Transport Operations Optimisation through Lean Implementation – A Case Study

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Abstract
Lean has benefited industries, however, the research regarding its implementation in the transportation sector is limited. Therefore, there is huge potential for the implementation of Lean in the transportation sector. With the growing population and production, traffic congestion is no surprise, placing constraints on transport operations. This research utilises two extensions of the Lean tools of Transportation Value Stream Mapping (TVSM) and Transportation Overall Vehicle Effectiveness (TOVE). This research presents a case study of company XYZ based in Thailand, to optimise their transport operations through utilisation of Lean and its extensions mentioned earlier. As a result, the TOVE index is projected to improve from 17% to 31% and TVSM from 51% – 70%. The empirical study presented in this research paves the way for further research and adoption of Lean in transportation operations.

Keywords
Lean, Transportation, Transportation Value Stream Mapping, Transportation Overall Vehicle Effectiveness

1. Introduction
The lean approach was developed by Toyota to strengthen and establish itself against its US rivals after world war II (Garza-Reyes, 2015). The concept focuses on a systematic approach to identify/eliminate waste throughout the business processes and create value for its customers (Womack et al., 2007). Ever since its successful outcomes, the scope of Lean has been extended to various other industries, including the service sector (Nadeem et al., 2017). These modifications/extensions of Lean have resulted in both broadening the impact of Lean and yet at the same time to make it precisely applicable to specific industries through development of adapted niche approaches such as healthcare (Teichgräber and De Bucourt, 2012), service sector (Barber and Tietje, 2008), supply chain and administration (Myerson, 2012), and transportation (Villarreal, 2012; Villarreal et al., 2016a, 2016b, 2009).

This research explores the impact and benefit of Lean in the transportation sector. There are two major developments in terms of Lean extension specifically for the transportation sector. These extensions are Transportation Value Stream Mapping (TVSM) and Transportation Overall Vehicle Effectiveness (TOVE). Value Stream Mapping (VSM) not only assist in scoping the current state of the company but helps to identify the potential areas of improvement through the identification of waste (Seifullina et al., 2018). TVSM is an extension of VSM and it aims to specifically analyse transport operations to illustrate the current state with the identification of waste (Villarreal, 2012). Overall equipment effectiveness (OEE) is another of the Lean tools to measure the effectiveness of the equipment in the manufacturing sector (Gólcher-Barguil et al., 2019). Its scope has been further extended as TOVE to measure the efficiency of the vehicle (Villarreal, 2012).

This research aims to improve transport operations of XYZ Company by utilising Lean thinking. To achieve this aim, the following research objectives are defined

- To analyse the transport operations of XYZ Company through utilisation of TVSM and TOVE.
- Identify waste occurring in transport operations of XYZ Company
- Propose the waste elimination strategy to optimise the transport operations of XYZ Company.

With the above aim and objective, the paper is organised in seven sections. Section 2 describes the research methodology and an overview of the case study; section 3 provides findings from observations; section 4 and 5 provides an overview of TOVE and |TVSM analysis; section 6 and 7 provides the recommendations and future state TOVE and TVSM of XYZ company; and finally section 8 concludes this paper with future research directions.

2. Research Methodology

This research is both exploratory and analytical as it explores the potential application of Lean in management through analysing the transportation operations of XYZ Company operating in Thailand. A combination of inductive and positivism approach is deployed; whereby empirical observations are made, and analysis is conducted quantitatively. The research outcomes can be classified as applied research as it aims to improve transport operations of XYZ Company.

Through literature review, the research identifies and utilises two tools of TVSM and TOVE (Villarreal, 2012), along with observations to understand the current state of the XYZ Company and to analyse its operations to develop recommendations for improvement. The case study and its brief profile are presented below.

2.2 Case Study

The case study approach is best to ensure that the data collected and analysed is empirical and that the research outputs and proposed solution are of real value. The case study chosen for this research is a medium size company manufacturing of plastic bags, with other businesses as their customer base. The name and any details that could lead to the identification of the company is anonymised and therefore the company is called XYZ. A brief profile of the XYZ Company is described in Table 1.

Table 1 Profile of the case study

Company name	XYZ Plastic Bags manufacturing
Sector	Manufacturer
Number of employees	200
Main product	Plastic Bags (as per customer's requirements)
Location	Thailand
Customers' categorisation by XYZ	The retail industry, food industry, clothes industry, shoe industry, equipment manufacturers, and floral industry
Annual revenue	Around 8 million US$

The company employs 200 staff members and serves its customers (businesses) within Thailand only. It has categorised its customer base in six categories (see Table 1), of which the major buyers are retail and food industry. The company has an in-house transportation system (see Table 2) and has an overall annual revenue of around US$ 8 million. The company uses four small size trucks with each truck's capacity of 3500kg. Each truck has 2 members crew and customer servicing duration of 9 hours between 8am – 5pm. In total, an average of 40 – 50 customers are served per day, with an average of 10 – 12 customers per truck.

Table 2 Transportation profile of XYZ company

Number of trucks	4
The capacity of each truck	3500 kg
Maximum capacity for daily delivery	14000 kg
Transportation crew	8 people (2 person/truck)
Average number of customers served during a day	40 – 50

3. Observations of Shipping Process

Company XYZ currently serves a total of 20 routes by the given fleet over the span of one week, repeated weekly. This research observes 6 out of 20 routes, which are 30% of the entire weekly routes. Overall, the transportation division has four major steps of shipment preparation, servicing customers, transit and closing the transportation service; discussed below.

3.2.1 Shipment Preparation

Shipment preparation process consists of four activities portrayed in Figure 1. Delivery route planning is done manually based on information of finished products and daily collection report. Meanwhile, drivers carry out routine inspection/ maintenance to the fleet, this activity takes around 10 minutes (see Table 3).

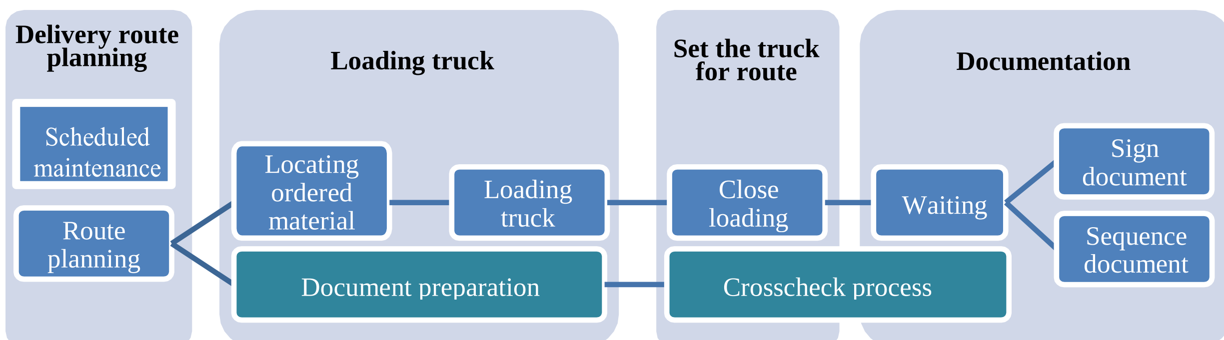

Figure 1 Shipment preparation process

Once the delivery route planning is complete, the order shipment material is located from the outbound area and checked against the ordered quantity. It takes around 1.3 minutes to locate each order in one shipment. The truck driver and three assistants under the monitoring of the warehouse manager then load the products in the truck in the sequence of the delivery schedule. Once one order has been loaded then the next order in the same shipment goes through the same process until all planned orders have been loaded. A parallel activity of document preparation by the sales and accounting department occurs to prepare invoices, billing, and receipt for customers according to the order quantities. The warehouse storage area is separated according to customers' locations and all products' size and weight are written in all dimension of the product. An observation was made that different products for the different customers in the same storage zone are stacked in disorder, which makes locating and loading process slower.

After the loading process and document preparation, the truck drivers close the loading to dispatch the truck. During this time, order quantities are cross-checked with the loaded quantity reports to avoid any inaccurate amount of invoice or wrong quantity of loading products. Finally, with the truck set for the route, the driver goes to the office for signing and sequencing the documents based on order sequence in the route. It has been observed that the drivers wait in office for around 7 minutes on average (see Table 3).

Table 3 Transportation routes observation of XYZ company

Transport processes	Transport activities	Route duration (mins)						Avg. (min)	Averag (hrs)	%	IT activities	NIT activities	Value added time	Non-Value added time
		1	2	3	4	5	6							
Shipment Preparation	Delivery route planning	40	40	40	30	30	30	35	0.6			0.6		0.6
	Scheduled maintenance	10	7	9	10	13	8	10	0.2			0.2		0.2
	Locating orders and counting quantities	17	8	14	10	16	13	13	0.2			0.2		0.2
	Loading truck	23	52	16	48	34	47	37	0.6			0.6	0.2	0.4
	Close loading and set the truck for route	6	5	7	6	7	5	6	0.1			0.1	0.1	
	Waiting for document preparation	11	3	7	4	9	8	7	0.1			0.1		0.1
	Signing and sequencing documents	26	12	26	32	26	22	24	0.4			0.4	0.4	
	Total time for shipment preparation	**133**	**127**	**119**	**140**	**135**	**133**	**131**	**2.2**	**23%**		**2.2**	**31%**	**69%**
Serving Clients	Waiting time for available space at customer's plant	8	17	61	25	46	10	28	0.5		0.5			0.5
	Unloading truck	111	103	75	77	102	67	89	1.5		1.5		1.1	0.4
	Waiting for quality inspection of order delivery	0	0	0	10	0	0	2	0.0		0.0			0.0
	Loading returned products from customer	0	0	0	11	0	0	2	0.0		0.0			0.0
	Documentation	32	20	54	15	64	24	35	0.6		0.6			0.6
	Extra services	0	0	0	0	0	0	0	0.0		0.0			0.0
	Total time for serving clients	**151**	**140**	**190**	**138**	**212**	**101**	**155**	**2.6**	**28%**	**2.6**		**43%**	**57%**
Transit	Driver break	30	30	40	40	40	30	35	0.6		0.6			0.6
	Time for transporting goods to destination	230	148	159	185	165	227	186	3.1		3.1		2.4	0.7
	Time for transporting back to plant	51	93	22	24	35	50	46	0.8		0.8		0.6	0.2
	Total time for transit	**311**	**271**	**221**	**249**	**240**	**307**	**267**	**4.4**	**48%**	**4.4**		**67%**	**33%**
Closing	Unloading returned products from customers	0	0	0	12	0	0	2	0.0			0.0		0.0
	Returning documents, cash and cheques to office	4	5	3	6	5	5	5	0.1			0.1		0.1
	Total time for closing	**4**	**5**	**3**	**18**	**5**	**5**	**7**	**0.1**	**1%**		**0.1**	**0%**	**100%**
	Total journey time	**599**	**543**	**533**	**545**	**592**	**546**	**560**	**9.3**	**100%**	**7.0**	**2.3**	**4.8**	**4.5**
									100%		**75%**	**25%**	**51%**	**49%**
Number of clients served/ route		13	6	11	8	12	10	10						
Loading truck per 10 clients (hrs)		0.29	1.44	0.24	1.00	0.47	0.78							
Close loading per 10 clients (hrs)		0.08	0.14	0.11	0.13	0.10	0.08							
Unloading per 10 clients (hrs)		1.42	2.86	1.14	1.60	1.42	1.12							
Truck load (kg)		3,011	3,197	1,820	3,106	2,767	2,809	2,785						
Speed of truck (km/hrs.)		34	14	36	49	27	60	37						
Travel distance (km)		157	55	110	172	89	277	143						
Planned travel distance		143	50	98	160	80	250	130						

3.2.2 Servicing Customers

Many external factors impact the efficiency of transport operations. Firstly, often the driver needs to wait for available space at the customer's plant due to the customer's specific service time window and longer processing. Secondly, the speed of unloading process varies due to the storage location at the customer's plant and facilities (see Table 3). Thirdly, since the company offers a collection of returned products that the customer is not satisfied with. The customers usually count order quantities at the same time as the products are unloaded, but do not inspect and measure the quality of products in detail (see route number

1, 2, 3, 5, 6 in Table 3). However, customer number 5 in route number 4 inspected the quality and found it to be dissatisfactory. As a result, the complete order was returned, leading to the wastage of 11 minutes and 12 minutes for loading returned products and unloading returned products when arriving at the warehouse, respectively (see Table 3). Lastly, the documentation includes invoicing and collecting payments from customers. This activity can take a long time to process in case that the customer pays by cash.

3.2.3 Transit

Transit process consists of transporting goods to each customer, break-time of the driver, and driving the truck back to the company with returned items if any. The external factor that cannot be controlled in this section is the traffic congestion and the time of driver's break. These two factors can lead to a longer time for the transit process. From the observation, the average break-time of drivers and transporting goods are 0.6 hours and 3.9 hours respectively (see Table 3).

3.2.4 Closing the Transportation Service

When the truck arrives at the company, the returned products (if any) are unloaded by the driver and stored into internal processes by the warehouse operator. The truck drivers, then need to submit documents, cash, and cheques collected from customers to the accounting department and wait until the office staff complete the checking process. It is observed that on average, a driver needs to wait around 5 minutes (see Table 3).

4. Transportation Overall Vehicle Effectiveness (TOVE) Analysis

4.1 Administrative Availability Efficiency

This indicator measures overall vehicle utilisation and efficiency, currently being 38% (see Table 4a). There are two main types of waste that impact this indicator, non-scheduled time which refers to not utilising the full time of the day for the job and scheduled maintenance for preventive maintenance. Transportation is one of the high investment division and is expected to be operational 100% of the daily time (Villarreal, 2012), thus 24 hours are assumed as daily available time. The average total journey time of the six-routes is 9.3 hours (see Table 3), indicating vehicle utilisation to be only about 38% of daytime with wastage of 14.7 hours of non-scheduled time (see Table 4a). With scheduled maintenance of 0.2 hours/day (see Table 3), the time available for the route is 9.1 hours (see Table 4a).

4.2 Operating Availability Efficiency

This indicator measures the vehicle operating efficiency currently being 57% (see Table 4b). Following five factors impact the operating efficiency of the vehicle.

- NIT activities include delivery route planning, locating products, counting order quantities, waiting for document preparation, sign and sequence documents, and all activities in the closing process.
- Excess loading and unloading time. The calculation compares the actual versus the expected time. Since the company does not have expected loading and unloading time, the fastest loading and unloading time from the six-routes observed is utilised for calculation. Route number 3, 1 and number 6 are the fastest route for loading, close loading, and unloading activities respectively (see Table 3).
- Break time for drivers.
- Unscheduled maintenance refers to the duration of a vehicle breakdown or corrective maintenance. However, during observations, no vehicle breakdown or corrective maintenance occurred.
- Excess customer service time consists of waiting time for available space at the customer's plant, waiting for quality inspection of delivery, loading returned products and documentation.

The data from the observation of six-route (see Table 3) is utilised for calculations shown in Table 4b. A total of 3.9 hours are wasted, resulting in 5.2 hours available in transit (see Table 4b).

4.3 Performance Efficiency

Performance efficiency is used to measure the efficiency of trucks in terms of capacity utilisation, speed, and route optimisation. Following three wastes impact this indicator.

- Fill loss is the result of low capacity utilisation. The capacity of each of the four trucks at company

XYZ is 3,500 kg, while an average daily delivery order is 2,785.39 kg (see Table 3).

- Speed loss occurs when the truck's average speed is lower than 60 Km/Hrs, the standard speed of truck in Thailand (Ministerial Regulations, 1979).
- Excess distance refers to the actual distance covered in excess to the recommended route by Global positioning system (GPS). The route from GPS is used as the minimum distance requirement due to its reliable measurement of distance globally (Zgheib and El Khoury, 2018). However, the XYZ company has no GPS to generate smart route planning, thus the planned travel distance is utilised as a minimum requirement instead of the distance from GPS. Utilising the data from observations (see Table 3), the calculations of performance efficiency are presented in Table 4c.

Table 4 The calculation of efficiency in TOVE indicators (Villarreal, 2012)

		Formula		**Calculation**		**%**
(a) Administrative availability efficiency	=	$\frac{\text{Time available for route}}{\text{Calendar time}}$	=	$\frac{9.1}{24.0}$ = 14.7hrs	=	**38%**
(b) Operating availability efficiency	=	$\frac{\text{Time available in transit}}{\text{Time available for route}}$	=	$\frac{5.2}{9.1}$	=	**57%**
Calculation of waste that impacts operating availability efficiency						
Wastes		**Formula**		**Calculation**		**Result**
NIT activities	=	Delivery route planning Searching orders and counting order quantities Waiting for document preparation Sign and sequence documents Closing process	=	0.6 0.2 0.1 0.4 0.1	=	1.4 hrs.
Excess loading and unloading time	=	(Actual loading time - the fastest loading time) + (Actual unloading time - the fastest unloading time)	=	(0.6 + 0.1 - 0.24 - 0.08) + (1.5 - 1.12)	=	0.8 hrs.
Driver break	=	Breaking time for drivers	=	0.6	=	0.6 hrs.
Unscheduled maintenance	=	Duration of vehicle breakdown or corrective maintenance	=	0	=	0 hrs.
Excess customer service time	=	Waiting time for available space at customer's plant Waiting for inspection quality of order delivery Loading returned products from customer Documentation	=	0.5 0 0 0.6	=	1.1 hrs.
(c) Performance efficiency	=	1 – Average (fill loss, speed loss, excess distance)	=	1 - Average (20%, 38%, 10%)	=	**77%**
Calculation of waste that impacts performance efficiency						
Fill loss	=	|1 - (Truck load / Truck capacity)|	=	|1 - (2,785.39 / 3,500.00)|	=	20%
Speed loss	=	|1 - (Average speed of truck / standard speed in Thailand)|	=	|1 - (37 / 60)|	=	38%
Excess distance	=	|1 - (Actual travel distance / Planned travel distance)|	=	|1 - (143 / 130)|	=	10%
(d) Quality efficiency	=	1 - Average(clients not served, spoiled products)	=	1-Average (0%, 2%)	=	**99%**
Calculation of waste that impacts quality efficiency						
Damaged products	=	Spoiled products / Total orders	=	299.70 / 16,712.33	=	2%
TOVE = 38% x 57% x 77% x 99% = 17%						

4.4 Quality Efficiency

Quality efficiency calculation measures customer satisfaction in order to improve transport operations from the customer perspective. There are two wastes that can affect this indicator.

- The percentage of clients not served, and demand not satisfied in a route.
- Damaged/unsatisfactory products returned from customers.

During observations, no late delivery in six-route has been noticed. However, 299.70 kg of damaged/unsatisfactory products is returned from a customer on route number 4. The percentage of damaged products and their impact on performance efficiency is calculated in Table 4d.

5. Transportation Value Stream Mapping (TVSM)

The current state of TVSM in both macro and micro level are drawn based on the result of the observation in Table 3. Firstly, the macro TVSM is presented to describe the generic transport processes. Then, the micro TVSM is illustrated to make specific analysis and identify wastes.

5.1 Macro TVSM – General Perspective

The overall average daily journey time for distribution is 9.3 hours, divided into 2.3 hours (25%) of not in transit time and 7 hours (75%) of in-transit activities.

5.1.1 Not in Transit (NIT) Activities

NIT activities consist of shipment preparation and closing processes which take 25% of the journey time. To improve efficiency and reduce costs, NIT activities should be minimised and controlled to increase efficiency. There are no external factors that affect to these NIT activities, therefore the company can have complete control over it to improve efficiency in terms of both cost and time (Villarreal et al., 2016a).

5.1.2 In Transit (IT) Activities

IT activities consist of all activities pertaining to serving clients and transit processes and amounts to 75% of the entire journey time. There are both internal and external factors that affect these activities. In terms of external factors, traffic congestion and delay at customers' end for receiving, are the factors that could be out of control. However, the company can control and improve the efficiency of other factors such as unloading, waiting for available space at the customer's plant, and documentation (Villarreal et al., 2016a).

5.2 Micro TVSM – The Identification of Wastes

The micro TVSM provides a further in-depth analysis of transport processes is presented through TVSM and TOVE analysis for both NIT and IT activities (see Figure 2). This section focuses on waste analysis based on the measurement of vehicle efficiency by TOVE index in section 4 and wastes identification in transport operations by the elaboration of a TVSM in section 5.

5.2.1 Incorrect Processing and Resource Utilisation

It is observed that daily delivery routes are manually planned by the head of truck drivers. Although this person is experienced, manual planning takes more time than automatic route planning by transportation management software (TMS). Moreover, without TMS some factors that can impact planning such as traffic congestion, customer location, and customer time windows, can be underestimated or neglected. This inefficient planning of route can be classified as incorrect processing and resource utilisation waste (see Kaizen Burst No. 1 in Figure 2). This leads to poor sequencing of customer visits resulting in 14.7 hours of non-scheduled time, 20% of fill loss, 38% of speed loss, and 10% of the excess distance per route. After deducting the driver's break-time, the value-added time (VAT) of the transit process is 67%, which accounts for 32% of total journey time (see Table 3). Moreover, since the working hours are 8 hours, thus 9.3 hours of journey time leads to higher operating costs in the form of overtime and fuel consumption for 1.3 hours.

5.2.2 Unnecessary Movement and Waiting

Unnecessary movements and waiting can be observed in both the IT and NIT activities as shown by the Kaizen Burst No. 2 in Figure 2. In terms of IT activities, the truck drivers need to spend 0.5 hours on average to wait for available space at the customer's plant (see Table 3). Moreover, after unloading the shipment, the drivers need to wait for 0.6 hours of verifying associated document with the store manager and collecting the payment of the order from the customer. Furthermore, in case of returned products (due to damaged goods) the drivers need to spend a significant amount of time to wait for an inspection of order delivery, documentation, and reloading damaged product to the truck (see route number 4 in Table 3). Further analysis revealed the excess unloading time by 0.4 hours, compared to the fastest unloading time in six-route (see Table 3). Consequently, 57% of non-value adding activities while serving clients are accounted for 16% of total journey time and is classified as non-value-added time (NVAT).

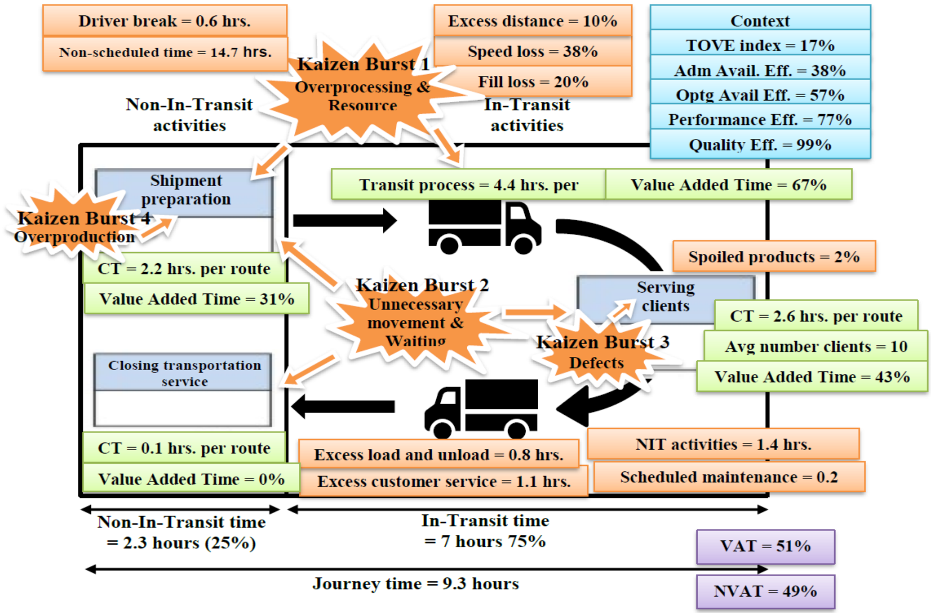

Figure 2 Micro TVSM of XYZ company

NIT activities are divided into two parts of the shipment preparation and closing process. During the preparation process, drivers need to wait around 0.2 hours for locating products in the outbound area, thereafter they need to wait for 0.1 hours for signing and sequencing documents. In addition, the time spent for loading the truck is 0.4 hours higher than the fastest loading time in six observed routes. Scheduled maintenance takes around 0.2 hours. As a result, 61% of the shipment preparation process, which is 14% of total journey time, is classified as waste. Furthermore, during the closing process, the drivers need to return documents and payments collected, for which they wait around 0.1 hours for verification by the accounting department. In the case of returned damaged products, the drivers need to unload these and wait for verification from the store operator, spending around 12 minutes (see route number 4 in Table 3). Thus, 100% of the closing process that accounts for 1% of the total journey is categorised as NVAT.

5.2.3 Defects

As indicated by Kaizen Burst No. 3 in Figure 2, waste in terms of defects include the percentage of unsatisfactory products returned by customers, which negatively impacts the efficiency of serving clients and closing processes. During observations, there are damaged products returned from customers in route 4, which was 2% of total order quantities of six-route observations. These defects lead to excess customer service time as the driver need to reload returned products to the truck and wait for the documentation process. Longer time for serving one client results in delayed delivery for subsequent customers in route. Since there are no specific customer time windows in this route, so the percentage of the client not served is zero. However, it leads to a longer closing process as the driver need to unload returned products.

5.2.4 Overproduction

Overproduction waste is indicated by Kaizen Burst No. 4 in Figure 2. During the loading process, operators in the sales department prepare and print invoice in advance based on the number of finished goods in a daily production report. However, there is a crosscheck after the loading process to avoid inaccurate amount on the invoice and/or overload and/or under-loading of the truck. In case of error identified during crosscheck, an invoice will need correction and reprinting, leading to the overproduction waste. From observation, this waste is estimated around 1% of daily issued invoice.

With the above analysis, it can be concluded that the value-added time is about 51% of the total journey time and non-value-added time is 49% of the total journey time (see Table 3 and Figure 2). The efficiency of transport operations measured by TOVE index is 17% (see Table 4). The three most important areas for improvement are administrative availability efficiency, operating availability efficiency, and performance efficiency with 38%, 58%, and 77% respectively.

6. Recommendations for XYZ Company

Following are the recommendations that XYZ Company could use to improve its operations.

6.1 Communication with Customers

Effective communication with a customers about the service time windows and potential constraints resulting in delays would eliminate in-transit wastes (Villarreal, 2012). The company can also develop an agreement with customers for nighttime deliveries, it will improve the administrative availability efficiency (Villarreal, 2012). However, night deliveries have their own advantages and disadvantages (Lowe and Pidgeon, 2016). Once the company has negotiated day and night service window, the potential to serve more customer is high as well as reducing the number of routes required for delivery (Villarreal, 2012), leading to an optimised level of operating availability. However, other solutions (discussed next) might lead to optimisation that may not require nighttime deliveries to manage current demand.

6.2 Transportation Management Software (TMS)

TMS is the key success factor to develop optimised routing (Rushton et al., 2014). There are various specialised TMS that can be utilised, for instance, the Roadnet Transportation Suite, proposed by Omnitracs (ThomasNet News, 2016). TMS provides various functions such as dynamic territory and street-level route plans, cost-efficient routing, fuel consumption management, driver safety management, centralisation of all related variables of delivery route planning, with real-time vehicle Global Positioning System (GPS) to allow for monitoring. By utilising TMS, the XYZ Company can reduce/eliminate wastes along transport operations in terms of incorrect processing, fill loss, speed loss and excess distance (Rushton et al., 2014).

6.3 Scheduling Internal NIT Activities for Night Shift

Internal NIT activities of shipment preparation, scheduled maintenance, and closing processes being performed during the daytime lead to the waste of around 1.3 hours, 0.2 hours, and 0.1 hours respectively. These internal NIT activities can be assigned to night shift operators who can load all delivery orders to the vehicle and prepare the related documents along with scheduled maintenance (Lowe and Pidgeon, 2016). In this way, the drivers and their assistants can focus on only serving customers and transit processes (Rushton et al., 2014). This will improve XYZ Company’s operating availability efficiency, by increasing the in-transit time of vehicle with the potential to serve more customers per route.

6.4 Shipping/Transport Process Automation

The company can invest in shipping/transport process automation, for instance using robots to replace dockworkers, and/or investing in an autonomous truck to replace drivers (Siegel et al., 2016). Automation will improve the speed of loading and unloading activities with minimal errors. Moreover, with transport automation there is no wasted time in terms of driver break, leading more time available in transit to serve customers. However, the limitation of this solution is the high capital investment required for implementation. Thus, before deciding to invest in transport automation, its feasibility must be ensured.

6.5 Technology Utilisation for Warehouse Operations Management

Since the company have different kind of inventories as it utilises the business model of made to order. The utilisation of technology such as a barcode or Radio-Frequency Identification (RFID) to manage inventories in the warehouse will reduce slow processing of locating orders and counting product, as well as eliminate errors due to the manual inventory management system (Akeroyd, 2010; Ustundag, 2012). This will lead to more time available in transit and a higher level of operating availability efficiency. Moreover, with such technology the company can track their inventory’s movement and will instantly know the exact stock level and location of products resulting in higher efficiency of inventory management (Akeroyd, 2010).

6.6 Simplification of Current Transport Operations

Since the adoption of technology imposes significant capital requirements (Akeroyd, 2010; Siegel et al., 2016); that the company might not be willing or in a position to invest in. In this case, focusing on improving current transport operations and resources is an effective alternative. Single Minute Exchange of Dies (SMED) is one of the Lean techniques that can reduce setup time by standardising setup process and externalise setup activities as much as possible (Henry, 2013; McIntosh et al., 2000). SMED can be adapted and applied to enhance the speed of shipment preparation process. The major bottleneck in the shipment preparation process of XYZ Company is locating products in the outbound area and checking product quantity before loading to the vehicle. Thus, to speed up shipment preparation process, products in the outbound area should be stored systematically for easy identification. In addition, the number of staffs dealing with warehouse operations should increase from one to two, to allow for efficient sharing of responsibilities. Moreover, the activities in the shipment preparation process should be standardised with specific time limits, to motivate and encourage employees to accomplish the task faster. As a result, higher available time for transit process and a higher level of operating availability efficiency will be achieved.

6.7 Employee Participation

Changes in the system and process can be faced with resistance from employees as they might assume that it would impact their working performance and endanger their job (Kumar et al., 2006). Thus, to avoid such resistance, the company needs to engage their employees to develop a sound understanding of the targets for improvement, so they would proactively engage in the proposed changes (Poksinska et al., 2013). As a result, the transport improvement can be achieved by operators with less control required from the top-level of the company (Soliman, 2013), especially when 77% of transport operations which include serving clients and transit process is operated outside the plants. Furthermore, an organisation wide culture of open communication should be created to allow for error/waste detection and sharing of ideas for improvement. Acknowledging employees input with rewards will lead to higher engagement from employees (Fliedner, 2016) and support continuous improvement (Morgan and Liker, 2006).

7. Projected Future State of XYZ Company

7.1 Future TOVE Index

By application of the proposed transport solution, TOVE index is projected to improve from 17% to 31%. The improvement of the TOVE index is the result of significant improvement in operating availability and performance efficiency indicators that are described in the following section.

- **Operating Availability Efficiency**

The first measurement of this indicator is 57% (see Table 4b). To improve this indicator, there are five proposed solutions which are scheduling NIT activities for the night shift, using transport automation, improving current transport operations and resources, technology utilisation, and making a clear communication about all associated delivery constraint with customers. Consequently, wastes in terms of NIT activities, excess customer service, and excess load and unload time will be minimised. In the result, the indicator is projected to improve from 57% to 89%.

- **Performance Efficiency**

This indicator can be improved significantly by the implementation of TMS, such as Roadnet Transportation Suite proposed by Omnitracs (ThomasNet News, 2016). In result, the company can generate the best routes and load plan for every delivery in short time (Rushton, Croucher and Baker, 2014), eliminating wastes of excess distance. Moreover, fill loss and speed loss would be decreased to 10% and 20% respectively and the performance efficiency is projected to increase from 77% to 90%.

7.2 The future State of TVSM

Based on the proposed solutions, IT time is projected to increase from 7 hours to 9.2 hours which is 99% of total journey time, with the number of clients served per route estimated to reach 18 clients per route.

Furthermore, value added time of transit and serving clients processes are projected to increase to 75% and 64% respectively. TMS can generate delivery route optimisation which eliminates the excess distance and reduces fill-loss and speed loss by 10% and 18% respectively. Moreover, automation can speed up loading and unloading, eliminating the excess time by 0.8 hours. Meanwhile, communication with customers can lead to the elimination of 0.5 hours of waiting time for available space at the customer's plant (see Table 3). Overall, the increase of value-added time of transport operations from 51% to 70% is projected.

8. Conclusions, Limitations and Future Research Direction

The research utilises Lean tools of TVSM and TOVE to optimise transport operations of XYZ company. The analysis and output further affirm the benefit that Lean implementation can bring to the transportation sector. The limitation of this research are the narrow span of time for observing only 30% of routes, as well as the lack of actual implementation of recommendations due to time constraints. Further research with the application is recommended.

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