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Integrating Activity-Based Costing and Computer Simulation to Investigate Thailand-Malaysia Cross Border: A Case Study of Sadao Customs House

P Suttishe, W Kongkaew, L Treeranurat and N Sirivongpaisal*

Business Logistics and Supply Chain Management Research Team, Department of Industrial Engineering, Faculty of Engineering, Prince of Songkla University, Hat Yai, Songkhla, 90112, Thailand

Corresponding author *: nikorn.s@psu.ac.th

Abstract. This research aims to study the cross border service between Thailand-Malaysia at Sadao Customs House, Songkhla, Thailand. Initial problem was stated as severe traffic jam at border and lots of trucks waiting for custom processes. With the purpose of investigating for solution, vital information such as cost of service was needed. Nevertheless; under the current costing system, it cannot lead to the improvement direction as it has not revealed the efficiency of resources consumption which are used to drive service activities. Also, it cannot indicate wastes or unproductive activities operating under the service. Hence this research proposed activity-based costing (ABC) and computer simulation as an integrated tool to investigate the cross border service in order to acquire service cost information which will be used for improvement stage. Results of study can be expressed in terms of cross border service unit cost and activities analysis.

1. Introduction

Thailand is bordered with four neighbouring countries which are Myanmar, Laos, Cambodia, and Malaysia. Thailand's trade with neighbours during the past three years, 2014-2016, has grown steadily with average 0.78%, annually. In 2016, the trade value was worth 1,013,389.20 million THB (125,123.16 million MYR), increased 0.71% from year 2015 (Note 1 THB is 0.12347 MYR on 17 Aug 2018). Then in 2017, it was totally valued 1,076,389.37 million THB (132,901.80 million MYR), which were export value 649,926.84 million THB (80,246.47 million MYR), and import value 426,462.53 million THB (52,655.33 million MYR). Among Thailand's neighbours, Malaysia is a key market with the highest value, accounted for 52.48% of total border trade.

Thailand and Malaysia border trade in 2017 had entire value 564,657.27 million THB (69,718.23 million MYR), increased by 12.61% to 2016, consisting of export value of 312,551.93 million THB (38,590.79 million MYR), and import value of 252,105.34 million THB (31,127.45 million MYR). Main exported products include rubber, rubber products, computer equipment and components, automobile parts and accessories, and particle boards, etc. Also, imported items are computer equipment and components, computer magnetic disk, industrial machinery, etc. Border trade of Thailand and Malaysia can be made through 9 permanent cross border customs houses which are: (1) Sadao Customs House, Sadao District, Songkhla Province; (2) Padang Besar Customs House, Sadao District, Songkhla Province; (3) Su-ngai Kolok Customs House, Su-ngai Kolok District, Narathiwat Province; (4) Tak Bai Customs House, Tak Bai District, Narathiwat Province; (5) Ban Pra Kob



Customs House, Nathawee District, Songkhla Province; (6) Wangprachan Customs House, Kuan Don District, Satun Province; (7) Satun Customs House, Muang District, Satun Province; (8) Betong Customs House, Betong District, Yala Province; and (9) Buketa Customs House, Wang District, Narathiwat Province. Each location of customs house can be illustrated in Figure 1.

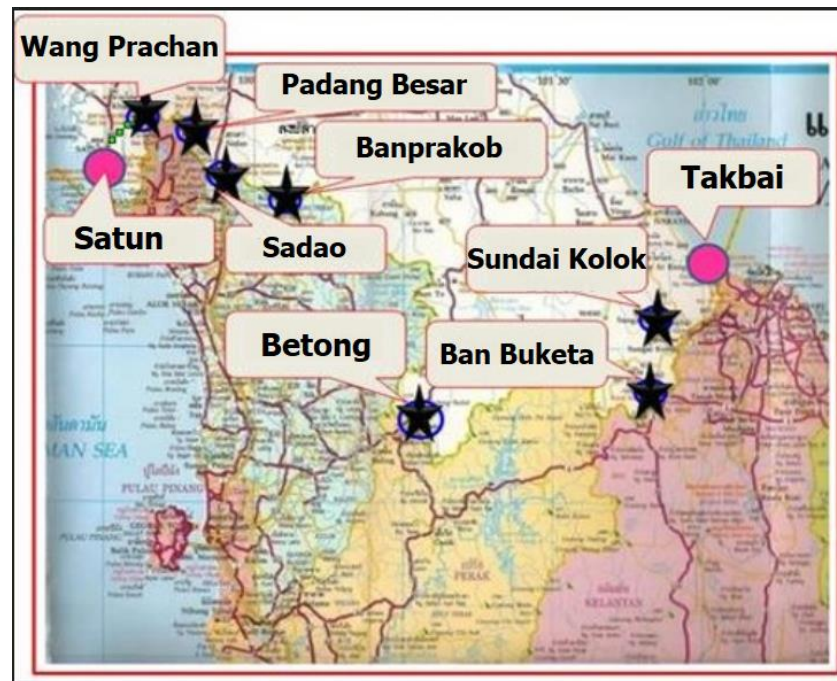


Figure 1. Thailand-Malaysia cross border customs house

With the highest trade value, Sadao Customs House had a trade volume more than 300,000 million THB during 2014-2017. Especially in 2017, its trade value was 348,902.79 million THB and still has the potential to increase unceasingly. Statistics of trade value at Sadao Customs House are illustrated in Table 1.

Table 1. Thailand-Malaysia Border Trade Value at Sadao Customs House.

Year	Export (Million)		Import (Million)		Total (Million)	
	THB	MYR ^a	THB	MYR ^a	THB	MYR ^a
2014	156,064.95	19,269.34	192,711.94	23,794.14	348,776.89	43,063.48
2015	143,474.24	17,714.76	181,459.78	22,404.84	324,934.02	40,119.60
2016	147,495.00	18,211.21	185,497.60	22,903.39	332,992.60	41,114.60
2017	165,682.32	20,456.80	183,220.47	22,622.23	348,902.79	43,079.03

^a 1 THB is 0.12347 MYR on 17 Aug 2018.

Key factor such highway infrastructure connecting central Thailand to ports in Malaysia is contributing to the highest trade value of Sadao Customs House compared to others. Consequently, the number of trucks crossing border at Sadao Customs House is increasing every year, resulting in congestion at border. As well as, customs clearance procedure at the border may cause delay and lead to more congestion.

The field survey was conducted during January 2018 and it was realized that the average number of trucks in queue was 308 trucks per day in regular time but it could be up to 370 trucks per day in festival period or long weekend, resulting in not only traffic jam at border but also missed shipments

to port. This delay problem has a negative impact on customs operations, rising in increased workflows, unnecessary overhead costs, which can affect to the efficiency of sector based on cost effectiveness. So information about costs is compulsory to investigate cost effectiveness. Currently, the costing system used in public sector is established on resources basis categorized into personnel costs and non-personnel costs. Personnel costs are such salaries, wages, and remunerations. Non-personnel costs include machinery and equipment cost, material cost, and overhead cost. It does not reflect to activity running in that sector. And there are not much details linking to processes and operations. Therefore this research targets to analyze cost of cross border service at Sadao Customs House based on activity or so called “Activity-Based Costing (ABC)” integrating with computer simulation. The key mechanism of ABC is cost allocation to activities. Besides, simulation model has beneficial role in this study by providing the reflection of cross border activities which are subjected to change under the uncertain working environment. Study objective is to realize the actual cost of cross border service of customs house by ABC and to identify value of improvement opportunities in Sadao Customs House.

This paper is organized into 5 sections, which are (1) Introduction, (2) Literature review, (3) Research methodology, (4) Results and discussion, and (5) Conclusions and future research.

2. Literature review

In this section, some related theories and research works were reviewed and presented. Beginning with ABC model, and computer simulation technique is reviewed after that. At last, former researches are wrapped up in order to give some ideas for all readers.

2.1. Activity-based costing

Activity-based costing (ABC) is the concept of cost management system, which is aimed for administrators focusing on managing activities and associated costs; therefore it aims directly to activities. Activities cause expenses and cost, and product is stemmed from those activities. Activity is the process of transforming an organization’s resources into a product and it drives cost incurred in organization. ABC system is an important and indispensable for cost and service analysis. It can illustrate cost of service and identify factors affecting to the cost and nature of activities. Besides, it can be used as a tool for decision making to improve operations or activities to be more efficiency thru waste identification or waste reduction. Three basic principles of ABC [1] can be stated as: (1) activities consume resources; (2) activities have a reason; and (3) customers, products, or channels cause different levels of activity. Hence ABC mainly spots on the activities of process and endeavour to identify the cost of each activity driven by resources in order to calculate product cost.

Difference between traditional costing system and ABC system can be stated in two key points. First, ABC allocates costs based on activity cost pool basis rather than cost pool basis. Second, activity or resource driver, which is used as a basis for calculating product cost, is structured differently from the traditional costing system. Each activity must be analysed what is the resource driver or the root cause that drives the cost of activity. This makes ABC more proper for organization having variety of products. Albeit product diversity is not the existing condition for organization; somehow, ABC still offers cost allocation principle which is in line with the proportion of activities that they actually consume contrasting to traditional costing system which ignores the principle that resources are actually consumed by activities.

A number of terms commonly used in ABC which is referred from [1] are presented in Table 2.

Table 2. Definition of ABC Terms.

Term	Definition
Resource	A resource used by the business in carrying out its business
Resource driver	A measurable quantity used to allocate resources to activities
Process	A series of connected activities required to achieve an outcome

Activity	A series of related tasks carried out repeatedly
Task	An element of work, a series of which make up an activity
Activity driver	An event or factor that causes an activity to be performed
Cost object	The entities that are to be costed

2.2. Computer simulation technique

Simulation is the method used to simulate real situation or system behaviour on a computer. With the ability of computer software, it can imitate the flow of activities by collecting and analysing data, building computer model, using it as a tool for investigating existing system and for improving future one without interfering the real system. Steps in conducting computer simulation study [2] can be summarized in the following steps: (1) define objective and plan the study, (2) collect and analyse system data, (3) build the model, (4) validate the model, (5) conduct experiments, and (6) present the results.

The great advantage of simulation is the power to deal with dynamic situation of system such as rapid change and high uncertainty. It makes system improvement more suitably. Nevertheless; there are still some drawbacks for computer simulation such (1) training and time exhausting for model building, (2) underlying comprehension of the system that decision maker must have, (3) necessity to have validated model, otherwise answers are hardly representative of system.

2.3. Related researches

In this section, earlier ABC research studies [3-5], focusing on methodology and applicability, are presented. Bokor and Markovits-Somogyi [3] studied logistics service providers who require reliable and true information about service costs. Distortions of costing information shall be minimized and the drivers of costs shall be accurately explored. Methodology of ABC and industry specific adaptations may be used to improve the accuracy of logistics service providers' costing procedures. Additionally, it can deliver information on cost efficiency as well. This paper aims to analyse the applicability of ABC for the case of logistics service providers.

While Ping and Yu [4] explored scientific and technological levels of Chinese society which had a substantial increase and domestic logistics industry had also achieved a rapid development. However, compared with the logistics enterprises of other countries, Chinese logistics enterprises costing system was still lagging behind and cost management awareness was relatively weak. This study discussed the practical application of the ABC system in the logistics business enterprise based on the analysis of cost management status of logistics from the microscopic point of view.

Prior that Baykasoglu and Kaplanoglu [5] investigated modern costing approaches including ABC for in-land transportation companies. One of the main difficulties of in-land transportation companies is to determine and evaluate true cost of their operations and services. If used and implemented properly, ABC can be very helpful for transportation companies to determine cost of their operations with higher accuracy. In this paper, an application of ABC to a land transportation company that is located in Turkey was presented in detail. In order to improve the effectiveness of the ABC, an integrated approach that combines ABC with business process modeling and analytical hierarchy approach was proposed. It was figured out that the proposed approach was quite effective in costing services of the land transportation company compared to the existing traditional costing system which was in use.

Additionally, simulation integrated to ABC works were reviewed in a number of works such as [6] developed a simulation model to measure costs in an emergency department setting for patients presenting with possible cervical-spine injury who needed radiological imaging. Simulation was introduced as a realistic means to perform ABC analysis, because traditional ABC methods had difficulty coping with process variation in healthcare. Simulation was found to be an accurate and viable means to conduct an ABC analysis. Research output provided more complete information than could be achieved through other conventional analysis, which extra influenced management to negotiate contractual reimbursements better. Also, Spedding and Sun [7] illustrated how discrete event

simulation may be used to evaluate the ABC of a manufacturing system. A visual interactive simulation software WITNESS was used to model a semi-automated printed circuit board (PCB) assembly line. The PCB assembly line case study demonstrated how ABC can be applied to a manufacturing system using simulation modelling techniques. Lastly, Takakuwa [8] studied a framework to design simulation models in order to perform ABC for flexible manufacturing systems. In this study, a simulation model for a FMS was constructed. Then a procedure for cost accounting was developed for obtaining the unit cost of the products through simulation experiment. It was shown that precise cost accounting can be performed compared to actual manufacturing activities, if kinds of designated products and their production quantities were specified.

3. Research methodology

In this section, the research methodology is presented. Actually, it can be derived from two parts which are ABC and simulation integrated to methodology having details as follows:

- Step 1: identify cross border system including with processes, activities, resources costs.
- Step 2: analyse cost of specific activities which are classified into six activities (A1-A6) for cross border system.
- Step 3: allocate resources into all activities in proportion to time spent.
- Step 4: analyse cost of activities.
- Step 5: collect, analyse data and develop computer simulation model by ProModel, also verify and validate the model.
- Step 6: develop activity cost drivers and allocate cost of activities to total cost of cross border service by running simulation model.

It can be illustrated in Figure 2.

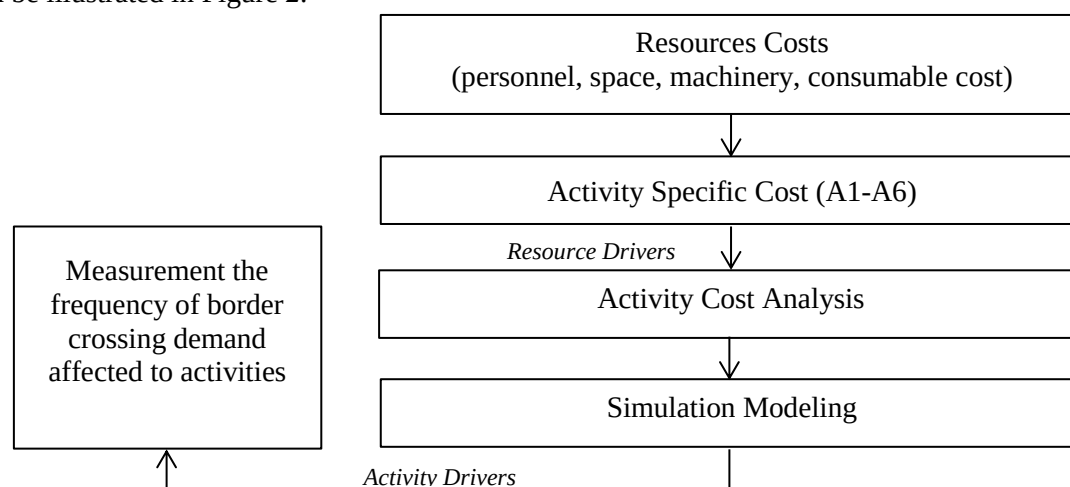


Figure 2. Research methodology (adapted from [1])

4. Results and discussion

According to research methodology illustrated from the last section, results and analysis will be discussed in the following. This study is mainly focused on all activities of Thailand-Malaysia cross border, especially import and export. Data were collected and analysed from primary and secondary sources.

4.1. Activities analysis

Cross border service at the Sadao Customs House can be divided into four main processes, which can be described as follows. When a truck arrives at the Customs House, the driver submits documents for custom inspection. After documents are approved, X-Ray inspection is the next process. And then, the

following stage is release inspection process for export. At last, the truck will drive to border for final release inspection process for crossing border. Entire processes of cross border, drawn in dash rectangle, can be illustrated in Figure 3.

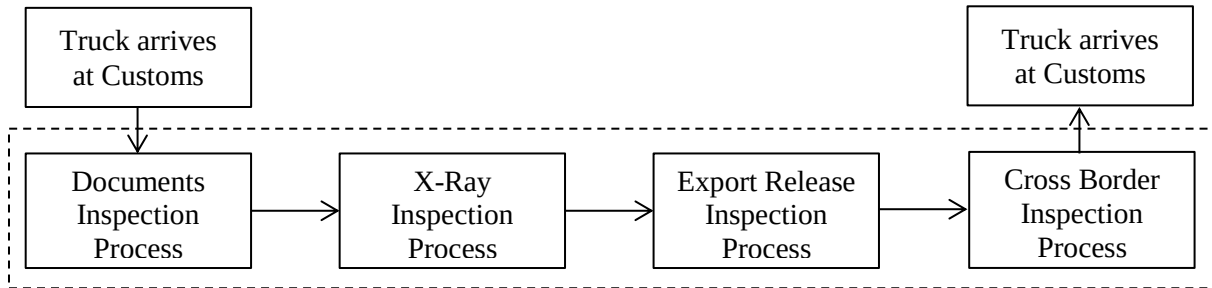


Figure 3. Processes of cross border service

From the four main cross border processes previously illustrated, they can be shown that the activities and the tasks embracing to these processes in Table 3.

Table 3. List of activities and tasks in cross border system

Activity Code	Activity	Task Code	Task
A1	Receive bill of lading	A11	Transact data to e-Export system
		A12	Authenticate information with shipping company by e-mail
A2	Inspect bill of lading	A21	Assign code number to bill of lading
		A22	Check the validity
		A23	File document to the system
A3	Validate the documents for X-Ray inspection	A31	Prepare documents for cargo inspection and identify type of cargo
		A32	Prepare documents for X-Ray inspection
		A33	Arrange the order for X-Ray inspection
A4	Inspect cargo by X-Ray	A41	Inspect cargo
		A42	Scan bill of lading
		A43	Arrange documents and submit X-Ray inspection results to e-Export system
A5	Prepare customs export's documents	A51	Verify X-Ray inspection results
		A52	Prepare export's documents

Table 3. (continued) List of activities in cross border process

Activity Code	Activity	Task Code	Task
A6	Validate documents for releasing export	A61	Check the authenticity of export's documents and bill of lading
		A62	Check truck's license plate and match with filed documents

4.2. Resources cost allocation

Resources cost data during January through December 2017 of Sadao Customs House was sourced for calculation the activity specific cost, as shown in Table 3. These resource costs are personnel cost, space cost, machinery and equipment cost, and consumable cost. In this study, the operating time of each activity and number of usages were used as resource driver. Allocation of resources cost framework can be illustrated in Figure 4.

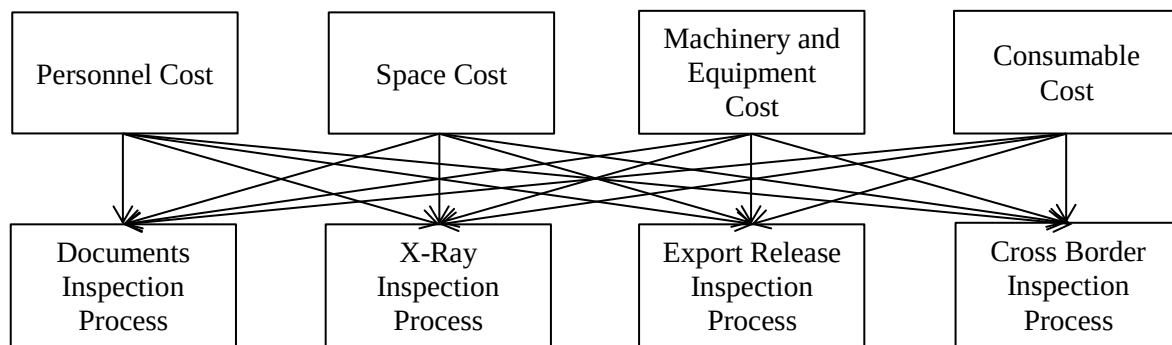


Figure 4. Resources cost allocation framework

Result of resources allocation to specific activities (tasks) and uniting them into the activity cost can be demonstrated in the following Figure 5.

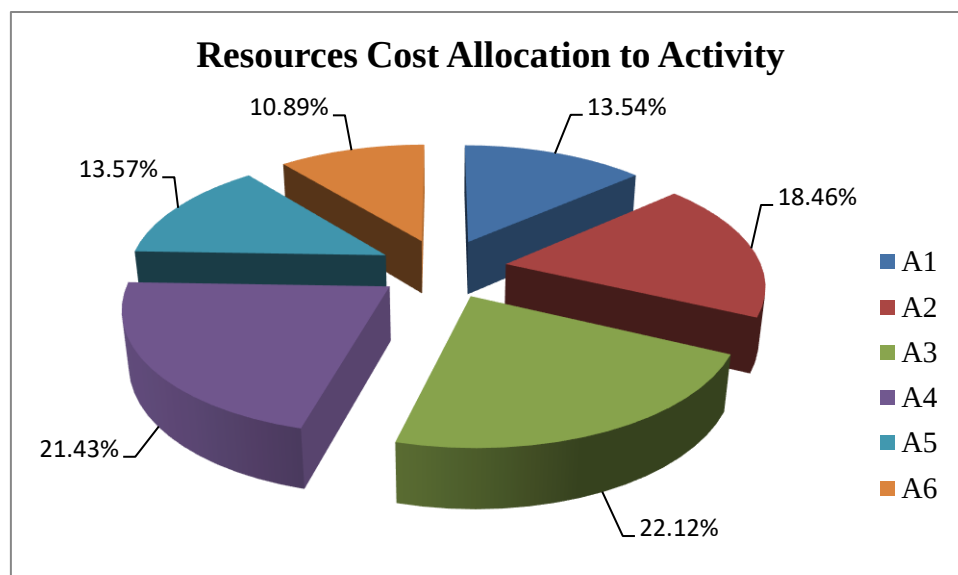


Figure 5. Resources cost allocation

4.3. Simulation modeling of cross border system

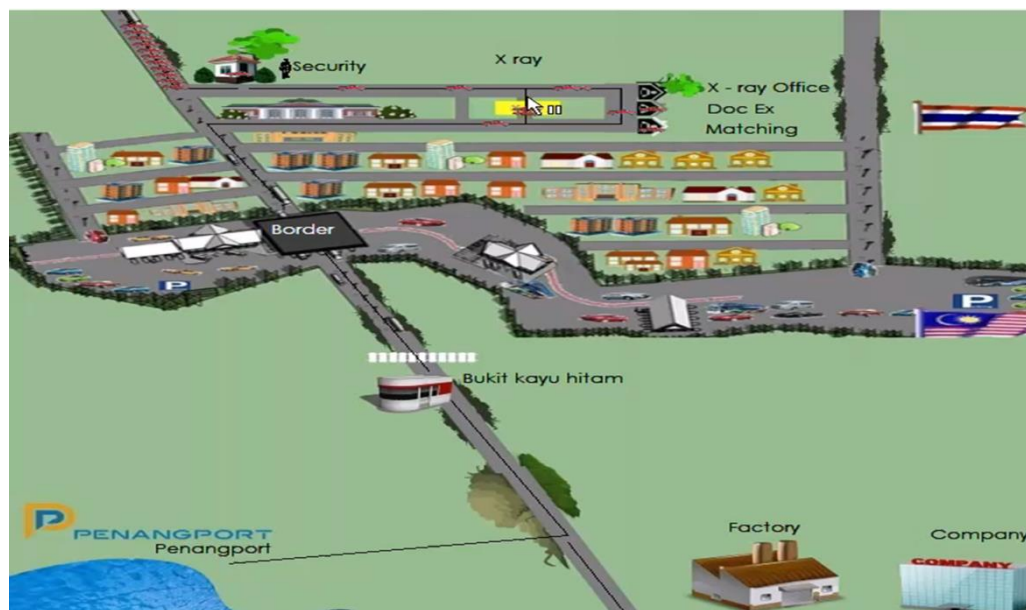
Cross border simulation model was handled by ProModel® 2016 software package and sequentially developed along Figure 3 above. Data collection and data analysis such truck arrival time, data inspection time, data inputting time, X-Ray inspection time, inspection time of releasing export, etc. were carried out. Data analysis can be presented the results in Table 4.

Table 4. Distribution and parameter estimation for cross border process

Process	Distribution	Parameter	Unit
Truck arrival time (05:00-23:00)	Weibull	$W(0,1.26,2.82)^a$	minutes/truck
Data inspection and data inputting time	Weibull	$W(3,1.75, 0.197)^a$	minutes/truck
X-Ray inspection time	Fixed	5	minutes/truck
Export release inspection time	Weibull	$W(4,7.65,0.496)^a$	minutes/truck
Cross border inspection time	Weibull	$W(2,2.44,0.191)^a$	minutes/truck

^a Weibull (min, alpha, beta)

Subsequently, cross border model was built, verified, and validated. In order to ensure that the simulation model can be the representative of the real system, it can be shown that the *P-value* of hypothesis testing is 0.437 which indicates no rejection on hypothesis. Illustration of cross border simulation model can be presented in Figure 6.

**Figure 6.** Cross border simulation model

4.4. Cost object of cross border service

As described in Figure 3, this study was integrated with simulation modeling to measure the frequency of border crossing demand affected by activities, which simulation results will serve as activity drivers for ABC. Activity cost was analyzed by tracking resources cost to each task and combining all together to activity cost. And simulation model was built and run for 15 replications to collect number of trucks that cross border through Sadao Customs House. The simulation outputs can be exhibited in Table 5.

Table 5. Simulation outputs and cost object

Activity Code	Activity Cost (Baht/Year)	Activity Driver (Number of Trucks)			Activity's Unit Cost ^a (Baht/Truck)
		$\bar{x}$	S.D.	95% CI	
A1	4,290,188.58	316,989	249	(316,852 ; 317,127)	(13.540 ; 13.528)
A2	5,849,288.35	474,173	44	(474,149 ; 474,197)	(12.336 ; 12.335)
A3	7,010,145.84	109,705	6	(109,702 ; 109,708)	(63.902 ; 63.898)
A4	6,791,095.42	109,705	6	(109,702 ; 109,708)	(61.905 ; 61.902)
A5	4,301,518.70	315,623	9	(315,618 ; 315,628)	(13.629 ; 13.628)
A6	3,450,073.44	314,341	6	(314,337 ; 314,344)	(10.976 ; 10.975)
Total					(176.288 ; 176.267)

^a equal "Activity cost is divided by number of trucks"

From Table 5, each activity cost resulting from resource allocation is presented and can be realized that the highest and second highest activity cost are from X-Ray inspection process. The key item which contributes to these costs is machine depreciation. Moreover, number of trucks which is obtained from running simulation is used as activity driver to calculate unit cost and eventually compute the total cost of cross border service.

Also, it can be recognized that high variation in number of trucks is only arisen at A1 activity, which is the first operation of Customs House where truck entering. This phenomenon is compliant to the field survey which was conducted before the study, which there is truck jam at the border. Trucks could be queued up, approximately to 300 trucks per day and it could be more severe during festival period or long weekend. Regularly, office hours of Sadao Customs House are between 05:00-23:00. The main reason of border jam is truck arriving border continually and concurrently since every single truck expects to obtain the first queue. However, some of them may have trouble with information authentication task between shipping company and Customs House, which can cause delay and queue up.

Next, each activity's unit cost is also calculated in Table 5. All are alike between lower and upper unit costs, except A1's unit cost is slightly different. Lastly, cost of cross border service at Sadao Customs House is 176.28 Baht/Truck.

5. Conclusions and future research

This study has main objective to investigate the cost of cross border service at Sadao Customs House, Songkhla, Thailand by integrating ABC and simulation. Major advantage of integration two techniques is from the outstanding aspect of each technique. ABC can accurately reflect the product or service cost based on resources consumed by activities running into that product or service. Simulation model can imitate the working environments that surround the activities which operate for product or service. Future research is to find the solution to improve cross border service focusing on operations or activities and making them to be more efficiency thru waste identification.

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