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On LSP Lifecycle Model to Re-design Logistics Service: Case Studies of Thai LSPs

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Abstract: Improving service logistics is crucial in order to reciprocate customer needs. The paper aims to validate the Logistics Service Provider (LSP) Lifecycle Model for re-designing logistics service in three LSP case studies in Thailand. The lifecycle-stage evaluation was adapted to identify the current status in its lifecycle. Afterward, logistics service strategies were implemented according to the voice of the customer by Quality Function Deployment (QFD). The study combined the Logistics Service Provider (LSP) Lifecycle Model with the application of Industry 4.0 (I4.0) to improve service logistics. Case studies showed the implementation of the service logistics strategies with the feasibility solution of Industry 4.0.

Keywords: LSP Lifecycle Model; Industry 4.0; Quality Function Deployment; Best-Worst Method

1. Introduction

Global enterprises fulfill customer satisfaction with trust and royalty [1,2]. The service sector is extremely significant in this competition [3,4]. In addition, the Logistics Service Provider (LSP) has become a role for smoothing cooperation, progressing association, and improving the value-added throughout the entire supply chain [5,6]. After the Industrial Revolution, LSPs have been essential to managing the supply chain in the global economy. It is a task for LSPs to offer what customer needs to compete in the service outsourcing that has arisen around the world [7]. Service innovation and efficiency improvement are needed to respond to the complexity of customer requirements [8]. The LSP Lifecycle Model was created to improve customer satisfaction throughout the whole lifecycle of the logistics services, comprising such states of the lifecycle as design, test, logistics operation, after-sales service, service evaluation, and decomposition. There are three phases [9]: the Beginning of Life (BOL), the Middle of Life (MOL), and the End of Life (EOL) [10]. The evaluation is needed to classify the phase of logistics service, which can be recognized to improve logistics services. The development and re-designing are important parts for examining service innovation in response to customer needs [11]. Quality Function Deployment (QFD) is a well-known methodology for design and re-design to acknowledge customer requirements [12–14]. Yet, implementing QFD with LSPs for re-designing appropriate services in order to extend the service lifecycle is questionable and, indeed, challenging. Customer satisfaction can be recorded as Customer Requirements (CRs), which is translated into Engineering Characteristics (ERs) to offer what customer needs [15,16]. Logistics service can be improved or develop new service from the Voice of Customer (VOC) [14,17–20].

Whilst the LSPs' end-customer lifestyles have changed due to technological advancement, their requirements have become more complicated and sophisticated than ever before. On-demand delivery, real-time information, and Circular Economy (CE) [21] are now among the basic customer requirements. Furthermore, customer behavior has changed too. Quick and immediate responses are expected. Information Technology (IT) has been increasingly used in the global business to satisfy the customer in terms of supply [22,23]. Today, Industry 4.0 is being used to accomplish the customer target, operation, and improvement in manufacturing [24,25]. Some examples of the advancement of Industry 4.0 are applying to self-learning automation, big data analytics, real-time information, Internet of Things (IoT), and smart sensors [26,27]. This improvement expands to the logistics industry in the form of, for example, on-demand delivery which offers an abrupt response to the customer [28,29]. The trend has changed rapidly around the world and the logistics service is demanded to support it. Therefore, LSPs need to innovate and create new service to address these complicated customer trends [30]. This paper demonstrates the use of the LSP Lifecycle Model to re-design the logistics service using three case-study LSPs in Thailand. It aims to address the research questions of whether the developed LSP Lifecycle Model is valid and if the Industry 4.0 concept is applicable and can be beneficial for LSPs. Firstly, the study identified the stage of the service. Secondly, services were re-designed using QFD. Thirdly, customer requirements were prioritized using the Multiple-Criteria Decision-Making (MCDM) tool. Finally, the Industry 4.0 concept was mapped to address these demands.

2. Literature Review

The goal of this literature review is to review if the LSP Lifecycle Model can be integrated with the Industry 4.0 concept. Whilst the Industry 4.0 is common and recognized to be beneficial to the industry and manufacturing sectors, the solid approach in logistics sectors is otherwise. In addition to maintaining service quality [31,32] and a standardized management system [33], re-designing the logistics service is required to extend its lifecycle.

2.1. LSP Lifecycle Model

LSPs play an important role in smooth operation and increasing the value-added in supply-chain management [34]. LSPs must satisfy customer requirements by collecting and analyzing data and managing the operations to resolve problems and to develop services that can support the whole lifecycle. The complexity of the logistics service is separated into activities which are based on what LSPs attempt to offer to match the customer needs. The level of party LSP is determined based on a set of characteristics that correspond to five levels, namely, 1PL, 2PL, 3PL, 4PL, and 5PL [10]. The level of service and commitment are incremental to the level of cooperation and adaptation of IT [35,36]. Agility is a highly important determinant of impressing the target group. The LSP Lifecycle Model cooperates with the physical flow (material flow) and information flow throughout each phase from forward and backward. The LSP Lifecycle Model is created by combing the logistics service characteristics of the entire lifecycle to fulfill customer requirements. The model comprises of three lifecycle phases: the Beginning of Life (BOL), the Middle of Life (MOL), and the End of Life (EOL). Creating and designing the logistics service is the first stage of implementing a new service to satisfy the customers [37]. Collecting and analyzing information data can assist in accommodating all of the requirements and lead to suggestions for service innovation. Evaluation and decomposition are the last phases of improving the service to satisfy customer needs throughout the lifecycle (see Figure 1).

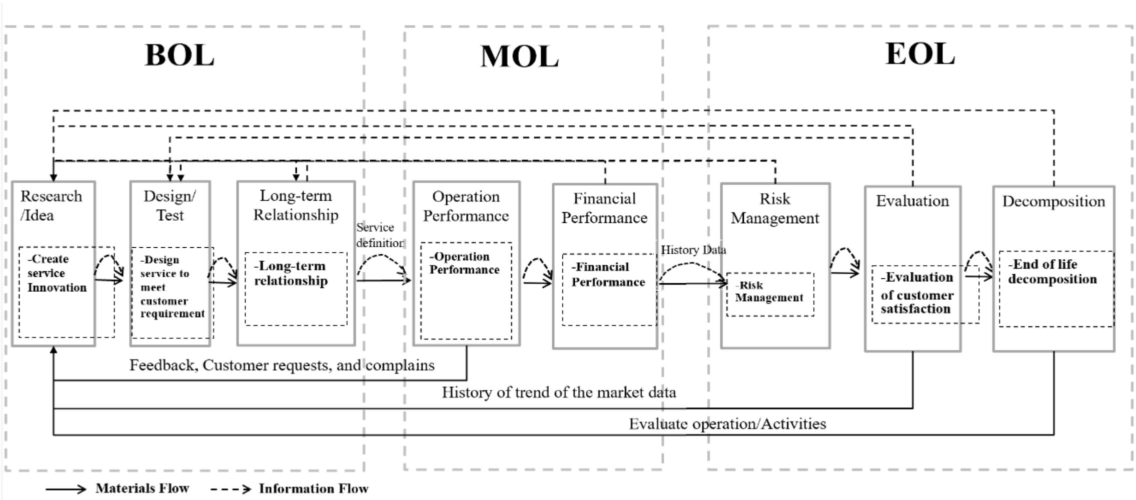


Figure 1. Interactions and relations in the Logistics Service Provider (LSP) Lifecycle Model [10]. Three lifecycle phases: BOL, Beginning of Life; MOL, Middle of Life; and EOL, End of Life.

2.2. Industry 4.0

Information Technology (IT) has been widely applied in manufacturing and the supply chain [22,23]. Industry 4.0 (I4.0) was first recognized in 2011 for progressing high-technology to advance the competitiveness in quality, cost, operation, and risk [38–41]. Supporting quick response, the phenomenon to offer customer satisfaction through "the right product at the right time and suitable cost" is now compulsory. The attractiveness of I4.0 is influenced by self-automation, Artificial Intelligence (AI), virtual technology, and real-time information [42]. Demand prediction and sales forecasting are examples of how to address customer expectations [43]. The main segments of I4.0 consist of Cyber-Physical Systems (CPSs), Internet of Things (IoT), Internet of Service (IoS), and smart factories or smart manufacturing. Real-time information, track, and trace technology are imperative parts of the logistics service, leading to trust and loyalty in the business market. Axiomatic Design and I4.0 were adapted to create service innovation using the LSP Lifecycle Model which creates new activities [44]. Figure 2 shows the strategies created based on I4.0 through the entire lifecycle of the logistics service. Figure 2 presents the Design Parameters (DP) in the Axiomatic Design, responding to customer need based on the LSP Lifecycle Model [44].

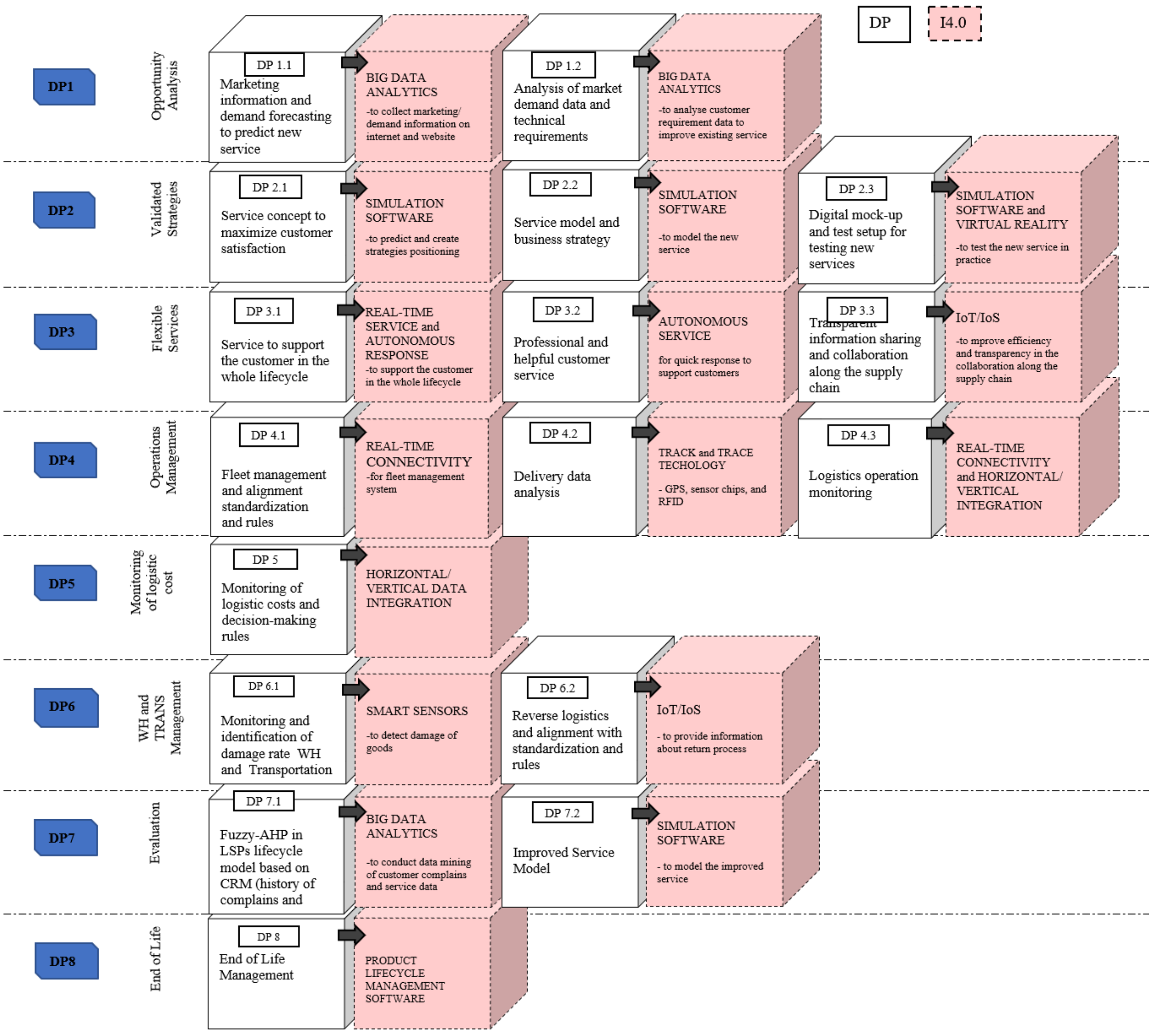


Figure 2. The implementation of Industry 4.0 (I4.0) in the LSP Lifecycle Model [44]. DP, Design Parameter.

3. Methodology

This section examines the two phases of the research methodology (see Figure 3). The first phase identified and evaluated the stage of the logistics service lifecycle. The second phase was the validation of the LSP Lifecycle Model. The study selected three case-study LSPs in Thailand.

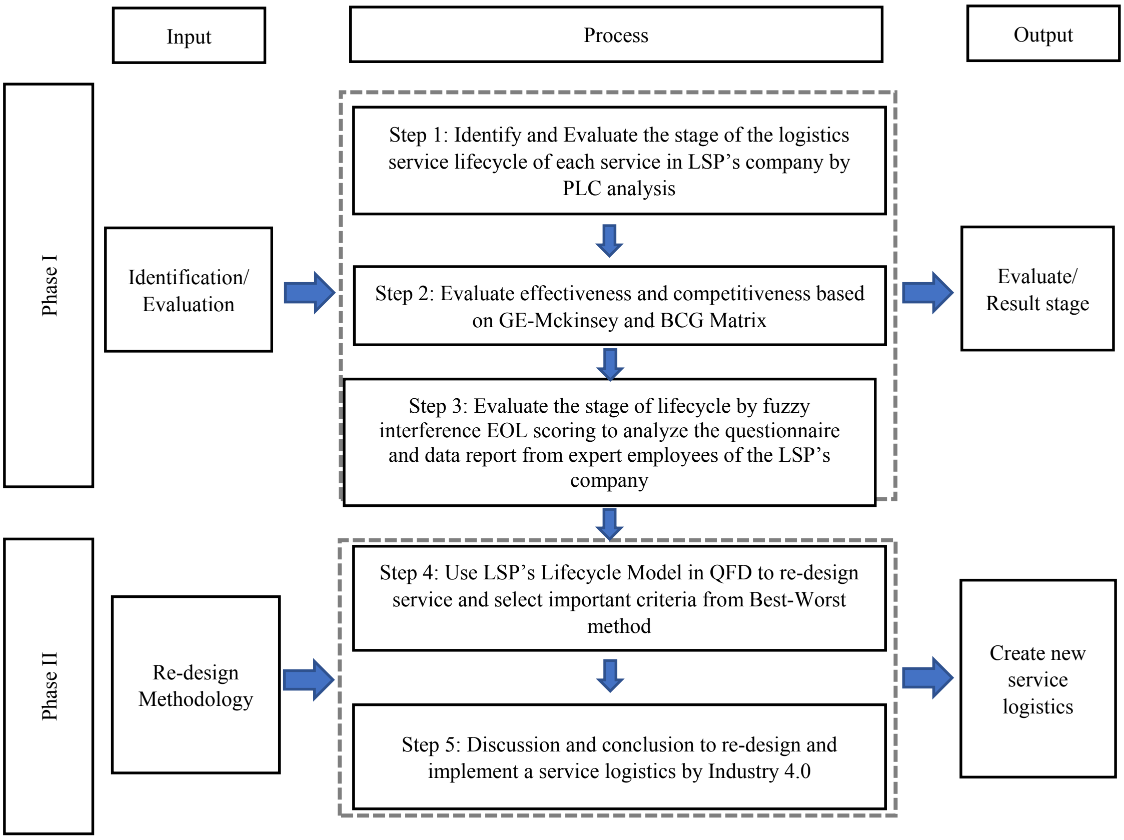


Figure 3. Phases of the research methodology. PLC, Production Lifecycle; QFD, Quality Function Deployment.

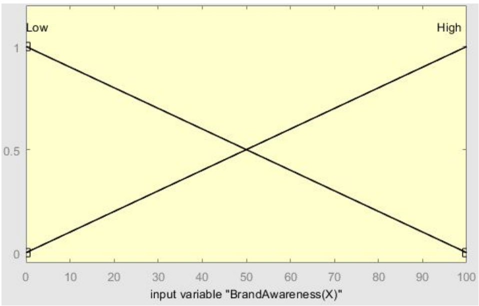
3.1. Phase I: Identification and Evaluation of the Lifecycle

The identification and evaluation of logistics service lifecycles involve recognizing the "As-Is" status of the product or service from the current status. "As-Is" is imperative in finding the correct way to be competitive in the global market [45,46]. A stage of the lifecycle can be evaluated using Production Lifecycle Analysis (PLC Analysis), Pareto analysis, and matrix analysis to estimate the current status of the lifecycle.

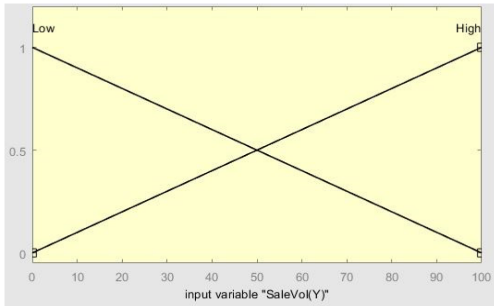
Step 1. PLC Analysis: The analysis consists of four stages of the lifecycle: introduction, growth, maturity, and decline. These four stages are analyzed in the market size, prime cost, profits, target customer, competitor, marketing strategy, product variety, and selling price.

Step 2. Matrix Analysis for qualitative evaluation: The effectiveness and competitiveness of the service are evaluated. GE-Mckinsey and BCG matrix can be used to estimate the target-market in business [47]. GE-Mckinsey matrix can evaluate the performance of product transition point by industry attractiveness (x-axis) and business strength (y-axis). It shows if any are weak, medium, or strong. BCG matrix has four fields in the market: question marks, dogs, stars, and cash cows. Question marks (problem child) products are those of high growth in the market but low in the market share. This field appears for new products to launch in the market. Dogs represent a low-growth product and low market share. This field is low-profit but normally is highly produced with high inventory costs. The company should get rid of this product. Cash-cow products are the products with a high market share in the slow-growing environment. This field can be a high-profit product but the company must determine if their product is mature in the market. The company should either improve or re-design these products to respond to customer requirements. Star products are those with high market demand in the rapid-growth industry. The company needs these products.

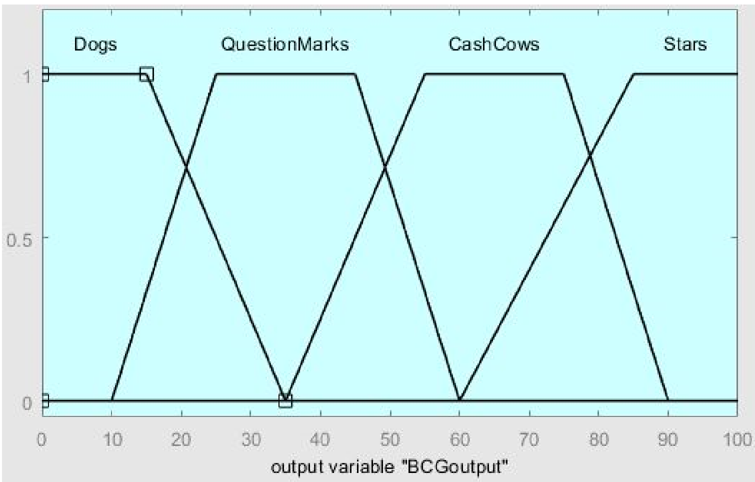
Step 3. Fuzzy Inference model: Qualitative information can be extracted from previous steps to quantify numbers using fuzzy logic. Fuzzy logic consists of three steps: fuzzification, rule evaluation, and defuzzification. The Fuzzy Inference model processes three main inputs: fuzzy of the BCG matrix, fuzzy of the GE matrix, and fuzzy of the EOL scoring. At first, the fuzzification determines the quantitative input as a value of 0 or 1. The membership function is to define the graph of the fuzzy set. For example, a fuzzy graph for the BCG matrix shows brand awareness on X-axis and sale volumes on Y-axis. Figure 4 shows the membership function on the BCG matrix, which separates 2 levels on X-Axis and Y-axis; low and high (Figure 4a,b). The second step, "If … Then rules," shows "If … Then rules" to find the relationship of the service. The last step, defuzzification, is used to evaluate and find the numerical values of the membership, using center of gravity techniques to compute defuzzification, namely, dogs, question marks, cash cows, and stars (Figure 4c). The evaluation of EOL scoring combines the analytics of the BCG matrix (X-axis) and the GE matrix (Y-axis) to classify the stage of logistics service.



(**a**) Fuzzy membership function on X-axis



(**b**) Fuzzy membership function on Y-axis



(**c**) Fuzzy membership function on BCG matrix

Figure 4. Fuzzy interference model in membership function for the BCG matrix.

The identification and evaluation of logistics service is a key part to detecting the current status and positioning in the global market. This information is vital to improving and developing service that meets customer requirements and strengthens loyalty.

3.2. Phase II: Re-Designing Logistics Service

After identifying the stages of the logistics service, the selected logistics service in maturity and decline stages is then used as the case of re-design. The adaptation of the Best-Worst Method is for reflecting customer requirements and interest (Step 4). In Step 5, service is re-designed based on customer requirements using QFD and the application I4.0 in technical requirements.

3.2.1. Step 4: Best-Worst Method

Best-Worst method (BWM) is a recent Multi-Criteria Decision-Making (MCDM) method, developed to reduce the complexity of pairwise criteria in the AHP (Analytic Hierarchy Process) method [48–53]. Compared to AHP, BWM uses less comparison (BWM= 2n − 3, AHP= n(n − 1)/2), yet the consistency is better [48,54]. BWM is used to solve various problems, namely, supplier selection [55], location selection [50,53,56], service quality improvement [57], product design selection [49,58,59], supply-chain management [60], and performance evaluation [52,61]. BWM allows the decision-maker to select the best and the worst criteria to be transformed into the weight of each criterion using linear programming.

3.2.2. Step 5: Quality Function Deployment (QFD)

QFD is a famous product design technique that considers whether to address customer requirement and improve product quality or reduce costs and time [62–65]. The method translates "Voice of Customer" (VOC) or Customer requirement (CRs) into Engineering Characteristics (ECs) to create Design Requirements (DRs) for each phase of product development and production [64,65]. QFD adapts the CRs within the product to improve the quality of products, reduce time, costs, resources, and control the capability of production. Complete QFD consists of four phases: the product planning matrix, the part planning matrix, the process planning matrix, and the production/operation planning matrix. Information is required for both forward and backward data to develop a traceability method in all of the various phases [66]. VOC (WHATs) is combined with quality characteristics (HOWs) to create new products or to estimate costs and quality of production. This paper uses QFD to improve the matured or declined service by re-designing an appropriate lifecycle transition. VOC is defined from internal and external requirements and the service lifecycle requirement of what the customer needs [16].

4. LSP Companies and Service Re-Design: Case Study

In 2019, LSPs in Thailand have grown by 7–9% YoY according to the report from the Kasikorn Research Center [67]. This paper summarizes the results of three case studies of small, medium, and large LSP companies in Thailand. The companies provide several logistics services from local and national-wide transportation to moving services in the city area. The results of the identification and evaluation stages of the lifecycle (Step 1) are shown in Table 1. The results will be discussed in the following section. Then, the developing service logistics (Step 2) is described.

Table 1. The results of the identification and evaluation stage of the lifecycle of the case study LSP.

Service	PLC	GE (X)	GE (Y)	GE	GE Score	BCG (X)	BCG (Y)	BCG	BCG Score	EOL	EOL Score
Case Study 1	Growth	75	80	Investment/ Growth	77.31	70	65	Stars	57.82	Medium	61.15
Case Study 2	Growth	70	55	Selectivity/ Growth	53.15	15	70	Question Mark	39.44	Medium	50.00
Case Study 3	Maturity	65	75	Selectivity/ Growth	62.45	70	15	Cash cows	39.44	Medium	52.24

4.1. Case Study 1: Small Moving Service LSP

Case study 1 is a small LSP in the North of Thailand. The company offers a moving service which can be for office, house, or exhibition. Target groups are local customers, for example, students, schools, and offices in the Chiang Mai area. The questionnaire was answered by a senior manager in the company.

4.1.1. Identification and Evaluation Stage of the Lifecycle: Case Study 1

The results of the PLC analysis shows that the service is at the growth stage due to positive customer feedback and constant sales growth. The service is highly profitable and there are few competitors in the market. In addition, the company has a strong market strategy that guarantees package delivery. The company also offers a variety of services to fulfill customer requirements. Figure 5 shows the company is positive in the GE-Mckinsey matrix. The service is in the Investment/Growth stage due to the business strength stemming from the fully equipped moving service compared to other competitors. The service attractiveness is also high due to the demand in the exhibition market. Home and office movings are also growing as a result of the urbanization trend. The GE score is 77.31, which shows the attractiveness of this moving business. The service is in the stars stage in the BCG matrix due to high sales volume and brand awareness based on the history of the business. This service and business unit are spun off from the LSP mother company, providing service since 1988. The BCG score is 57.82. From these evaluations, it is found that the stage of the lifecycle of this service is in the medium stage, with an EOL score of 61.15. The results show the company responds well to customer needs in the industry (see Table 1).

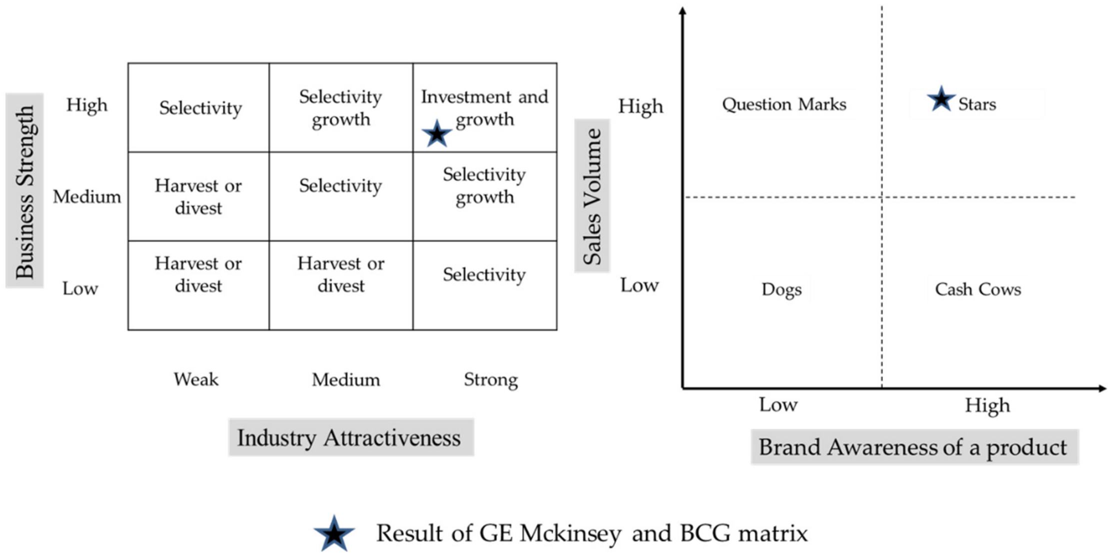


Figure 5. The analysis of GE Mckinsey and BCG matrix for Case Study 1.

4.1.2. Service Re-Design: Case Study 1

To improve the service by fulfilling customer requirements, the evaluation of the factor is conducted using the BWM (weight scale 1–9). The factors are prioritized from most to least important in Table 3. Design service to meet customer requirement criteria is the most significant criterion. The least important criterion is the evaluation of customer satisfaction. It leads to optimized weight for main attributes, shown in Tables 2 and 3.

Table 4 illustrates the scores on the Important Rate (IMP), analyzed by the BWM, which are allocated in QFD. The concern is in creating and re-designing the service to respond to customer needs. The aim is to build up loyalty by offering tracking service after sales, which will support fulfilling and delivery service. The high competition in the moving market is the main part that needs innovation. I4.0 suggests the following tools: text response, real-time tracking, and real-time monitoring of moving operation. This will help the customer to manage their plans easily. Moreover, IT is adapted to replace paper and to increase customer satisfaction. Engineering Characteristics and target setting are shown in Table 5.

Table 2. Comparison vectors for the best and worst criteria: Case Study 1.

Best to Others	Create Service Innovation	Design Service to Meet Customer Requirement	Long-Term Relationship	Operations Performance	Financial Performance	Risk Management	Evaluation of Customer Satisfaction	End of Life Decomposition
Best Criterion: Long-Term Relationship	4	1	3	5	2	8	9	7
Others to Worst							Worst criterion: End of life decomposition	
Create Service Innovation							6	
Design Service to Meet Customer Requirements							9	
Long-Term Relationship							7	
Operations Performance							4	
Financial Performance							8	
Risk Management							2	
Evaluation of Customer Satisfaction							1	
End of Life Decomposition							3	

Table 3. Optimized weight for the main criterion: Case Study 1.

Criterion	Weights	ξ^{L**}
Create Service Innovation	0.1023	0.0731
Design Service to Meet Customer Requirements	0.3361	
Long-Term Relationship	0.1364	
Operations Performance	0.0818	
Financial Performance	0.2046	
Risk Management	0.0511	
Evaluation of Customer Satisfaction	0.0292	
End of Life Decomposition	0.0584	

$**$ ξ^L is used as an indicator for the comparison.

Table 4. House of Quality (HoQ): Case Study 1. IMP, Important Rate.

Technical Requirement / Customer Need		IMP	BOL			MOL		EOL		
			Collect and Analyse Data from Customer Suggestions and Marketing data	**Design and Test Service to Satisfy Customer Requirements**	**Implement Customer Relationship Management Initiation**	**Improve Efficiency of Logistics Operations**	**Reduce Logistics Cost**	**Analyse and Evaluate the Risk of Warehouse and Transportation**	**Evaluate and Improve Service Life Cycle**	**Evaluate the End of Life Cycle**
BOL	Create Service Innovation	0.1023	9							
	Design Service to Meet Customer Requirements	0.3361		9						
	Long-term Relationship	0.1364			3					
MOL	Operations Performance	0.0818				9				
	Financial Performance	0.2046					9			
EOL	Risk Management	0.0511						1		
	Evaluation of Customer Satisfaction	0.0292							3	
	End of Life Decomposition	0.0584								3
Importance of Technical Indicators			0.92	3.02	0.41	0.74	1.84	0.05	0.09	0.18
Relative Importance of Technical Indicators			12.71	41.74	5.65	10.16	25.41	0.71	1.21	2.42

Table 5. Details of service re-design and improvement: Case Study 1.

	Engineering Characteristics	Target Setting
FR2.	Design and test service to satisfy customer requirements	Simulation and virtual technologies to create and test company strategies
	FR2.1 Understand the added value for the customer in service innovation	Using simulation software to predict and create strategic positioning
	FR2.2 Design the new/adapted service offer	Using simulation software and other tools to model the new service
	FR2.3 Test the new service for practical applicability	Using simulation software and virtual reality to test the new service in practice
FR4.	Reduce logistics cost	Horizontal/vertical data integration to enable sophisticated business intelligence for cost controlling, use paperless strategies to reduce cost
FR1.	Create service innovation	Big data analytics to collect and analyze customer requirement data and marketing demand
	FR1.1 Identify customer requirements and opportunities to generate new service	Using Big Data Analytics to collect marketing/ demand information on internet and website
	FR1.2 Innovate existing service to increase customer satisfaction	Using Big Data Analytics to analyze customer requirement data and evaluation data from the customer to improve existing service

4.2. Case Study 2: Courier Service Provider

Case study 2 is a medium-sized LSP offering courier services. The company uses passenger buses to move passengers and parcels within the routes mostly in the North of Thailand. The prominent point of the company is the specific route and time, which the customer can use to specify the departure and arrival times. The service of interest is parcel service. Targeted customers are local businesses, people, students, and hospitals. The questionnaire was answered by a senior manager of the company.

4.2.1. Identification and Evaluation Stage of the Lifecycle: Case Study 2

The service is identified and evaluated as a growth stage due to the continuous growth of sales and profit. The service is strong with the strategy of on-time delivery and flexibility of service, from agriculture products to motorcycles. The GE-Mckinsey matrix shows that the service is at the selective-growth stage. Business strength is medium due to the limitation of vehicles and its fixed route. The customer can pick the delivery up at the station only. Industry attractiveness is at the high stage due to the popularity of e-commerce. The service area is specific to its northern route. Thus, the parcel can be delivered quickly. For the BCG matrix, the service is in the question mark stage. Sale volume is high but the brand awareness of the product is low because of several competitors in the market, both domestic and overseas. The price is the key factor. From these evaluations, the service is considered to be at the medium stage of its lifecycle. Details are shown in Table 1.

4.2.2. Service Re-Design: Case Study 2

To improve service, fulfillment is suggested. The focus is to enhance the delivery service (see Table 5). A long-term relationship is the most important factor. Evaluation of customer satisfaction and financial performance are among the most important factors. The decision-maker decides to improve on these issues to gain trust and loyalty from the customer. At the start, the company will survey for suggestions and use this information to improve the service. I4.0 is applied by developing the website. Evaluation and improving service is highly recommended to increase customer satisfaction. The data can be collected from several available platforms such as social media. The feedback data is a critical part of re-designing the service. For example, if tracking is not online and updated on the platform, the customer cannot check the delivery status. GPS and RFID can be used to address the issue. Then the customers will be able to access real-time information. On-time delivery will be possible to satisfy customer expectations; the customer should be able to access real-time information. In addition, parcel tracking and tracking information can be sent to the customer (via SMS), informing them when their package is due to arrive. Table 6 shows an example of the measurements to improve the service life cycle for the case-study company.

Table 6. Details of service re-design and improvement: Case Study 2.

	Engineering Characteristics	Target Setting
FR7	Evaluate and improve the service life cycle	Big data analytics and simulation
FR7.1	Evaluate the service life cycle	Collecting Data from the branch, application online (Facebook, line) and feedback data
FR7.2	Re-design and improve service after evaluation	Simulation software to model the improved service

4.3. Case Study 3: Large LSP

Case study 3 is a large LSP in the North of Thailand. The company has more than 500 trucks and more than 1000 employees. The service is the delivery of mass products between Chiang Mai and Bangkok. Most of the customers in Chiang Mai are local small and medium Enterprises (SMEs) and farmers who sent their goods to Bangkok. On the contrary, most of the products from Bangkok are industry products, shipped to wholesalers and retailers in Chiang Mai. From the surveying of the senior manager who is responsible for the company strategy, the results are as follows.

4.3.1. Identification and Evaluation Stage of the Lifecycle: Case Study 3

The service is at the maturity stage due to the market size and low prime costs. Profit is high but is declining. Selling price is competitive-edged but it cannot be reduced because there is not much profit. The GE-Mckinsey matrix suggests that the service is at the selectivity growth stage. Industry attractiveness is at the middle stage. As a result, this business may face a lot of competition. Business strength is at a high level due to the variety of vehicles such as trucks and trailers, as well as a refrigerated container which can cater to a larger variety of customer requirements. The BCG matrix identifies the service at the cash cow stage. BCG(X) shows the middle volume of sales but BCG(Y) shows high brand awareness because the company has been in business for a long time and has gained loyalty from their customers. Identification and evaluation showed that the stage of the lifecycle is medium. Details are shown in Table 1.

4.3.2. Service Re-Design: Case Study 3

The improvement to satisfy the customer is significant and the data is suggesting that the company should re-design its delivery service. From BWM, long-term relationship criterion is the most important one. The least important criterion is end of life decomposition. Table 7 shows an example of CRM implementation for the case-study company.

Table 7. Details of service re-design and improvement: Case Study 3.

Engineering Characteristics		Target Setting
FR3	Implement CRM initiation	Internet of Things/service and real-time autonomous service to support customer
FR3.1	Focus long term partnership	Real-time service, track and trace technology for support product delivery
FR3.2	Respond quickly to the customer	Autonomous service for quick response to support customers, Application Technology to offer the client
FR3.3	Increase supplier relationship	Internet of Things/Service to improve efficiency and transparency in the collaboration along the supply chain (e.g., responsive information platform)

5. Discussion

The study confirms the significance of technology advancement in business competitiveness. In the case of logistics management, Industry 4.0 can fulfill the needs of Smart Logistics [42,68–70]. However, in the case of LSPs, limited research has clearly demonstrated the benefits of implementing the Industry 4.0 concept [71,72], especially for re-designing service to accommodate customer needs depending on their lifecycle stages.

It can be seen from the case studies that the Industry 4.0 concept can be applicable for re-designing logistics services. With different growth stages and business strengths, the lifecycle stage of the service can be identified. As a result, a suitable measurement can be suggested based on customer requirements and technology readiness. Industry 4.0 tools, such as IoT, Big Data Analytics, and Virtual Technology, are found to be supportive if the LSP wishes to accommodate their customers. This will increase their competitiveness in the highly ambitious market. The implementation can be costly and complicated [73], however further study must be conducted to determine if the measures are feasible.

6. Conclusions

In the Fourth Industrial Revolution, the customers require high-quality service from LSPs. Service innovation is an important tool to compete in the world economy. This paper identified and investigated each stage of the LSP service re-design. In the first step, the status of a lifecycle state was evaluated using PLC analysis, Pareto analysis, matrix analysis (GE, BCG matrix), and fuzzy interference. The second step re-designed the matured services for attaining customer satisfaction. QFD was used to create and re-design logistics services. In the significant evaluation of criteria, BWM was applied to estimate the important criteria in LSP's Lifecycle Model that had eight criteria. The paper showed the results from three logistics services which were at the maturity stage and that each company needed Industry 4.0 to improve their service quality. For case study 1, the most important factor was to design service that meets customer requirements. To create new service and increase information, responsiveness is an important factor to advance their operations. There are available tools of Industry 4.0 to address these issues such as simulation, virtual technology, horizontal/vertical data integration, and Big Data Analytics. As a result, the new service can be modeled and tested. The costs can be reduced. Data can be analyzed to improve the existing service to meet customer requirements. For case study 2, on-time delivery was the main point of competitiveness in the business. A long-term relationship was also the main interest. Therefore, it was suggested that the service data should be used and analyzed in order to improve service. The data should also be shared with the customers to improve their satisfaction. For case study 3, the main focus was concerned with CRM initiation. Fulfilling customer satisfaction to sustain their clients and to generate loyalty and trust was recommended. Here, IoT, IoS, and autonomous service are a few examples of what can be used for that purpose.

The paper shows that Industry 4.0 can be applied to re-design logistics service, but with caution. Although the developed LSP Lifecycle Model and the presented methodology can provide suggestive measures for LSP per their service requirements, there are some limitations. Whilst the first phase of identification and evaluation can give contemplative and multi-dimensional observation of the service of interest, the second phase of new service re-design can only be suggestive and the result is rather dynamic. The implementation of the measures to solidly validate the model is required, which can be even more challenging.

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