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An Approach to Improve Customer Satisfaction in Logistics: the Case of HEPCO

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Abstract

Customer service is increasingly being recognized as a source of competitive advantage. Determining customer needs accurately, meeting and exceeding them in a consistent manner is the key to the effective customer service. Companies should adapt a strategic, proactive focus on customer service based on understanding logistics process and designing logistics system to meet their needs. This paper provides an approach based on quality function deployment (QFD) to rank strategic actions to improve logistics service and addresses issue of how to deploy house of quality (HOQ) to effectively and efficiently improve logistics process and customer satisfaction. In data collecting, fuzzy logic is used to deal with ill-defined nature of qualitative linguistic judgments required in proposed HOQ. Finally, we found that JIT implementation has highest priority in strategy actions with inventory management and demand-forecasting method coming next.

Introduction and Literature Review
Introduction

In today's competitive market, the companies are increasingly being encouraged to incorporate environmental strategies into their business strategies. The increased competition and globalization have caused organizations to shift from local optimization at the firm level towards the entire supply chain. Hence the scope of environmental activities is extended beyond the firm's internal borders. This operational transition in environmental practice provides companies with opportunities for the broader development of sustainability. In this respect, integrating environmental strategies into supply chain management has become a subject of growing interest among academics and practitioners (Masoumik et al., 2015).Among leading firms, logistics has evolved over the years to the point where logistical competency is frequently viewed as a strategic resource (Mentzer et al., 1989). Properly exploited, logistical performance can help gain and maintain profitable customers. Service quality enhancements have been shown to consistently result in increased market share and revenue gains. Studies by Arthur D. Little indicate that quality of a company's service can cause the company to gain or lose as much as 10 percent in sales revenue (Shycon, 1992). Service may well be competitive arena of the future.

"Competition is shifting away from how companies build their products to how well they service customers before and after they build them. The manufacturers that thrive into the next generation will compete by anticipating and responding to a truly comprehensive range of customer needs" (Chase and Garvin, 1989).

Recognizing that meeting customers' needs should be core objective of a firm, many of today's most progressive and successful firms emphasize logistics service as a competitive differentiator (Livingstone, 1992; Stern et al., 1993).

Customer service represents output of logistics system and place component of firm's marketing mix. It is a measure of effectiveness of logistics system in creating time and place utility for a product (Lambert and Stock, 1993). A number of service elements are commonly associated with logistics customer service, although the degree of importance attached to them varies from case to case depending on specific customer needs (LaLonde and Zinszer, 1976; Sterling and Lambert, 1987; Lambert and Harrington, 1989; Sharma and Lambert, 1991). There is general agreement that excellent logistics customer service is a source of competitive advantage, and determining customer needs accurately and responding to them in a consistent manner is the key to effective customer service (Lambert and Stock, 1993). For this reason logistics customer services planning must be carried out at strategic level, that should follow a systematic framework to be the most effective planning process (Huiskonen and Pirttila, 1996).

Several planning frameworks have been presented by researchers (Lambert and Stock, 1993; Fuller et al., 1993), and they have similarities in the stages a comprehensive logistics customer service planning process should include, and analyses that should be performed. Usually, to manage logistics customer service as a strategic competitive weapon, three issues must be evaluated: (1) customers' requirements, (2) company's performance, and (3) competitors' performance (Lambert and Stock, 1993).

Schary (1992) believes that customer service has become a dominant objective for logistics management in the 1990s. Effective customer service has become a basic requirement for establishing and maintaining a presence in the market. DeRoulet (1993) supports Schary by stating that customer service is a key part of a company's marketing.

In this paper, we'll review the concept of customer services strategy, and fuzzy QFD. We describe the proposed methodology, and finally, we will demonstrate that the use of fuzzy QFD approach can support strategic management process. This research seeks to prioritize identified strategic factors using QFD in uncertainty conditions. The purpose of this paper is to examine strategy actions of HEPCO and prioritize them by using Fuzzy QFD.

Literature Review

Customer Service and Customer Service Strategy

The concept of customer service has gone through a profound evolution during last decades. Before 1970s, physical distribution was approached from a mechanistic and firm-oriented point of view, and customer satisfaction was provided by creating time and place utility to the product (Manrodt and Davis, 1992). In the 1970s and 1980s customer service was still considered reactive and firm oriented while in the late 1980s the definition of customer service was shifted towards the development of customer value (Manrodt and Davis, 1992).

Schary (1992) calls for a strategic, proactive focus on customer service based on understanding logistics process and designing logistics system to meet their needs. The objective is to create value for customers. The recent trends in customer service can be summarized as follows (Manrodt and Davis, 1992): (1) companies are becoming proactive in their approach to customer service, and considerable attention is focused on how to provide the customer with value-creating service before, during and after the physical product is delivered, (2) the change is taking place especially in response to aggressive customers who request suppliers to take formal steps to identify customer's needs and to provide the desired value, (3) the key to provide breakthrough levels of customer service is to manage information flows effectively, (4) a shift from transaction to contractual-driven systems is taking place, and (5) companies are under increasing pressure to create value through enhanced customer service, and companies with the required capabilities are evidencing an ability to achieve sustainable competitive advantages (Korpela and Tuominen, 2007).

Prior studies have shown inconsistent results in examining the relationship between CSR and corporate financial performance or customer behaviors. This may well be attributed to the notion that the effect of CSR on corporate financial performance or customer behaviors largely depend on mediating variables and situational contingencies (Yu-Hern Chang and Chung-Hsing, 2017). In addition, when speaking about service management, a dynamic perspective should be adopted. Customer service is not a steady concept, but is continually in a state of change, and evolves through a continuous improvement cycle (Morris, 1996; Baines, 1996). Therefore, the quantitative measure of logistics performance delivered and expected has to be repeated over time, periodically auditing gaps between expectations and perceptions. When a lack of correspondence occurs, viable logistics areas and factors of intervention have to be identified, pondered and ranked in terms of efficiency and effectiveness. Since interventions imply costs, before taking steps toward implementation, a costs/benefits analysis is appropriate, in order to undertake actions starting from those factors with the highest impact on customer service. To conclude, providing logistics service which meets customer expectations is a continuous process, which can be summarized in the following steps (Bottani and Rizzi, 2006): understanding customer's voice, that is requirements and expectations in terms of relevant logistics performance; assessing customer's service perception. If a gap between perception and requirements occurs, identifying viable steps that can be implemented to improve customer satisfaction; identifying costs and benefits related to each step; and implementing the most efficient actions for customer satisfaction by means of a cost/benefit analysis.

The quality function deployment (QFD) methodology has been found as a viable tool which can be successfully applied for this purpose (Akao, 1990). QFD has been defined by the American Supplier Institute as "A system for translating consumer requirements into appropriate com pany requirements at each stage from research and product development to engineering and manufacturing to marketing / sales and distribution'' (Bottani and Rizzi, 2006).The QFD is a technique for product or service development, brand marketing, and product management (Celik et al., 2009). By focusing on listening to the customers, QFD has been a successful tool to help a company's product development team systematically translate customer requirements (CRs) to appropriate product features. The success of QFD applications may be the result of some of its benefits, such as high customer satisfaction, greater customer focus, shorter lead time, development of cross-functional teamwork, and preservation of knowledge.

A preliminary review of the literature has highlighted only few references where QFD has been associated to service assessment. Lapidus and Schibrowsky (1994), illustrate the QFD applicability as a method for improving service starting from customer complaints. In their approach, customer complaints become the "what's" to be considered in the house of quality (HOQ). Conversely, we propose a proactive approach to be adopted before complaints occur: thus, "what's" do not emerge from complaints but from logistics and supply chain management literature.

Behara and Chase (1993) illustrated the QFD process in matching customer requirements to specific topic areas in service management. However, these applications do not provide a general methodology to plan and manage the trade-offs and correlations associated with customer requirements and firm viable actions. Stuart and Tax (1996), propose the QFD application to manage service design phase. They suggest the use of HOQ as an effective mean to plan processes for a successful execution of services. Their approach is general purpose and depicts the general traits of a QFD approach to design service strategies. However, the authors do not provide the details how the approach may be deployed for a practical in-field application. In conclusion, the works cited above deal with service management under a general perspective, and do not focus the approach on service performance which stem from logistics processes and activities. Starting from the work of Bottani and Rizzi (2006), we develop a tool suitable to be adopted in the logistics and customer service. Moreover, one of our main objectives is to introduce a methodology that could be directly adopted by practitioners in the logistics field. A cost/benefit analysis is also introduced to identify and rank the most efficient steps toward improvement of logistics processes and customer satisfaction. A fuzzy approach is adopted since the methodology mainly relies on qualitative judgments given by panel of experts and by customers.

QFD and Fuzzy QFD

The QFD, originated in 1972 in Japan, has been a successful tool to assist the product design and development team systematically in translating market research and customer requirements into the technical requirements to be met in product design. According to Bottani and Rizzi (2006), QFD is composed of four successive matrices: customer requirement planning matrix, product characteristics deployment matrix, process and quality control matrix, and operative instruction matrix. The current research concentrates on the first matrix (customer requirement planning matrix).The customer requirement planning matrix, also known as "house of quality" (HOQ), is the first step in investigating customer needs and market requirements. HOQ begins with customer requirements (CRs) which are usually obtained from market survey or customer interview. The acquired CRs are translated into a list of measureable ECs. Based on the acquired CRs and ECs, the team can determine the relationships between CRs and ECs, the competitive analysis, and the correlations between ECs. The obtained information can be used to calculate the importance of ECs (Hauser and Clausing, 1988). The components of HOQ are illustrated in Fig (1).

Fuzzy set theory, introduced by Zadeh (1965), was developed for solving problems in which description of activities, observations, and judgments are subjective, vague, and imprecise.

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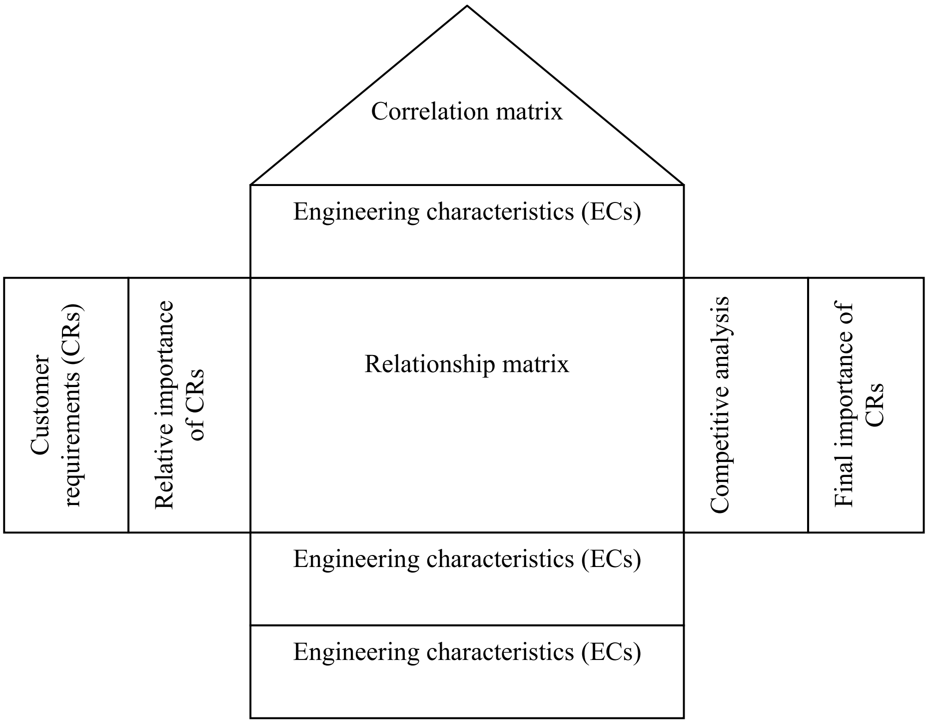

Fig 1.Components of HOQ

A number of scholars have applied the fuzzy set theory to QFD and developed various fuzzy QFD approaches. Khoo and Ho (1996) proposed the concept of fuzzy QFD and fuzzified linguistic variables to make them more reasonable. Besides, they also considered the correlations among CRs and ECs

Shen et al. (2001) found that it is necessary to translate customer requirements into trends of future analysis. They added a future tendency index to importance of CRs to compute the final importance of CRs. Shen et al (2001) mentioned that the importance ranking of ECs may be affected by several factors, including types of fuzzy numbers, defuzzification methods, and the number of fuzzy numbers. It was found that defuzzification methods have relatively larger impact on the ranking result. Sohn and Choi (2001) applied fuzzy QFD to supply chain and included reliability in the assessment. They used a fuzzy MCDM method to select a design with an optimal combination of reliability and customer satisfaction.

Chen et al (2006) integrated fuzzy weighted average method and fuzzy expected value method to evaluate the importance of ECs. Bottani and Rizzi (2006) applied QFD in logistics and supply chain management. They translated linguistic values of customer requirements into fuzzy numbers and computed the importance of ECs using the conventional QFD method. Kahraman et al. (2006) employed the analytic network process (ANP) method to determine the importance of each EC, incorporated resource constraints, such as cost budget, to form a multi-objective programming problem, and derived important ECs. Kwong et al. (2007) developed a fuzzy expert system approach to measure the importance of ECs and the correlations among ECs. These two measures were integrated to calculate the aggregated importance of ECs, etc. In recent years, QFD integrated from different theories, which have been widely used in many fields. Chang (2012) used the interconnectedness of supply and demand to apply QFD in the analysis of uncertainty and flexibility of the manufacturing system. Anwar et al. (2016) used the QFD structure to define customers' needs to enhance the service quality of cafes. Büyükozka and Çifçi (2016) used QFD as a tool to improve the product or system planning. Zaim et al. (2016) integrated QFD with the fuzzy analytic network process (FANP) to explore product development. Lin et al. (2017) also used QFD to improve the service process of Taiwanese banquet culture.

The Proposed Fuzzy QFD Approach

The methodology proposed is based on the translation of HOQ principles from product development field to logistics service management. Traditional HOQ correlates customer requirements ("whats") with engineering characteristics of new product under the development ("hows"). However, in our approach, customer service requirements in terms of logistics performance ("whats") are crossed over with viable strategic actions, either technical or managerial, that could be undertaken by the firm's top management to improve logistics processes ("hows"). The related customer service HOQ is shown in Fig (2).

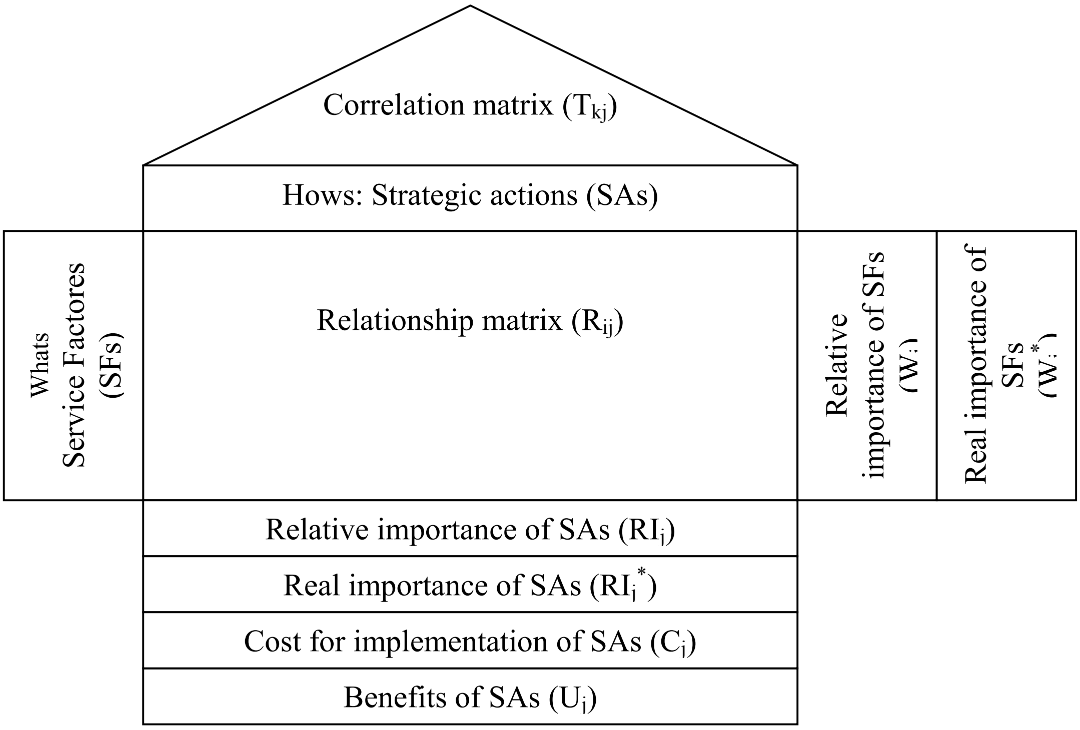

Fig 2. The house of quality for the strategic management of logistics service (Bottani & Rizzi, 2006)

As it can be seen in the table, ‘‘whats’’ elements express service factors SFi, i=1;...; n affecting logistics service perception. These factors have been extensively described in logistics and supply chain management literature. The reader will find a comprehensive list of the main criteria that can be used for the evaluation of the logistics service. For the sake of clarity, the service factors proposed by the authors are shown in Table (1), together with a brief description

Table 1. List of viable factors for the evaluation of logistics service

Serice factors ‘‘whats’’	Description
Lead-time	Time period elapsing from customer’s order until receipt
Regularity	The dispersion around the mean value of the delivered lead-time
Reliability	Capability to deliver orders within the due date
Completeness	Capability to deliver full orders when required
Flexibility	Capability to modify orders in terms of due date and quantity when required
Correctness	Avoidance of mistakes in orders delivered
Harmfulness	Avoidance of damages in orders delivered
Productivity	Number of item produced in a given time period

Table 2. List of viable strategic actions (Bottani & Rizzi, 2006).

Strategic actions ‘‘hows’’	Description
Just-In-Time Implementing	JIT helps to streamline the logistics pipeline through the efficient flow of materials and information, i.e. by providing the right materials, in the right quantities and quality, in the right place at the right time.
Warehouse management optimization	The efficiency and the effectiveness of the logistics flows are deeply affected by optimized warehouse & distribution centers management policies. Shipping & receiving, storage, picking activities can largely benefit from ad hoc optimization tools.
Transport Management	Transportation has been recognized as a paramount factor affecting effectiveness and efficiency of logistics processes. Through transportations, the product value is increased by making it available where and when it is required. However, transports add significant costs, which could jeopardize the profitability of the supply chain. Therefore, specific optimization tools can be considered as viable actions to improve logistics performance perceived by customers.
Information Technology	Information technology is generic term used to include hardware, software, and networking technologies, such as servers, computer networks, expert systems, software for communication, such as Enterprise Requirement Planning (ERP), Electronic Data Interchange (EDI), etc. All these tools play a significant role in synchronizing the flow of goods with the flow of information, which affects the logistics performance of the supply chain.
Demand forecasting Methods	Accurate forecasting methods make it possible to match supply and demand, smoothing uncertainty, reducing safety stocks and stock outs. The set up of collaborative programs, such as CPFR, VMI, or consignment aimed at reducing uncertainties may be encompassed in this category.
Other	Depending on the particular circumstance, other strategic actions in the logistics field may be considered.

Obviously, service factors listed in table do not provide an absolute description of all viable factors that could be considered when perceived service has to be assessed. Depending on particular circumstances, factors could be either added or removed.
Once customer service has been assessed, viable strategic actions SAj, j =1; . . . m the firm can undertake in the logistics field to improve service performancet. Those actions correspond to "hows" in the proposed customer service HOQ. A list of possible "hows" related to logistics activities has to be improved is shown in Table 2.
To well cope with vagueness of linguistics judgments required in building the HOQ, we propose to express importance weights, as well as relationships and correlations, with fuzzy triangular numbers. Thus, unless specified, all terms computed should be considered as fuzzy numbers. According to this premise, the importance weights Wi is a fuzzy vector expressing the relative importance of SFs based on a defined fuzzy linguistic scale. The reader may refer to Zadeh (1965), and Zimmermann (1991), for a complete description of fuzzy numbers and related algebra.
In our approach, four new fuzzy elements have been added to the traditional HOQ, namely:

- the weighted importance of service factors;
- the weighted importance of strategic actions;
- the cost for the implementation of strategic actions;
- the marginal benefit of strategic actions.

These elements, as well as their role in ranking SAs, are detailed below.

1. Weighted importance of service factors
The weighted importance Wi* of SFs is a [n×1] vector which expresses the real importance of each SF. Wi* is required to weight each service factor considering not only the importance the customer gives it, which is expressed by the value Wi, but also the performance delivered by the firm for that factor. To gain a competitive advantage, the firm must provide superior service to the customers on critical service factors, that is either those that are perceived as the most important ones or where service perceived is inferior. Conversely, improving service either for a factor, whose importance is trivial or where the firm already delivers a superior service is useless.
The weighted importance Wi* is computed by assessing the distance di between firm performance and that which is perceived by customers as superior, the latter being the performance that allows the firm to achieve customer satisfaction. Both the performance delivered and the target superior value could be retrieved from customer service surveys by asking the customer directly. Since both performance values are fuzzy, a distance between fuzzy numbers has to be assessed. To this extent, the Hamming procedure is suggested to be adopted (Chien and Tsai, 2000). This procedure identifies the distance between two fuzzy numbers as the distance between the centers of gravity of the respective membership functions. From a mathematical point of view, given two fuzzy sets A and B, the Hamming distance d(μA(x), μB(x)) between two fuzzy numbers belonging to A and B respectively, can be computed as

$$d(\mu_A(x), \mu_B(x)) = \int_X |\mu_A(x) - \mu_B(x)| dx \quad (1)$$

Where X is the universe of discourse. Due to the calculation method, the resulting Hamming distance is a crisp value.
The di parameters are then calculated according to Eq.(1). Then, the weighted importance Wi* of SFs can be derived as follows:

$$W_i^* = d_i \otimes W_i, \quad i = 1, \ldots, m. \ (2)$$

2. Weighted importance of strategic actions
This element strives to determine which strategic action has the highest impact on

customer satisfaction. It takes into account the weighted importance of service factors, the relationships matrix and the correlations matrix.

As already detailed, the generic position Rij in the relationships matrix expresses the relationship between the jth SA and the ith SF. A fuzzy linguistic scale may be usefully adopted by DMs to interpret the vagueness and incomplete understanding of the relationships between "hows" and "whats". The importance RIj of each strategic action can then be calculated applying the following equation:

$$RI_j = \sum_{i=1}^{n} W_i^* \otimes R_{ij},\ j = 1,\dots,m,\ (3)$$

Where Wi* is the fuzzy weighted importance of ith service factor, while Rij is the fuzzy number expressing the impact of the jth SA versus the ith SF.

In a similar manner, the generic position Tkj, j, k=1,…,m, k≠j, in the correlations matrix expresses the correlation between the kth and the jth "hows". According to the authors, the correlation Tkj can be interpreted as the incremental changes of the degree of attainment of the jth "how" when the attainment of the kth one is unitary increased. Using this definition, the weighted importance RIj* can be computed as follows:

$$RI_j^* = RI_j \oplus \sum_{k=j} T_{kj} \otimes RI_k,\quad j = 1,\dots,m,\ (4)$$

Cost and Marginal Benefit of Strategic Actions

In order to complete the assessment and ranking of strategic actions, their cost of implementation should be considered. In this situation fuzzy logic becomes a fundamental tool in dealing with ill-defined issues such as the evaluation of costs. While a DM may find objective difficulties in quantitatively assessing the costs of implementation of strategic actions, he/she can more easily give a judgment on a linguistic scale, ranging for instance from Very High to Very Low. This is why, in the lower part of the HOQ a fuzzy parameter Cj has been added to ponder the cost of implementing the jth strategic action.

The marginal benefit Uj of strategic actions can be calculated through the ratio between benefits and costs, as expressed by the following equation:

$$U_j = RI_j^* \otimes \frac{1}{C_j},\quad j = 1,\dots,m \qquad (5)$$

Since both RIj* and Cj parameters are fuzzy numbers, Eq. (5) describes an operation between fuzzy numbers; the resulting Uj is thus a fuzzy number. In order to make SAs comparable and rank the results, defuzzified values should be computed. Due to its simplicity, the Yager method (Yager, 1981) is suggested as a viable tool to adopt in order to obtain final crisp marginal benefits. Starting from a fuzzy triangular number a (l,m,u), the defuzzified value is computed as:

$$\frac{l + 2m + u}{4} \qquad (6)$$

Once crisp values have been computed, SAs can be finally ranked. In particular, according to Trappey et al. (1996), the greater the crisp Uj parameter, the higher the implementation priority of the corresponding strategic action. Strategic action, which scores the highest is the one which has the highest impact on customer service, and therefore its implementation should be considered by the firm's top management to improve the logistics performance.

Case Study

In this section, the methodology developed is applied to a real industrial case, which refers to a major Iranian company operating in the manufacturing industry.

HEPCO Company was established & registered in March 1974, with the intention of assembly & production of road construction equipment. In 1975 Hepco resumed operation in its premises in Arak consistory of 1000000 square meters of land & 40000 square meters of production hall in collaboration with licencors; namely : International Harvester, Dynapac , Poclain , Sakai & Lokomo .

In 1984, Hepco development project was designed in collaboration with Liebherr & Volvo companies, aiming at fabrication of steel structures of road construction equipments.

The capabilities thus gained, was later consolidated in a new company in 2002 Energy Equipment Production Co. (Teta), fully owned by Hepco today. Hepco, together with its subsidiaries, and in collaboration with its world famous partners is active in production, supply and support of road construction, mining and industrial projects.

The main customers of the firm are major manufacturers, which have recently set up programs to streamline the supply processes. Buyers have been requiring adequate logistics performances from their suppliers to reduce inventory, avoid control of orders, accuracy and turn the supplying process from a traditional approach to a JIT one. Consequently, the firm has not been asked only for remarkable products from a technical point of view, but also for remarkable logistics performance, basically in terms of lead time, reliability and accuracy of shipments. Operating in a very competitive scenario from a logistics point of view, the firm needs to proactively manage customer service to retain its customers and gain new market shares. To this extent, the QFD approach proposed in this paper has been recognized by experts in logistics as a valid tool to control logistics performance and promptly tune service delivered to match customer requirements.

Results and Discussion

When applying the proposed HOQ to the real case, appropriate ‘‘whats’’ have to be identified. Four main buyers were asked to take part in the application. In the following, they will be indicated as C1, C2, C3, and C4.

First of all, the importance of each customer has been weighted through the percentage of profit margin generated, as shown in Table (3).

The main service factors ‘‘whats’’ to be considered in the real case application have emerged from a preliminary survey phase, which has been performed through direct interviews carried out by academicians with the customers involved in the project. A survey has been adopted because it emerged as one of the most efficient and effective ways to ponder the performance perceived for each factor affecting customer satisfaction (Keller et al., 2002).

The relevant logistics ‘‘whats’’ are shown in Table (4), together with a brief description

Table 3.Importance ranking of the firm’s main customers

Customer	Importance judgment
C1	Very high
C2	Very high
C3	High
C4	High

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Table 4.Service factors considered in the real case application

Service factors	Description
Lead-time	Time period elapsing from customer's order until receipt
Flexibility	Capability to modify orders in terms of due date and quantity when required
Accuracy	Avoidance of mistakes and damages in orders delivered.
Reliability	Capability to deliver orders within the due date
Fill rate	Common indicator of customer service performance related to inventory. It can be defined as the percentage of units available when requested by customers.
Frequency	Number of deliveries accomplished in a given time period.
Organization Accessibility	Customers' opportunity to establish a contact with a firm's staff.
Complaints Management	Process subsequent to the recognition of some errors in service provided, that allows service quality standards to be reestablished.

Table 5.Strategic actions considered in HEPCO Company

Strategic actions	Description
Transport Management	Transportation has been recognized as a paramount factor affecting effectiveness and efficiency of logistics processes. Through transportations, the product value is increased by making it available where and when it is required. However, transports add significant costs, which could jeopardize the profitability of the supply chain.
Just-In-Time	JIT helps to smooth the production process through the efficient flow of materials, i.e. by providing the right materials, in the right quantities and quality, Just-In-Time for production.
Information Technology	Information technology is generic term used to include hardware, software and networking technologies, such as servers, computer networks, expert systems, software for communication, such as Enterprise Requirement Planning (ERP), Electronic Data Interchange (EDI), etc.
Demand forecasting Methods	Forecasting methods are tools that aim at foreknow customers' demand, in order to reduce its uncertainty.
Warehouse management optimisation	Warehouses lay-out embrace the optimal assignment of items to storage locations, the arrangement of the functional areas of the warehouse, the number and location of docks and input/output (I/O) points, the number of aisles, etc.
Inventory management	Inventory management is a tool that aims at planning and controlling the act of determining and allocating the products inventory to customers.
Customer relationship management	CRM is a generic term, which encompasses methodologies, software, and Internet capabilities that help the firm to manage customer relationships in an organized way.

Table 6.Linguistic judgments and corresponding fuzzy numbers

Judgment	Fuzzy number
Very high (VH)	(0.7; 1; 1)
High (H)	(0.5; 0.7; 1)
Low (L)	(0; 0.3; 0.5)
Very low (L)	(0; 0; 0.3)

The second part of the application focused on the assessment of viable SAs "hows", their mutual correlations, as well as the relationships judgments between SAs and customer SFs. We agreed to adopt a linguistic approach. In a similar manner, appropriate linguistic scales were set up for the evaluation of relative and weighted importance of SFs, the relative and weighted importance of SAs, the costs for the implementation of SAs, together with values in the relationships and correlations matrixes.

Strategic actions “hows” were identified based both on literature analysis and the firm characteristics, whose peculiarities have emerged from group thinking by experts in HEPCO company. Results are shown in Table (5) with a brief description for each point

During the survey phase, the four customers have also been asked about the importance of service factors, in order to determine the relative importance of service factors, as well as to assess the distance between the service delivered for each factor and the performance that is perceived as superior. The four customers have been asked to rank the relative importance of each SF on a 4-point linguistic rating scale, ranging from VL (Very Low) to VH (Very High). The fuzzy scale is shown in Table (6).

wi,x is the fuzzy triangular number which is adopted to translate the linguistic importance judgment given to the ith SF by the xth customer. wi,x fuzzy numbers have been pooled to determine an aggregate value to be used in the HOQ, that is the previously defined relative importance Wi. The relative importance Wi of service factor ith can be computed as a weighted average of wi,x. The weighted average takes into account the issue that not all customers are equal: being resources limited, the firm should tend to provide best class service for those factors, which are important for key customers. In the specific case, the following equation is applied.

$$W_i = \sum_{x=1}^{4} I_x \otimes w_{i,x}, \quad i = 1,\ldots,n \qquad (7)$$

being Ix the importance of xth customer surveyed (x =1,…,4).

Based on the values shown in Table 3, the work group has expressed a fuzzy importance judgment using the same 4-point linguistic scale. The resulting fuzzy numbers have been used in the computation of Wi. Results are shown in Table (7).

As can be seen from the table, the four customers consider lead-time, accuracy and reliability as the most important factors.

Once Wi were calculated, the weighted importance Wi* [n × 1] of SFs was computed in accordance with Eq. (2). As to the crisp distance di between the firm’s performance and the one that is perceived by customer as superior, the parameter has been computed as the average of crisp distances di,x. The generic xth customer perceives ith service factor, as shown in the following equation:

$$d_i = \frac{\sum_{x=1}^{4} d_{i,x}}{4}, \quad i = 1,\ldots,n \qquad (8)$$

Parameters di,x have been obtained based on the survey results and by applying Eq. (1). The customers were asked to judge the service level they were receiving for each service factor, using the linguistic scale shown in Table 6. Moreover, for each SF, the customers had to indicate the judgment which best matched their perception of a superior service. di,x parameters as they result from the survey, di values, and the corresponding weighted importance Wi* are shown in Table (8 and 9).

Table 7. Fuzzy importance wi,x assigned to service factors by each customer and the relative importance of service factors Wi

Service factors	Importance judgment				Relative importance wi,x				Relative Importance of service factors wi
	C1	C2	C3	C4	C1	C2	C3	C4	
Lead-time	VH	VH	VH	VH	(0.7,1,1)	(0.7,1,1)	(0.7,1,1)	(0.7,1,1)	(1.68,3.4,4)
Flexibility	VH	H	H	L	(0.7,1,1)	(0.5,0.7,1)	(0.5,0.7,1)	(0,0.3,0.5)	(1.09,2.4,3.5)
Accuracy	VH	VH	VH	VH	(0.7,1,1)	(0.7,1,1)	(0.7,1,1)	(0.7,1,1)	(1.68,3.4,4)
Reliability	VH	VH	VH	VH	(0.7,1,1)	(0.7,1,1)	(0.7,1,1)	(0.7,1,1)	(1.103,3.4,4)
Frequency	VH	H	H	H	(0.7,1,1)	(0.5,0.7,1)	(0.5,0.7,1)	(0.5,0.7,1)	(1.34,2.68,4)
Fill rate	VH	VH	H	VH	(0.7,1,1)	(0.7,1,1)	(0.5,0.7,1)	(0.7,1,1)	(1.58,3.19,4)
Organization accessibility	VH	VH	H	VH	(0.7,1,1)	(0.7,1,1)	(0.5,0.7,1)	(0.7,1,1)	(1.58,3.19,4)
Complaints management	VH	L	H	H	(0.7,1,1)	(0,0.3,0.5)	(0.5,0.7,1)	(0.5,0.7,1)	(0.99,2.28,3.5)

Table 8.Distances di from the optimum performance and weighted importance Wi* of each service factor

	Performance judgments				Optimum performance				Distance di,x			
	C1	C2	C3	C4	C1	C2	C3	C4	C1	C2	C3	C4
Lead-time	H	L	L	L	VH	VH	VH	VH	0.1	0.6	0.6	0.6
Flexibility	H	L	L	L	VH	H	VH	VH	0.1	0.5	0.6	0.6
Accuracy	H	H	H	H	VH	VH	H	VH	0.1	0.1	0	0.1
Reliability	L	L	L	H	VH	VH	VH	VH	0.6	0.6	0.6	0.1
Frequency	H	L	L	L	VH	VH	VH	VH	0.1	0.6	0.6	0.6
Fill rate	L	H	L	L	VH	VH	VH	VH	0.6	0.1	0.6	0.6
Organization accessibility	VH	VH	H	H	VH	VH	H	H	0	0	0	0
Complaints management	H	H	L	H	VH	VH	H	H	0.1	0.1	0.5	0

Table 9. Weighted importance Wi* of each service factor

	Distance di	Relative importance Wi	Weighted importance Wi*
Lead-time	0.475	(1.68, 3.4, 4)	(0.798, 1.615, 1.9)
Flexibility	0.45	(1.09,2.4, 3.5)	(0.491, 1.08, 1.575)
Accuracy	0.075	(1.68, 3.4, 4)	(0.126, 0.255, 0.3)
Reliability	0.475	(1.103, 3.4, 4)	(0.524,1.615, 1.9)
Frequency	0.475	(1.34, 2.68, 4)	(0.637, 1.273, 1.9)
Fill rate	0.475	(1.58, 3.19, 4)	(0.751, 1.515, 1.9)
Organization accessibility	0	(1.58, 3.19, 4)	(0, 0, 0)
Complaints management	0.175	(0.99, 2.28, 3.5)	(0.173, 0.399, 0.613)

From outcomes analysis, it emerges that customers perceive a significant difference between the firm's service performance and optimum one in terms of lead-time, accuracy, reliability, frequency & fill rate.

Considering crisp values gained for Wi*, we found that lead-time factor has the highest priority in customer's opinion, and organization accessibility has the lowest priority.

Table 10.Degree of relationship, graphic symbols and corresponding fuzzy numbers

Degree of relationship	Fuzzy number
Strong	(0.7; 1; 1)
Medium	(0.3; 0.5; 0.7)
Weak	(0; 0; 0.3)

Table 11.Degree of correlation, graphic symbols and corresponding fuzzy numbers

Degree of correlation	Fuzzy number
Strong positive	(0.7; 1; 1)
Positive	(0.5; 0.7; 1)
Negative	(0; 0.3; 0.5)
Strong negative	(0; 0; 0.3)

The next step in the construction of the HOQ was the assessment of the relationships matrix Rij [n × m]. Strategic actions SAs for customer satisfaction have been listed in columns, while service factors SFs have been crossed over in rows. The degree of relationship (weak, medium, strong) between SAs and SFs has been expressed with linguistic judgments. Since fuzzy logic is exploited to well cope with the ill-defined nature of linguistics judgments, these judgments have been translated to corresponding fuzzy numbers according to table (10)

During this phase, we benefited from a preliminary literature survey phase, which strived to highlight the relationships between service factors and strategic actions. The resulting relationships matrix is shown in the centre of Table (12).

The roof of correlations was built up in a similar manner. Linguistic judgments have been used to express the correlations between strategic actions (strong negative, negative, positive, strong positive). Then they have been translated into fuzzy triangular numbers, as shown in Table (11).

Once the relationships matrix and the roof of correlations were compiled, the relative importance RIj and the weighted importance RIj* of each strategic action were computed in accordance with Eqs. (3) and (4) respectively. Results are shown in Table 12.

Then, the cost Cj for the implementation of each strategic action was determined to evaluate the marginal benefit Uj. To this extent, experts were asked to express a linguistic judgment about the investment required for each strategic action, by using the same 4 value fuzzy scale previously shown in Table 6. Results are shown in Table 12. It should be remarked that fuzzy logic was found to be a very consistent and easy to use tool to handle such a vague, imprecise, and ill-defined issue as costs estimation for strategic actions.

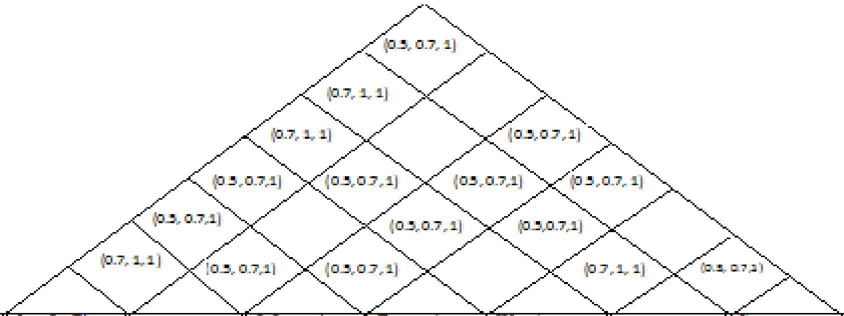
Then, the fuzzy resulting benefits Uj have been computed according to Eq. (5).

Finally, fuzzy Uj parameters were de-fuzzified applying Eq. (8). Crisp Uj obtained can be regarded as synthesis parameters, expressing the overall efficiency of implementing the jth strategic action. The final ranking of strategic actions together with the fuzzy and crisp Uj values are shown in the last two rows of Table (12).

As a result, JIT implementation emerged as the strategic action with the highest implementation priority, since it makes it possible to improve most of service factors: lead time, flexibility, reliability, frequency and fill-rate. JIT has also been proved to have positive correlations against other strategic actions.

Finally, we can rank strategic actions as follows:

JIT implementation, inventory management, demand forecasting methods, customer relationship management, warehouse layout optimization, information technology, and transport management.



Strategic actions / Service factors		Just-In-Time implementation	Transport management	Information technology	Demand forecasting methods	Warehouses lay-out optimization	Inventory management	Customer relationship management	Relative importance W_i	Real importance W_i^*
	Lead-time	(0.7, 1, 1)	(0.7, 1, 1)	(0.3, 0.5, 0.7)	(0.7, 1, 1)	(0.7, 1, 1)	(0.7, 1, 1)	(0.7, 1, 1)	(1.68,3.4,4)	(0.798, 1.615, 1.9)
	Flexibility	(0.7, 1, 1)	(0.7, 1, 1)	(0.3, 0.5, 0.7)	(0.7, 1, 1)	(0.7, 1, 1)	(0.7, 1, 1)	(0.7, 1, 1)	(1.09,2.4,3.5)	(0.491, 1.08, 1.575)
	Accuracy	(0.3, 0.5, 0.7)	(0.7, 1, 1)	(0.7, 1, 1)				(0.3, 0.5, 0.7)	(1.68,3.4,4)	(0.126, 0.255, 0.3)
	Reliability	(0.7, 1, 1)	(0.7, 1, 1)	(0.7, 1, 1)	(0.7, 1, 1)	(0, 0, 0.3)	(0.7, 1, 1)	(0.3, 0.5, 0.7)	(1.103,3.4,4)	(0.524,1.615, 1.9)
	Frequency	(0.7, 1, 1)			(0.7, 1, 1)	(0, 0, 0.3)	(0.7, 1, 1)	(0.3, 0.5, 0.7)	(1.34,2.68,4)	(0.637, 1.273, 1.9)
	Fill rate	(0.7, 1, 1)			(0.7, 1, 1)		(0.7, 1, 1)	(0.3, 0.5, 0.7)	(1.58,3.19,4)	(0.751, 1.515, 1.9)
	Organization accessibility			(0.7, 1, 1)				(0.7, 1, 1)	(1.58,3.19,4)	(0, 0, 0)
	Complaints management			(0.7, 1, 1)				(0.7, 1, 1)	(0.99,2.28,3.5)	(0.173, 0.399, 0.613)
Relative importance RI_j		(2.277, 7.226, 9.385)	(1.357, 4.565, 5.675)	(0.963, 3.617, 5.245)	(2.24, 7.098, 9.175)	(0.902, 2.695, 4.615)	(2.24, 7.098, 9.175)	(1.634, 5.423, 8.288)		
Real importance RI_j^*		(7.845, 32.88, 51.56)	(3.883, 16.21, 24.92)	(6.288, 27.49, 51.56)	(5.797, 23.45, 41.27)	(5.224, 22.75, 34.1)	(6.883, 28.32, 45.88)	(5.494, 22.95, 41.27)		
Cost of implementation C_j		(0.5, 0.7, 1)	(0.5, 0.7, 1)	(0.7, 1, 1)	(0.5, 0.7, 1)	(0.5, 0.7, 1)	(0.5, 0.7, 1)	(0.5, 0.7, 1)		
Utility factor U_j		(7.845, 46.97, 103.1)	(3.883, 23.16, 49.84)	(6.288, 27.49, 73.65)	(5.797, 33.5, 82.54)	(5.224, 32.49, 68.19)	(6.883, 40.45, 91.77)	(5.494, 32.79, 82.54)		
Crisp values		51.23	25.01	33.73	38.83	34.6	44.89	38.4		

Figure 3.Final report of QFD

Conclusion

This paper has discussed a way of strategic management of logistics services and processes based on the case study of a big manufacturer. It has proposed an approach based on the quality function deployment (QFD), for ranking strategic actions to improve logistics services. The paper addresses the issue of how to deploy the house of quality (HOQ) to effectively and efficiently improve logistics processes and thus customer satisfaction. In data collecting, fuzzy logic is used to deal with the ill-defined nature of the qualitative linguistic judgments required in the proposed HOQ. The methodology has been tested by means of a real case application, which refers to an Iranian company operating in the manufacturing industry.

The approach proposed could be rightly considered as a useful tool for selecting the most efficient and effective logistics leverages to reach customer satisfaction. In particular, the methodology allows the identification of the service factors that are perceived to affect logistics performance from the customer's point of view, enabling the assessment of possible gaps between customers and firm's perception of logistics service. In fact, this is why firm's perception should not be considered as the starting point in developing service strategies, but direct interviews with customers are required.

In order to assess and rank viable strategic actions, in the approach proposed we have introduced a utility factor, which considers the costs of implementation for each "how". The utility factor can be directly adopted as a synthesis parameter to select the most suitable strategic action to implement.

Ultimately the strategic actions have been ranked as follows:

1) JIT implementation,
2) Inventory management
3) Demand forecasting methods
4) Customer relationship management
5) Warehouse layout optimization
6) Information technology
7) Transport management.

As we can see, JIT implementation has the highest priority, and it can be the result of strong relationship between JIT and the most important service factors. After JIT implementation, inventory management and demand forecasting method has the highest priority. It could be the result of strong relationship between these two strategic actions and fill-rate.

Although information technology can have a strong effect on service improvement, its priority is low, because according to HEPCO's experts, organization needs high budget for implementing information technology.

Given the limited number of interviewees in this study, future studies are suggested being conducted on a larger population applying MCDM techniques in uncertainty condition.

Managers in the industry are suggested considering the cultural aspects of society and customers and use them to promote sales. In addition, managers should implement their own macro-level strategies, to be able to compete

References

1. Akao, Y. (1990). *An Introduction to Quality Function Deployment. Quality Function Deployment (QFD): Integrating Customer Requirements into Product Design,* Y. Akao, ed., Productivity Press,Cambridge, Massachusetts, 1-24.
2. Anwar, A., Mulyati, D.S., & Amelia, W. (2016). Application quality function deployment to improve the quality of services in Ngodoecafe. *Int. J. Innovation, Manag.Technol.*, 4(6), 574-578.
3. Baines, A. (1996). Designing customer service programmes. *Work Study,* 45 (1), 20–23.
4. Behara, R. S., & Chase, R. B. (1993). *Service quality deployment: Service quality by design. In: Sarin, R.V.* (Ed.), Perspectives in Operations Management: Essays in Honor of Elwood S. Buffa. Kluwer Academic Publisher, Norwell, MA.
5. Bottani, E., & Rizzi, A. (2006). Strategic management of logistics service: A fuzzy QFD approach. *International Journal of Production Economics*, 103, 585–599.
6. Büyükozka, G., & Cifci, G. (2016). A integrated QFD framework with multiple formatted € and incomplete preferences: a sustainable supply chain application. *Appliled Soft Computing,* 13(9), 3931-3941.
7. Celik, M., Kahraman, C., Cebi, S., & Er, I. D. (2009). Fuzzy axiomatic design-based performance evaluation model for docking facilities in shipbuilding industry: The case of Turkish Shipyards. *Expert Systems with Applications*, 36(1), 599–615.
8. Chang, A. Y. (2012). Prioritizing the types of manufacturing flexibility in an uncertain environment.International *Journal Production Research*. 50 (8), 2133-2149.
9. Chase, R. B. & Garvin, D. A. (1989). The service factory. *Harvard Business Review*, 67(4), 61-69.
10. Chen, Y., Fung, R.Y. K., & Tang, J. (2006). Rating technical attributes in fuzzy QFD by integrating fuzzy weighted average method and fuzzy expected value operator. *European Journal Operation Research*, 174, 1553–1566.
11. Chien, C. J., & Tsai, H. H. (2000). Using fuzzy numbers to evaluate perceived service quality. *Fuzzy Sets and Systems*, 116, 289–300.
12. DeRoulet, D. G. (1993). Designing and sustaining the gains from a service strategy. *Journal of Business Strategy,* 14 (I), 21-30.
13. Fuller, J. B., O'Conor, J., & Rawlinson, R. (1993). Tailored logistics: the next advantage. *Har. Bus. Rev.*, 71(3), 87-98.
14. Hauser, J. R., & Clausing, D. (1988). The house of quality. *Harvard Business Rev.,* 63–73.

15. Kahraman, C., Ertay, T., Buyukozkan, G. (2006). A fuzzy optimization model for QFD planning process using analytic network approach. *European Journal Operation Research*, 171, 390–411.
16. Keller, S.B., Savitskie, K., Stank, T.P., Lynch, D.F. & Ellinger, A. E. (2002). A summary and analysis of multi-item scales used in logistics research. .*Journal of Business Logistics*, 23 (2), 83–281.
17. Khoo, L. P., & Ho, N. C.(1996). Framework of a fuzzy quality function deployment system. *International Journal Production,* 34, 299-311.
18. Korpela J., & Tuominen, M. (2007). Group decision support for analyzing logistics development projects. *The Proceedings of the 30th Hawaii International Conference on System Sciences*. (pp 493-502). Los Alamitos, CA: vol. II, IEEE Computer Society.
19. Kwong, C. K., Chen, Y., Bai, H., & Chan D.S.K. (2007). A methodology of determining aggregated importance of engineering characteristics in QFD. *Computer and Industrial Engeenring,* 53(2), 667–679.
20. LaLonde, B. J., & Zinszer P. H. (1976). Customer Service: Meaning and Measurement. National Council of Physical Distribution Management, USA.
21. Lambert, D. M., & Harrington, T. C. (1989). Establishing customer service strategies within the marketing mix: more empirical evidence. *Jouranl Bus. Logistic*, 10(2), 44-59.
22. Lambert, D. M., & Stock, J.R. (1993). *Strategic Logistics Management*. 3rd ed. Richard D. Irwin, Homewood, IL.
23. Lapidus, R. S., & Schibrowsky, J. A. (2004). Aggregate complaint analysis: A procedure for developing customer service satisfaction. *Journal of Services Marketing*, 8 (4), 50–60.
24. Lin, L. Z., Yeh, H. R., & Wang, M. C. (2017). Integration of Kano's model into FQFD for Taiwanese Ban-Doh banquet culture. *Tour. Management*, 46, 245-262.
25. Livingstone, G. (1992). Measuring customer service in distribution. *International Journal of Physical Distribution and Logistics Management*, 22(6), 4-6.
26. Manrodt, K. B., & Davis, Jr. F. W. (1992). The evolution to service response logistics. *International Journal of Physical Distribution and Logistics Management*, 22 (9), 3-10.
27. Mentzer, J. T., Games, R. & Krapfel, R. E. Jr. (1989). Physical distribution service: a fundamental marketing concept. *Journal of the Academy of Marketing Science*, 17(l), 53-62.
28. Masoumik, M., Salwa Hanim Abdul-Rashid , & Ezutah, U. O. (2015). The Development of a Strategic Prioritisation Method for Green Supply Chain Initiatives. https://doi.org/10.1371/journal.pone.0143115.
29. Morris, J. (1996). Leading to customer care. *Industrial and Commercial Training*, 28(5), 7–10.
30. O'Neil, B. F., & Iveson, J. L. (1991). An operational procedure for prioritizing customer service elements. *Journal of Business Logistics,* 12 (2), 157-191.
31. Pirttila, T., & Huiskonen, J. (1996). A framework for cost-service analysis in differentiation of logistics services. *International Journal Production Economic,* 45, 131-137.
32. Schary, P. B. (1992). A concept of customer service. *Logistics and Transportation Review*, 28 (4), 341-352.
33. Sharma, A., & Lambert, D. M. (1991). Using salespeople to collect customer service information. *Int. J. Phys. Distribution Logistic. Management,* 21(6), 27-31.
34. Shen, X. X., Tan K. C., & Xie, M. (2011). The implementation of quality function deployment based on linguistic data. *Interntional Manufacturing,*12, 65–75.
35. Shycon, H. N. (1992). Improved customer service: measuring the payoff. *The Journal of Business Strategy*, 13-17.
36. Sohn, Y. S., & Choi, I. S. (2001). Fuzzy QFD for supply chain management with reliability. *Reliability. Engineering System Safe,* 72, 327–334.
37. Sterling, J. U., & Lambert, D. M. (1987). Establishing customer service strategies within the marketing mix. *J. Bus. Logist,* 8(l), l-23.
38. Stern, L. W., Sturdivant, F. D., & Getz, G. A. (1993).Accomplishing marketing channel change:paths and pitfalls. *European Management Journal,* 1(1), l-8.
39. Stuart, F.I., & Tax, S.S. (1996). Planning for service quality: An, integrative approach. *International Journal of Service Industry Management,* 7 (4), 58–77.
40. Trappey, C.V., Trappey, A. J. C., & Hwang, S. J. (1996). A computerized quality function deployment approach for retail services. *Computers and Industrial Engineering,* 30 (4), 611–622.
41. VanHuss, S. H. (1993).Effective customer service. *B & E Review,* 21-25.
42. Yu-Hern Chang, A., & Chung-Hsing, Yeh. (2017). Corporate social responsibility and customer loyalty in intercity bus services. *Transport Policy,* 38-45.
43. Zadeh, L.A. (1965). Fuzzy sets. *Information and Control*, 8, 338–353.

44. Zaim, S., Sevkli, M., Camgoz-Akda, G, H., Demirel, O. F., Yayla, A.Y., & Delen, D. (2016). Use of ANP weighted crisp and fuzzy QFD for product development. *Expert Syst. Appl.*, 41 (9), 4464-4474.

45. Zimmermann, H. J. (1991). *Fuzzy Set Theory and its Applications*. second ed. Kluwer Academic Publishers, Boston.