SIMULATION MODELING FOR AUTOMATED PHARMACY DISPENSING SYSTEM: A CASE STUDY IN HOSPITAL

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ABSTRACT

In the past, pharmacists were focusing on product compounding and dispensing. Nowadays, pharmacy profession has moved from a product-oriented to patient-oriented with multidisciplinary team, which required reduction of pharmacist's workload and rely on Automated Dispensing System (ADS) to reduce those workloads. Investing on the ADS has a financial risk. It is suggested to evaluate its performance before implement. Simulation models are developed to investigate possible risks and expect highest benefits from the investment. The aim of this study is to develop a simulation model for investigate the implementation factors and design new business processes for implementing the ADS. This research is conducted at the Out-Patient Department of public hospital under Ministry of Higher Education Science Research and Innovation (HESRI) with special administration system by firstly modeling an Integration Definition for Function Modeling (IDEF0). Then it would be beneficial to analyze workflow and implementing simulation models by Arena software version 16 to predict the situations on different assumptions to get the most suitable situation. This study focuses on two performance indicators, dispensing time which the hospital target is patients received medicine within 10 minutes, and pharmacist workforce. The results showed that the dispensing time, which achieve the target and full time equivalent (FTE) of pharmacist of ADS model 1 and ADS model 2 were 99.31%, 99.18% and 9.01, 12.16 respectively. Compared to the current system, only 94.5% of patients achieve targets and required 26.4 FTE of pharmacists. In summary, both model 1 and 2 can reduce dispensing time and pharmacist workforce.

Keywords: Business Process Reengineering, Automated Dispensing System, Simulations, Pharmacy

1. INTRODUCTION

According to the declaration of The Pharmacy council and committee of The Pharmacy Education Consortium of Thailand (PECT) 16, June 2017 related to the number of pharmacists required to serves in a role of primary prevention, safety of medication and medication expenditure for Thailand population; The need of healthcare system has been changed due to the increasing aging population, higher number of patient with chronic non-communicable disease (NCD), and drug resistant problem. Therefore, the amount of health care services is required from pharmacist to correspond with service plan in order to improve healthcare service and public health system of Thailand (Pharmacist council, 2017).

In the past, pharmacists were focusing on product compounding and dispensing. Nowadays pharmacy profession has moved from product-oriented to patient oriented with multidisciplinary teams (Azhar1,S.,& Izham, M., Ibrahim, M. , 2018). To compete successfully in the current hypercompetitive market, pharmacist will need to develop core competencies on clinical skill and provide superior service to the patient (Singleton, J.A, & Nissen, L.M. ,2014). In public hospital under Ministry of Higher Education Science Research and Innovation (HESRI) with special condition of administration system has the vision of "The most admired hospital in Thailand 2020". Therefore, hospital's executive management team has new ambition to change the role of pharmacist to provide more clinical intervention (patient care). Previously the hospital has been providing patient care service for inpatient only, so the next goal is to develop pharmaceutical care service in outpatient department as well. Conversely, workload of pharmacists will also increase and the number of pharmacist also limited. In order to decrease the pharmacist's workload and dispensing error, the Medication and Blood Transfusion management committee has planned to implement the outpatient Automated Dispensing System (ADS), but the use of ADS for the outpatient does not yet widespread in Thailand and system implementation use high investment cost. Then, designing the system is also at a risk.

In addition, time guarantee is an important issue of outpatient dispensing. For the hospital in this research, at least 90% of patients who wait to receive medication must receive within 10 minutes. Now, it can be done at 94%. Therefore, the implementation of ADS must be ensured that ADS can be administered according to this KPI. It is suggested to evaluate its performance before an implementation. Simulation models are developed to investigate possible risks and expect highest benefits from the investment. So, the aim of this study is to develop a simulation model to investigate the implementation factors and design new business processes for implementing the ADS.

2. LITERATURE REVIEW

2.1 Pharmacy Health Services

Pharmacy health services include patient care service from pharmacists which generally focuses on drug safety, effectiveness, and treatment outcomes. Pharmacy health services are defined as "an action or set of actions undertaken in or organized by a pharmacy, delivered by a pharmacist or other health practitioner, who applies their specialized health knowledge personally or via an intermediary, with a patient/client, population or another health professional, to optimize the process of care with the aim to improve health outcomes and the value of health care".

Initially, pharmacists were recognized as chemist or apothecary which primarily focus on product compounding and dispensing, then in the 17th century the drug research and development started. Pharmacy has come through many revolutions and the pharmacy profession has transform from product- and service oriented to patient- and public-focused. Pharmacy's focus began to expand again during the 1980s. A pharmacy professional movement that proponents called clinical pharmacy gained momentum, urging the pharmacists to take on an important role in the healthcare system by providing medication expertise to ensure patients properly and safely use of medications. At first the concept of pharmaceutical care posited that pharmacy involves "the responsible provision of drug therapy for the purpose of achieving definite outcomes that improve a patient's quality of life". In 1997, Strand coined a new definition of pharmaceutical care as "a practice in which the practitioner takes responsibility for a patients' drug-related needs and is held accountable for this commitment". At present, the pharmacy profession is undergoing important development in terms of providing a better quality of patient-centered services. Due to patients' poor adherence, increase in health demands, and an increasingly complex range of medication pharmacists have implemented a patient-centered approach.

Pharmaceutical care became a standard for providing patient-centered, pharmacy profession transformed to become more responsible for patient care in terms of drug therapy. This transformation has placed the pharmacist as key member of the healthcare team with responsibility for the outcome of medication therapy (Azhar1, S.,& Izham, M., Ibrahim, M. , 2018).

2.2 Business Process Reengineering

Business Process Reengineering (BPR) involves the radical redesign of core business processes to achieve better improvements in productivity, quality and cycle times. Davenport (1993), a co-founder, stated that the reengineering is highlighting on redesigning the work process and necessary methods including reorganizing human resources with the use of IT tools and organizational goals (Kiran, D.R., 2017). An organization can add or skip a few steps based on any particular requirements. However the arrangement remains the same.

Example of BPR study: Business Process Reengineering at the Hospitals: A Case Study at Singapore Hospital by Arun Kumar and Linet Ozdamar the study need to increase efficiency in operation room by setting 3 models and use simulation software to find the model with efficiency (%) (Kumar,A., Ozdamar.L, 2004).Prescription-Filling Process Reengineering of an Outpatient Pharmacy by Ying-Chyi Chou & Been-Yuan Chen.et.al which study at the outpatient pharmacy in the central Taiwan medical Center. The reengineering process resulted not only reduce outpatients' waiting time but also enhanced the quality and competitiveness of the Hospital's medical treatment (Chou,Y.C.,Chen, B.Y.,Tang,Y.Y,, 2010).

2.3 Simulation models

Simulation is important tool which has been used for several years in several fields. Usually simulation has been used as soon as possible during a system's design phase. This paradigm is called "Simulation-Based Design" or SBD. Using SBD aims to eliminate unnecessary designs as early as possible before significant resources have been consumed. Simulation Based Design for software has been fundamentally used to manage with the difficulty of the development of some software (Mefteh, W., 2018). Moreover, the simulation technique is used to exemplary the possible situations and the study said 24 percent of the simulation was on computer. One of the most common tools is ARENA with Integration Definition for Function Modeling (IDEF0), as 13.3 percent, to get the workflow structure (Gunasekaran,A.,& Kobu,B., 2002). Then the next process is demonstrating root-cause analysis to get the solutions by Lean and KAIZEN method.

The examples of the simulation model and the use of IDEF0 are described as follows: Kritchanchai and Soriya Hoeur (2017) demonstrated the simulation modeling for facility allocation of outpatient department. Simulation experimental results on ARENA program showed that separating the primary and support facilities can reduce congestion of the patient flow in the old OPD's clinics (Hoeur,S., 2017). Kumar A. and Rahman S. (2014) conducted the study using Radio-frequency identification (RFID) - enabled process reengineering of closed-loop supply chains in the healthcare industry of Singapore to discuss the feasibility of integrating RFID technology into the business process. Using the simulation on ARENA program, the study highlighted the decrease of time searching for lost or stolen linens and the increase of productivity (Kumar, A., Rahman,S., 2014).

From the literature review about Business Process Reengineering (BPR) and Simulation models as mentioned above, it could be implied that to start integrating BPR or improving the work process, it is necessary to understand the structure of workflow and able to improve an overall business process. The diagram or IDEF0: Integration Definition for Function Modeling would be beneficial to analyze workflow then implementing simulation models on a computer to predict the situations on different assumptions to get the most suitable situation.

2.4 Automated Dispensing System: ADS

The era of the pharmaceutical robot was sparked by an automatic pill counting machine. In the past, the counting tools were pill counting tray and spatula which was wasting time and workforce while the main point should have been patient safety. In 1967, John Kirby and Frank Kirby from England developed the electronic pill counting machine to count both tablets and capsules accurately. The revolution of the machine began with counting a single type tablet to multiple type tablets. This machine had capacities to print out the label and to pack medicines into the package for OPD's patients or daily dose unit for IPD's patients (Tripak, D & Pamonsinlapatham, P., 2016). The studies about the benefit of pharmacy robots or automated dispensing systems are reviewed as follows.

- Decrease human error (Tripak, D & Pamonsinlapatham, P., 2016), (Wulff Risør, B.W., Lisby, M., & Sorensen, J., 2017) , (Goundrey-Smith S., 2013)
- Decrease dispensing time (Tripak, D & Pamonsinlapatham, P., 2016), (Goundrey-Smith S., 2013), (Roman, C., Poole, S., Walker, C., Smit, D.V., & Dooley, M.J., 2016)
- Decrease the congestion of patient flow in the hospital (Magadzire, B.P., Marchal, B., & Ward, K., 2015)
- Decrease pharmacist workload (Tripak, D & Pamonsinlapatham, P., 2016), (Goundrey-Smith S.,2013), (Magadzire, B.P., Marchal, B., & Ward, K.,2015), (Spinks, J., Jackson, J., Kirkpatrick, C.M., & Wheeler, A.J.,2017)
- Cost-effectiveness (Wulff Risør, B.W., Lisby, M., & Sorensen, J., 2017)
- Outpatient satisfaction (Goundrey-Smith S.,2013)
- Support staff attitudes (Goundrey-Smith S., 2013), (Roman, C., Poole, S., Walker, C., Smit, D.V., & Dooley, M.J., 2016)

Interestingly, the study about Comparison on Human Resource Requirement between Manual and Automated Dispensing System stated that ADS can reduce the pharmacist workforce but it increased pharmacist working hours (Noparatayaporn, P., Sakulbumrungsil, R., Thaweethamcharoen, T., & Sangseenil, W., 2017). This study can be implied that the increase of pharmacist workforce was associated with the more comprehensive workflow.

Another interesting system is Centralized automated dispensing systems. The systematic review, including 69 papers by Jean Spinks et al., described three models of centralized automated dispensing systems. When applying the centralized automated system, the pharmacist role will gradually change. In the past, the workforce of pharmacists was measured from the number of prescriptions. With this centralized automated system, the pharmacist role will focus on the quality use of medicines (QUM). However, the checking prescription process before submitting to the centralized automated system and the role of dispensing and counseling are the main important roles of pharmacists (Spinks, J., Jackson, J., Kirkpatrick, C.M., & Wheeler, A.J., 2017), (Kwint, H.F., Faber, A., Gussekloo, J., & Bouvy, M.L., 2011).

Centralized automated dispensing systems can be applied to this study due to the advantage of reducing the ADS cost.

Therefore, From the literature review related to Business Process Reengineering (BPR) and Simulation models as mentioned above, it could be implied that to start integrating BPR or improving the work process, it is necessary to understand the structure of workflow and able to improve an overall business process. The diagram or IDEF0: Integration Definition for Function Modelling would be beneficial to analyze workflow then implementing simulation models on a computer to predict the situations on different assumptions to get the most suitable situation. From the literature review, the benefit of automated dispensing systems can be measured and applied to be the result or performance indicator in this study. Moreover, the literature review related to ADS has the other interesting method which is Centralized automated dispensing systems. The method helps reducing pharmacists' workload and enhance patient safety. Also it is encourage pharmacist to focus more on the quality use of medicines which match with the objective of this study. Therefore, Centralized automated dispensing systems might be one of the scenario to be tested in the future.

In summary, this research will develop simulation models to investigate the implementation factors for the ADS by arena software. Then, this study will compare the result of proposed KPI, discuss on the advantages, and disadvantages between AS-IS and To-BE model.

3. METHODOLOGY

Hospital in case study is a 306-bed public hospital where special management, under the Ministry of Higher Education Science Research and Innovation (HESRI). This research conducted at the outpatient pharmacy department. The outpatient pharmacy department consists of 4 units which are on the 1st floor to the 4th floor. This study conducted in 3 units which are the pharmacy room on the 2nd, 3rd, and 4th floor.

3.1 Pharmacy department workflow (AS-IS)

Outpatient pharmacy department process starts from receiving the medicine from drug warehouse and stores on the shelf area. When a doctor prescribes the medicine, a pharmacist reviews for drug appropriateness. Then, the pharmacist assistant picks the medicine following the doctor's prescription order and dispenses the medicine by a pharmacist. In the case that the patient receives the medicine on the difference floor, the medicine will be transported to the destination where the patient comes in contact. Each pharmacy room on each floor has a similar workflow, as shown in IDEF0 pattern, Figure 1.

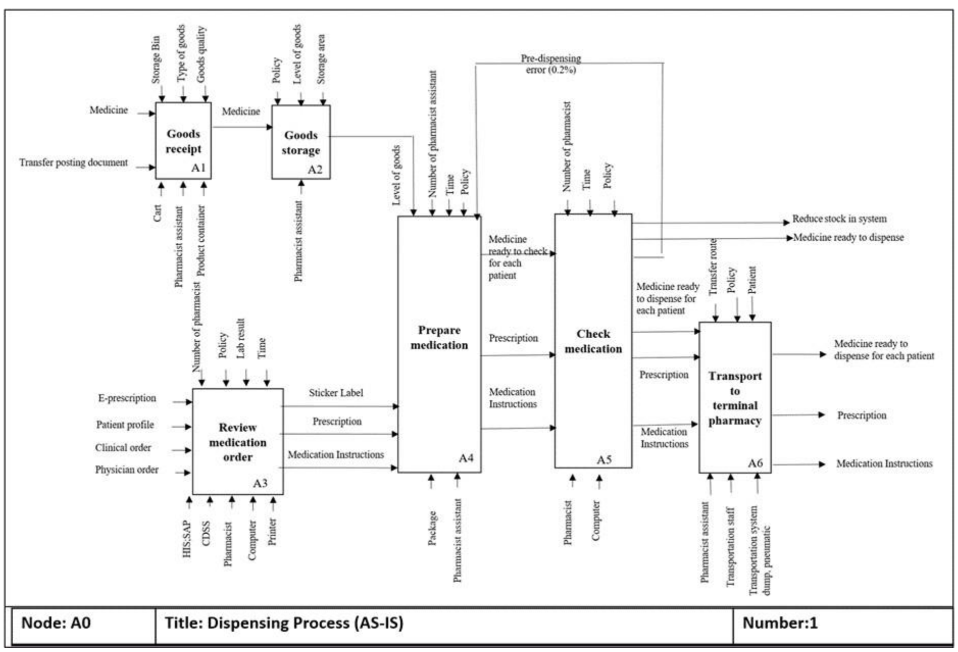

Figure 1. Dispensing process of 2^{nd}, 3^{rd} and 4^{th} floor

From medical preparation process (A4), pharmacist assistants pick the wrong medication

463 times or 0.2% of total medical picking time (231,275 times). In addition, check medication process (A5) has 0.06% dispensing error. Design of experiments: ADS method

The pharmacy department's workflow will be a centralized distribution system. The hospital in this study will merge from 3 pharmacy rooms into 1 pharmacy room with the ADS. Outpatient pharmacy department process starts from receiving the medicine from drug warehouse with a barcode product. When a doctor prescribes medicine, a pharmacist reviews for drug appropriateness and medication order will be separated into ADS and manual system, depend on drug dosage form. A medication prepared by ADS will be transported by a conveyor belt. Whereas, manual drug will be prepared by pharmacist assistants and sent to pharmacists in order to check the medicine. Medication from both ADS and manual system will be matched by pharmacist assistants. Finally, medications are ready to dispense to the patient, as shown in IDEF0, figure 2.

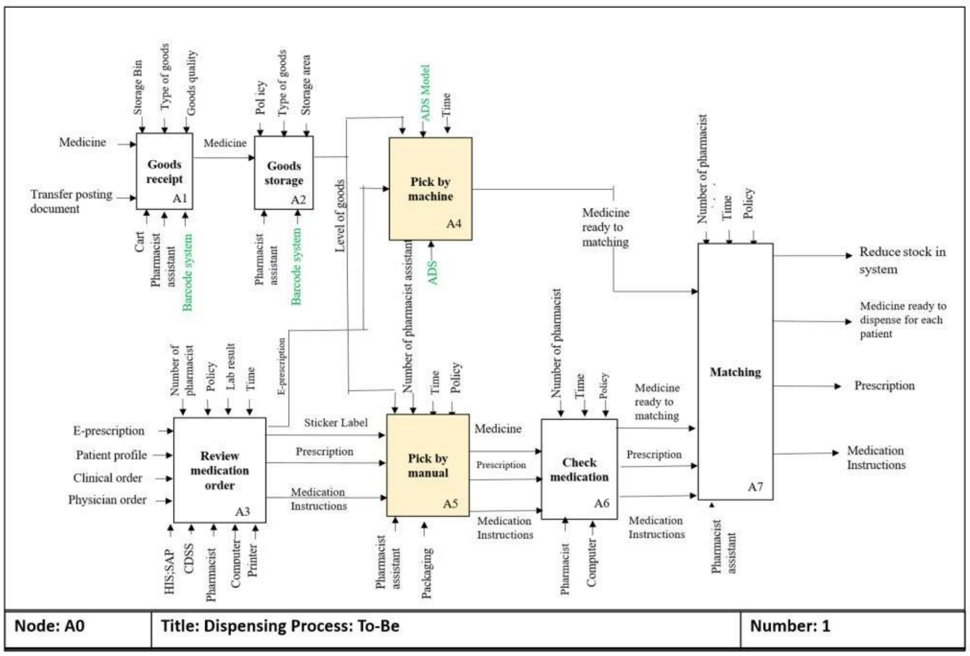

Figure 2. Dispensing process after process development

3.2 Develop conceptual flow

Conceptual flow shows the step of simulation model construction that must clarify the delivery process before modeling. In this study, 2 ADS model is studied, Figure 3 and 4. Conceptual flow relates with the dispensing process (to-be) except in good receipt process (A1) and good storage (A2), which is a one-time process per day.

ADS Model I is a parallel triple machine. The process starts with having a drug prescription into the system, which is data from Excel. The data consists of patients' arrival and medication list that will be prepared. The medication order will be validated by a pharmacist, then the medication list will be separated to 3 machines by drug type. The hard blister pack will be sent to the hard blister machine, the soft blister pack will be sent to the soft blister machine and bottle, box medicine will be sent to box machine. Other forms of medicine will be prepared by pharmacist assistant. All four parts are working in parallel. The medicine that prepared by machine will be transported by conveyer to the matching process. The manual drug must check by pharmacist,0.2% pre-dispensing error was found, if it wrongs the medication must be sent back to the manual process again. The correct manual medication will be sent to the matching process. The matching process is a process in which combines the medicine of one patient form both machine and manual process. When all the medicines have been combined, it is the end of the medication preparation process. At this point, the time can be compared with the time of patient's arrival that the patient has to wait for the medication or not.

ADS Model II is a parallel double machine, which the working time is not equal to the model I. Every process is like model I, the difference is in model II does not have a soft blister pack. Therefore, the soft blister pack will be prepared by manual process.

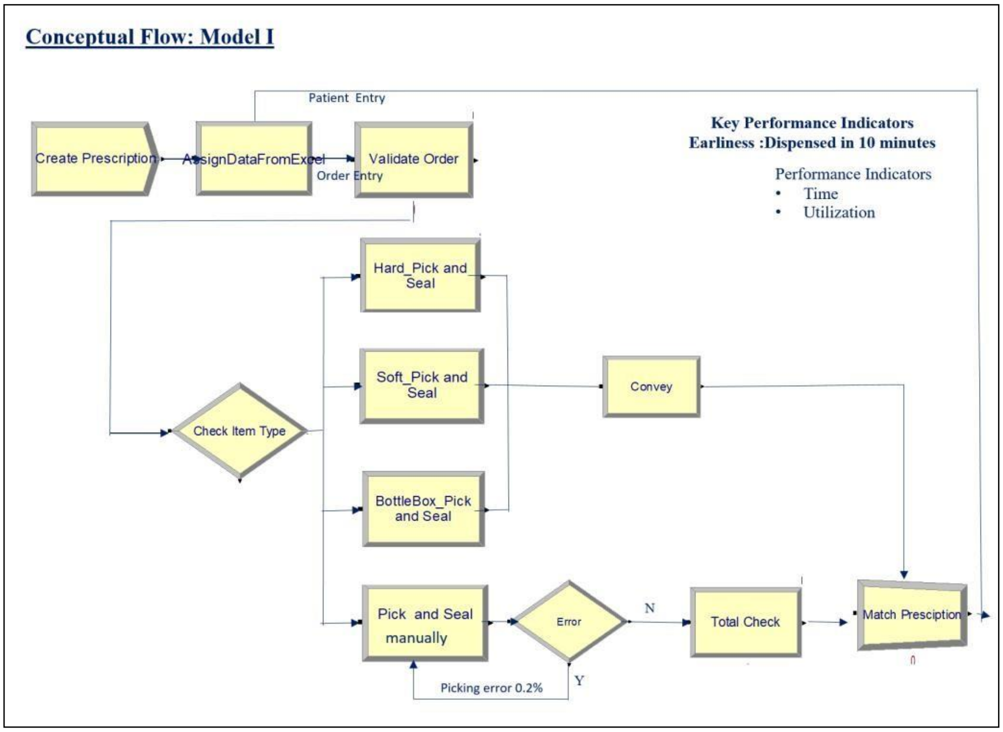

Figure 3. Conceptual flow of simulation modeling: Model I, Parallel triple machine

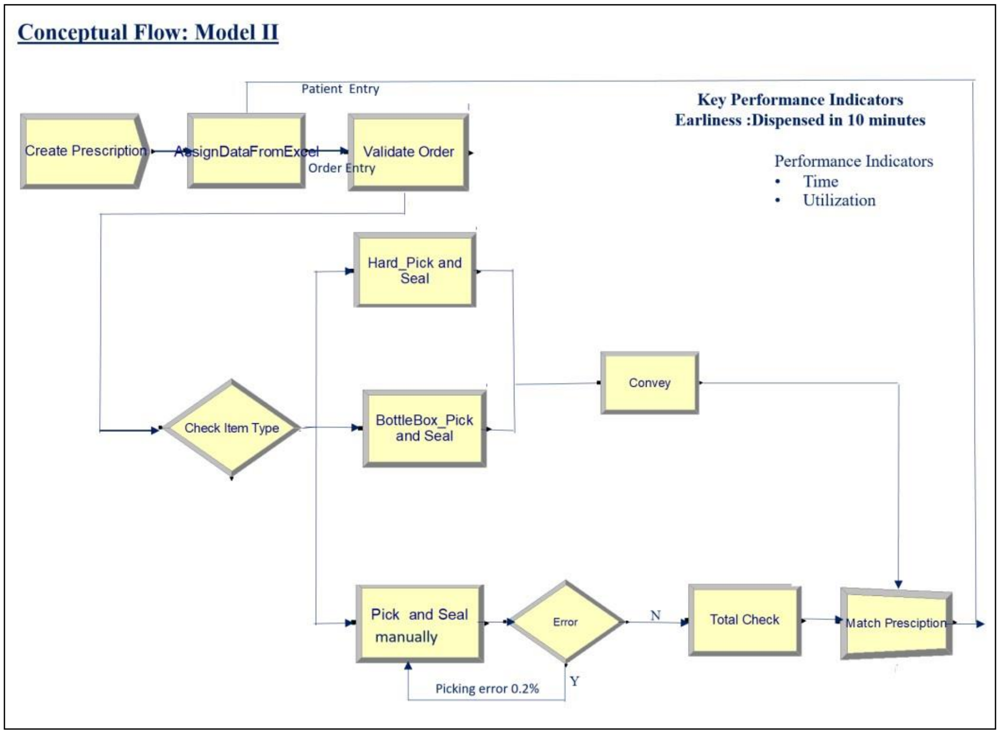

Figure 4. Conceptual flow of simulation modeling: Model II, Parallel double machine

3.5 Data collection

To facilitate the data collection, a computer program was developed using SAP database system version 7400.2.7.1112 Patch Level 7. With this program, the time of events can be automatically recorded by the computer and stored in the database simply. Data was collected 3 month during October to December 2018. From October 1 to December 31, 2018 (92 days), the average number of outpatients who visit at the outpatient pharmacy department is 829 people per day and the average number of medication items are 2,514 items per day. The 2nd floor's pharmacy room has the most workload, there are 113,390 medicine picking time, which is 49% medicine picking time of all outpatient pharmacy departments. So, this study will centralize the pharmacy department on the 2nd floor. 3 months data from October 1 to December 31, 2018 (92 days). The data were tested by Analysis Of Variance (ANOVA) by using Minitab version 17, p-value 0.678, reject the alternative hypothesis. In summary, the patient's distribution in each hour per one day is not different. So, this study selects the most workload day, which is day 2 as a representative for an analysis of the simulation model.

3.6 Input data for the model

The simulation ran by imports the data from excel to Arena program. Data from Excel indicates patient's reference number and drug's reference number of each patient and drug with a time of receiving medication order. The data in excel indicates the time that the patient arrival from order entering. In which the research can compare the time between the finished-drug preparation process (A7) and the patient arrival time. Consequently, the patient waiting time can be calculated. Input the resource and service time parameters data in each process as shown in table 1 and 2. However, the pharmacist's and pharmacist assistant's work schedule are varied somehow to make sure that the utilization is acceptably high and all the patients receive all services within working hours. The validation model is done by input the drug preparation process data, not only medication orders, but also time and work schedule for both pharmacists and pharmacist assistants. The data is run in simulation model created in the Arena and then compare the actual service level agreement (SLA) results and simulation model.

Table 2. Resource and service time parameters in each process of Model I

Process	Resource: Model I	Process time parameters/item
Validate order	Pharmacist (schedule)	15 - 30 sec.
Pick by Hard package machine	Hard package machine	13 - 16 sec.
Pick by Soft package machine	Soft package machine	14 - 17 sec.
Pick by Box package machine	Box package machine	21 - 24 sec.
Pick by manual	Pharmacist assistant (schedule)	100 - 120 sec.
Check	Pharmacist (schedule)	50 sec.
Matching	Pharmacist assistant (schedule)	5 sec.

Table 3. Resource and service time parameters in each process of Model II

Process	Resource: Model II	Process time parameters/item
Validate order	Pharmacist (schedule)	15 - 30 sec.
Pick by Hard package machine	Hard package machine	10 - 12 sec.
Pick by Box package machine	Box package machine	18 - 24 sec.
Pick by manual	Pharmacist assistant (schedule)	100 - 120 sec.
Check	Pharmacist (schedule)	50 sec.
Matching	Pharmacist assistant (schedule)	5 sec.

4. SIMULATION RESULTS

4.1 Dispensing time

Dispensing time starts from the patient’s arrival and they have to wait for the medicine no more than 10 minutes. On the other hand, waiting time less than 10 minutes. In simulation models measure from earliness.

This research runs 30 replications of 931 patients and 3,083 items in day 2. The average SLA result of simulation model I and II is 99.31% and 99.18% respectively, as shown in table 4.

Table 4. Display results of the 30 simulation replication of model I and II

ADS Type	Minimum Average	Maximum Average	Average
AS-IS	94.03%	95.25%	94.81%
Model I	99.18%	99.66%	99.31%
Model II	99.10%	99.25%	99.18%

4.2 Process time

Time period from drug entry into the system until the drug is available to dispense for each patient or matching process from simulation in the computer as shown in Figure 5, 6, 7.

The processing time of model I and II are very minor differences but the processing time of each prescription in AS-IS, the model I and II deviation study shows that the current situation model I and II have the $\overline{x}$, and UCL summarized in table 5.

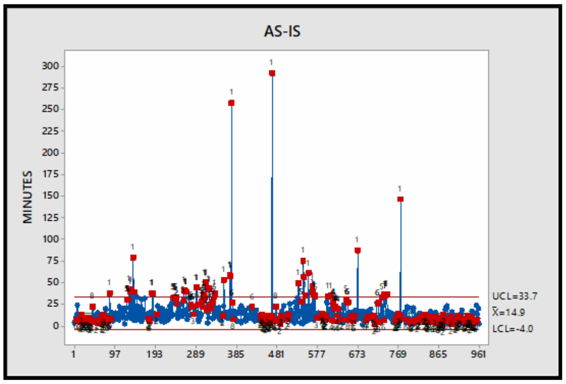

Figure 5. Display control chart of process time in

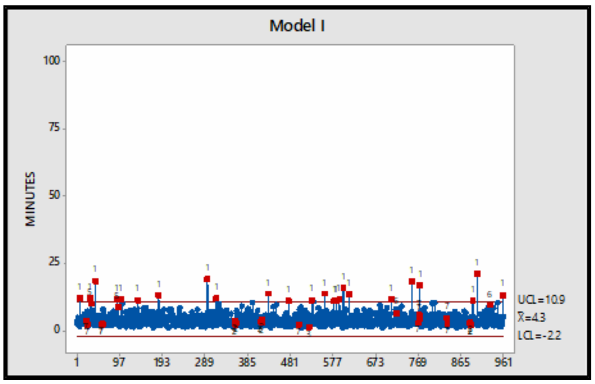

Figure 6. Display control chart of process time of model I AS-IS situation

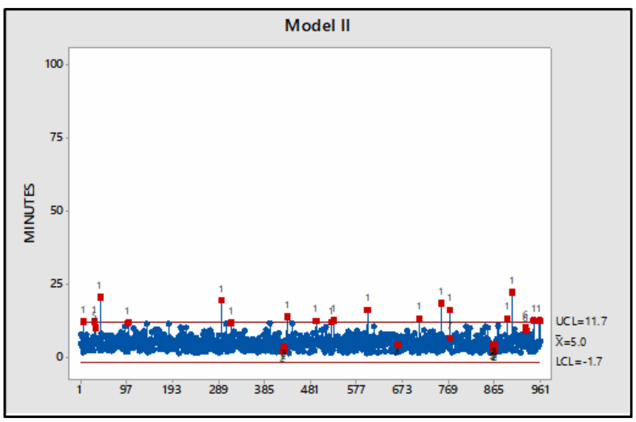

Figure 7. Display control chart of process time of model II

Table 5. Summary of $\overline{x}$, and UCL of the AS-IS, Model I and Model II

ADS Type	Average(minutes)	UCL(minutes)
AS-IS	14.9	33.7
Model I	4.3	10.9
Model II	5	11.7

The table 5 shows that the use of ADS for both models I and II have a smaller UCL value than AS-IS and also have a similar value.

4.3 Full time Equivalent (FTE)

FTE stands for full-time equivalent and it represents the number of working hours that one full-time employee during a fixed time period, such as one day or one month. FTE converts workload hours into the number of people required to complete that work, which can help to simplify scheduling.

Table 6. Comparative FTE between pharmacist and pharmacist assistant for both AS-IS, model I and model II

Resources	FTE:AS-IS	FTE:Model I	FTE:Model II
Pharmacist	26.43	9.01	12.16
Pharmacist assistant	33.86	8.21	13.64

5. DISCUSSION

Developing a simulation of 2 ADS model creates a new business process that uses a machine to reduce the workload of pharmacists and pharmacist assistant. The modeling derived from using IDEF0 to analyze workflow AS-IS and To-be situation. The simulation model of 2 ADS model on Arena program showed that the dispensing time, which achieve the target and full time equivalent (FTE) of pharmacist of model I and model II were 99.31%, 99.18% and 9.01, 12.16 respectively. Compared to the current system, only 94.5% of patients achieve targets and required 26.4 FTE of pharmacists. In summary, both model I and II can reduce dispensing time and pharmacist workforce. However, the simulation is based on the assumption that medical stock management is sufficient.

From table 6 shows that in model II use human resources, pharmacists and pharmacist assistants, more than model I because of the differences in the number of machines (model I; 3 machines and model II; 2 machines). Therefore, the percent of drug automation in model II less than model I, 68.99% and 93.80% respectively.

To apply this study result, the area of operation and the machine's weight in each model should be discussed because of both models I and II are placed in 2nd-floor which is not the ground floor of the building, so there should be an engineer team to participate in the project in order to evaluate the machine's weight per area.

The selection of model I or II should be considered in terms of the price and the team that will be involved or implement the project. In this study, the centralized pharmacy will bring back the floor space and reduce the drug's stock. Changing from product-oriented to patient-oriented requires further study about the number of pharmaceutical care pharmacists.

In summary, the benefits of IDEF0 and simulation technique tools in BPR for the ADS are to understand the workflow and exemplary the possible situations as a systematic method respectively. It leads to the determination of appropriate options. Consequently, in this study IDEF0 and simulation technique are an important tools for the BPR.

6. Conclusion

Transformation of Pharmacy profession from product-oriented to patient-oriented required reduction of pharmacist's workload and rely on ADS to reduce those workloads. Investing on ADS has financial risk, so simulation models will be developed to investigate possible risk and gain the highest benefit from the investment. The main objective of this study is to develop a simulation model to investigate the implementation factors and design the new business processes for implementing the ADS. This research is conducted at Out-Patient Department of a public hospital under Ministry of Higher Education Science Research and Innovation (HESRI) with special administration system. From the literature review related to Business Process Reengineering (BPR) and Simulation models as mentioned in 2.2 , it could be implied that to start the integrating BPR or improving the work process, it is necessary to understand the structure of workflow. Then, it could be able to improve an overall business process. The diagram or IDEF0: Integration Definition for Function Modelling would be beneficial to analyze workflow then implementing simulation models on a computer to predict the situations on different assumptions to get the most suitable situation. From the literature review, the benefit of automated dispensing systems can be measured and applied to the result or performance indicator in this study. Moreover, the literature review related to ADS has the other interesting method which is Centralized automated dispensing systems. The method helps reducing pharmacist's workload and enhance patient safety. Besides, it is encouraging the pharmacist to focus more on the quality use of medicines which match with the objective of this study. Therefore, this research are developed simulation models to investigate the implementation factors for the ADS by arena software version 16 to predict the situations on different assumptions to get the most suitable situation. The hospital in this study will merge from 3 pharmacy rooms into 1 pharmacy room by using the ADS model I and II. The 3 months data from October 1 to December 31, 2018 (92 days) were tested by Analysis of Variance (ANOVA) by using Minitab version 17, p-value 0.678, reject the alternative hypothesis. The result show that the patient's distribution in each hour per one day is not different. So, this study selects the most workload day, which is day 2 as a representative for an analysis of the simulation model. The simulation ran by imports the data from excel to Arena program. Data from Excel indicates patient's reference number, drug's reference number of each patient and drug with a time of receiving medication order. The data in excel indicates the time that the patient arrival from order entering. In which the research can compare the time between the finished-drug preparation process and the patient arrival time. Consequently, the patient waiting time can be calculated. The resource and service time parameters data in each process as shown in table 2 and 3. This study focuses on two performance indicators, dispensing time which the hospital target is patients received medicine within 10 minutes, and pharmacist workforce. The results showed that the dispensing time, which achieve the target and full time equivalent (FTE) of pharmacist of model I and model II were 99.31%, 99.18% and 9.01, 12.16 respectively. Compared to the current system, only 94.5% of patients achieve targets and required 26.4 FTE of pharmacists. In summary, both model I and II can reduce dispensing time and pharmacist workforce. The decreased workload of pharmacist has a beneficial effect. So, pharmacists' profession will focus on pharmaceutical care. However, the hospital in this case study requires pharmacist's competency to ensure the pharmaceutical care method. However, the simulation is based on the assumption that medical stock management is sufficient. In addition, this study does not cover the cost of implementation. Therefore, the hospital in this case study should cover the cost of investment in each model to make a decision, not only the cost of implementation but also human resource expenses by including FTE of both pharmacist and pharmacist assistant from this study to calculate the cost in order to select the most suitable model for the hospital.

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