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Productivity Improvement for Unit Terminal Container using Lean Supply ChainManagement and Single Minute Exchange of Dies (SMED): A Case Study at Semarang Port in Indonesia

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Abstract: The main business process in Unit Terminal Container (UTC) is collecting containers from the hinterland or other ports for transportation to the destination. The company that operates UTC is required to improve services in supporting the smooth process of goods services and creating optimal port productivity. This study aims to increase UTC productivity using the concept of lean supply chain management by analyzing using value stream mapping (VSM) and improvement with Single Minute Exchange of Dies (SMED) and 5S (Seiri, Seiton, Seiso, Seiketsu, Shitsuke). Based on result of VSM, it is obtained the highest waste in unnecessary motion (18,574%) and transport of documents (18,154%) with value added activities of 60,81% and the percentage of non-value-added activities of 39,19%. Improvements using SMED method and 5S resulted in increased efficiency from 60,81% to 70,20%.

Keywords: Unit Terminal Container, Port, Value Stream Mapping, Lean Supply Chain Management, Single Minute, Exchange of Dies (SMED), 5S

1. Introduction

Indonesia is a country that has a geographical condition in the form of islands where two thirds of its territory consists of waters. For island nations, the existence of ports plays an important role as one of the means in connecting between islands. The port is part of the transportation infrastructure to support economic activities in an area, where the port is a major milestone in the running of the transportation and logistics system [1]. At present, most export-import activities as well as domestic and foreign goods distribution are carried out through the sea transportation system. The system of sea transportation using ships is considered to be better compared to other transportation systems, because the ships have greater carrying capacity or capacity so that export-import activities and distribution of goods are more effective [2]. One of the port companies in Indonesia that provides container stacking and services handling, which in its operational activities acts as a party that supports the smooth running and regulates the process of transporting goods in export and import activities to and from Indonesia. This port company does not focus on cargo or goods but only focuses on containers that carry cargo for export or have been imported. As for the last five years, loading and unloading activities carried out by the company have increased. This increase is due to the increasing number of suppliers doing goods services (distribution) through the sea [3].

Therefore, in a port company, an increase in service is needed to support the smooth process of goods service and in an effort to create optimal port productivity [4]. Improving productivity can be done by reducing the waste increasing the

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value-added products, as well as shortening the lead time [5]. Increased productivity can occur if there is a downsizing operation that can identify earlier waste and quality problems that are likely to occur in the future [6]. Implementation of lean supply chain management can be applied to identify the wastes that exist and identify the causes of wastage that occurs along the supply chain [7]. The lean supply chain management concept can be interpreted as a concept that focuses on process improvement or efficiency improvement.

The port research has been carried out by previous researchers even today, but there is still a lack of research on ports related to the implementation of lean supply chain management by using value stream mapping. Research on value stream mapping has been carried out in the Thai automotive industry, where to increase industry competitiveness approach is implemented lean supply chain management. The results show that the application of VSM can shorten the lead time production by 80%, reduce the total cycle time by 21,3%, and increase the value added by 293,3% [8]. Furthermore, value stream mapping is also used in ship safety inspections in Surabaya Port in investigating existing procedures and to identify waste activities and non-value added (NVA) activities in the existing process. The mapping results shown on value added activities throughout the process namely delays, queuing, doing the same job repeatedly, and losing documents [9]. Then, value stream mapping is also used to analysee and optimize company processes that operate in complex supply chain networks, where the application of value stream mapping helps optimize value in the company's supply chain. [10].

Based on previous studies, then with the application of lean supply chain management, it is expected to improve the productivity of the goods service process in port companies to be better. Implementation of lean supply chain management is done through the use of value stream mapping to map the company's current operational conditions, involving the identification of seven wastes that has been modified in accordance with the service companies [11,12,13]. Existing problems have been formulated in indicators related to lean supply chain. In value stream mapping can be known the flow of information contained along the supply chaining the company. In addition, through value stream mapping can also be known the lead time of each process that occurs [14]. This research is done at Unit Terminal container at Semarang port In Indonesia.

2. Method

The study was conducted at one of the port companies in Indonesia. The research focuses on the process when the container enters the port company until the container process is loaded onto the ship. At this early stage is to identify waste by using waste assessment model that helps to show how the relationship between waste and how to rank each type of waste that occurs so that it can immediately be minimized. Waste assessment models performed by administering a questionnaire and discussion to the parties involved in the process of occurring, so the answers obtained based on expert judgment. Types of waste used in the questionnaire are Doing Work not Requested, Backlog of Work, Errors in Documents, Transport of Documents, Unnecessary Motion, Waiting for the Next Step, Process Steps and Approval. Furthermore, an indicator formulation of the concept is carried out lean supply chain which is then represented in stream mapping current state value as a benchmark in reducing waste. The waste that dominates the cause and effect identification then can be proposed for improvement by using the Single Minute Exchange of Dies and 5S. So that at the final stage of this research, there will be future state stream mapping.

3. Result and Discussion

3.1 Analysis of Waste Assessment Model

Identification of waste was performed using methods Waste Assessment Model (WAM), which aims to simplify the search for waste that dominates in a process. In addition, the waste assessment model is able to contribute accurate results in identifying waste [15]. Waste ratings and adjusted to the type of waste that has been modified according to the service company [11,12,13].Based on the assessment results shown in Table1, the type of waste that will be analysed and reduced further is the motion (unnecessary motion) of 18,574% and transportation (transport of documents) of 18,154%.

Table 1 - Recapitulation of Waste Assessment Model

Waste	O	I	D	M	T	P	W
Score (Yj)	0,037	0,040	0,031	0,031	0,047	0,018	0,033
Pj Factor	0,020	0,014	0,026	0,027	0,017	0,012	0,015
Final Result (Yj Final)	0,001	0,001	0,001	0,001	0,001	0,000	0,000
Final Result (%)	16,778	12,629	17,908	18,574	18,154	4,897	11,060
Rank	4	5	3	1	2	7	6

3.2 Analysis of the Current State Value Stream Mapping

Mapping using value stream mapping can later be obtained an overview of the information flow and the physical flow of the existing system, identify the waste, and describes the cycle time and lead time required of each process that occurs. Based on the current state value stream mapping, the total cycle time of the entire goods service process in the company is 527.800seconds or 146, 3 hours for a single work. After known cycle time is, it can also be seen that the total lead time is 867.900 seconds or 241,1hours. The results of mapping the current state value stream also shows the percentage of efficiency in the goods service process in the company the total cycle time and the total lead time obtained. The percentage of efficiency in the process of goods service in the company amounted to 60,81%, as well as the percentage of activity in value added by 60,81%and the percentage of activities non value added amounted to 39,19%. Current state visual stream mapping can be seen in Appendix A.

3.3 Problem Solving

Waste of unnecessary motion and transport of documents are waste that has a related relationship so that reduction in waste can be done at the same time [16]. Based on the results of problem-solving analysis using 5W+1H (as depicted on Figure 1) can be given recommendations for improvement by re-layout and re-arranging the work. This improvement recommendation is given to shorten the distance between containers stacked in the container yard and shorten the distance between the stacking field and office area. Re-layout can be done by considering inter-activity. However, based on the results of observations in the company and expert discussions that re-layout will be difficult in the company environment. This is because, the operational activities carried out in the company use large-sized tools and will require large costs if this is done. In addition, if this re-layout is done it cannot be ascertained whether it is able to reduce the waste that occurs in the company. So, the researchers suggest implementing Single Minute Exchange of Dies (SMED) to reduce unnecessary motion, as well as the application of 5S periodically.

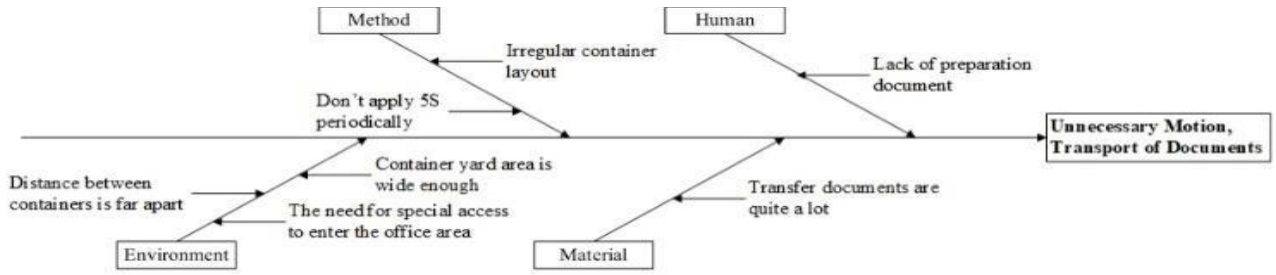

Fig. 1 - Fishbone for waste of unnecessary motion and transport of documents

3.4 Propose Solution

Single Minute Exchange of Dies (SMED) is done by changing activities or activities that can be changed from internal activities to external activities to save time setup. Next parallel or combine external activities to simplify and shorten time setup [14]. Before the application of SMED, the total time setup needed was 375 minutes or 22.500 seconds as seen on Table 2 and 3. Based on Table 3, combining the activity of collecting goods and sorting items in CFS into one activity. Furthermore, the implementation of 5S is done by doing colour labelling when collecting items, so that it will be easier when sorting items. In addition, the merging of activities is also carried out in the activity of submitting an application for requesting inspection of goods and submitting a letter requesting inspection of goods into one activity because it is considered to be carried out simultaneously. After the implementation of SMED, it can be seen that the resulting improvement is the reduction in the total time setup from 375minutes or 22.500 seconds to 160minutes or 9.600 seconds. This shows that there is an improvement of 57,33%with a difference in time setup of 215 minutes or 12.900 seconds. Besides the application of 5S periodically can facilitate access for workers as well as in an effort to reduce waste of unnecessary motion. The 5S design in the work environment is as follows:

1) Seiri

The application of seiri can be done by doing colored labeling to identify items based on their type (classification cargo). The design of color labeling based on classification type is cargo as follows green label for containers with perishable loads, red label for containers with dangerous loads, blue color labels for containers with liquid cargo, yellow label for container with mandatory insurance load, orange label for containers with special loads (potentially damaging containers), brown labels for containers with documented contents. This design can be used in the CFS area or container yard area to separate containers based on the type of classification cargo that is loaded so as to shorten the time.

2) Seiton

Upon entering the office area, documents were piled up on the workers' desks and on the floor around the workbench, whether the documents had been completed or not. Therefore, the application of seiton can be done by providing a

document storage area with a label so that it makes it easier for workers or operators to search and store documents according to their place.

3) Seiso

The application of seiso can be done by providing adequate cleaning equipment and applying a periodic cleaning schedule to keep the workplace always clean. To expedite the application of seiso, a schedule for cleaning the entire office area should be made periodically, at least once a month. As for cleaning in the CFS area or container yard, each operator clears the work area immediately after working hours.

Table 2 - Before Application of SMED

No	Activity	Time Setup	Activity
A1	Entrance Gate In	10	Internal
B1	Preparation Forklift	30	Internal
B2	Collecting goods at CFS	20	Internal
B3	Sorting of goods	20	Internal
B4	Entering goods into containers (stuffing)	15	External
C1	Preparation of customs documents	40	Internal
C2	Submission of application for request for inspection of goods	20	Internal
C3	Submission of a letter requesting inspection of goods from customs and excise items	20	Internal
C4	Clearing of Funds	15	Internal
D1	Terminal parties coordinate with agents shipping regarding the contents of the plan to be loaded	15	Internal
D2	Agent shipping sends pre-plan the allocation of place container on the board	10	Internal
D3	Ship planner to create and coordinate pre-plan before it is submitted to the ship	10	Internal
D4	document creation loading for field personnel	30	Internal
D5	Trucking, container in stack yard (CY)	60	External
D6	Stevedoring (CY to Wharf)	60	External
	Total time Setup	375	

Table 3 - After Application of SMED

No	Activity	Time Setup	Activity	Time Setup
A1	Entrance Gate In	10	Internal	10
B1	Preparation *Forklift*	30	External	
B2	Collecting and sorting items in CFS	30	External	
B3	inserting goods into containers (*stuffing*)	15	External	
C1	Preparation of customs documents	40	Internal	40
C2	Submission of a request for inspection of goods from customs and excise	40	Internal	40
C3	Clearing of funds	15	Internal	15
D1	Terminal parties coordinate with agents shipping regarding the contents of the plan to be loaded	15	Internal	15
D2	Agent shipping sends pre-plan the allocation of place container on the board	10	Internal	10
D3	Ship planner to create and coordinate pre-plan before it is submitted to the ship	10	Internal	10
D4	document creation loading for field personnel	20	Internal	20
D5	Trucking, container in stack yard (CY)	60	External	
D6	Stevedoring (CY to Wharf)	60	External	

	Total time Setup	355	160

4) Seiketsu

Seiketsu is considered as a repetition of sorting, structuring, and cleaning or can also be made by making rules or standards related to 3S and its provisions. In addition, it is also an awareness and activity that guarantees that 5S conditions are maintained. The steps for applying seiketsu are as follows:

- Ensure the workplace is always neat.
- Check if there are documents or equipment that are still left behind after labeling.
- Check of storage. Ensure that all documents and *containers* are neatly arranged, ensuring the arrangement of the storage area in accordance with the list of contents and types.
- Check for dust and dirt.
- Determine the standard so that abnormal things are easily visible.

5) Shitsuke

In its application, the company should view the 5S program that has been created as a culture that must be carried out continuously, with the aim of increasing the morale and participation of its workers. If the 4S has been done without habituation, the program will not work, so habituation needs to be done by all parties involved. In addition, it is necessary to audit the 5S program for a maximum of 1 month. This aims to evaluate the implementation of the 5S program so that the 5S program can run well and increase.

3.5 The Design of the Future State Value Stream Mapping

Based on the identification of waste using the waste assessment models, analysis of the root cause of the problem, as well as recommendations for improvements that are designed, it can be described analysis related to the manufacture of future state visual stream mapping after repair to the service process items that occurred in the company. Future state visual stream mapping can be seen in Appendix B.

4. Conclusions

The following are the conclusions obtained from the research that has been done in answering the formulation of the problem which has been set as follows:

1) The results of an assessment on waste assessment models and analyse the current state of visual stream mapping obtained waste that predominates throught the supply chain process service goods that occur in the company. As for the waste with the highest known percentage is unnecessary motion of 18,574% and transport of documents amounted to 18,154% where the results are based on expert judgment who understand the whole process of business processes in the enterprise service items. The percentage of activity value added that occurred was 60,81% and the percentage of activities non value added was 39,19%.
2) Recommendations for improvement are given by the author to reduce the existing waste, namely the application of the SMED method to reduce time setup so as to increase productivity in the process flow that occurs in the company. After the implementation of the SMED in the service process, there is a reduction internal setup timefor 215 minutes or 12.900 seconds, it can also be said that there is a reduction internalsetup timeof 57,33%. The other improvement recommendations given are the application of 5S periodically in the work area.
3) The magnitude of the percentage of the efficiency of the goods procurement process in the company has increased from 60,81% to 70,20% after overcoming waste.

The next research can combine several methods in lean supply chain management so that in can increase productivity in the supply chain more significantly, as well as design company facility layout (relayout more efficient) to reduce waste of unnecessary motion by taking into account the financial aspects company if the company's relayout is done.

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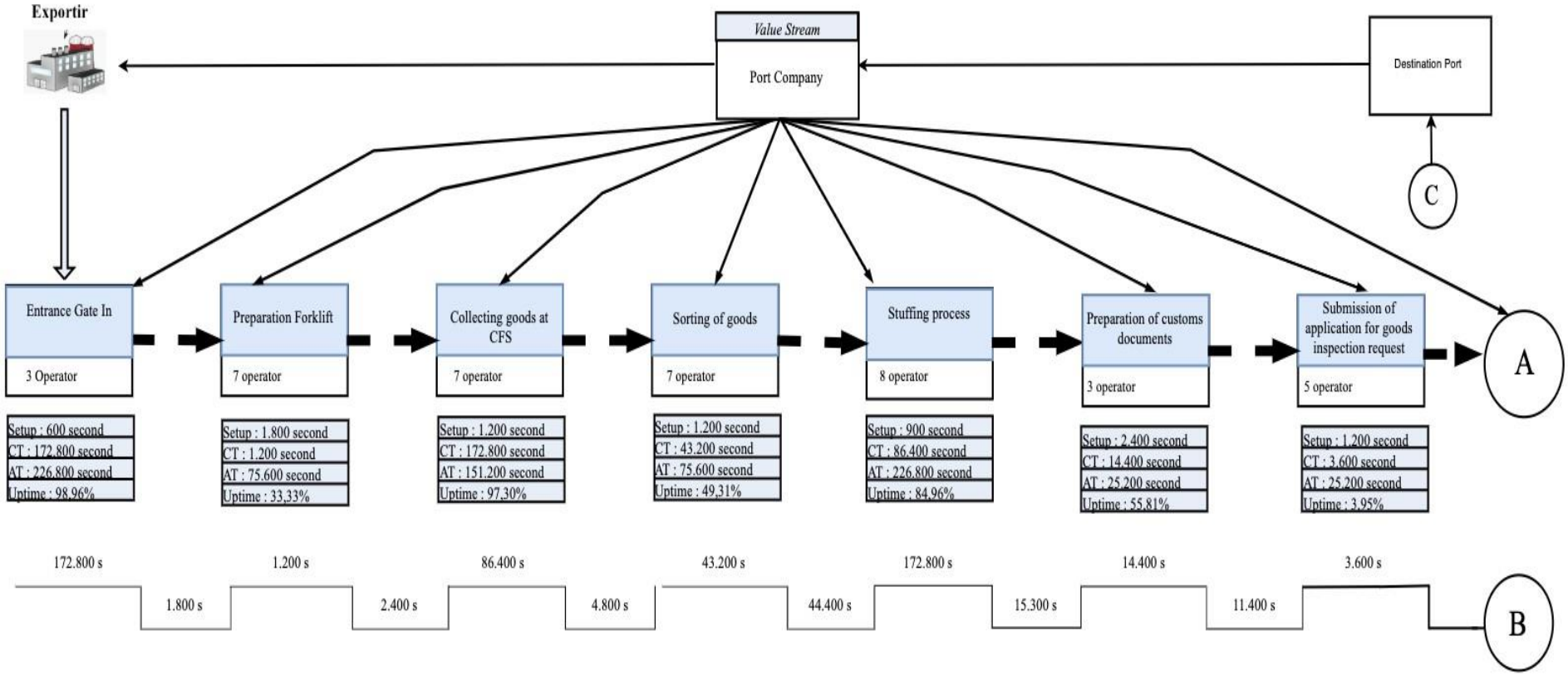
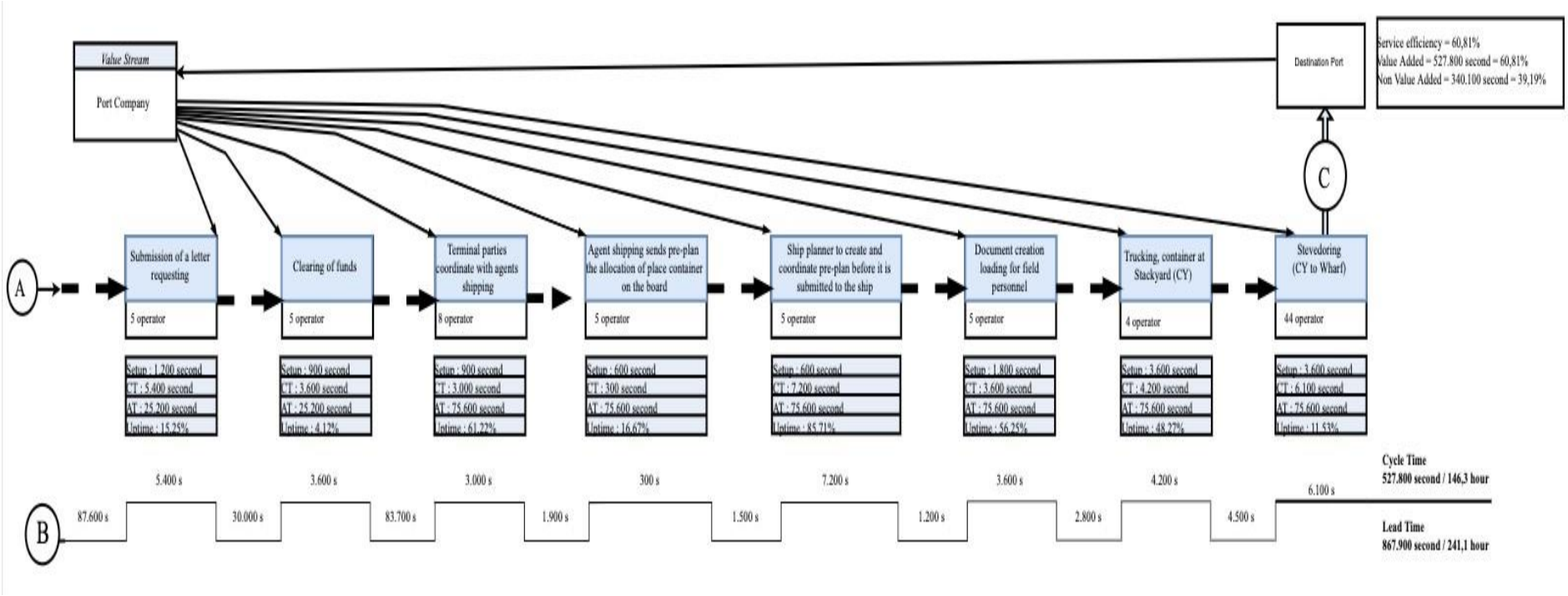
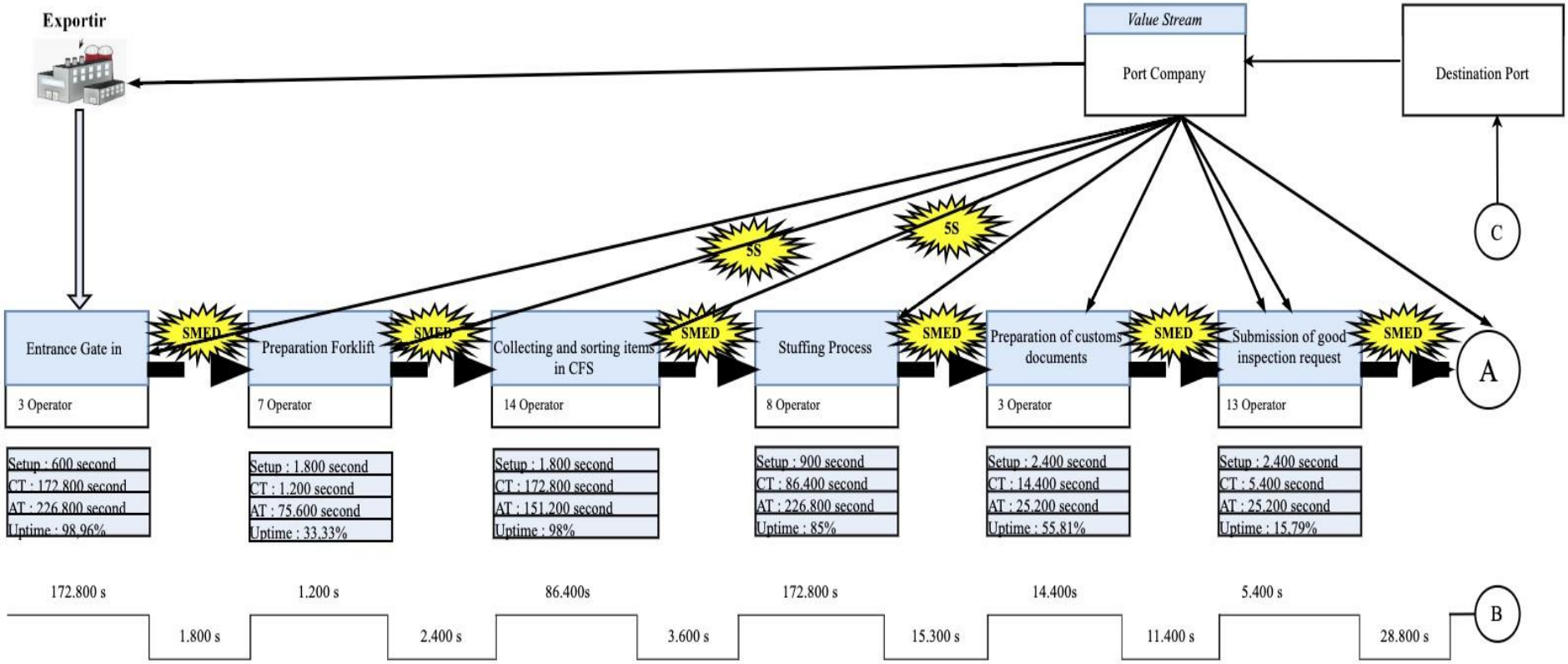
Appendix A: *Current State Visual Stream Mapping*



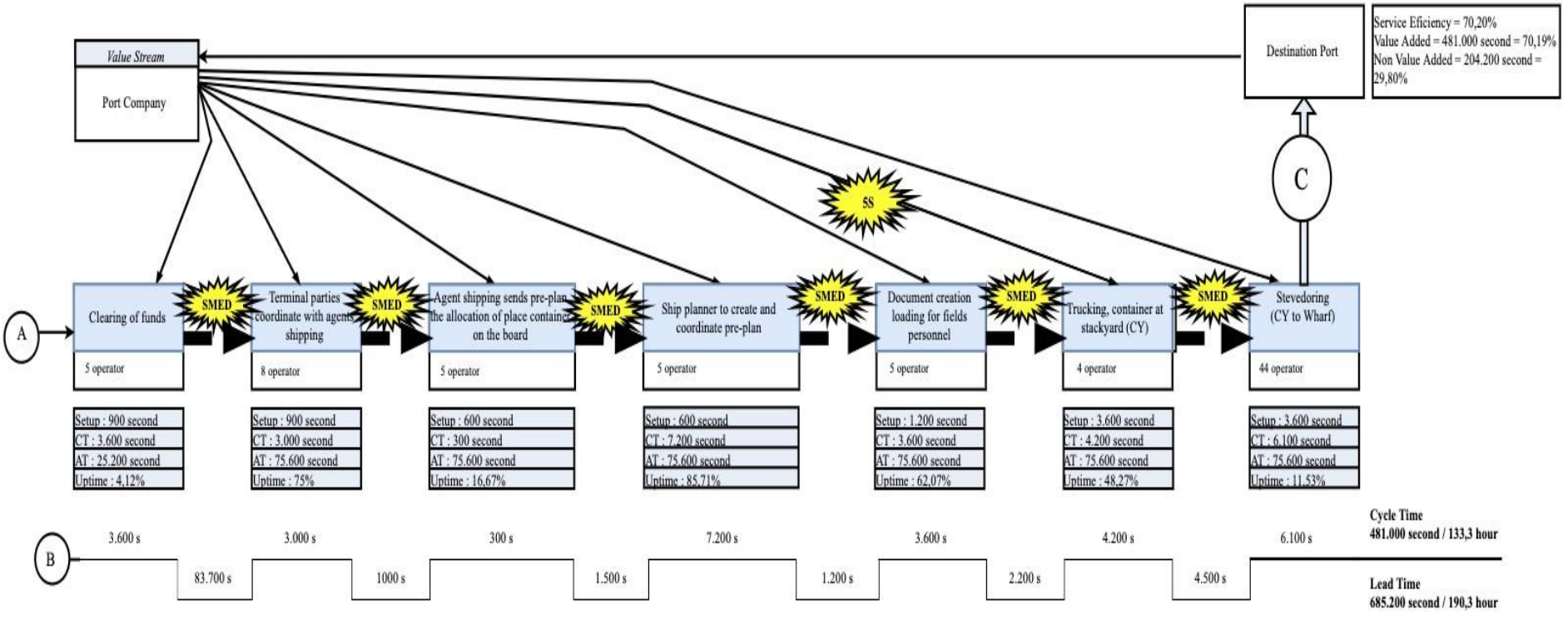
Appendix A: ***Current State Visual Stream Mapping (Continued)***



Appendix B: ***Future Visual Stream Mapping***


Exportir
Value Stream
Port Company
Destination Port
C
5S
5S
Entrance Gate in
SMED
Preparation Forklift
SMED
Collecting and sorting items in CFS
SMED
Stuffing Process
SMED
Preparation of customs documents
SMED
Submission of good inspection request
SMED
A
3 Operator
7 Operator
14 Operator
8 Operator
3 Operator
13 Operator
Setup : 600 second
CT : 172.800 second
AT : 226.800 second
Uptime : 98,96%
Setup : 1.800 second
CT : 1.200 second
AT : 75.600 second
Uptime : 33,33%
Setup : 1.800 second
CT : 172.800 second
AT : 151.200 second
Uptime : 98%
Setup : 900 second
CT : 86.400 second
AT : 226.800 second
Uptime : 85%
Setup : 2.400 second
CT : 14.400 second
AT : 25.200 second
Uptime : 55,81%
Setup : 2.400 second
CT : 5.400 second
AT : 25.200 second
Uptime : 15,79%
172.800 s
1.800 s
1.200 s
2.400 s
86.400s
3.600 s
172.800 s
15.300 s
14.400s
11.400 s
5.400 s
28.800 s
B

Appendix B: ***Future Visual Stream Mapping (continued)***



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