental clinic, and also show standard time to perform additional services such as dental filling, dental extraction, and dental care. This session will discuss about the time equation model in dental clinic. Time equation can accommodates the probability of different service types that lead to different resources usage. Recall that activities related to each processes has already discuss in Sub-Chapter 4.2.

As shown in Figure 4.10 that basic standard time to do patient registration is 1.9 minutes, added with 2.1 minutes if it is registered patient or 2.4 minutes if it is unregistered patient. The standard time in additional services is determined based on the proportion of activities needed in each condition. Basic activities for patient registration include receiving patient arrival, and receive patient documents. There is a difference while serving registered and unregistered patient. Registered patient requires smaller process time as it is only checking patient status and its medical histories, no need to processing new documents such as for unregistered patient. Patient registration time within the clinics is different since the document required is also different.

Other than that, payment process is also has basic primary activities includes receiving patient, input and processing the medical bills. The basic activity needs 2.4 minutes, while there is an additional 1.1 minute needed to perform receiving money and give the changes for cash payment; and there is an additional 2.4 minute needed to perform preparing card machine, input the bill, and processing the bill for debit payment. Payment process standard time is same within the clinics since the job descriptions of cashier is same for all clinics in outpatient unit.

There is also an additional time while performing different type of services. For example when the patient needs temporary filling, the nurse will prepare the

medical material that has standard time 2.29 minutes, and additional 20 minutes for the care services that are done by dentist.

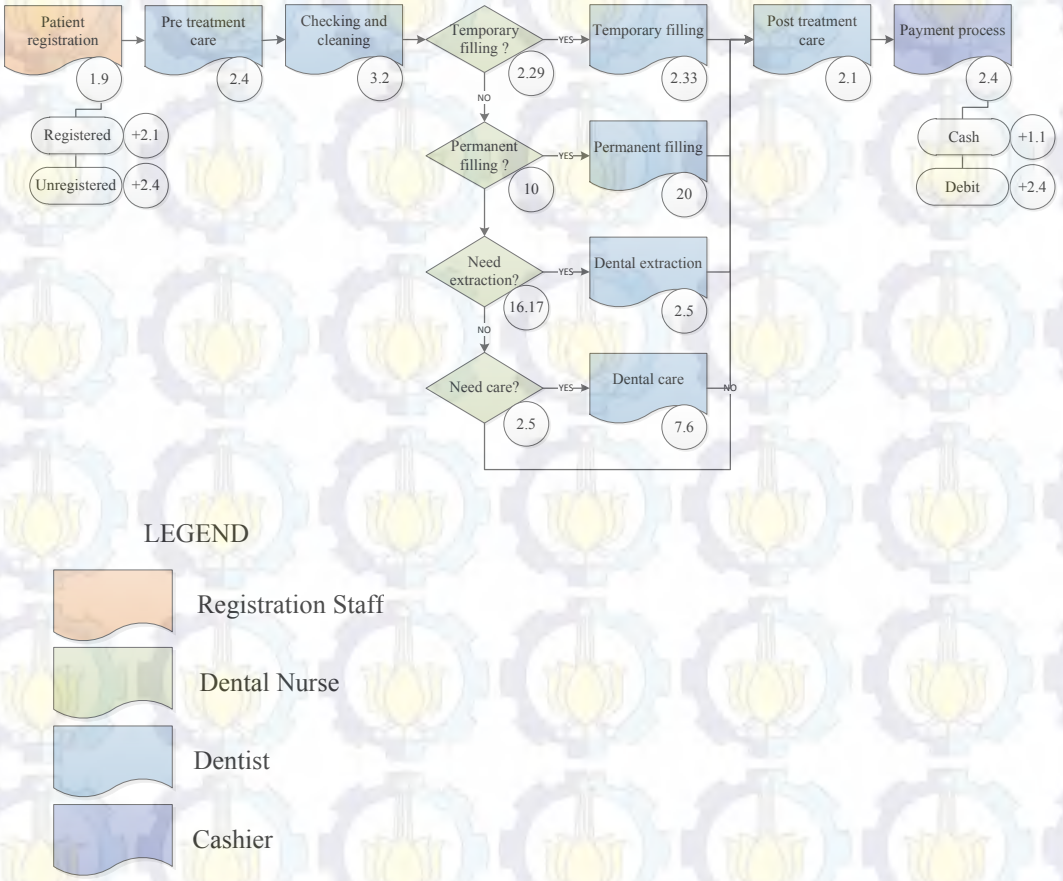


Figure 4.10 Dental Clinic Mapping Process

Here are the details about time equation that represents total time to perform a service product in dental clinic shown in Formula 4.10.

$$Td = 1.9 + (2.1Xd_1 + 2.4Xd_2) + 2.4 + 3.2 + ((2.29 + 2.4)Xd_3) + ((10 + 20)Xd_4) + ((16.17 + 2.5)Xd_5) + ((2.5 + 7.6)Xd_6) + 2.1 + 4.17 + (1.1Xd_7 + 2.4Xd_8)\ (\text{minutes}) \ldots (4.10)$$

Subject to;

$Xd_1 + Xd_2 = 1$

$Xd_7 + Xd_8 = 1$

$Xd_1, Xd_2, Xd_3, Xd_4, Xd_5, Xd_6, Xd_7, Xd_8 = 0$ or 1 (binary)

Where;

Td = time equation of process, total time to perform a service in dental clinic

Xd_1 = registered patient

Xd_2 = unregistered patient

Xd_3 = temporary filling

Xd_4 = permanent filling

Xd_5 = dental extraction

Xd_6 = dental care

Xd_7 = cash payment

Xd_8 = debit payment

Here is the case B as an example of total time to perform a care services in dental clinic. Rahman is new patient that come to the dental clinic for the first time; this implied that Rahman is an unregistered patient. He got consultation and dental care based on the doctor's diagnosis. After the medical treatment, he leaves the examination room and pay the medical bill with cash payment.

Td of case B = 1.9 + (2.1(0) + 2.4(1)) + 2.4 + 3.2 + ((2.29 + 2.4)(0)) + ((10 + 20) (0)) + ((16.17 + 2.5)(0)) + ((2.5 + 7.6)(1)) + 2.1 + 4.17 + (1.1(1) + 2.4 (0)) minutes

Td of case B = 27.37 minutes

Hence, total time to perform case B in dental clinic is 27.37 minutes.

Hemodialysis Clinic

Table 4.32 shows the recap of standard time using STS calculation in hemodialysis clinic. The standard time for patient registration is 2.1 minutes, pre-treatment process is 3.9 minutes, consultation process is 1.5 minutes, post-treatment is 2.7 minutes, and payment process is 2.4 minutes.

Table 4.32 STS calculation in hemodialysis clinic

Process	Activity	Actual Time	Performance Rating	Normal Time	Allowance	Standard Time	Activity Total Time (minutes)
Patient registration	Call for patient number	18	1.11	19.98	0.09	21.7782	2.117325
	Receiving patient document	17	1.11	18.87	0.09	20.5683	
	Create clinical note	70	1.11	77.7	0.09	84.693	
Pre-treatment	Call in the patient	25	1.11	27.75	0.09	30.2475	3.932175
	Check the patient number	20	1.11	22.2	0.09	24.198	
	Check the patient medical histories	150	1.11	166.5	0.09	181.485	
Consultation	Consultation	4	1.11	4.44	0.09	4.8396	1.58066
	Physical check up	0	1.11	0	0.09	0	
Post-treatment	Post consultation	50	1.11	55.5	0.09	60.495	2.78277
	Make another appointment	20	1.11	22.2	0.09	24.198	
	Make a referral	20	1.11	22.2	0.09	24.198	
	Make a drug prescription	25	1.11	27.75	0.09	30.2475	
	Make a payment notes	23	1.11	25.53	0.09	27.8277	
Payment process	Take the payment notes	15	1.11	16.65	0.09	18.1485	2.4198
	Input patient data	30	1.11	33.3	0.09	36.297	
	Give the payment notes	15	1.11	16.65	0.09	18.1485	
	Check the payment notes	20	1.11	22.2	0.09	24.198	
	Accept the money	15	1.11	16.65	0.09	18.1485	
	Give money changes	25	1.11	27.75	0.09	30.2475	

Based on Table 4.33 it is shown that there is defuzzification column. It is represent the crisp output of fuzzy set that translated into standard working time. The standard time for pre-treatment care is 3.9 minutes, hemodialysis process is 255.08 minutes, and post-treatment care is 4.20 minutes.

Table 4.33 Fuzzy set in hemodialysis clinic

Department	Work Operation	Fuzzy Level	Fuzzy Value (minutes)			Defuzzification
			1	2	3	
Hemodialysis clinic	Pre-treatment activities	Slow	5.5	4.5	5.3	3.90
		Average	3	3.5	3.3	
		Fast	2.5	2.1	2.3	
	Hemodialysis process	Slow	330	346	329	255.08
		Average	249	250	276	
		Fast	212	209	208	
	Post treatment activities	Slow	7	7.5	7	4.20
		Average	4.5	5.1	5	
		Fast	1	1	1	

The details about mapping process is shown in Figure 4.11 that contains the standard time to perform basic service in hemodialysis clinic, and also show standard time to perform additional services such as consulatition with the doctor for the patient that has fluctuated physical condition. This session will discuss about the time equation model in hemodialysis clinic. Time equation can accommodates the probability of different service types that lead to different resources usage. Recall that activities related to each processes has already discuss in Sub-Chapter 4.2.

As shown in Figure 4.11 that basic standard time to do patient registration is 2.1 minutes, added with 2.4 minutes if it is registered patient or 3.1 minutes if it is unregistered patient. Standard time for registered and unregistered patient in hemodialysis clinic is longer than other clinic since it has larger data document contains personal data information and medical histories of patient. The standard time in additional services is determined based on the proportion of activities needed in each condition. Basic activities for patient registration include receiving patient arrival, and receive patient documents. There is a difference while serving registered and unregistered patient. Registered patient requires smaller process time as it is only checking patient status and its medical histories, no need to processing new documents such as for unregistered patient. Patient registration time within the clinics is different since the document required is also different.

Other than that, payment process is also has basic primary activities includes receiving patient, input and processing the medical bills. The basic activity needs 2.4 minutes, while there is an additional 1.1 minute needed to perform receiving money and give the changes for cash payment; and there is an additional 2.4 minute needed to perform preparing card machine, input the bill, and processing the bill for debit payment. Payment process standard time is same within the clinics since the job descriptions of cashier is same for all clinics in outpatient unit.

There is also an additional time while performing different type of services. When the patient needs emergency consultation hemodialysis assistants will prepare for doctor's appointment and the doctor can give consultation and check up that has standard time for 15 minutes for each services.

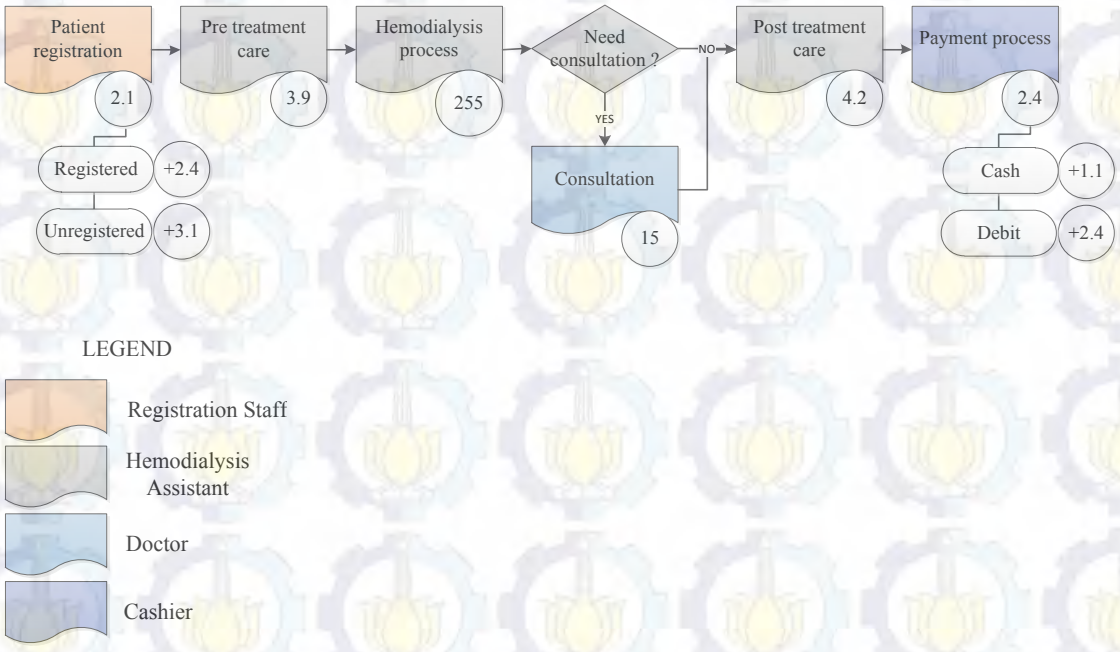


Figure 4.11 Hemodialysis Clinic Mapping Process

Here are the details about time equation that represents total time to perform a service product in hemodialysis clinic shown in Formula 4.11.

$$Th = 2.1 + (2.4\,Xh_1 + 3.1\,Xh_2) + 3.9 + 255 + (15\,Xh_3) + 4.2 + 2.7 + (1.1\,Xh_4 + 2.4\,Xh_5)\ (\text{minutes}) \ldots (4.11)$$

Subject to;

$Xh_1 + Xh_2 = 1$

$Xh_4 + Xh_5 = 1$

$Xh_1, Xh_2, Xh_3, Xh_4, Xh_5 = 0$ or 1 (binary)

Where;

Th = time equation of process, total time to perform a service in hemodialysis clinic

Xh_1 = registered patient

Xh_2 = unregistered patient

Xh_3 = consultation

Xh_4 = cash payment

Xh_5 = debit payment

Here is the case C as an example of total time to perform a care services in hemodialysis clinic. Rahman is new patient that come to the hemodialysis clinic for the first time; this implied that Rahman is an unregistered patient. He got basic hemodialysis care. After the medical treatment, he leaves the examination room and pay the medical bill with cash payment.

$$Th \text{ of case C} = 2.1 + (2.4(0) + 3.1(1)) + 3.9 + 255 + (15(0)) + 4.2 + 2.7 + (1.1(1) + 2.4(0))\ \text{minutes}$$

$$Th \text{ of case C} = 272.1 \text{ minutes or } 4.5 \text{ hours}$$

Hence, total time to perform case C in hemodialyis clinic is 272.1 minutes or 4.5 hours.

Antenatal Clinic

Table 4.34 shows the recap of standard time using STS calculation in antenatal clinic. The standard time for patient registration is 2.1 minutes, pre-treatment process is 2.3 minutes, post-treatment is 4.9 minutes, and payment process is 2.4 minutes.

Table 4.34 STS calculation in antenatal clinic

Process	Activity	Actual Time	Performance Rating	Normal Time	Allowance	Standard Time	Activity Total Time (minutes)
Patient registration	Call for patient number	18	1.11	19.98	0.09	21.7782	2.117325
	Receiving patient document	17	1.11	18.87	0.09	20.5683	
	Create clinical note	70	1.11	77.7	0.09	84.693	
Pre-treatment	Call in the patient	20	1.11	22.2	0.09	24.198	2.33914
	Check the patient number	18	1.11	19.98	0.09	21.7782	
	Check the patient medical histories	78	1.11	86.58	0.09	94.3722	
Post-treatment	Post consultation	125	1.11	138.75	0.09	151.237	4.940425
	Make another appointment	20	1.11	22.2	0.09	24.198	
	Make a referral	30	1.11	33.3	0.09	36.297	
	Make a drug prescription	40	1.11	44.4	0.09	48.396	
	Make a payment notes	30	1.11	33.3	0.09	36.297	
Payment process	Take the payment notes	15	1.11	16.65	0.09	18.1485	2.4198
	Input patient data	30	1.11	33.3	0.09	36.297	
	Give the payment notes	15	1.11	16.65	0.09	18.1485	
	Check the payment notes	20	1.11	22.2	0.09	24.198	
	Accept the money	15	1.11	16.65	0.09	18.1485	
	Give money changes	25	1.11	27.75	0.09	30.2475	

Based on Table 4.35 it is shown that there is defuzzification column. It is represent the crisp output of fuzzy set that translated into standard working time.

The standard time for basic consultation services is 2.9 minutes and immunization 3.19 minutes.

Table 4.35 Fuzzy set in antenatal clinic

Department	Work Operation	Fuzzy Level	Fuzzy Value (minutes)			Defuzzification
			1	2	3	
Antenatal clinic	Basic	Slow	3.5	4	5	2.90
		Average	2	2.5	2.5	
		Fast	1	1	1	
	Immunization	Slow	5	5.5	4.5	3.19
		Average	3	3	3	
		Fast	0.8	0.8	1	

The details about mapping process is shown in Figure 4.12 that contains the standard time to perform basic service in antenatal clinic, and also show standard time to perform additional services such as give an immunization for the babies. This session will discuss about the time equation model in hemodialysis clinic. Time equation can accommodates the probability of different service types that lead to different resources usage. Recall that activities related to each processes has already discuss in Sub-Chapter 4.2.

As shown in Figure 4.12 that basic standard time to do patient registration is 2.1 minutes, added with 1.9 minutes if it is registered patient or 3.1 minutes if it is unregistered patient. The standard time in additional services is determined based on the proportion of activities needed in each condition. Basic activities for patient registration include receiving patient arrival, and receive patient documents. There is a difference while serving registered and unregistered patient. Registered patient requires smaller process time as it is only checking patient status and its medical histories, no need to processing new documents such as for unregistered patient. Patient registration time within the clinics is different since the document required is also different.

Other than that, payment process is also has basic primary activities includes receiving patient, input and processing the medical bills. The basic activity needs 2.4 minutes, while there is an additional 1.1 minute needed to perform receiving money and give the changes for cash payment; and there is an additional 2.4

minute needed to perform preparing card machine, input the bill, and processing the bill for debit payment. Payment process standard time is same within the clinics since the job descriptions of cashier is same for all clinics in outpatient unit.

There is also an additional time while performing different type of services. When the patient needs an immunization, the pediatrician nurse will prepare the immunization and doing immunization process that has standard time 3.2 minutes for each activity.

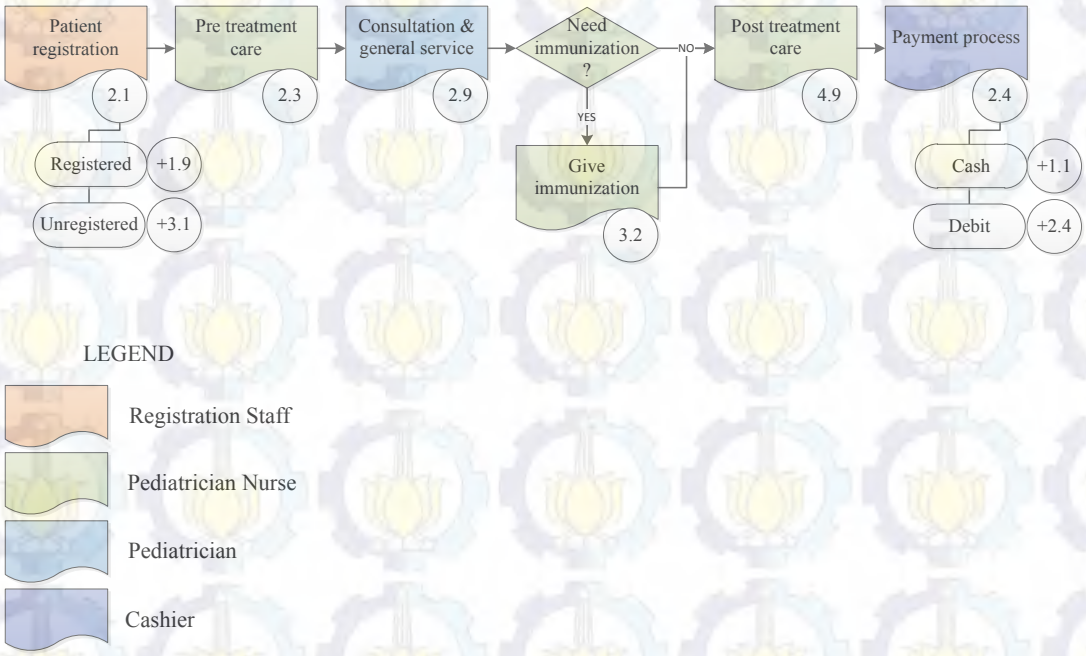


Figure 4.12 Antenatal Clinic Mapping Process

Here are the details about time equation that represents total time to perform a service product in antenatal clinic shown in Formula 4.12.

$$Ta = 2.1 + (1.9Xa_1 + 3.1\ Xa_2) + 2.3 + 2.9 + (3.2\ Xa_3) + 4.9 + 2.4 + (1.1\ Xa_4 + 2.4\ Xa_5)\ (\text{minutes}).....(4.12)$$

Subject to;

$Xa_1 + Xa_2 = 1$

$Xa_4 + Xa_5 = 1$

$Xa_1, Xa_2, Xa_3, Xa_4, Xa_5 = 0$ or 1 (binary)

Where;

Ta = time equation of process, total time to perform a service in antenatal clinic

Xa_1 = registered patient

Xa_2 = unregistered patient

Xa_3 = immunization

Xa_4 = cash payment

Xa_5 = debit payment

Here is the case D as an example of total time to perform a care services in antenatal clinic. Rahman is new patient that come to antenatal clinic for the first time; this implied that Rahman is an unregistered patient. He got consultation and BCG immunization from the doctor's diagnosis. After the medical treatment, he leaves the examination room and pay the medical bill with cash payment.

Ta of case D= 2.1 + (1.9(0) + 3.1(1)) + 2.3 + 2.9 + (3.2(1)) + 4.9 + 2.4 + (1.1(1) + 2.4(0)) minutes

Ta of case D = 22 minutes

Hence, total time to perform case D in antenatal clinic is 22 minutes

4.3.6 Service Cost Estimation in General Clinic

The last step of fuzzy-TDABC method is cost calculation stage. The data input that needed in this process is standard time of each activities followed by

capacity cost rates of related economic resources. The cost estimation is done by assigning capacity cost rate based on their resource time usage per activity.

Service Cost Formulation

The general formula to build a healthcare services cost model in this research is shown in Formula 4.13.

$$SC = \sum T_i \times CCR_i + V_j \times CCR_k + (AT_i \times CCR_k + AV_j \times CCR_k) \times X_i \quad \text{(IDR)} \ldots (4.13)$$

Where;

SC = service cost of a healthcare product (IDR)

T_i = time in process i

V_j = volume of object j (with volume based recource)

AT_i = time in additional process i (if there are any additional time)

AV_j = volume of object j (if there are any object with volume based in additional process)

X_i = binary code for additional process i

CCR_i = capacity cost rate k that include in process i or additional process i or volume object j

The formula above is made by using total multiplication of CCR per resources with its standard working time. The equation is also accommodate various service types in healthcare services.

General Clinic

Table 4.36 shows the recap of capacity cost rate of economic resources that used in general clinic.

Table 4.36 Recap of CCR in general clinic

CCR code	Economic Resources	CCR
CCRg1	Computer, office equipment, and cash register	IDR 1,578.28
CCRg2	Registration staff	IDR 858.29
CCRg3	Doctor	IDR 827.92
CCRg4	Nurse	IDR 803.57
CCRg5	Cashier	IDR 858.29
CCRg6	Medical equipments and tools	IDR 236.74
CCRg7	Consumable drugs	IDR 1,500.00

Recall the Figure 4.9 shows the mapping process contains its standard time. The service cost formula to calculate healthcare service cost in general clinic is shown in Formula 4.14.

$$SCg = 1.9(CCRg_1 + CCRg_2) + 1.9(CCRg_1 + CCRg_2)Xg_1 + 2.3\ (CCRg_1 + CCRg_2)Xg_2 + 2.4(CCRg_4 + CCRg_6) + 5.12CCRg_3 + (2.4(CCRg_3 + CCRg_4) + 1(CCRg_7)Xg_3 + 2.79(CCRg_6+CCRg_3) + 2.4(CCRg_1 + CCRg_5) + 1.1(CCRg_1 + CCRg_2)Xg_4 + 2.4(CCRg_1 + CCRg_2)Xg_5\ (IDR)\ldots.(4.14)$$

Subject to;

$Xg_1 + Xg_2 = 1$

$Xg_4 + Xg_5 = 1$

$Xg_1, Xg_2, Xg_3, Xg_4, Xg_5 = 0$ or 1 (binary value)

Where;

SCg = service cost of a healthcare product in general clinic

$CCRg_1$ = capacity cost rate of administration instruments

$CCRg_2$ = capacity cost rate of registration staff

$CCRg_3$ = capacity cost rate of doctor

$CCRg_4$ = capacity cost rate of nurse

$CCRg_5$ = capacity cost rate of cashier

$CCRg_6$ = capacity cost rate of medical equipment and tools

$CCRg_7$ = capacity cost rate of consumable drugs

Xg_1 = gregistered patient

Xg_2 = unregistered patient

Xg_3 = anesthesia care

Xg_4 = cash payment

Xg_5 = debit payment

Based on Table 4.37 it is shown that total basic services cost is IDR 20,183. The basic cost of patient registration is not accommodating the activity related to patient document processing time since it has different value between registered and unregistered patient. The basic cost of payment process is not accommodating the activity related to customer's bill processing time since it has different value between cash payment and debit payment. To accommodate this condition, there is an additional cost for differences of service types.

Table 4.37 Calculation of Basic Healthcare Cost in General Clinic

Activity	Economic Resources	Standard Time	CCR	Basic Cost
Patient registration	Administration instruments	1.90	IDR 1,578	IDR 2,999
	Registration staff	1.90	IDR 858	IDR 1,631
Pre treatment care	Nurse	2.40	IDR 804	IDR 1,929
	Medical equipments and tools	2.40	IDR 237	IDR 568
Consultation	Doctor	5.12	IDR 828	IDR 4,239
Post Treatment care	Medical equipments and tools	2.79	IDR 237	IDR 661
	Doctor	2.79	IDR 828	IDR 2,310
Payment process	Administration instruments	2.40	IDR 1,578	IDR 3,788

Activity	Economic Resources	Standard Time	CCR	Basic Cost
	Cashier	2.40	IDR 858	IDR 2,060
			Total Basic Services	IDR 20,183

Table 4.38 shows the recap of cost estimation of different services types in patient registration, medical treatment (anesthesia), and payment process.

Table 4.38 Additional cost calculation in general clinic

Activity	Description	Economic Resources	Standard Time	CCR	Service cost	Total Additional Cost
Patient registration	registered	Administration instruments	1.9	IDR 1,578.28	IDR 2,998.74	IDR 4,629.49
		Registration staff	1.9	IDR 858.29	IDR 1,630.75	
	unregistered	Administration instruments	2.30	IDR 1,578.28	IDR 3,630.05	IDR 5,604.11
		Registration staff	2.30	IDR 858.29	IDR 1,974.06	
Payment process	Cash	Administration instruments	1.1	IDR 1,578.28	IDR 1,736.11	IDR 2,680.23
		Registration staff	1.1	IDR 858.29	IDR 944.12	
	debit	Administration instruments	2.4	IDR 1,578.28	IDR 3,787.88	IDR 5,847.77
		Registration staff	2.4	IDR 858.29	IDR 2,059.89	
Consultation	anesthesia	Nurse	2.4	IDR 827.92	IDR 1,987.01	IDR 3,974.03
		Doctor	2.4	IDR 828	IDR 1,987.01	
		Consumable drugs	1	IDR 1,500	IDR 1,500.00	

Based on Table 4.38, there are several additional services that include cost of registration for registered patient, cost of registration for unregistered patient, cost for cash payment, cost for debit payment, and anesthesia cost.

Here is the case A as an example of total time to perform a care services in general clinic. Rahman has already come to the general clinic twice; this implied that Rahman is a registered patient. He got consultation and anesthesia care based on the doctor's diagnosis. After the medical treatment, he leaves the examination

room and pays the medical bill with debit payment. To calculate service cost of case A, the equation that used is shown;

SCg of case A= 1.9 (1,578 + 858) + 2.3 (1,578 + 858) + 2.4 (804 + 237) + 5.12 (828) + (2.4(827.92 + 828) + 1 (1500) + 2.79 (237+ 828) + 2.4 (1,578 + 858) + + 2.4 (1,578 + 858) (IDR)

SCg of case A = IDR 34,635

The columnal view of cost calculation of case A is shown in Table 4.39

Table 4.39 Cost Calculation of Case A in General Clinic

Healthcare Services Status	Cost
Basic Services	IDR 20,183
Registered patient	IDR 4,629.49
Debit payment	IDR 5,847.77
Anesthesia care	IDR 3,974.03
Total Cost	IDR 34,635

Hence, total cost to perform case A in general clinic is IDR 34,635.

Dental Clinic

Table 4.40 shows the recap of capacity cost rate of economic resources that used in dental clinic.

Table 4.40 Recap of CCR in dental clinic

CCR code	Economic Resources	CCR
CCR_{d1}	Computer, office equipment, and cash register	IDR 1,578.28
CCR_{d2}	Registration staff	IDR 858.29
CCR_{d3}	Dentist	IDR 1,915.58
CCR_{d4}	Nurse	IDR 1,163.10
CCR_{d5}	Cashier	IDR 858.29
CCR_{d6}	Medical equipments and tools	IDR 631.31
CCR_{d7}	Temporary filling drugs	IDR 20,833.33

CCR_{d8}	Permanent filling drugs	IDR 62,500.00
CCR_{d9}	Dental extraction drugs	IDR 17,500.00
CCR_{d10}	Dental care drugs	IDR 38,750.00

Recall the Figure 4.10 shows the mapping process contains its standard time. The service cost formula to calculate healthcare service cost in dental clinic is shown as below.

$$SCd = 1.9(CCRd_1 + CCRd_2) + 2.1(CCRd_1 + CCRd_2)Xd_1 + 2.4(CCRd_1 + CCRd_2)Xd_2 + 2.4(CCRd_3 + CCRd_4 + CCRd_6) + 3.2(CCRd_3 + CCRd_4 + CCRd_6) + (2.29CCRd_4 + 2.33(CCRd_3 + CCRd_6) + 1CCRd_7)Xd_3 + (10CCRd_4 + 20(CCRd_3 + CCRd_6) + 1CCRd_8)Xd_4 + (16.17CCRd_4 + 2.5(CCRd_3 + CCRd_6) + 1CCRd_9)Xd_5 + (2.5CCRd_4 + 7.6(CCRd_3 + CCRd_6) + 1CCRd_{10})Xd_6 + 2.1(CCRd_6 + CCRd_3) + 4.17(CCRd_1 + CCRd_5) + 1.1(CCRd_1 + CCRd_2)Xd_7 + 2.4(CCRd_1 + CCRd_2)Xd_8 \text{ (IDR)} \ldots..(4.15)$$

Subject to;

$Xd_1 + Xd_2 = 1$

$Xd_7 + Xd_8 = 1$

$Xd_1, Xd_2, Xd_3, Xd_4, Xd_5, Xd_6, Xd_7, Xd_8 = 0$ or 1 (binary)

Where;

SCd = service cost of a healthcare product in dental clinic (IDR)

$CCRd_1$ = capacity cost rate of administration instruments

$CCRd_2$ = capacity cost rate of registration staff

$CCRd_3$ = capacity cost rate of dentist

$CCRd_4$ = capacity cost rate of nurse

$CCRd_5$ = capacity cost rate of cashier

$CCRd_6$ = capacity cost rate of medical equipment and tools

$CCRd_7$ = capacity cost rate of temporary filling drugs

$CCRd_8$ = capacity cost rate of permanent filling drugs

$CCRd_9$ = capacity cost rate of dental extraction drugs

$CCRd_{10}$ = capacity cost rate of dental care drugs

Xd_1 = registered patient

Xd_2 = unregistered patient

Xd_3 = temporary filling

Xd_4 = permanent filling

Xd_5 = dental extraction

Xd_6 = dental care

Xd_7 = cash payment

Xd_8 = debit payment

Based on Table 4.41 it is shown that total basic services cost is IDR 40,449. The basic cost of patient registration is not accommodating the activity related to patient document processing time since it has different value between registered and unregistered patient. The basic cost of payment process is not accommodating the activity related to customer's bill processing time since it has different value between cash payment and debit payment. To accommodate this condition, there is an additional cost for differences of service types.

Table 4.41 Calculation of Basic Healthcare Cost in Dental Clinic

Activity	Economic Resources	Standard Time	CCR	Basic
Patient registration	Administration instruments	1.90	IDR 1,578	IDR 2,999
	Registration staff	1.90	IDR 858	IDR 1,631
Pre treatment care	Dentist	2.40	IDR 1,916	IDR 4,597

Activity	Economic Resources	Standard Time	CCR	Basic
	Nurse	2.40	IDR 1,163	IDR 2,791
	Medical equipments and tools	2.40	IDR 631	IDR 1,515
Checking & cleaning	Nurses	2.80	IDR 1,163	IDR 3,257
	Dentist	3.20	IDR 1,916	IDR 6,130
	Medical equipments and tools	3.20	IDR 631	IDR 2,020
Post Treatment care	Medical equipments and tools	2.10	IDR 631	IDR 1,326
	Dentist	2.10	IDR 1,916	IDR 4,023
Payment process	Administration instruments	4.17	IDR 1,578	IDR 6,581
	Cashier	4.17	IDR 858	IDR 3,579
			Total Basic Services	IDR 40,449

Table 4.42 shows the recap of cost estimation of different services types in patient registration, medical treatment (dental filling, dental extraction, and dental care), and payment process.

Table 4.42 Additional cost calculation in dental clinic

Activity	Description	Economic Resources	Standard Time	CCR	Service cost	Addititonal cost
Patient registration	Registered	Administration instruments	2.1	IDR 1,578.28	IDR 3,314.39	IDR 5,116.80
		Registration staff	2.1	IDR 858.29	IDR 1,802.41	
	Unregistered	Administration instruments	2.40	IDR 1,578.28	IDR 3,787.88	IDR 5,847.77
		Registration staff	2.40	IDR 858.29	IDR 2,059.89	
Payment process	Cash	Administration instruments	1.1	IDR 1,578.28	IDR 1,736.11	IDR 2,680.23
		Registration staff	1.1	IDR 858.29	IDR 944.12	
	Debit	Administration instruments	2.4	IDR 1,578.28	IDR 3,787.88	IDR 5,847.77
		Registration staff	2.4	IDR 858.29	IDR 2,059.89	
Checking & Cleaning	Temporary filling	Nurses	2.29	IDR 1,163	IDR 2,663.50	IDR 29,437.49
		Dentist	2.33	IDR 1,916	IDR 4,469.70	
		Medical equipments and tools	2.33	IDR 631	IDR 1,470.96	
		Dental temporary filling drugs	1.00	IDR 20,833	IDR 20,833.33	
	Permanent fliing	Nurses	10.00	IDR 1,163	IDR 11,631.02	IDR 125,068.97

Activity	Description	Economic Resources	Standard Time	CCR	Service cost	Addititonal cost
		Dentist	20.00	IDR 1,916	IDR 38,311.69	
		Medical equipments and tools	20.00	IDR 631	IDR 12,626.26	
		Dental permanent filling drugs	1.00	IDR 62,500	IDR 62,500.00	
	Dental extraction	Nurses	16.17	IDR 1,163	IDR 18,803.48	IDR 42,670.72
		Dentist	2.50	IDR 1,916	IDR 4,788.96	
		Dental extraction drugs	1.00	IDR 17,500	IDR 17,500.00	
		Medical equipments and tools	2.50	IDR 631	IDR 1,578.28	
	Dental care	Nurses	2.50	IDR 1,163	IDR 2,907.75	IDR 61,014.18
		Dentist	7.60	IDR 1,916	IDR 14,558.44	
		Dental care drugs	1.00	IDR 38,750	IDR 38,750.00	
		Medical equipments	7.60	IDR 631	IDR 4,797.98	

Based on Table 4.43, there are several additional services that include cost of registration for registered patient, cost of registration for unregistered patient, cost for cash payment, cost for debit payment, and medical treatment cost.

Here is the case B as an example of total time to perform a care services in dental clinic. Rahman is new patient that come to the dental clinic for the first time; this implied that Rahman is an unregistered patient. He got consultation and dental care based on the doctor's diagnosis. After the medical treatment, he leaves the examination room and pay the medical bill with cash payment.

$$SCd = 1.9(CCRd_1 + CCRd_2) + 2.1(CCRd_1 + CCRd_2)Xd_1 + 2.4(CCRd_1 + CCRd_2)Xd_2 + 2.4\ (CCRd_3 + CCRd_4 + CCRd_6) + 3.2(CCRd_3 + CCRd_4 + CCRd_6) + (2.29CCRd_4 + 2.33(CCRd_3 + CCRd_6) + 1CCRd_7)Xd_3 + (10CCRd_4 + 20(CCRd_3 + CCRd_6) + 1CCRd_8)Xd_4 + (16.17\ CCRd_4 + 2.5(CCRd_3 + CCRd_6) + 1\ CCRd_9)\ Xd_5 + (2.5CCRd_4 + 7.6(CCRd_3 + CCRd_6) + 1CCRd_{10})\ Xd_6 + 2.1(CCRd_6 + CCRd_3) + 4.17\ (CCRd_1 + CCRd_5) + 1.1(CCRd_1 + CCRd_2)\ Xd_7 + 2.4(CCRd_1 + CCRd_2)Xd_8$$ (IDR)

SCd for Case B = 1.9 (1,578 + 858) + 2.1(1,578 + 858) + 2.4(1,916 + 1,163 + 631) + 3.2(1,163 + 1,916 + 631) + (2.5(1,163) + 7.6(1,916 + 631) + 1(38,750) + 2.1(631 + 1,916 + 4.17(1,578 + 858) + 1.1(1,578 + 858) (IDR)

SCd for Case B = IDR 78,415

The columnal view of detail about service cost of case B in dental clinic is shown in Table 4.43.

Table 4.43 Service Cost of Case B in Dental Clinic

Healthcare Services Status	Cost
Basic Services	IDR 40,449
Unregistered	IDR 5,847.77
Cash payment	IDR 2,680.23
Dental care	IDR 61,014.18
Temporary filling total cost	IDR 78,415

Hence, it is shown in Table 4.43 total cost for temporary filling care is IDR 78,415.

Hemodialysis Clinic

Recap of capacity cost rate of each resources in hemodialysis clinic is shown in Table 4.45.

Table 4.44 Recap of CCR in hemodialysis clinic

CCR code	Economic Resources	CCR
CCRh1	Computer, office equipment, and cash register	IDR 1,578.28
CCRh2	Registration staff	IDR 858.29
CCRh3	Doctor	IDR 827.92
CCRh4	Hemodialysis assistant	IDR 1,539.82
CCRh5	Cashier	IDR 858.29
CCRh6	Medical equipments and tools	IDR 2,564.71
CCRh7	Hemodialysis drugs	IDR 32,500.00

Recall that Figure 4.11 show mapping process contains with its standard time. The service cost formula to calculate healthcare service cost in hemodialysis clinic is shown in Formula 4.16.

$$SCh = 2.1(CCRh_1 + CCRh_2) + 2.4(CCRh_1 + CCRh_2)Xh_1 + 3.1(CCRh_1 + CCRh_2)Xh_2 + 3.9(CCRh_4 + CCRh_6) + 255(CCRh_4) + 1(CCRh_7) + 15(CCRh_3)Xh_3 + 4.2(CCRh_4 + CCRh_6) + 2.7(CCRh_1 + CCRh_5) + 1.1(CCRh_1 + CCRh)Xh_4 + 2.4(CCRh_1 + CCRh_2)Xh_5 \text{ (IDR)}\ldots.(4.16)$$

Subject to;

$Xh_1 + Xh_2 = 1$

$Xh_4 + Xh_5 = 1$

$Xh_1, Xh_2, Xh_3, Xh_4, Xh_5 = 0$ or 1 (binary)

Where;

SCh = service cost of a healthcare product in hemodialysis clinic (IDR)

$CCRh_1$ = capacity cost rate of administration instruments

$CCRh_2$ = capacity cost rate of registration staff

$CCRh_3$ = capacity cost rate of doctor

$CCRh_4$ = capacity cost rate of nurse

$CCRh_5$ = capacity cost rate of cashier

$CCRh_6$ = capacity cost rate of medical equipment and tools

$CCRh_7$ = capacity cost rate of hemodialysis drugs

Xh_1 = registered patient

Xh_2 = unregistered patient

Xh_3 = consultation

Xh_4 = cash payment

Xh_5 = debit payment

Based on Table 4.45 it is shown that total basic services cost is IDR 731,443. The basic cost of patient registration is not accommodating the activity related to patient document processing time since it has different value between registered and unregistered patient. The basic cost of payment process is not accommodating the activity related to customer's bill processing time since it has different value between cash payment and debit payment. To accommodate this condition, there is an additional cost for differences of service types.

Table 4.45 Calculation of Basic Healthcare Cost in Hemodialysis Clinic

Activity	Economic Resources	Standard Time	CCR	Basic
Patient registration	Administration instruments	2.10	IDR 1,578	IDR 3,314
	Registration staff	2.10	IDR 858	IDR 1,802
Pre treatment care	Hemodialysis assistant	3.90	IDR 1,540	IDR 6,005
	Medical equipments and tools	3.90	IDR 2,565	IDR 10,002
Hemodialysis process	Medical equipments and tools	255.00	IDR 2,565	IDR 654,000.95
	Hemodialysis assistant	10.00	IDR 1,540	
	Hemodialysis drugs	1.00	IDR 32,500.00	IDR 32,500.00
Post Treatment care	Medical equipments and tools	4.20	IDR 2,565	IDR 10,772
	Hemodialysis assistant	4.20	IDR 1,540	IDR 6,467
Payment process	Administration instruments	2.70	IDR 1,578	IDR 4,261
	Cashier	2.70	IDR 858	IDR 2,317
			Total Basic Cost	IDR 731,443

Based on Table 4.46, the additional cost calculation in hemodialysis clinic consists of registered patient registration cost, unregistered patient registration cost, cash payment cost, debit payment cost, and hemodialysis consultation cost.

Table 4.46 Additional cost calculation in hemodialysis clinic

Activity	Description	Economic Resources	Standard Time	CCR	Service Cost	Additional Cost
Patient registration	registered	Administration instruments	2.4	IDR 1,578.28	IDR 3,787.88	IDR 5,847.77
		Registration staff	2.4	IDR 858.29	IDR 2,059.89	
	unregistered	Administration instruments	3.10	IDR 1,578.28	IDR 4,892.68	IDR 7,553.37
		Registration staff	3.10	IDR 858.29	IDR 2,660.70	
Payment process	cash	Administration instruments	1.1	IDR 1,578.28	IDR 1,736.11	IDR 2,680.23
		Registration staff	1.1	IDR 858.29	IDR 944.12	
	debit	Administration instruments	2.4	IDR 1,578.28	IDR 3,787.88	IDR 5,847.77
		Registration staff	2.4	IDR 858.29	IDR 2,059.89	
Hemodialysis process	Consultation	Doctor	15	IDR 827.92	IDR 12,418.83	IDR 12,418.83

Based on Table 4.46, there are several additional services that include cost of registration for registered patient, cost of registration for unregistered patient, cost for cash payment, cost for debit payment, and hemodialysis consultation cost.

Here is the case C as an example of total time to perform a care services in hemodialysis clinic. Rahman is new patient that come to the hemodialysis clinic for the first time; this implied that Rahman is an unregistered patient. He got basic hemodialysis care. After the medical treatment, he leaves the examination room and pay the medical bill with cash payment.

SCh for case C = 2.1(1,578 + 858) + 3.1(1,578 + 858) + 3.9(1,540 + 2,565) + 255(2,565) + 1(32,500) + 4.2 (2,565 + 1,540) + 2.7(1,578 + 858) + 1.1(1,578 + 858) (IDR)

SCh for case C = IDR 741,677

The columnal views about service cost for Case C in Hemodialysis Clinic is shown in Table 4.47.

Table 4.47 Service Cost for Case C in Hemodialysis Clinic

Healthcare Services Status	Cost
Basic Services	IDR 731,443
Unregistered patient	IDR 7,553.37
Cash payment	IDR 2,680.23
Hemodialysis total cost	IDR 741,677

Based on Table 4.47, total cost for hemodialysis care case C is IDR 741,677.

Antenatal Clinic

Recap of capacity cost rate (CCR) of each economic resources are shown in Table 4.48.

Table 4.48 Recap of CCR in antenatal clinic

CCR code	Economic Resources	CCR
CCRa1	Computer, office equipment, and cash register	IDR 1,578.28
CCRa2	Registration staff	IDR 858.29
CCRa3	Doctor	IDR 441.02
CCRa4	Nurse	IDR 593.01
CCRa5	Cashier	IDR 858.29
CCRa6	Medical equipments and tools	IDR 631.31
CCRa7	Consumable drugs	IDR 3,250.00

Recall that Figure 4.12 shows the mapping process contains the working standard time. The service cost formula to calculate healthcare service cost in antenatal clinic is shown in Formula 4.17.

$$SCa = 2.1(CCRa_1 + CCRa_2) + 1.9\ (CCRa_1 + CCRa_2)Xa_1 + 3.1(CCRa_1 + CCRa_2)Xa_2 + 2.3(CCRa_4 + CCRa_6) + 2.9(CCRa_3) + 1(CCRa_7) + (3.2CCRa_4 + 1(CCRa_7))Xa_3 + 4.9(CCRa_6 + CCRa_3) + 2.4(CCRa_1 + CCRa_5) + 1.1\ (CCRa_1 + CCRa_2)Xa_4 + 2.4(CCRa_1 + CCRa_2)\ Xa_5\ (IDR)\ldots..(4.17)$$

Subject to;

$Xa_1 + Xa_2 = 1$

$Xa_4 + Xa_5 = 1$

$Xa_1, Xa_2, Xa_3, Xa_4, Xa_5 = 0$ or 1 (binary)

Where;

SCa = service cost of a healthcare product in antenatal clinic (IDR)

$CCRa_1$ = capacity cost rate of administration instruments

$CCRa_2$ = capacity cost rate of registration staff

$CCRa_3$ = capacity cost rate of doctor

$CCRa_4$ = capacity cost rate of nurse

$CCRa_5$ = capacity cost rate of cashier

$CCRa_6$ = capacity cost rate of medical equipment and tools

$CCRa_7$ = capacity cost rate of consumable drugs

Xa_1 = registered patient

Xa_2 = unregistered patient

Xa_3 = immunization

Xa_4 = cash payment

Xa_5 = debit payment

Based on Table 4.49 it is shown that total basic services cost is IDR 723,564. The basic cost of patient registration is not accommodating the activity related to patient document processing time since it has different value between registered and unregistered patient. The basic cost of payment process is not accommodating the activity related to customer's bill processing time since it has different value

between cash payment and debit payment. To accommodate this condition, there is an additional cost for differences of service types.

Table 4.49 Calculation of Basic Healthcare Cost in Antenatal Clinic

Activity	Economic Resources	Standard Time	CCR	Basic
Patient registration	Administration instruments	2.10	IDR 1,578	IDR 3,314
	Registration staff	2.10	IDR 858	IDR 1,802
Pre treatment care	Nurse	2.30	IDR 593	IDR 1,364
	Medical equipments and tools	2.30	IDR 631	IDR 1,452
Consultation and general service	Doctor	2.90	IDR 441	IDR 1,279
	Consumable drugs	1.00	IDR 3,250	IDR 3,250
Post Treatment care	Medical equipments and tools	4.90	IDR 631	IDR 3,093
	Doctor	4.90	IDR 441	IDR 2,161
Payment process	Administration instruments	2.40	IDR 1,578	IDR 3,788
	Cashier	2.40	IDR 858	IDR 2,060
			Total Basic Cost	IDR 23,564

Based onTable 4.50, the additional cost calculation in hemodialysis clinic consists of registered patient registration cost, unregistered patient registration cost, cash payment cost, debit payment cost, and hemodialysis consultation cost.

Table 4.50 Additional cost calculation in antenatal clinic

Activity	Description	Economic Resources	Standard Time	CCR	Service cost	Additional cost
Patient registration	Registered	Administration instruments	1.9	IDR 1,578.28	IDR 2,998.74	IDR 4,629.49
		Registration staff	1.9	IDR 858.29	IDR 1,630.75	
	Unregistered	Administration instruments	3.10	IDR 1,578.28	IDR 4,892.68	IDR 7,553.37
		Registration staff	3.10	IDR 858.29	IDR 2,660.70	
Payment process	Cash	Administration instruments	1.1	IDR 1,578.28	IDR 1,736.11	IDR 2,680.23
		Registration staff	1.1	IDR 858.29	IDR 944.12	
	Debit	Administration instruments	2.4	IDR 1,578.28	IDR 3,787.88	IDR 5,847.77
		Registration staff	2.4	IDR 858.29	IDR 2,059.89	
Consultation	immunization	Nurse	3.2	IDR	IDR	IDR

Activity	Description	Economic Resources	Standard Time	CCR	Service cost	Additional cost
				3,691.02	11,811.26	15,061.26
		Consumable drugs	1	IDR 3,250	IDR 3,250.00	

Based onTable 4.50, the additional cost calculation in antenatal clinic consists of registered patient registration cost, unregistered patient registration cost, cash payment cost, debit payment cost, and immunization cost.

Here is the case D as an example of total time to perform a care services in antenatal clinic. Rahman is new patient that come to antenatal clinic for the first time; this implied that Rahman is an unregistered patient. He got consultation and BCG immunization from the doctor's diagnosis. After the medical treatment, he leaves the examination room and pays the medical bill with cash payment.

$$SCa \text{ of case D} = 2.1\,(1{,}578 + 858) + 3.1\,(1{,}578_1 + 858) + 2.3\,(593 + 631) + 2.9\,(441) + 1\,(3{,}250) + (3.2(3{,}691) + 1\,3{,}250) + 4.9\,(631 + 441) + 2.4\,(1{,}578 + 858) + 1.1\,(1{,}578 + 858)$$

$$SCa \text{ of case D} = \text{IDR } 48{,}859$$

The columnal view of details information about total service cost in antenatal clinic is shown in the Table 4.51

Table 4.51 Service Cost of Case D in Antenatal Clinic

Healthcare Services Status	Cost
Basic Services	IDR 23,564
Unregistered patient	IDR 7,553.37
Cash payment	IDR 2,680.23
BCG immunization	IDR 15,061.26
BCG immunization total cost	IDR 48,859

Based on Table 4.53, total cost for basic services plus BCG immunization for case D in antenatal clinic is IDR 739,971.

CHAPTER V
DATA ANALYSIS

This chapter consists of analysis and discussion about the implementation of fuzzy-TDABC to estimate healthcare service cost. It is includes the analysis of existing healthcare cost system, analysis of fuzzy-TDABC implementation, and profitability analysis.

5.1 Analysis of Existing Healthcare Service Cost

In order to estimate healthcare service costs, hospital management adopted fee-for-services method. Fee-for-services accommodate three cost pools includes administration expenses, medical personel salary, and medical consumption. In the existing system, hospital management has set healthcare tariff based on the types of service. Generally, healthcare tariffs in outpatient unit include 15% gross profit from healthcare service costs.

Here is an example of a patient that receives healthcare services in Al Irsyad Hospital. Rahman came to hospital to get healthcare services in general clinic. As Rahman arrives, he registered in the administration desk to pay the administration process. The administration process is where he got a queue number and healthcare card that contains of medical bills recap based on the treatment that he will get. As the nurse is calling out the queue number, he entered the examination room and get primary activities which consists of consultation process and physical check up. Other than that, he also has anesthesia process based on the suggestion from the doctor. After those medical treatments are done, he doing post consultation with the doctor that includes receiving doctor's prescription and get the medical bills. Subsequently, he leaves the examination room to the cashier. In the existing tariff system, Rahman need to pay the medical bills twice, which consists of; (1) administration fees in registration desk and (2) medical treatment fees in cashier.

Registration tariff in existing system is IDR 15,000 which is used as administration fee for each patient. Likely other service industries, healthcare service has high variation of process types. In administration process, there are several drivers that resulted different costs with different service types. For example, resources consumption while serving an unregistered patient is different with serving a registered patient. The other example is time consumption for serving cash payment is different with a debit payment. Hence, usages of economic resources between those activities are also different. In conclusion, the assumptions about the value of economic resources usage is same between one activity and another can not hold true.

Another highlight aspects about cost components in existing cost estimation is there is no specifics information about proportion of healthcare personnel utilization while they are performing a care activities. This assumptions are also insuitable since it should use a consideration about the proportion of clinical and non-clinical hours allocation to estimate healthcare service costs.

In existing cost system, the medical supplies that includes in cost components are medical drugs and consumable drugs. There is not any considerations about the cost expenses for medical equipment and tools. There is some missings cost allocation in the cost estimation since it is also supports the activities to provide a healthcare product.

In conclusion, there are several drawbacks by implementing existing cost estimation; (1) the cost allocation of economic resources can not be detected, (2) the utilization and the availability of economic resources can not be detected.

5.2 Analysis of Fuzzy-TDABC implementation

The implementation of fuzzy-TDABC in healthcare services industries is a challenge for the hospital management to give a better accuracy of about cost allocation by assigning economic resources in related activities.

As healthcare services has high various service types and has complex organizations, it creates a big job to do the right service cost estimation. But, in

order to achieve the hospital vision, the right cost estimation creates a high urgency to be implemented. Many approaches and methods are available to estimate healthcare service costs; ABC, TDABC and other. The most recent and updated method to do cost estimation using basis of process time and resources cost rate is by using TDABC. The unique characters of TDABC lies in time equation model, which accommodates various service type based on capacity cost rate of economic resources.

5.3 Analysis of Economic Resources; The Cost Allocation and Its Practical Capacity

The process of economic resources identification is started by deploying a general process maps of outpatient unit in Al Irsyad Hospital. The breakdown of working activities is done by doing a direct observation and pre-work sampling of medical personnel. The economic resources that identified in outpatient unit is categorized to administrative equipments, medical personnel, and medical supports.

Administrative equipment is used for supporting administrative process, which is includes registration process and payment process. The cost allocation of administrative equipment includes the usage of electronics facilites (computer and cash register), other operational activities, and usage of office equipments. The practical capacity of this administrative equipment is considered as full two shifts hours which are 14 hours daily. The considerations is based on the assumptions that office equipment and its operational activities is started from the beginning of working hours until the end of the day, or maybe even more. The calculated practical capacity for administrative equipment is 221,760 minutes/year.

Medical personnel salary is categorized based on the job descriptions such as general doctor, nurse, administration staff (registration staff and cashier), dentist, dental nurse, pediatrician, pediatrician nurse, and hemodialysis assistant. The total expenses of medical personnel is includes the additional costs related to safety insurance, malpractice insurance (only for doctor and dentist), personnel

consumptions, and other personal expenses. The practical capacity of medical personnel in a year is assumed based on clinical time of all medical personnel. The considerations is based on the assumptions that there are 15% non-clinical time for morning activities, research, discussion, meeting, training, or personnal allowance during their work hours. The calculated practical capacity for medical personnel is 118,496 minutes/year.

In this research, the medical instruments is differentiate into two entities, which are medical equipments and medical consumable drugs. Medical equipment cost allocations is assigned for maintenance activities, repairment activities, buying for new set of tools, and other related expenses. The practical capacity calculation of medical equipment is based on its availability during a year includes the time for non-clinical activities that doesn't need medical treatments, maintenance, and repairment. The considerations is based on the assumptions that there are 25% non-clinical time of medical equipment during active work hours. The calculated practical capacity for medical equipment is 126,720 minutes/year.

Medical consumable drugs as one entity on medical instruments has different characteristic with medical consumable drugs. Cost allocation for medical consumable drugs is based on the purchasing that counted in sets. To calculate cost allocation for consumable drugs is not easy, while there are limited data information in the real business. To simplify the cost allocation in high uncertain condition of economic resources, the cost estimator can do demand forecasting to make sure what is the minimum number of drug set required during a year. The hospital also need some minimum stocks, so the purchasing of medical drugs is calculated larger than its minimum value. Practical capacity of medical consumable drugs is using the same logic with cost allocation. Practical capacity of a consumable drugs is using the logic of safety stock level during a year. To determine specific practical capacity for different service types within one clinic, cost estimator can perform pre-work sampling and direct observations to identify which services that has more frequent, since then the proportions number of consumable drugs in a year can be identified. Hence, the capacity cost rate of

medical consumable drugs is calculated based on the total costs of purchasing divided by number of consumable drug sets.

5.4 Analysis of Fuzzy Set Method

In this research, the use of fuzzy method was conducted to support the usage of stopwatch time study (STS) while determine working standard time. To accommodate a homogenous activity, STS is developed since it has cyclical working elements. But, there are some constraints that limit the usage of STS; (1) it requires a long time to do the project to meet the adequacy and uniformity test; as healthcare product has different service types, (2) STS can not accommodate the variations in heterogenous activity, which requires many working elemental breakdown.

Based on those limitations, this research was also conducting a fuzzy set. The main considerations of developing a fuzzy set are based on several points. The first point is there should be high uncertainty environment where data collected is biased, as it can influence the accurateness of the results of study. The second ponit is there should be adequate sources of information to replace the unbiased factors while collecting data, which can represents that the data is valid. The last point is there should be a validation parameter while conducting data collection process. In case that the data collection process is by doing direct interview and based on an expert judgements. There should be a parameter of choosing the expert such as the job position within the departments, the working duration, expert skills and knowledge, and other considerations.

What if there is a difference of dental time processing as each of care services has different severity, what if there is a difference of dental time processing as dentist working skills to perform dental care is different, what if there is a difference of dental time processing that caused by external factors such as the physical condition of the patients. Those questioned is accomodated in the form of fuzzy set approach.

The fuzziness can be accomodated through data collection about standard working time based on expert judgements. The ideal criteria of expert judgements

is based on adequate skills and knowledge that usually represent in working duration and its job position. In this research expert judgements is collected from several different medical personnel, which has different job position includes the clinic nurse, the head of nurse, doctors, dentist, hemodialysis assistants, and head of outpatient unit. Fortunately data collection process for fuzzy set has performed in good procedures, hopefully the biased information can be minimized.

5.5 Analysis of Time Equation Development

Time equation as the unique characteristic of fuzzy-TDABC has accomodate large data varieties, especially when it is performed in various service types. In this research the development of time equation was performed based on variations in mapping process.

The data used as the input in this stage is standard working time while performing an activity. By then, based on the mapping process, it can be known the formulation of time needed to perform a healthcare product within the department.

$$T = \sum T_i + (A_i \times X_i) \text{ (minutes)}$$

Where;

T = time equation of process, total time to perform a service

T_i = time in process i

A_i = additional time in process I (if there are any additional time)

X_i = binary code for additional time i (0 or 1)

Recall that T is the time equation for a healthcare product in general clinic. It is accomodates the time needed to perform basic activities which shown in the number that doesn't have X variables. The semi colon shows the logic what-if conditional situation which is the optional activities.

The usage of time equation help to mapping the probabilities of additional services in a clinic. By developing the right time equation, the cost estimation can be done easily since it already has standard template that can be used to estimate several healthcare services, since it already accomodates the various type of services that may occur.

5.6 Analysis of Service Cost Estimation

Service cost estimation includes the calculation of basic service cost and additional service cost. Basic service cost is formulated based on the basic services without any additional medical treatment. Service cost is the sum of multiplication between standard time and CCR of each economic resource. By assigning economic resources into the activities of care process, the accuracy of cost estimation is better rather than existing cost system.

Take a note about basic services in registration process and payment process. It is using condition when the administrative staff is limited to receiving patient and collecting their document. To process patient documents it need additional time that has two options; the document of registered patient and the document of unregistered patient. Registered patient didn't need new medical card, data information processing, documents checking while unregistered patient need additional processing time for their documents. Each of the condition has different cost, which will influence the additional cost that should take into account. The payment process also has special considerations. The basic services of payment process are limited to receiving patient and receiving patient's bill. To process patient payment documents, it also needs additional time that has two options; cash payment and debit payment. Debit payment requires the usage of electronic device, which will lead to different cost that should take into account.

5.7 Analysis of Healthcare Services Cost

This sub chapter mainly discuss about the comparison analysis of fuzzy-TDABC implementation and existing cost system.

Table 5.1 Comparison of Healthcare Costs in General Clinic

Healthcare Service	Existing		Fuzzy-TDABC	
	Healthcare tariff	Healthcare cost	Healthcare tariff	Healthcare cost
Basic services; consultation and physical checking	IDR 40,000.00	IDR 34,782.61	IDR 31,617	IDR 27,493
Basic services plus anesthesia	IDR 50,000.00	IDR 43,478.26	IDR 36,187	IDR 31,467

There are two services that available in general clinic, which are consultation and consultation with anesthesia. Table 5.1 shows the fuzzy-TDABC cost result and existing cost. Take a note that the healthcare cost in the table is the condition for registered patient with cash payment. As mentioned in sub chapter 5.1, healthcare tariff includes 15% of healthcare services cost. Existing tariff has higher cost rather than healthcare tariff using fuzzy-TDABC.

Table 5.2 Comparison of Healthcare Costs in Dental Clinic

Healthcare Service	Existing		Fuzzy-TDABC	
	Healthcare tariff	Healthcare cost	Healthcare tariff	Healthcare cost
Basic services; consultation and physical checking	IDR 50,000.00	IDR 43,478.26	IDR 55,483.20	IDR 48,246.26
Basic services plus temporary filling	IDR 100,000.00	IDR 86,956.52	IDR 89,336.31	IDR 77,683.75
Basic services plus permanent filling	IDR 250,000.00	IDR 217,391.30	IDR 199,312.51	IDR 173,315.23
Basic services plus dental extraction (typical anesthesia)	IDR 100,000.00	IDR 86,956.52	IDR 104,554.52	IDR 90,916.98
Basic services plus dental care (pulpektomi)	IDR 125,000.00	IDR 108,695.65	IDR 125,649.50	IDR 109,260.43

As shown in Table 5.2, type of services is ranging from consultation, temporary filling, permanent filling, dental extraction, and dental care. Based on the data recap, there are the evidence of overprice and underprice of healthcare products. Healthcare products that overprice include temporary filling and permanent filling. Healthcare products that underprice include consultation and dental extraction. While cost estimation of dental care (pulpektomi) is

approximately the same with existing cost. The condition of overprice will affects customer satisfaction if it is applied in long period of time. While underpricing of a healthcare product will affects the profitability of hospital management.

Table 5.3 Comparison of Healthcare Costs in Hemodialysis Clinic

Healthcare Service	Existing		Fuzzy-TDABC	
	Healthcare tariff	Healthcare cost	Healthcare tariff	Healthcare cost
Hemodialysis care	IDR 860,000.00	IDR 747,826.09	IDR 850,967	IDR 739,971
Hemodialysis with additional consultation session	-	-	IDR 865,249	IDR 752,390.02

Hemodialysis has two types of services that are observed includes primary hemodialysis care, and hemodialysis care with a medical consultation. The existing service cost in hemodialysis is not accommodating the probability of additional care services that may occur. Whereas, the service cost must be distinguished as it use more economic resources. Hemodialysis care cost is overprice when compared to hemodialysis existing cost.

Table 5.4 Comparison of Healthcare Costs in Antenatal Clinic

Healthcare Service	Existing		Fuzzy-TDABC	
	Healthcare tariff	Healthcare cost	Healthcare tariff	Healthcare cost
Basic services; consultation and physical checking	IDR 40,000.00	IDR 34,782.61	IDR 35,504.64	IDR 30,873.60
Basic service plus BCG immunization	IDR 57,500.00	IDR 50,000.00	IDR 52,825.08	IDR 45,934.85

Based on the findings about the gap between fuzzy-TDABC cost and existing cost, it can be concluded that fuzzy-TDABC has several advantages; (1) it can identifies which one that profitable and non-profitable healthcare product for the

management by doing comparation analysis, (2) fuzzy-TDABC can accommodate resources allocations better based on mapping process and its capacity cost rates, (3) accommodates the uncertainty factors about standard working time by develop a fuzzy set; need less time, simple and easy to be implemented, (4) once a fuzzy-TDABC model is develop, it requires lower budget to do cost estimations and easier to updated, (5) model of fuzzy-TDABC is suitable if it is used in high complexity business process by using approach of time equation since it can accommodate high various service types.

5.8 Analysis of Fuzzy-TDABC Implementation in Healthcare Service Industry

In conclusion, fuzzy-TDABC is recommended to be implemented in high complexity business process where there are various services types such as in hospital. In this research, fuzzy-TDABC accomodate the problems about the cost estimation related to those issues;

1. Fuzzy-TDABC can reduce the probabilities of wrong estimation of cost analysis. It provides better details on economic resources utilization; includes its availability by volume basis and time basis.By comparing fuzzy TDABC result with the existing system it is shown that there are underpricing and overpricing condition. For example consultation cost in general clinic is higher than cost estimation using fuzzy-TDABC, this condition show that there is underpricing condition that will lead to customer dissatisfaction.
2. The highlight point is that existing cost system didn't include economic resources practical capacity. The practical capacity calculation process has a significant role to determine the availability and capacity cost rate of each economic resources. The existing cost system shows that there is no any cost allocation of medical equipments, while fuzzy-TDABC give detailed information of economic resources such as admistrative

equipment, medical personnel salary, medical equipment, and consumable drugs.

3. Overpricing of a healthcare service costs will have a big impact on customer satisfaction. Furthermore, fuzzy-TDABC method can give precise cost allocation which is give better result than other healthcare provider. Underpricing of a healthcare service costs will give a serious impact for hospital management since there is missing information about cost pools that are not detected into the account. This will give bad impact on hospital management if it is not early detected.
4. As seen in hemodialysis cost estimation, it is includes the shareable economic resources; the outsource doctor that are available only when there are special cases in hemodialysis care. This implied that fuzzy-TDABC can also accommodate cost allocation of shareable economic resources.
5. Fuzzy-TDABC also can allocates practical capacity of consumable drugs, which the consumption is not using time basis, but using volume basis. The model can calculate cost per consumable set drugs that are going to used in care services. For example cost allocation for anesthesia is IDR 80,000,000 annualy for 3000 drugs set. Hence the capacity cost rate for anesthesia drug is IDR 26,666for one set treatment.
6. Time equation method give a simple equation cost estimation that can accommodates various type of services. The meaning of simple equation is it is easy to understand and it will create cost transparency for internal stakeholder usage.
7. The model of fuzzy-TDABC is easily to updated as it contains simple equation and formula that developed in Microsoft Excel.
8. To accommodate the drawback of existing cost system; not identifying all economic resources that includes in care activities. Fuzzy-TDABC assigning all economic resources into related activities, which minimize the wrong estimation about source of expenses that will influence the accuracy of services cost estimation. This is shown in time equation model in outpatient clinics.

9. Fuzzy-TDABC can capture the costs in the form of healthcare packages since it is identifying process from registration process until payment process. The patient doesn't longer need to pay administration fees different with medical treatment fees. For example for case D in antenatal clinic as an example of total time to perform a care services in antenatal clinic. Rahman is new patient that come to antenatal clinic for the first time; this implied that Rahman is an unregistered patient. He got consultation and BCG immunization from the doctor's diagnosis. After the medical treatment, he leaves the examination room and pays the medical bill with cash payment.

SCa of case D = 2.1 (1,578 + 858) + 3.1 ($1{,}578_1$ + 858) + 2.3 (593 + 631) + 2.9 (441) + 1 (3,250) + (3.2(3,691) + 1 3,250) + 4.9 (631 + 441) + 2.4 (1,578 + 858) + 1.1 (1,578 + 858)

SCa of case D = IDR 48,859

Based on the calculation, for basic services plus BCG immunization for case D in antenatal clinic is IDR 739,971.

6 CHAPTER VI
CONCLUSIONS AND SUGGESTIONS

This chapter consists of research conclusions and suggestions for further research.

6.1 Research Conclusions

This session mainly discuss about the conclusions of this research;

1. The economic resources that are used in TDABC model include administration instruments, medical personnel, medical equipment, and consumable drugs. The practical capacity of administration instruments calculated 221,760 minutes per year, medical personnel has 188,496 minutes per year, medical tools and equipment has 126,720 minutes per year.
2. The recap for healthcare service cost in general clinic is IDR 27,493 for consultation and IDR 31,467 for consultation plus anesthesia care. For dental clinic; (1) consultation has cost of IDR 48,246, (2) temporary filling is IDR 77,683, (3) IDR 173,315 for permanent filling, (4) IDR 90,916 for dental extraction, and (5) IDR 109,260 for dental care. The recap of healthcare service cost in hemodialysis is IDR 739,971 and IDR 752,390 for hemodialysis plus consultation session. The recap of healthcare service cost in antenatal clinic is IDR 30,873 for consultation and IDR 45,934 for consultation plus BCG immunization.
3. Fuzzy set is developed to estimate standard working time while performing care activities. Different process time between medical personnel is gathered from three different experts. Time needed to prepare anesthesia is categorized into three values, most frequent process time (average process time), possible value of maximum process time (slowest process time), and possible value of minimum process time (fastest process time). The average value of crisp input is used to be translated into

membership value. Membership value is data processing stages by using interpolation method to give the proportion of each fuzzy level. The fuzzy level that has membership value is Slow and Average level. As crisp input is translated into membership value, it is ready for the defuzzification process. Defuzzification process is the processing stage of fuzzy value into crisp output. Crisp output is use as the final resulf of fuzzy set stages.

4. As healthcare services has high various service types and has complex organizations, it creates a big job to do the right service cost estimation. But, in order to achieve the hospital vision, the right cost estimation creates a high urgency to be implemented. Many approaches and methods are available to estimate healthcare service costs; ABC, TDABC and other. The most recent and updated method to do cost estimation using basis of process time and resources cost rate is by using TDABC. The unique characters of TDABC lies in time equation model, which accommodates various service type based on capacity cost rate of economic resources. Fuzzy-TDABC is recommended to be implemented in hospital organization since it can accommodates vagueness while performing a cost estimation model
5. Based on the findings about the gap between fuzzy-TDABC cost and existing cost, it can be concluded that fuzzy-TDABC has several advantages; (1) fuzzy-TDABC can accommodate resources allocations better based on mapping process and its capacity cost rates, (2) accommodates the uncertainty factors about standard working time by develop a fuzzy set; need less time, simple and easy to be implemented, (3) once a fuzzy-TDABC model is develop, it requires lower budget to do cost estimations and easier to updated, (4) model of fuzzy-TDABC is suitable if it is used in high complexity business process by using approach of time equation since it can accommodate high various service types.

6.2 Suggestions for Further Research

This sub-chapter discuss of the suggestions for further research. The suggestions are made based on six months experience to build fuzzy-TDABC model.

1. To build a good fuzzy-TDABC model, a pilot study and direct observation is needed to use as the basis to determine research scope. By knowing overall and understanding deeply about business process, the economic resources identification can be done better.
2. For further research, the capacity cost rate of medical equipment and other medical equipment should be distinguished based on its operational costs (maintenance hours and its breakdown time) by using volume basis proportions to get better results.
3. Learn about profitability analysis of a healthcare products – how to maintain the sales rate of healthcare products.
4. Since fuzzy-TDABC is a top-down cost estimation methods, it is considering internal factors and conditions of hospital management. for further research, gather the informations and data about the external comparison of healthcare costs from the other hospital. The aim of this activity is to consider the external factors that may also affects the cost estimation such as customer perspective, willingness to pay and ability to pay of the customer.

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References

Al Irsyad Hospital. (2014). *Annual Report 2014 Al Irsyad Hospital.* Surabaya: Al Irsyad Hospital Management.

Badan Pusat Statistik. (2013). *Proyeksi Penduduk Indonesia 2010-2035.* Jakarta: Badan Perencanaan Pembangunan Nasional.

Bank Indonesia. (2013). *Kajian Ekonomi Regional.* Kepulauan Riau: Pemerintah Kepulauan Riau.

Bezdek, C. J., & Pal, S. (1992). Fuzzy Models for Pattern Recognition. *IEEE Press*.

Blocher, E., Stout, D. E., & Cokins, G. (2011). *Manajemen Biaya dengan Penekanan Strategis.* Jakarta: Salemba Empat.

Brent C. James, M. (1989). *Quality Management for Health Care Delivery.* Chicago: The Hospital Research and Educational Trust.

Chansaad, A. P. (2012). A Fuzzy Time Driven Activity Based Costing Model in an Uncertain Manufactuting Environment. *Proceedings of the Asia Pasific, Industrial Engineering and Management Systems Conference*, 1949-1959.

Chou, S., & Chang, Y. (2008). A decision support system for supplier selection based on a strategy-aligned fuzzy SMART approach. *Expert system with applications no 344*, 2241-2253.

Coulter, D., McGrath, G., & Wall, A. (2011). Time Driven Activity Based Costing. In A. Ireland, *Activity Based Costing* (p. 12). Ireland: Accountancy Ireland.

Demeree, N. (2009). Time-driven activity based costing in an outpatient clinic environment: Development, relevance and managerial impact. *Health Policy*, 296-304.

Demeree, N., Stouthuysen, K., & Roodhooft, F. (2009). Time-driven activity based costing in an outpatient clinic environment: Development, relevance and managerial impact. *Health Policy*, 296-304.

Dewi, Y. (2006). *Metode Activity Based Costing Sebagai Penentuan Tarif Rawat Inap di RSJ Puti Bungsu.* Padang: Universitas Andalas.

Everaert P, B. W. (2008). Cost Modeling in Logistics Using Time-Driven ABC. Experiences from a wholesaler. *International Journal of Physical Distribution & Logistic Management*, 172-91.

Everaert P, B. W. (2008). Cost Modelling in Logistics using time-driven ABC, experiences from a wholesaler. *International Journal of Physical Distribution and Logistics Management*, 38 (3):172-91.

Gani, A. (1993). *Analisis Kebijakan Tarif dalam Pelayanan Kesehatan.* Jakarta: Seminar Optimalisasi Investasi Perorangan dan Kelompok di Bidang Pelayanan Kesehatan.

Hansen, D. R., & Mowen, M. M. (2009). *Akuntansi Manajerial.* Jakarta: Salemba Empat.

Health Research & Educational Trust. (2013). *The Role of Small and Rural Hospital and Care Systems in Effective Population Health Partnership.* Chicago: American Hospital Association.

Healthwise, WebMD Medical Reference. (2013, November 5). *WebMD Medical Reference from Healthwise*. Retrieved April 6, 2015, from Healthwise, Incorporation: http://www.webmd.com/a-to-z-guides/outpatient-services-learning-about-outpatient-services

Heru, A. (2010). *Langkah-langkah Strategis Penghitungan Analisis Biaya (Perhitungan Unit Cost) di Rumah Sakit* . Jakarta: Workshop Penghitungan Tarif Berbasis Unit Cost di Rumah Sakit.

Horngren, C. T., & Foster, G. (1988). *Akuntansi Biaya.* Jakarta: Erlangga.

Ibrahim, A. (2004). Fuzzy logic for embedded systems applications. *Elsevier science USA*.

Kaplan, R. A. (2007). *Time-Driven Activity Based Costing; A simpler and more powerful path to higher profit* . Boston, Massachucets: Harvard Business School Press.

Kaplan, R., & S., A. (2004). *Time driven activity based costing.* Harvard Business Review.

Kaufmann, A., & M.M, G. (1988). Fuzzy Mathematical Methods in Engineering and Management Science. *Elsevier Science Publishers BV North-Holland*.

Kowsari, F. (2013). *Changing in Costing Models from Traditional to Performance Focused Activity Based Costing (PFABC).* Shiraz, Iran: European Online Journal of Natural and Social Sciences.

Lee, C. (1990). Fuzzy logic in control systems: fuzzy logic controller. *IEEE transaction on systems part I and II no 20*, 435-440.

Naraswari, F. (2013). *Penerapan Time Driven Activity Based Costing dalam Perhitungan Biaya Instalasi Radiologi di Rumah Sakit Yakkum Purwodadi.* Yogyakarta: Universitas Atmajaya Yogyakarta.

Pratiwi, T. (2012). *Faktor yang Mempengaruhi Penyebaran Penyakit.* Banten: SMK Kesehatan Banten.

Saputri, D. (2012). *Penerapan Metode Activity Based Costing dalam Menentukan Besarnya Tarif Jasa Rawat Inap Pada RS Hikmah.* Makassar: Universitas Hasanuddin.

Sarokolei, A., & Saviz, M. (2013). Time Driven Activity Based Costing by using Fuzzy Logic. 3-9.

Setiaji, H. (2006). *Analisis Biaya Pelayanan Rawat Inap di Ruang VIP Cendrawasih RSUD Dr. Soeselo Kabupaten Tegal.* Semarang: Universitas Diponegoro.

Setyawan, J. (2004). *Sistem Penganggaran Rumah Sakit dengan MS Excel.* Surabaya.

Soltani, S., & Kalani, M. (2010). Time-Driven Activity Based Costing .

Southern Regional Health Authority. (2014). *Hospital Classification*. Retrieved May 8, 2015, from Southern Regional Health Authority: http://www.srha.gov.jm/?page_id=137

Szychta, A. (2010). *Time-Driven Activity-Based Costing in Service Industries*. Poland: University of Lods.

Thabrany, H. (1999). Penetapan Tarif Rumah Sakit. *Jurnal Managemen dan Administrasi Rumah Sakit Indonesia, Program Pascasarjana Universitas Indonesia No 1 Volume 1*, 5-16.

Widjaya Tunggal, A. (1993). *Akuntansi Biaya.* Jakarta: PT Rineka Cipta.

Wignjosoebroto, S. (1995). *Ergonomi, Studi Gerak dan Waktu.* Jakarta: PT. Candimas Metropole.

Zadeh, L. (1978). Fuzzy Set as a Basis for Theory of Possibility. *Fuzzy Set Sytems*, 3-28.

APPENDIX 1

Research Validation Sheet

Validation Sheet
Final Project Observation
Industrial Engineering Department
Institut Teknologi Sepuluh Nopember Surabaya

The validation sheet below is used as the supports tools of the data and information gathering for the research of:

Name : Elsa Camelia Harmadi

Student ID : 2511100047

Research title : Implementation of Fuzzy Logic Time Driven Activity Based Costing (Fuzzy-TDABC) to Estimate Healthcare Service Costs in Outpatient Unit

Hereby I undersigned below:

Name : Drg Afiati

Position/Department : Poli Gigi

Data Information : Process maps, resources and drugs usage, healthcare tariffs, job description of medical personnel

Surabaya, ...16/6/2015.....

(...Drg...Afiati.....)

Validation Sheet
Final Project Observation
Industrial Engineering Department
Institut Teknologi Sepuluh Nopember Surabaya

The validation sheet below is used as the supports tools of the data and information gathering for the research of:

Name : Elsa Camelia Harmadi

Student ID : 2511100047

Research title : Implementation of Fuzzy Logic Time Driven Activity Based Costing (Fuzzy-TDABC) to Estimate Healthcare Service Costs in Outpatient Unit

Hereby I undersigned below:

Name : RENI DWI WAHYUNI

Position/Department : PERAWAT GIGI

Data Information : resources and consumable drugs

Surabaya, ...

(.....)

Validation Sheet
Final Project Observation
Industrial Engineering Department
Institut Teknologi Sepuluh Nopember Surabaya

The validation sheet below is used as the supports tools of the data and information gathering for the research of:

Name : Elsa Camelia Harmadi

Student ID : 2511100047

Research title : Implementation of Fuzzy Logic Time Driven Activity Based Costing (Fuzzy-TDABC) to Estimate Healthcare Service Costs in Outpatient Unit

Hereby I undersigned below:

Name : R. Ratna Mahmudah

Position/Department : ka Unit

Data Information : direct observation ; process maps, working process of dental treatments

Surabaya, 16-6-2015

POLI GIGI SURABAYA

Drg. Ratu Ratna Mahmudah
503.446/0055/I/IP.DG/436.6.3/2012

(.....)

Validation Sheet
Final Project Observation
Industrial Engineering Department
Institut Teknologi Sepuluh Nopember Surabaya

The validation sheet below is used as the supports tools of the data and information gathering for the research of:

Name : Elsa Camelia Harmadi

Student ID : 2511100047

Research title : Implementation of Fuzzy Logic Time Driven Activity Based Costing (Fuzzy-TDABC) to Estimate Healthcare Service Costs in Outpatient Unit

Hereby I undersigned below:

Name : NINIS KHOIRUNNISAH

Position/Department : KA. UNIT HEMODIALISA

Data Information : Direct observation ; working process, time needed in each activity, resources and consumable drugs

Surabaya, 16 06 2015

HEMODIALISA RS. AL-IRSYAD SURABAYA

(NINIS KHOIRUNNISAH)

Validation Sheet
Final Project Observation
Industrial Engineering Department
Institut Teknologi Sepuluh Nopember Surabaya

The validation sheet below is used as the supports tools of the data and information gathering for the research of:

Name : Elsa Camelia Harmadi

Student ID : 2511100047

Research title : Implementation of Fuzzy Logic Time Driven Activity Based Costing (Fuzzy-TDABC) to Estimate Healthcare Service Costs in Outpatient Unit

Hereby I undersigned below:

Name : BANUN Amd. Keb

Position/Department : BIDAN KIA

Data Information : Process time of care activities, resources that used in antenatal clinic, direct observation, working process healthcare tariff in antenatal clinic

Surabaya, 16/6/2015

(..... BANUN Amd. Keb .....)

Validation Sheet
Final Project Observation
Industrial Engineering Department
Institut Teknologi Sepuluh Nopember Surabaya

The validation sheet below is used as the supports tools of the data and information gathering for the research of:

Name : Elsa Camelia Harmadi

Student ID : 2511100047

Research title : Implementation of Fuzzy Logic Time Driven Activity Based Costing (Fuzzy-TDABC) to Estimate Healthcare Service Costs in Outpatient Unit

Hereby I undersigned below:

Name : Retno Kushiman, AK

Position/Department : Wakil Kepala

Data Information : Accounting system in hospital

Surabaya, 15 Juni 2015

(Retno Kushiman, AK)

Validation Sheet
Final Project Observation
Industrial Engineering Department
Institut Teknologi Sepuluh Nopember Surabaya

The validation sheet below is used as the supports tools of the data and information gathering for the research of:

Name : Elsa Camelia Harmadi

Student ID : 2511100047

Research title : Implementation of Fuzzy Logic Time Driven Activity Based Costing (Fuzzy-TDABC) to Estimate Healthcare Service Costs in Outpatient Unit

Hereby I undersigned below:

Name : Bu Widaryanti

Position/Department : Kabag Akuntansi

Data Information : Discussion, direct interview about hospital expenses, review of cost estimation in medical services unit

Surabaya, ...16../.6./2015...

(.....)

Validation Sheet
Final Project Observation
Industrial Engineering Department
Institut Teknologi Sepuluh Nopember Surabaya

The validation sheet below is used as the supports tools of the data and information gathering for the research of:

Name : Elsa Camelia Harmadi

Student ID : 2511100047

Research title : Implementation of Fuzzy Logic Time Driven Activity Based Costing (Fuzzy-TDABC) to Estimate Healthcare Service Costs in Outpatient Unit

Hereby I undersigned below:

Name : Bu Catur Handayani

Position/Department : Staff Akuntasi

Data Information : Hospital general expenses, interview session about hospital business process

Surabaya, 16 Juni 2015

(AGUSTIN CH)

Validation Sheet
Final Project Observation
Industrial Engineering Department
Institut Teknologi Sepuluh Nopember Surabaya

The validation sheet below is used as the supports tools of the data and information gathering for the research of:

Name : Elsa Camelia Harmadi

Student ID : 2511100047

Research title : Implementation of Fuzzy Logic Time Driven Activity Based Costing (Fuzzy-TDABC) to Estimate Healthcare Service Costs in Outpatient Unit

Hereby I undersigned below:

Name : ARINTA KUSUMA WANDIRA, S.KM.

Position/Department : STAF PERSONALIA / DIKLAT

Data Information : Organization structure, Annual report in 2012, Annual report 2013, annual report 2014, SWOT analysis from hospital business process

Surabaya, 16 JUNI 2015

RUMAH SAKIT AL-ISTIQOMAH SURABAYA DIKLAT

(ARINTA KW.)

Validation Sheet
Final Project Observation
Industrial Engineering Department
Institut Teknologi Sepuluh Nopember Surabaya

The validation sheet below is used as the supports tools of the data and information gathering for the research of:

Name : Elsa Camelia Harmadi

Student ID : 2511100047

Research title : Implementation of Fuzzy Logic Time Driven Activity Based Costing (Fuzzy-TDABC) to Estimate Healthcare Service Costs in Outpatient Unit

Hereby I undersigned below:

Name : Dra. Lies Sedyaningsih, Apt

Position/Department : Ka Instalasi Farmasi

Data Information : Process and business process in pharmacy unit, accounting system, proportion of expenses in outpatient unit, drugs procurement and warehouse system

Surabaya, 16/6/2015

(Dra. Lies Sedyaningsih, Apt)

Validation Sheet
Final Project Observation
Industrial Engineering Department
Institut Teknologi Sepuluh Nopember Surabaya

The validation sheet below is used as the supports tools of the data and information gathering for the research of:

Name : Elsa Camelia Harmadi

Student ID : 2511100047

Research title : Implementation of Fuzzy Logic Time Driven Activity Based Costing (Fuzzy-TDABC) to Estimate Healthcare Service Costs in Outpatient Unit

Hereby I undersigned below:

Name : Fitriya Emy P

Position/Department : koordinator poli spesialis

Data Information : Process maps in specialist clinics, Process time in specialist clinics, healthcare tariffs, the materials and equipments that used in specialist clinics, consumable drugs that used in specialist clinics

Surabaya, 16/12/2015

(Fitriya)

Validation Sheet
Final Project Observation
Industrial Engineering Department
Institut Teknologi Sepuluh Nopember Surabaya

The validation sheet below is used to supports the data and information for thesis report of:

Name : Elsa Camelia Harmadi

Student ID : 2511100047

Thesis title : Implementation of Fuzzy Logic Time Driven Activity Based Costing (TDABC) to Determine Outpatient Clinics Service Cost in Healthcare Services.

Hereby I undersigned below:

Name : Dr ARLP R M

Position/Department : Poli Umum.

Data Type : Interview about business process and cost estimation in outpatient unit

Surabaya, 1-4-2015

(.....)

Validation Sheet
Final Project Observation
Industrial Engineering Department
Institut Teknologi Sepuluh Nopember Surabaya

The validation sheet below is used to supports the data and information for thesis report of:

Name : Elsa Camelia Harmadi

Student ID : 2511100047

Thesis title : Implementation of Fuzzy Logic Time Driven Activity Based Costing (TDABC) to Determine Outpatient Clinics Service Cost in Healthcare Services.

Hereby I undersigned below:

Name : Indra Fitriansyah

Position/Department : Humas dan Marketing

Data Type : Customer complaints data, problems that the management has, company profile (interview session)

Surabaya, 1-4-2015

(.....)

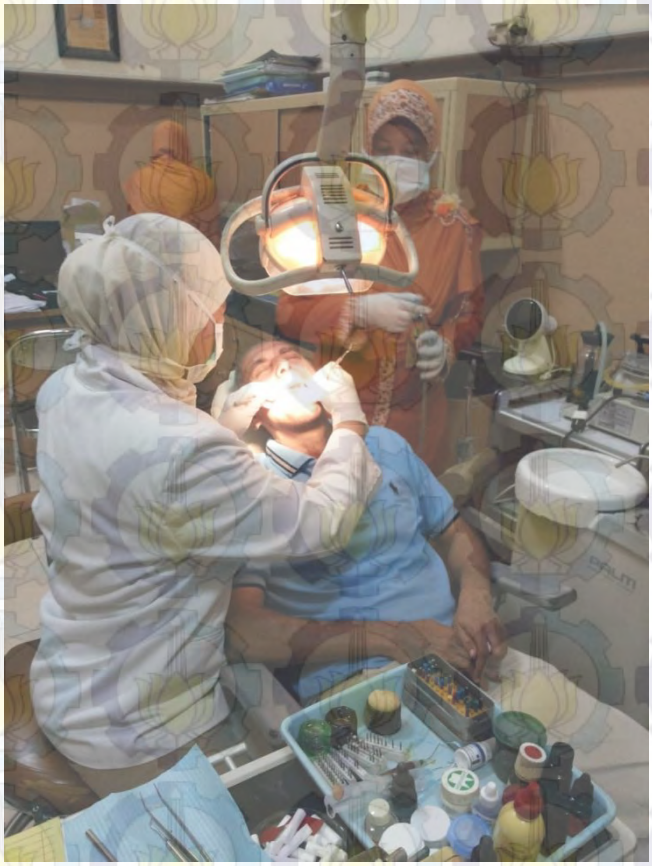
APPENDIX 2

Research Documentations

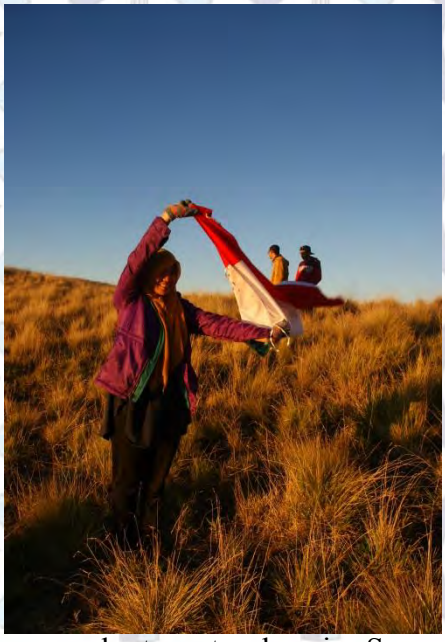

KASIR RAWAT JALAN
INSTALASI
FARMASI
(KAMAR OBAT)


JADWAL PRAKTEK
LABORATORIUM
RADIOLOGI


PERUSAHAAN / ASURANSI YANG BEKERJASAMA DENGAN RS. AL IRSYAD
- PT. P A L
- PT. ASPIRASI LUHUR
- PT. INDONESIA FERRY
- PT. DOK PERKAPALAN
- PT. SAMUDRA INDONESIA
- PT. D L U
- PT. PERTAMINA
- PT. HM. SAMPOERNA
- NAYAKA
- PT. ADN HEALT
PENDAFTARAN PASIEN
TPPGD



BIOGRAPHY



Elsa Camelia Harmadi was born in 6th October 1993. The author of this research is the first daughter of Usa Harmadi and Elvi Zulaiha, whose raised 17 years in Malang, East Java. The author has educational background from Muslimat NU 34 Malang, MIN Malang I, SMPN 1 Malang, and SMAN 3 Malang.

During her study in Industrial Engineering Department, her third semester was done in Universiti Teknikal Malaysia Melaka (UTeM). In the fourth semester, the author has a chance as voluntary teacher in Sawasdee Summer Camp in Bannongkhuen School Petchaburee Thailand. In fifth semester she was actively involved as assistant of Ergonomics and Work System Design Laboratory until the last semester of her study. The author has special interest on product design and development based on sustainable design. Her achievement during four years were became Runner Up Female Basketball Team in SAF 7 UTeM, first winner of INCEPTION 2014, fourth winner of INDISCO 2014, and finalist of IE FAIR USU 2015.

Besides doing academic activities, the author also involved in organizational activities such as in UMTI Sport Club 2013/2014, Industrial Engineering Youth Club 2013/2014, MAHAPATI ITS, Future Leader Anti Corruption (FLAC) Surabaya, and Karya Salemba Empat Scholars 2014/2015. The author has special interest on travelling, hiking, reading a books, writing, and cooking. The author is open to receive any suggestions and questions about the research at camelia.elsa@yahoo.com.