

all the data, Time-driven activity-based costing was developed for patient activity without Special treatment and patient activity with Special treatment.

3.2. Time driven ABC model development

The hospital traditional costing system is so complicated and have more problem in tracking the cost of resource usage with the demand of the patient. Hence, ABC is one of the best costing systems which can control the cost and help improving balancing between resource and demand. Even though, it still has a limitation. So, in this study, the new update ABC model, TDABC was developed and the step in developing and implementing are presented below.

Step 1: Identify the outpatient logistics activity in medicine department in hospital

In this research, the case study is based on the outpatient flow in the medicine clinics. First, the patients arrive at the OPD. Before going to particular clinics, they need to go through some other OPD facilities. Regardless of any arrival types need to go to Triage first. The triage is performed to observe the patients' critical level. All patients must then register for their clinics. The registration counters are classified into two categories: appointment patient (Lab, X-ray, and clinical appointment patients) registration, and non-appointment patient (new patient) patient registration. After the registration, only appointment patients will be screened in front of their clinics and meet with their doctor. After the patients are done with their doctors, they go to submit their prescriptions to the pharmacist assistants. The pharmacist assistants will key-in all items (drugs) and calculate all the fees including, medicine fee. Next, the patients go to pay their fee at the cashier counters. Finally, they pick up the medicine from the pharmacists and leave the hospital (Hoeur 2016).

Step 2: Identify the resource group of outpatient clinics service

First, we identified the groups of resources (e.g., surgeons, nurses, etc.) that perform activities for outpatient in hospital. The cost of resources supplied to an operating department consists of several elements. There are 4 basic resources in clinical such as: Nurse, Machine, Medical material and secretary cost (Demeree 2009) includes labor cost, cost of a secretary's room, office material cost, other secretary costs (each department employs secretaries for the execution of administrative tasks).

In this study, the researcher scope to analyze cost in view of provider perspective and classify cost by input which divides into two groups: capital cost and Recurrent Cost (operating cost).

Step 3: Estimate the total cost of each resource group

The total cost of each resource can be calculated by equation 1: Total cost of each resource = $\sum_{i=1} q_i \times r_i$ (1)

Let r resource used (resource cost) and q the quantity of resource used

In this study, there are 2 main resources: capital cost and recurrent cost

Capacity cost consists of building cost and equipment cost.

1. Building cost was calculated by multiply the average construction cost by the floor area of the clinic. To determine the depreciation cost of building in FY 2017, several values need to be calculated as following:

- Depreciation cost per year can be calculated by divide lifespan by the purchased cost.
- Depreciation rate can be calculated by divide 100% by the number of year in the asset life
- Residual value or salvage value can be calculated by equation 2: Salvage value = $P(1-i)^y$ (2)

Which P is the purchase cost, i is the depreciation rate and y is the lifespan of equipment

- Annual cost can be determined by multiply the current value of the asset by depreciation rate
2. Equipment cost can be calculated by the same formula of depreciation of building.

Recurrent cost consists of labor cost, material cost, and public utility cost. These costs can be calculated by equation 1.

Step 4: Estimate the Practical Capacity of each resource group

Practical capacity can be assumed as a specified percentage, 80 or 85 percent, of theoretical capacity (Kaplan & Anderson 2004). That is, if an employee can normally work forty hours per week, the practical capacity could be assumed to be thirty-two hours per week, allowing 20 percent of personnel time for breaks, arrival and departure, training, meetings, and employee chitchat that is unrelated to direct work performed. For machines, an allowance of 15 to 20 percent can be made for downtime due to maintenance, repair, and scheduling fluctuations.

The theory capacity can be calculated by the equation 3:

Theory capacity in minute = working hour per day*working day in a week*number of week in a year*number of minute in an hour (3)

Step 5: Calculate the capacity cost rate/cost per time unit

The capacity cost rate of each resource can be calculate by equation 4 (Kaplan & Anderson 2007):

Capacity cost rate =Cost of capacity supplied ÷ Practical capacity of resources supplied (4)

Step 6: Determine the time estimation for each event, based upon the time equation for the activity and character of event

Time equation can be developed through direct observation and multiple interviews with employee/manager (Demeree 2009). Based on the study of The general time equation needed by the event E of the activity A with p of possibility is given by:

$$T_{E,A} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_p X_p \quad (5)$$

$T_{E,A}$ time require for executing the event E in term of activity A

β_0 Constant amount of time for activity A

β_1 time consume per unit of time driver 1

X_1 time driver 1

X_p time driver p

p number of driver need to run for activity A

Step 7: Calculate the total cost per patient/transaction

Total cost per patient can be calculate by equation 6: Total Cost =total time used *cost per time unit (6)

4. Results and Discussions

4.1. Time Driven Activity based costing model development

4.1.1. Activity analysis

To construct an appropriated time equation, three main activities were identified which possibly extended by several optional depending on the different clinic service of the patient without Special treatment and patient with Special treatment. On the first arrival of a patient, the patient needs to take the weight and height check in front of the clinic. This process is assisted by clerk. Secondly, the patient needs to submit the appointment card to a nurse. After checking the appointment card, the nurse will inform the patient about the number of the examination room. Thirdly, Patient will be measured the vital sign that shows the heart rate, blood pressure and body temperature of the patient and then they wait to meet with the doctor. Next, the patient meets with the doctor for consultation and gets diagnosis and treatment from doctor and doctor will assess the condition of the patient and decides whether the patient requires further services from another service. Next, the document of the patient will be checked by a nurse after meeting with the doctor. In case of patient need further treatment at Special treatment procedure, they will meet with the doctor at

Special treatment unit and then leave the hospital. The outpatient logistics activities were illustrated in the flowchart as shown in figure 4.2.

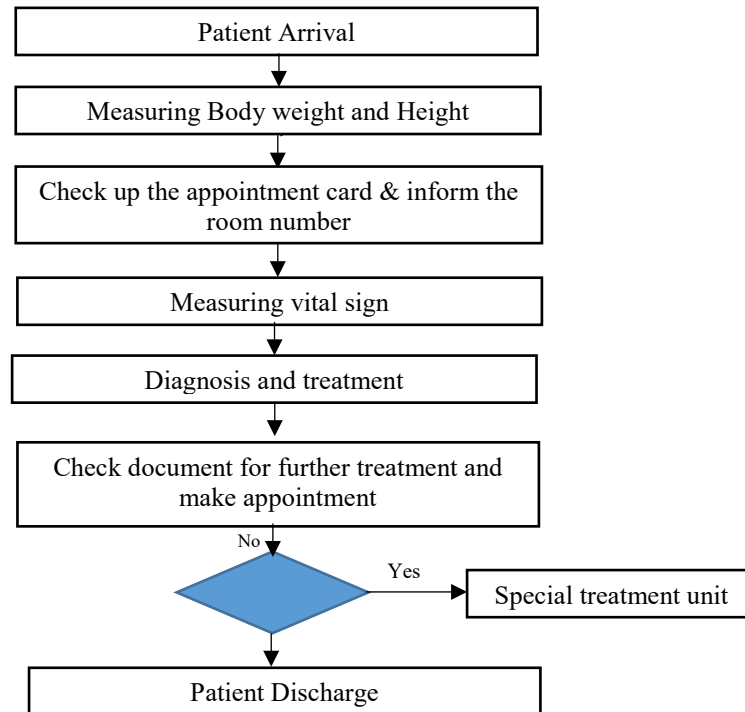


Figure 4.2. Outpatient logistics flow in the hospital

4.1.2. Resource group identification of OPD clinic

There are two main resource groups including capital cost and recurrent cost. The capital cost consists of building cost, depreciation cost of equipment, the recurrent cost was composed of Labor cost, Material cost (Office and household supply cost, and cost of drug and medical supply), other costs (public utility cost and maintenance/repairing cost).

4.1.3. Total cost of each resource

The resource used in the OPD clinic is classified into two main group: Capacity cost and recurrent cost. Capacity cost consists of building cost and equipment cost and recurrent cost consist of material cost (labor cost, drug, and medical supply cost) and public utility cost (water supply cost, electricity cost, and maintenance cost). The total cost of each activity is summarized in table 1.

Table 1. Total cost of each resource in without Special treatment and with Special treatment unit (baht/year)

Location	Capital cost		Recurrent cost						
	Building cost	Equipment cost	RN	LPN	Clerk	Material cost		Public utilities cost	
						Office material cost	Medicine & medical supply cost	Water supply cost	Electricity cost
Without Special treatment	1,756,677.89	445,583.43	2,936,640	8,109,636	3,224,448	634,883.79	166,726.68	32,127.16	315,884.61
Special Treatment Unit	351,335.58	126,910.52	2,569,560	1,071,084		166,726.68	90,557.68	7754.83	63,176.92

4.1.4. Practical capacity of each resource group

We assume the practical capacity of working time is 85% of theory capacity. The service time of medicine clinic started from 7 AM until 4 PM and SDSI service starts from 6 AM until 7 PM. So, the theory capacity per year of each service can be determined as following:

- (1) Theory capacity of without special treatment = $8*5*52*60 = 124800$ min/year
- (2) Theory capacity of Special treatment = $12*5*52*60 = 187200$ min/year

Therefore, practical capacity of Without special treatment = $85%*124800 = 106080$ min/year and practical capacity of special treatment = $85%*187200 = 159120$ min/year.

4.1.5. Capacity cost rate

Capacity cost rate is determined by divide the total resource cost by practical capacity. So we can get, the unit cost of each resource group as shown in table 2.

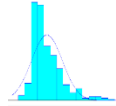
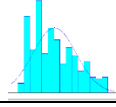
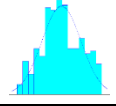
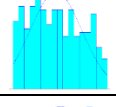
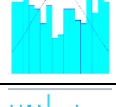
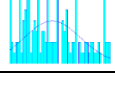
Table 2. The unit cost of each resource of without special treatment and Special treatment
(baht/minute/year)

Location Unit cost	Without Special treatment	Special treatment
Depreciation of Building	7.62	2.21
Depreciation of equipment	4.2	0.8
Registered Nurse	1.73	1.15
Practical Nurse	0.96	0.96
Clerk	1.69	
Office & household supply cost	5.98	0.14
Drug & medical supply cost	1.57	0.71
Water supply cost	0.3	0.05
Electricity cost	2.98	0.4

4.1.6. Time equation for each patient logistics activity in OPD clinic

Activity time will be estimated by collecting the time observation of each activity in the outpatient clinic. Onsite observation is conducted, firstly, to collect more data related to the time need to process each activity of outpatient Medicine clinic in the hospital. Observation time data will be analyzed by the input analyzer of Arena software for fitting distribution and to estimate the time data. Data is summarized in table 3.

Table 3. Service time of each patient activity time

Process	Number of sample	Histogram	Mathematic Expression	Test Statistic		P-value		MSE	IQR/ Q ₃	Service time
				Chi Square	KS	Chi Square	KS			
Measure Body Weight (A1)	300		NORM (0.199, 0.088)	90.3	0.145	< 0.005	< 0.01	0.03		M=0.2
Look up appointment card (A2)	300		NORM (0.302, 0.123)	89	0.076	< 0.05	0.065	0.02		M=0.3
Record vital sign (A3)	300		NORM (0.4, 0.0978)	35.3	0.035	< 0.005	> 0.15	0.01		M=0.4
Meet doctor (A4)	300		NORM (10.2, 4.95)	72.1	0.106	< 0.005	< 0.01	0.01	8.3	Q ₃ =8.3
Check document (A5)	300		NORM (4, 0.607)	112	0.085	< 0.005	0.025	0.01		M=4
Special treatment (A6)	150		NORM (27.3, 15.1)	39.2		< 0.005		0.01	24.75	Q ₃ =24.75

4.1.7. Total cost of each OPD clinic logistics activity

Total cost of each activity was calculated by multiply the unit of each resource cost by its activity time. The total cost of patient in medicine clinic without Special treatment and with Special treatment show in the table 4 and table 5.

Table 4. Total activity cost of patient without Special treatment (baht/year/patient)

Activity	Time	Capital cost		Recurrent cost							Total cost
		Building cost	Equipment cost	RN cost	LPN cost	Clerk cost	Material cost		Public utilities cost		
							Office material cost	Medicine & medical supply cost	Water supply cost	Electricity cost	
A1	0.2	1.52	0.84	0.35	0.19	0.34	1.20		0.06	0.60	5.09
A2	0.3	2.29	1.26	0.52	0.29	0.51	1.79		0.09	0.89	7.64
A3	0.4	3.05	1.68	0.69	0.38	0.68	2.39		0.12	1.19	10.18
A4	8.3	63.25	34.86	14.36	7.97	14.03	49.63	13.03	2.49	24.73	224.35
A5	4	30.48	16.80	6.92	3.84	6.76	23.92		1.2	11.92	101.84
Sub total		100.58	55.44	22.84	12.67	22.31		13.03			349.10

Table 5. Total activity cost of patient with Special treatment

Activity	Time	Capital cost		Recurrent cost							Total cost
		Building cost	Equipment cost	RN cost	LPN cost	Clerk cost	Material cost		Public utilities cost		
							Office material cost	Medicine & medical supply cost	Water supply cost	Electricity cost	
A1	0.2	1.52	0.84	0.35	0.19	0.34	1.20		0.06	0.60	5.09
A2	0.3	2.29	1.26	0.52	0.29	0.51	1.79		0.09	0.89	7.64
A3	0.4	3.05	1.68	0.69	0.38	0.68	2.39		0.12	1.19	10.18
A4	8.3	63.25	34.86	14.36	7.97	14.03	49.63	13.03	2.49	24.73	224.35
A5	4	30.48	16.80	6.92	3.84	6.76	23.92		1.2	11.92	101.84
A6	24.75	54.70	19.80	28.46	23.76		3.47	17.57	1.24	9.90	158.90
Sub total	37.95	155.28	75.24	51.30	36.43	22.31	82.41	30.60	5.20	49.24	508.00

4.3. Discussion

The data shows that each activity significantly differs depending on the characteristics of patient activity and the activity cost increase with the larger quantity of resource used and longer time of each activity. Therefore, to reduce the activity cost, the outpatient clinics need to be considered how to the management of each activity time, especially, the meeting doctor processing and Special treatment that take longer time than other activity in the clinics.

In order to reduce the time of each process, the clinics should develop processes for advanced beneficiary notices (ABN) to be present during patient registration. So that patient can understand the whole process of the clinic and no need to ask the clinic staffs during the clinics' activity. The physician should be educated on how to check the electric medical record of the patient which will reduce the time of consultation. Moreover, the clinic should work with the Information Technology system (IT) to adjust computer printing and scanning focus which minimize the verification time and It can minimize the error risk of pulling wrong patient paperwork. As the material cost in the clinics can be reduced by improving the process of purchasing, reducing inventory cost, decrease the turnover rate, etc. In addition, some recurrent cost can be reduced such as electricity, the staff can reduce this cost by reducing the electricity cost, for example, turning off the computer and equipment in the afternoon, turning off the air conditioner before the work finished, and buying the save energy electric instrument.

4.3. Data Analysis

4.3.1. Activity Analysis

In this part, the activity analysis was the most efficiency and effectiveness indicators in the time driven activity-based costing. The time spent on each activity not include the waiting time of patient in the clinics. This study indicated that the total estimated time spent in all activities not over one hour (37.95 minutes). The time of meeting doctor and SDSI time processing take longer time than other activities because the doctor needs time to check the patient medical record and diagnose the patient. Additionally, the patient will ask more question in this process than other processes as this process is more important for them.

4.3.2. Total cost and activity cost of outpatient clinics

4.3.2.1. Total cost of patient activity without Special treatment

The result of the study shows that the building cost is the biggest portion (28.81 %) compare with the other recurrent cost. The second and third proportion of resource cost is the office and household material cost and the equipment cost which take 22.63% and 15.88% of the total cost, respectively. The high cost of this resource which is resulted from this resource is the main function of the clinic service. The office material cost is regularly change with the volum of patient. As mention before, the medicine clinic is the clinic which have the most patient visit comparable with other clinic in the outpatient department. Therefore, the increasing of patient lead to the rise of office material cost which is used in each activity to provide service to each patient.

4.3.2.2. Total cost of patient activity with Special treatment

In this case, the patient needs to do the further process to Special treatment as the doctor recommends after using medicine clinic service. The results of this study indicate that the total cost of this service (349.10 baht) is the larger proportion than the total cost of patient activity without Special treatment (508.00 baht). Because of one more activity need to be added, so service time increase and lead to more resource cost are consumed. The result of this patient service show the similar result with the patient activity without special treatment. The biggest proportion is the building cost which consume 30.57% of total cost. The second and third portion are the office and household material cost and the equipment cost which take 16.22% and 14.81% of the total cost, respectively.

To summarize of comparison between these two patient activities, the results imply that the timing and resource are directly proportional.

4.3.2.3. Activity cost of outpatient medicine clinics in the hospital

The result in the study indicated that meeting doctor activity, Special treatment and check document activity was the first, second and third highest costing activity, which was consumed 44.16%, 31.28% and 20.05% of the total cost respectively. The fourth costing activities are recorded vital sign activity which consumed 2.00% of total cost. And the last one is looking up appointment card and measure body weight activity was consumed 1.50% and 1.00% of total cost respectively.

4.4. Research benefit and Limitation

In this study, the TDABC information can help the department head and healthcare manger's understanding of the difference clinic activity and the resource cost of each clinic activity. As such, the clinic management can determine the strategic change that increased the value and effectiveness of the current and future outpatient clinic. This study model is appropriated for further studies in the hospital or another industry that never use Time driven activities based costing system. Time-driven activities based costing in this study does not only impact to the cost but also include performance measurement. Activity time, activity cost and performance data provide information for hospital management to determine the effectiveness and efficiency of service, facilitating elimination of non-value added activities and improve service.

Even though this study model has more advantage, but it still faces limitation. This study focus only in one OPD clinics in the hospital. Some data need to be estimated from the total cost of hospital, so the resource cost cannot be estimated for specific location of activity. Some resource data lost track of record. Moreover, time data can be estimated by observe clinic only one week. One more, this study can analyze only the front activity which process directly with the patient and back activity is exclude from the study as the author cannot observe the time data of this activity and it take time. The waiting time and non-value-added activity are excluded from this study.

5. Conclusion

As the growth of the healthcare industry and more competition in the healthcare environment, the hospital needs to develop the efficient costing system to provide financial feedback. Time Driven Activity-based costing become the alternative tool for administrators to use for efficiency non-human resource and human resource management and to improve service quality. In this research, we try to explain the Time driven Activity-based costing development in an OPD clinic in the hospital. The TDABC seem to be faster model adaptability in the real world operates. In this study, it was found that medicine clinic in the hospital was identified into 6 activities such as body weight, look up appointment card, record vital sign, meet with the doctor in the treatment room, check document after meeting with the doctor and need to further to Special treatment. The activity was classified in two 2 groups of patient, the first group was called "Without Special treatment" that no need to further to treatment after meeting with the doctor in the clinic and the second group was called "With Special treatment " which the patient needs to further to treatment. Based on the result of table 4 and 5, the unit cost for the patient without procedure and patient with the procedure range from 3.96 to 155.28 baht/year/patient. The total cost of patient activity without procedure and with procedure are 349.10 baht/year/patient and 508.00 baht/year/patient respectively. It shows the influence of usage of activity, the resource used and time increasing between these two service cost. These result indicated that administrator should concern with

the real cost driver such as material cost, especially, the time spent in each activity which is the cost driver for resource cost and the activity which consumed the highest cost. In this study, the TDABC information clearly improved the department head and healthcare manager's understanding of the difference clinic activity. As such, the clinic management can determine the strategic change that increased the value and effectiveness of the current and future outpatient clinic.

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