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Application of Fuzzy AHP for Assessment of Transitional Barriers to Electronic Bill of Lading

Elektronik Konşimentoya Geçiş Engellerinin Değerlendirilmesinde Bulanık AHP Uygulaması

Türk Denizcilik ve Deniz Bilimleri Dergisi Cilt: 10 Sayı: 2 (2024) 89-104

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ABSTRACT

Advances in technology have converted the traditional paper-based bill of lading into an electronic bill of lading (eBL) format in recent years. In this regard, different eBL systems have been introduced and are increasingly being employed in the maritime transportation industry. In line with this, some major container shipping lines have started to declare their eBL services to their customers recently. However, it has been observed that there have not been come across any Türkiye origin container shipping lines to utilize eBL systems. Therefore, considering container shipping lines of Türkiye, this paper sought to disclose the barriers to the transition of eBL systems in Türkiye. The barriers have been revealed through literature review and confirmed by industrial experts. Following that Fuzzy-AHP method was performed to prioritize their importance quantitatively. It was revealed that the legal barrier among the main barriers appeared as the most important barrier.

Keywords: Digitalization, Container shipping, Electronic bill of lading, Transitional barriers, Fuzzy AHP.

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ÖZET

Teknolojideki gelişmeler, son yıllarda geleneksel kâğıt tabanlı konşimentoyu elektronik konşimento (eBL) formatına dönüştürmüştür. Bu bağlamda, deniz taşımacılığı endüstrisinde farklı eBL sistemleri tanıtılmış ve giderek daha fazla kullanılmaya başlanmıştır. Bu doğrultuda bazı büyük denizyolu konteyner hatları son dönemde müşterilerine eBL hizmetlerini deklare etmeye başlamışlardır. Ancak, eBL sistemlerini kullanan herhangi bir Türkiye menşeili denizyolu konteyner taşıma hattına rastlanmadığı gözlemlenmiştir. Bu nedenle, Türkiye'deki denizyolu konteyner nakliye hatlarını göz önüne alarak, bu çalışma Türkiye'de eBL sistemlerine geçiş engellerini açıklamaya çalışmaktadır. Engeller, literatür taraması yoluyla ortaya çıkarılmış ve endüstri uzmanları tarafından onaylanmıştır. Daha sonra önemlerini nicel olarak önceliklendirmek için Fuzzy-AHP yöntemi uygulanmıştır. Ana engeller arasında yasal engelin en önemli bariyer olduğu ortaya çıkmıştır.

Anahtar sözcükler: Dijitalleşme, Konteyner taşımacılığı, Elektronik konşimento, Geçiş engelleri, Bulanık AHP.

1. INTRODUCTION

Global competition is becoming more intense day by day, and gaining a competitive advantage is one of the primary goals of businesses. To remain competitive, firms must provide exceptional value to their customers (Balcı, 2021). Philip and Gary (2012) emphasize the need of gaining a competitive advantage and see it as a marketing extension. According to Porter (1985), the proper application of technology can be a source of competitive advantage. Lenka *et al.* (2017) indicate that digitalization is the primary facilitator for value creation in today's highly competitive business environment. Therefore, creating value, and thereby obtaining competitive advantage has become vital for shipping firms to survive in such a dynamic business environment.

Gunasekaran *et al.* (2017) point out that digitalization of the services is regarded to be a crucial source for differentiation and competitive advantage. Aside from the obvious benefits of digital transformation in the shipping industry, shipping firms are also under pressure to digitize their operations. This has become particularly evident in the Coronavirus pandemic period. Digital solutions offered by firms have aided in the continuity of their supply chains (Kamal, 2019). During the early phases of the COVID-19 pandemic, for instance, lockdown measures hampered some courier services, and several importers were unable to discharge shipments from ports owing to the absence of printed bills of ladings (Balcı, 2021). Because actors in the seaway freight processes are interconnected and due to the high cost of transmission, this interconnectedness results in error-prone and delayed procedures (Wunderlich and Saive, 2020). Since the original bill of lading cannot be delivered to the carrier and the delivery order cannot be obtained, delays might occur in receiving the cargoes, and storage, demurrage, detention costs might be incurred, also agglomeration might occur in ports and warehouses. As a result of these situations, prolonged discussions might arise between the seller and the buyer as to who will bear these costs (Manaadiar, 2020).

The document review process takes a long time, and in the worst-case scenario, it takes longer than the actual transportation. Hence, the transportation process is slowed, and the cost of the items rises. In sum, transportation-related documentation obligations contribute to 5–10% of total transportation expenditures. In light of the significant cost pressure, it is thus critical to develop a means to relieve the transport players of the burden of the paper-based documentation process of sea freight. In this regard, the eBL appears as an effective solution to eliminating the disadvantages stemming from paper-based bill of lading. Using the eBL, the complicated paper-based transportation documentation would be avoided. It also eliminates the

complexity of payment methods and the problem of language differences. Utilizing the eBL, the trading process is enormously accelerated and ultimately becomes more cost-effective. Particularly in light of the still-ongoing shipping issue, companies are reliant on more cost savings (Wunderlich and Saive, 2020).

The eBL was developed as a concept about 20 years ago and there have been several initiatives for replacing the paper version of the transportation documents with digital equivalents so far (Dubovec, 2005). Among them, the BOLERO project is the pioneer of this digitization endeavor (Ma, 2000). Based on a widespread opinion, eBL will lead to a radical change in the sector, as it is faster, enables efficient transactions, and reduces costs (document fee, courier costs, etc.), as well as being safer and less risky (Manaadiar, 2020). However, in today's world, shipments under the eBL are limited (Todd, 2019).

Traditional and still widely used bills of lading, especially negotiable and transferable bills of lading, are issued in paper form and stamped by the carrier, usually in 3 copies. For the transported materials to be received, such bills of lading must be physically sent to the buyer by courier (Manaadiar, 2020). Due to the lockdown in many countries caused by the coronavirus pandemic, exporters cannot receive their bills of lading even after the goods have been loaded onto the ship and the ship has sailed. Parallel to this, cargoes that have arrived at the unloading port experience many problems since the bills of lading have not arrived or, in the worst-case scenario, the bills of lading are lost. For this very reason, almost all shipowners and customers wished to have access to e-bill of lading during this period (Manaadiar, 2020).

In line with this, many shipowning firms particularly major ones have started to announce eBL applications. Considering what we're going through right now, it might be the perfect solution. For instance, ZIM broke new ground in this regard and implemented the first pilot e-bill of lading within the scope of blockchain technology in 2017 in cooperation with Sparx and Wave software companies (ZIM, 2017). Similarly, French CMA-CGM, the world's 4th largest container operator, has recently announced its e-bill of lading systems (CMA-CGM, 2019). In this regard, it should be indicated that the Digital Container Shipping Association (DCSA), which was established by major container shipping lines in 2019 to establish information technology standards that would enable the interoperability of the technology solutions across the container industry, published data and procedural standards for the submission of shipping instructions and issuance of the eBL. Via this initiative, the aim of the DCSA is to facilitate the acceptance and adoption of the eBL by different stakeholders in the industry such as regulators, banks, insurers, carriers, and their customers (Digital Container Shipping Association, 2020).

Considering previous studies on the issue, it is observed that the majority of the current literature on eBL is devoted to the legal ramifications of going paperless in shipping transactions and the viability of offering an electronic version that is operationally and legally similar to the traditional paper-based bill of lading considering the various legal frameworks of various nations (Doan, 2018; Arıman and Erol, 2023; Ren, 2023). In this regard, for instance, examining defects of Vietnamese legal mechanism, Doan (2018) provided some recommendations for the use of electronic bills of lading in Vietnam. Similarly, Arıman and Erol (2023) evaluated the applicability of the electronic bill of lading concept for Türkiye by analysing the national legislation and as a result of the study, in relation to the subject, some suggestions have been made to overcome the deficiencies in the domestic legislation. Ren (2023) investigated the extent to which eBLs can be governed by the English legal system and whether electronic tools can replicate the features of paper-based bill of ladings to create an electronically equivalent version of the latter that is both legally and functionally equal. Some of the papers with regard to eBL have also concentrated on the technologic and cyber security aspect of the issue (Kara, 2019; Kapnissis *et al*., 2020; Petronilho *et al*., 2022). Additionally, some papers have partially

revealed the transitional barriers of the eBL qualitatively (Mei and Dinwoodie, 2005; Dubovec, 2005; Civelek *et al.,* 2015; Ziakas, 2018; Civelek and Özalp, 2018; Yıldız and Baştuğ, 2018; Meral, 2020).

The above papers have provided a valuable insight into the advantages and disadvantages of the paperless bill of lading processes. However, each of these papers has solely concentrated on one or more eBL transitional barriers qualitatively and no research papers have comprehensively investigated all possible transitional barriers from a quantitative perspective and assessed their relative importance. Therefore, concentrating on container shipping lines of Türkiye origin, this is a pioneering study that qualitatively and quantitatively examines the barriers to the adoption of eBL systems since no container shipping companies from Türkiye have been found to use eBL systems yet to our best knowledge. There have been many criteria appearing as barriers to transition to the eBL. Identification of these barriers to transition to the eBL, evaluating the significance of these causal barriers would holistically require a well-designed multi-criteria decision making. Fuzzy Multiple Criteria Decision Making approach has been largely used to handle the decision-making problems including multi-criteria choosing and/or assessment of the alternatives (Park *et al.,* 2018; Kamal *et al.,* 2020). In the literature, practical applications of the Fuzzy Analytical Hierarchy Process (Fuzzy-AHP) have revealed advantages for managing qualitative criteria and obtaining accurate findings (Hsieh *et al.,* 2004; Satir, 2014; Chang *et al.,* 2019a). Thus, the Fuzzy-AHP approach was utilized to prioritize the importance of the transitional barriers in adopting the eBL. The rest of the paper is organized as follows. After providing the identifications of the barriers in Section 2, the stages of the employed method are explained in Section 3. Following that the use of utilized methodology on transitional barriers is provided in Section 4. Results of the method are provided, discussed and also some recommendations are proposed in Section 5 and finally, the study is summarized and some suggestions are put forward in the last section.

2. MATERIALS AND METHODS

2.1. Transitional barriers to eBL

To reveal the transitional barriers to eBL in Türkiye, literature was reviewed comprehensively. The possible barriers to the transition to the eBL systems are revealed through literature review utilizing databases such as Google Scholar, Sciencedirect and industrial reports and are suitably placed in the related part of the following section. These barriers are examined under 6 headings as technological, business culture, standardization, adaptation of external stakeholders, legal, reliability barriers, and are explained respectively as follows.

2.1.1. Technological Barrier

Cyber Security Risk: The digital transformation taking place in the maritime transport sector also has negative aspects. Because the developments in technology have created opportunities for maritime transport companies and their commercial stakeholders as well as criminal actors and have made the sector vulnerable to cyberattacks. The increase in the size of cyberattacks is considered to have the potential to disrupt critical infrastructure in the future (Chang *et al.,* 2019b). In particular, the industry's lack of standardization for cyber security, the necessity of establishing an international safety net rather than a domestic approach, and the implementation of a global mandatory standard when necessary will take a long time. The eBL systems are also not immune from the risk of cyberattacks, and cyberattacks stand as a fundamental barrier to the transition from paper bill of lading to eBL systems (Kara, 2019).

Counterfeiting / Fraud Risk: One of the main risks attributable to the electronic format of the bill of lading is the vulnerability of the bill of lading to fraudulent practices. To put it simply, hackers can have access to data, albeit any encryption-decryption system. It is technically possible to create a fake copy of the original bill of lading and the created copy may be indistinguishable from the original. It should also be noted that, since it is in written form, it

is much easier to detect a forgery in a printed bill of lading compared to a computer-generated counterfeit copy (Ziakas, 2018).

2.1.2. Business Culture Barrier

Negative Perception of Stakeholders: Stakeholders in the supply chain such as consignor, carrier, consignee, bank may have a negative view of this technology. Thus, it is necessary to build trust in these systems in order to improve the attitude of users regarding eBL (Mei and Dinwoodie, 2005).

Resistance to Change: Employees may be reluctant in the digitalization process of documentation of the bill of lading. Employees' negative attitudes towards the electronic documentation system are most likely due to resistance to change and the system's lack of interoperability (Civelek *et al.,* 2015).

2.1.3. Standardization Barrier

Electronic signature: The legal validity of electronic documents is based on the electronic signature they carry. Also, the legal validity of the electronic signature is based on the electronic signature laws of the countries. The legal basis of the Bill of Lading is based on transnational commercial law (lex mercatoria), international law, rules, and agreements. The lack of an integrated system that brings together all the parties involved in a foreign trade transaction, the differences between countries, and the fact that electronic signature applications are not accepted in every country stand as one of the obstacles to the widespread adoption of the eBL (Civelek and Özalp, 2018).

Utilization of Different Platforms: The use of different eBL platforms such as Bolero, Seadocs, Wave, E-Title, and Tradelens is another challenge for the universal acceptance of these systems for companies trading internationally. Attitudes in countries adopting the eBL may change and do not necessarily have to be compatible with all international markets, especially countries that are slow to implement new technology. These complications can arise in matters of commercial disputes and litigation (Marsh, 2016).

2.1.4. Adaptation Barrier of External Stakeholders

Adaptation of State Institutions: As long as government agencies are ready for eBL integration, it will facilitate the transition. For example, it is important that some documents, including the bill of lading, are fully completed in such a way that they can be submitted to the customs administration, depending on the way the goods arrive. Here, for example, the fact that the customs administration does not have a technological infrastructure that can accept eBL constitutes a serious barrier.

Adaptation of Banks: One of the serious obstacles to the spread of eBL is that banks prefer to provide financing to the parties by using the original, paper bills of lading as collateral, which still reflects the ownership of the goods in practice. The importer can obtain the necessary documents for importation and clear the goods from customs only by paying the original, physical bill of lading to her bank (Meral, 2020). In addition, the fact that banks are not ready and familiar with the use of eBL poses a serious obstacle. The use of eBL remained limited due to the problems experienced by the banking sector. Traditional eBL's have compatibility problems with the financial system. For example, while TradeCard and GlobalTrade are fully supported in the financial system, SeaDocs and Bolero project could not be included in the banking system (Yıldız and Baştuğ, 2018). For example, the lack of support from the banking industry is stated as an important reason for the failure of the Bolero eBL system (Dubovec, 2005).

Adaptation of P&I and Cargo Insurance Companies: The issue of whether the disputes/risks that may arise from a shipment containing eBL will be covered appears as an obstacle to the transition to the eBL system due to the fact that the P&I Club (Protection and Indemnity Club) or cargo insurers do not approve any eBL system (Global Trade Review, 2021a).

2.1.5. Legal Barrier

Inadequacy of Domestic Legislation: In the event that a bill of lading is prepared

electronically, it has not been fully clarified whether it will be qualified as a negotiable document. Assuming that the reference to the validity of the eBL in the Commercial Code of Türkiye is made to all issues related to the bill of lading in the aforementioned law, it can be claimed that the eBL has the same value as the printed bill of lading. However, a legal arrangement should be made in a way that leaves no room for doubt as to whether the eBL has the qualification of negotiable paper, and many problems related to the relevant issue should be resolved with this legislation (Kara, 2019). Since the legal infrastructure of the countries does not allow the implementation of the eBL, its usage could not become widespread (Meral, 2020).

Differences Between Foreign Legislation: In case of a dispute arising from bills of lading in international trade, the legal systems to be applied may differ from country to country. In this regard, customers using eBL should be careful and check whether the legal status of such documents is accepted as valid digital documents in the laws of the country (Turk P&I, 2021). In this context, the issue should be standardized by the relevant international organizations to eliminate the conflicting situations that may arise from the eBL. The fact that the Rotterdam Rules, which is one of the first efforts in this context, have not been fully implemented yet is one of the factors underlying the failure of the eBL to become widespread (Meral, 2020).

2.1.6. Reliability Barrier

Consignor/Consignee Trust Issue: The parties involved in the import/export business do not want their bills of lading to be recorded in the main database of the companies which are providing this electronic service due to the confidentiality of the shipment information (Yıldız and Baştuğ, 2018).

Carrier's Trust Issue: In the eBL systems, the rights and responsibilities of the parties are parallel to the printed bills of lading. But the most obvious difference between them is the procedure that makes the endorsement transfer of the bill of lading possible between the exporter and the importer. The eBL system is built on a kind of digital signature system. Here, the encrypted codes are produced by the carrier, and when the owner of the cargo changes, the encrypted code is replaced by the carrier with the new ones. At this point, when the carrier informs the owner of the goods about the place and time of delivery, the cargo owner must determine the buyer of the cargo precisely and convey the key code and delivery conditions. On the other hand, this mechanism does not work effectively in practice. Some carriers complain about the loss of key roles during the digital signature process, and doubts arise about the security of these private keys generated and the uniqueness of the electronic documents produced as a result (Yıldız and Baştuğ, 2018).

2.2. Establishment of Hierarchical Structure

After reviewing the literature regarding transitional barriers to the eBL system, a set of interviews was conducted to validate the findings of the literature review and reveal any additional transitional barriers for container shipping companies. Before performing the interviews, the experts were shortly informed concerning the aim of the research and fuzzy-AHP implementation. An Excel sheet, that includes identifications of the barriers, was sent to the interviewees. In the interviews, the industrial experts were asked to modify the barriers if they felt any barriers indicated in the Excel sheet are inappropriate, to confirm and support the barriers if they thought the barriers are appropriate, or to suggest other relevant barriers if they felt there exist some other barriers that have been considered but yet mentioned in the provided Excel sheet.

In total, 13 experts from different segments of the container shipping lines participated in the interviews. These experts who contributed to the hierarchical structure of the barriers have been actively engaged in the maritime container shipping industry for a long time. They have been employed in various positions in the container shipping industry such as vice general manager, documentation manager, forwarder relations manager, trade line manager, academician with a freight forwarding background etc., and details of the experts are

presented in Table 1. Based on the outcomes of the interviews, all the barriers provided in the literature review section are endorsed by the consensus of experts, no extra barriers are specified and the ultimate hierarchical structure appears as given in Figure 1.

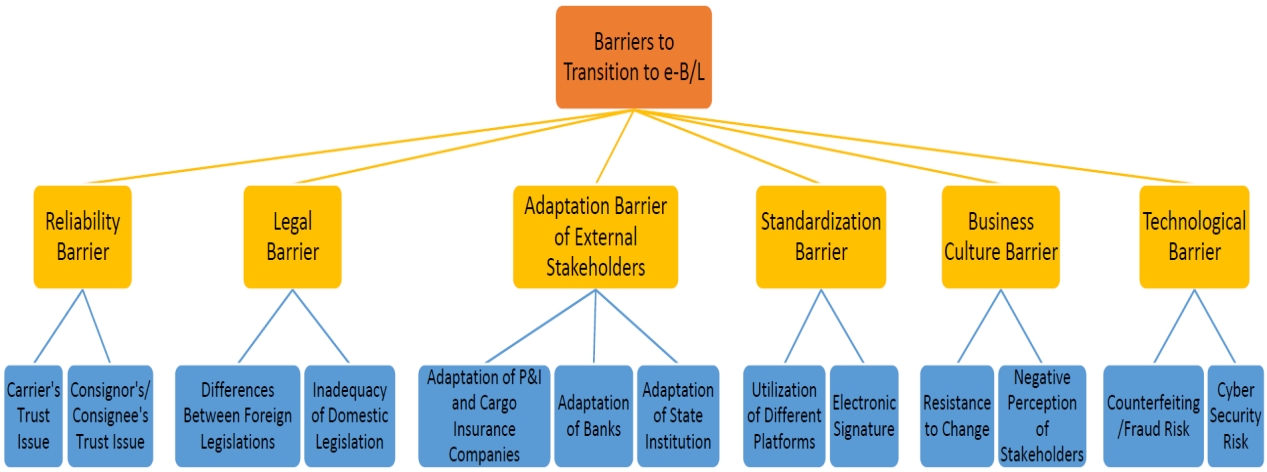

Figure 1. Hierarchical structure for barriers to transition to eBL usage

Table 1. Details of the experts

Position	Education	Industrial Experience (years)
Assistant General Manager	Maritime Transportation Management Engineering (Bsc)	17
Procurement Manager	Maritime Transportation Management Engineering (Bsc)	14
Ocean Freight Manager	Maritime Business (Bsc)	17
Associate Professor (Maritime)	Phd	17
Assistant Professor (Maritime)	Phd	14
Senior Export Specialist	International Trade and Logistics (Bsc)	5
Trade Lane Manager	Maritime Transportation Management Engineering (Bsc)	16
Senior Export Specialist	International Trade (Bsc)	6
Documentation Chief	Logistics (Bsc)	15
Forwarder Relationship Manager	High School	31
Ocean Freight Specialist	Maritime Business (Bsc)	12
Export Manager	Maritime Transportation Management Engineering (Bsc)	16
Documentation Manager	Shipping Operations & Port Technology (Bsc)	23

2.3. Fuzzy Analytical Hierarchy Process (FAHP)

Due to the ambiguous nature of decision-making problems, humans frequently fail to describe their preferences exactly in many practical scenarios (Kamal, 2021b; Kamal and Kutay, 2021). Zadeh (1965) originally presented the fuzzy set theory, which was geared to the rationality of uncertainty owing to vagueness, to deal with the ambiguity of human thought (Beşikçi *et al.*, 2016). FAHP method is considered to be a suitable method for this research since expert opinion will be employed in weighing the transitional barriers to adopting the eBL usage.

The AHP method is largely employed in multiple criteria decision-making approaches

and has been utilized in many fields (Seo *et al.,* 2018; Çakir, 2019; Ha *et al.,* 2021). This method, however, is frequently criticized for its inability to assign precise numerical values to comparison judgments and for being ineffectual when performed to ambiguous problems. To handle fuzzy comparison matrices, several scholars have merged the Fuzzy theory with the AHP approach since the standard AHP still cannot provide adequate guidance regarding the extremely ambiguous environment (Chang *et al.,* 2019a; Kamal *et al.,* 2020; Ergin, 2021). One of these approaches is the extent analysis method developed by Chang (Chang, 1996) and in this paper, the extent fuzzy AHP is utilized in order to prioritize the transitional barriers in adopting eBL. $X = \{x_1, x_2, ..., x_n\}$ be an object set, and $U = \{u_1, u_2, ..., u_m\}$ be a goal set. Based on Chang's approach, each criterion is taken and the extent analysis is performed for each target. Therefore, m extent analysis values can be achieved for each object. These values are provided as follows.

M^j_{gi} = extent analysis value for each object

$$M^1_{gi}, M^2_{gi} ..., M^m_{gi}, \ i = 1,2,...,n, \tag{1}$$

At this point, $M^j_{gi} \ (j = 1,2,\ldots,m)$ are all triangular fuzzy numbers and linguistic scale utilized in this research is indicated in Table 2 (Ho, 2011).

Table 2. Triangular Fuzzy Numbers

Linguistic Scale	Triangular Fuzzy Numbers	Reciprocal Triangular Fuzzy Numbers
Absolutely Important	(9,9,9)	(1/9,1/9,1/9)
Intermediate	(7,8,9)	(1/9,1/8,1/7)
Very Strong	(6,7,8)	(1/8,1/7,1/6)
Intermediate	(5,6,7)	(1/7,1/6,1/5)
Strong	(4,5,6)	(1/6,1/5,1/4)
Intermediate	(3,4,5)	(1/5,1/4,1/3)
Weak	(2,3,4)	(1/4,1/3,1/2)
Intermediate	(1,2,3)	(1/3,1/2,1/1)
Equally Important	(1,1,1)	(1,1,1)

The stages of Chang's extent analysis can be presented as in the following (Chang, 1996).

Stage 1: The value of the fuzzy synthetic regarding the ith object is outlined as in the following:

S_i = the value of fuzzy synthetic extent regarding the ith object.

$$S_i = \sum_{j=1}^{m} M^j_{g_i} \otimes \left[\sum_{i=1}^{n} \sum_{j=1}^{m} M^j_{g_i} \right]^{-1} \tag{2}$$

$\sum_{j=1}^{m} M^j_{g_i}$ to compute the value; the fuzzy addition operation of m extent analysis values for a particular matrix is executed like so:

$$\sum_{j=1}^{m} M^j_{g_i} = \left(\sum_{j=1}^{m} l_j, \sum_{j=1}^{m} m_j, \sum_{j=1}^{m} u_j \right) \tag{3}$$

$$\sum_{i=1}^{n} \sum_{j=1}^{m} M^j_{g_i} = \left(\sum_{i=1}^{n} l_i, \sum_{i=1}^{n} m_i, \sum_{i=1}^{n} u_i \right) \tag{4}$$

The inverse of the vector in equation (4) is computed as follows.

$$\left[\sum_{i=1}^{n} \sum_{j=1}^{m} M^j_{g_i} \right]^{-1} = \left(\frac{1}{\sum_{i=1}^{n} u_i}, \frac{1}{\sum_{i=1}^{n} m_i}, \frac{1}{\sum_{i=1}^{n} l_i} \right) \tag{5}$$

Stage 2: The degree of possibility of $M_2 = (l_2, m_2, u_2) \geq M_1 = (l_1, m_1, u_1)$ is framed as

$$V(M_2 \geq M_1) = \sup_{y \geq x} \lfloor \min(\mu_{M_1}(x), \mu_{M_2}(y)) \rfloor \tag{6}$$

and the equivalent can be stated as follows;

$$V(M_2 \geq M_1) = hgt(M_1 \cap M_2) = \mu_{M_2}(d) = \begin{cases} 1, & \text{if } m_2 \geq m_1, \\ 0, & \text{if } l_1 \geq u_2, \\ \dfrac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} & \text{otherwise,} \end{cases} \tag{7}$$

where d is the ordinate of the highest intersection point D between between M1 and M2.

Stage 3: The possibility degree of convex fuzzy values being greater than k convex fuzzy values $M_i (i = 1,2,.....,k)$ can be given as follows;

$$V(M \geq M_1, M_2, ..., M_k) = V[(M \geq M_1) \text{ and } (M \geq M_2) \text{ and } ... \text{and } (M \geq M_k)] = \min V(M \geq M_i), \quad i = 1,2,....., k. \tag{8}$$

$$d'(A_i) = \min V(S_i \geq S_k), \tag{9}$$

For $k = 1,2,....., n; k \neq i$. After the weight vector is given by

$$W' = (d'(A_1), d'(A_2), ..., d'(A_n))^T \tag{10}$$

Here $A_i (i = 1,2,....., n)$ are n elements.

Stage 4: Normalized weight vectors are as in the following.

$$W = (d(A_1), (A_2), ... d(A_n))^T \tag{11}$$

Here, w is a non-fuzzy number (Chang, 1996).

3. APPLICATION OF FUZZY AHP ON TRANSITIONAL BARRIERS TO EBL

Following the establishment of the hierarchical structure, it is attempted at comparing the main and sub-criteria of the transitional barriers according to their degree of importance. To do this, the FAHP (Fuzzy Analytic Hierarchy Process) questionnaire, which was created to determine the importance levels of these factors, was presented to the interviewed experts, and finally, among them, 11 experts filled out the questionnaire and sent them back. The data obtained from the questionnaires were evaluated with the synthetic extent analysis developed by Chang (1996), which is one of the solution methods of the FAHP application, and 6 main factors (criteria) and 13 sub-factors were ranked according to their importance in terms of being an obstacle to the use of eBL.

Six main factors which are technological barrier (TB), business culture barrier (BCB), standardization barrier (SB), external stakeholder adaptation barrier (ESAB), legal barrier (LB), and reliability barrier (RB), and 13 sub-factors which are cybersecurity risk (CSR) and counterfeiting/fraud risk (CFR), stakeholder negative perception (NPS) and resistance to change (RC), electronic signature (ES) and use of different platforms (UDP), adaptation of state institution (ASI) and adaptation of banks (AB) and adaptation of P&I and cargo insurers companies (APCIC), the inadequacy of domestic legislation (IDL) and differences between foreign legislation (DBFL), consignor's/consignee's trust issue (CCTI), and carrier's trust issue (CTI), determined within the scope of the study were compared in pairwise form by 11 experts using the fuzzy linguistic statements provided in Table 2. Therefore, 64 pairwise comparisons performed by each expert were combined with the FAHP via geometric mean, which enables multiple expert decisions to be represented as a single consensus decision in group decision-making processes. Due to the non-reciprocity, power condition of the group's common pairwise comparison matrices, using the arithmetic mean at this step is not suggested (Ossadnik *et al.,* 2016). The geometric mean method used in the creation of the joint decision matrix of the expert group was applied as given in eq.12 (Davies, 1994).

$$I_{ij} = \left(\prod_{k=1}^{K} I_{ijk}\right)^{\frac{1}{K}}, m_{ij} = \left(\prod_{k=1}^{K} m_{ijk}\right)^{\frac{1}{K}}, \quad u_{ij} = \left(\prod_{k=1}^{K} u_{ijk}\right)^{\frac{1}{K}} \tag{12}$$

Where, $K = \{1,2,3,\ldots,k\}$ represents the set of the expert group participating in the evaluation, $I_{ijk}, m_{ijk}, u_{ijk}$ represent respectively, the lower, middle and upper limit values of the i factor of the kth expert according to the j factor and I_{ij}, m_{ij}, u_{ij} represent respectively, the lower, middle and upper values of the i factor of the expert group as the geometric mean of the importance level according to the j factor.

The judgments of 11 experts were combined and the common decision matrix of the group was formed via the geometric mean method. Based on this common decision matrix, the weights of the priority degrees of the criteria relative to each other were calculated with the synthetic extent analysis method. For this study, the joint decision matrix of the group consisting of 11 experts and the weights of the priority degrees are provided as in Table 3.

In the AHP method, the reliability of the results is measured by the consistency index. A consistency index below 0.1 reflects that the survey responses are consistent and reliable. In this study, the consistency index of the joint decision matrix obtained from the responses of 11 experts was calculated as 0.007. Since the inequality 0.007<0.1 is satisfied, the results of the study are consistent and reliable.

Table 3. Joint Decision Matrix of the Expert Group and Weights of Main Factors

	TB	BCB	SB	ESAB	LB	RB	Local Weights
TB	(1.00,1.00,1.00)	(2.89,3.42,4.00)	(1.57,1.91,2.29)	(0.64,0.78,0.92)	(0.46,0.52,0.57)	(0.94,1.07,1.21)	0.00
BCB	(0.25,0.29,0.35)	(1.00,1.00,1.00)	(0.41,0.51,0.68)	(0.25,0.28,0.33)	(0.14,0.16,0.19)	(0.28,0.36,0.46)	0.00
SB	(0.44,0.52,0.64)	(1.47,1.96,2.44)	(1.00,1.00,1.00)	(0.30,0.37,0.47)	(0.19,0.23,0.28)	(0.32,0.39,0.52)	0.00
ESAB	(1.08,1.28,1.56)	(3.03,3.57,4.00)	(2.12,2.70,3.33)	(1.00,1.00,1.00)	(0.42,0.48,0.60)	(0.78,1.00,1.25)	0.16
LB	(1.75,1.92,2.17)	(5.26,6.25,7.14)	(3.57,4.35,5.26)	(1.67,2.08,2.38)	(1.00,1.00,1.00)	(1.37,1.82,2.34)	0.78
RB	(0.82,0.93,1.06)	(2.17,2.78,3.57)	(1.92,2.56,3.13)	(0.80,1.00,1.28)	(0.43,0.55,0.73)	(1.00.1.00,1.00)	0.06

Local weights expressing the priority values of the main factors are calculated as follows according to Table 3. In this calculation, firstly, the synthetic extent values of each factor were determined as follows:

$$S_{TB} = (7.5,8.7,9.99) \otimes \left(\frac{1}{61.15},\frac{1}{52.04},\frac{1}{43.74}\right) = (0.12,0.165,0.229)$$

$$S_{BCB} = (2.33,2.6,3.01) \otimes \left(\frac{1}{61.15},\frac{1}{52.04},\frac{1}{43.74}\right) = (0.037,0.049,0.069)$$

$$S_{SB} = (3.72,4.47,5.35) \otimes \left(\frac{1}{61.15},\frac{1}{52.04},\frac{1}{43.74}\right) = (0.059,0.084,0.123)$$

$$S_{ESAB} = (8.43,10.03,11.74) \otimes \left(\frac{1}{61.15},\frac{1}{52.04},\frac{1}{43.74}\right) = (0.134,0.19,0.27)$$

$$S_{LB} = (14.62,17.42,20.29) \otimes \left(\frac{1}{61.15},\frac{1}{52.04},\frac{1}{43.74}\right) = (0.233,0.33,0.466)$$

$$S_{RB} = (7.14,8.82,10.77) \otimes \left(\frac{1}{61.15},\frac{1}{52.04},\frac{1}{43.74}\right) = (0.114,0.167,0.247)$$

The triangular fuzzy numbers of synthetic extent values obtained as above and the minimum degree possibilities were calculated as follows.

$$d'(A_i)=\min V(S_i \geq S_k),\ k=\{1,2,3,\ldots,n\};\ k \neq I$$

$$d'(1)=\min V(S_1 \geq S_2,S_3,S_4,S_5,S_6) = \min(1.00,1.00,0.25,0.00,0.95)$$

$$d'(2)=\min V(S_2 \geq S_1,S_3,S_4,S_5,S_6) = \min(0.00,0.25,0.00,0.00,0.00)$$

$$d'(3)=\min V(S_3 \geq S_1,S_2,S_4,S_5,S_6) = \min(0.04,1.00,0.00,0.00,0.10)$$

$$d'(4)=\min V(S_4 \geq S_1,S_2,S_3,S_5,S_6) = \min(1.00,1.00,1.00,0.21,1.00)$$

$$d'(5)=\min V(S_5 \geq S_1,S_2,S_3,S_4,S_6) = \min(1.00,1.00,1.00,1.00,1.00)$$

$$d'(6)=\min V(S_6 \geq S_1,S_2,S_3,S_4,S_6) = \min(1.00,1.00,1.00,0.83,0.08)$$

The weight vector of the factors obtained from the minimum degree possibility values calculated in the previous part was formed as $W'=(0.00,0.00,0.00,0.21,1.00,0.08)^T$ and the normalized weight vector was formed as $W'=(0.00,0.00,0.00,0.16,0.78,0.06)$. According to these findings, the priority degrees of the obstacles encountered in the use of eBL were listed as 0.78, 0.16, 0.06, 0.00, 0.00, 0.00, respectively, as LB, ABES, RB, TB, BCB, SB. The normalized weight vectors representing the priority degrees of the sub-factors under the main factors were determined by applying the same principles. The joint decision matrices, local weight vectors and global weights of the sub-factors related to each main factor are given in Tables 4-10:

Table 4. Joint Decision Matrix and Local Weights of Sub-Factors of TB

	CSR	**CFR**	**Local Weights**
CSR	(1.00,1.00,1.00)	(1.13,1.27,1.42)	1.00
CFR	(0.7,0.79,0.88)	(1.00,1.00,1.00)	0.00

Table 5. Joint Decision Matrix and Local Weights of the Sub-Factors of BCB

	NPS	**RC**	**Local Weights**
NPS	(1.00,1.00,1.00)	(1.59,1.78,1.95)	1.00
RC	(0.51,0.56,0.63)	(1.00,1.00,1.00)	0.00

Table 6. Joint Decision Matrix and Local Weights of the Sub-Factors of the SB

	ES	**UDP**	**Local Weights**
ES	(1,00,1.00,1.00)	(0,79,0.82,0.86)	0.00
UDP	(1.16,1.22,1.27)	(1.00,1.00,1.00)	1.00

Table 7. Joint Decision Matrix and Local Weights of the Sub-Factors of the ESAB

	ASI	**AB**	**APCIC**	**Local Weights**
ASI	(1.00,1.00,1.00)	(1.78,2.04,2.35)	(1.11,1.35,1.6)	1.00
AB	(0.43,0.49,0.56)	(1.00,1.00,1.00)	(1.01,1.26,1.5)	0.00
APCIC	(0.63, 0.74, 0.9)	(0.67,0.79,0.99)	(1.00,1.00,1.00)	0.00

Table 8. Joint Decision Matrix and Local Weights of the Sub-Factors of the LB

	IDL	**DBFL**	**Local Weights**
IDL	(1.00,1.00,1.00)	(0.63,0.68,0.74)	0.00
DBFL	(1.35,1.47,1.59)	(1.00,1.00,1.00)	1.00

Table 9. Joint Decision Matrix and Local Weights of the Sub-Factors of the RB

	CCTI	**CTI**	**Local Weights**
CCTI	(1.00,1.00,1.00)	(2.01,2.2,2.37)	1.00
CTI	(0.42,0.45,0.5)	(1.00,1.00,1.00)	0.00

Table 10. Local and Global Weights of Main and Sub-Factors

Main Factor	**Sub Factor**	**Local Weight**	**Global Weight**
TB (0.00)	CSR	1.00	0.00
	CFR	0.00	0.00
BCB (0.00)	NPS	1.00	0.00
	RC	0.00	0.00
SB (0.00)	ES	0.00	0.00
	UDP	1.00	0.00
ESAB (0.16)	GIA	1.00	0.16
	BA	0.00	0.00
	PICA	0.00	0.00
LB (0.78)	DDL	0.00	0.00
	DFL	1.00	0.78
RB (0.06)	SRTI	1.00	0.06
	CTI	0.00	0.00

4. FINDINGS AND DISCUSSION

As obtained from the findings, considering the main barriers, the most important barrier to the transition to eBL appears as LB (0.78). From this point of view, it is understood that the steps taken towards the digitalization of the global maritime transport networks must first of all be within the limits determined by legal frameworks. This finding implies that the priority concerning the transition to eBL should be given to eliminating the lack of legal infrastructure. In this context, the United Nations Commission on International Trade Law (UNCITRAL) Model Law on Electronic Transferable Records (MLETR) appears as an effective tool to combat the problems stemming from the legal issues. MLETR was adopted by UNCITRAL on 13 July 2017 to guide the states to eliminate the confusion caused by different practices and rules in international trade with transferable electronic records. The aim of the Model Law is to provide functional equality (same legal standing) between the traditionally issued paper-based transferable documents (e.g. bill of lading) and the electronic records (e.g. eBL) (İstemi, 2020). So far, some countries adopted the MLETR such as Singapore and Bahrain and it is considered that adopting the MLETR by the government of Türkiye into domestic legislation would address the problem to a large extent. The container shipping lines which are operating in Türkiye are relatively small firms considering Alphaliner Top 100 list and such an adoption, as indicated by Paul Mallon, director of legal and regulatory affairs at Bolero International, instills more confidence in smaller organizations that may have been hesitant to participate in (Global Trade Review, 2021b; Alphaliner, 2022). Taking the sub-factors of the legal barrier into account, it is found that differences between foreign legislation are given the highest importance. This is an expected situation since the fact that maritime trade to large extent occurs internationally.

Considering the main barriers, what follows the LB is ESAB (0.16) and RB (0.06), respectively. As a result of the evaluation of the expert group, the fact that the ESAB main factor ranks second compared to other factors undoubtedly highlights the importance of the integration of government institutions (customs, etc.), banks, and marine insurers, which are among the most important stakeholders of maritime trade, to each other and the system.

When the sub-factors of ESAB are examined, it has been determined that the adaptation of government institutions has priority over the other two sub-factors in this group. Thus, it is crucial to make the digital infrastructure of the related governmental bodies ready for eBL systems for transition. Also, it is observed that adaptation of P&I and cargo insurance barrier is given less importance. The fact that the majority of the domestic container shipping firms have their insurance services from I&G P&I Clubs and I&G is increasingly recognizing new eBL systems implies why less importance is given to this sub-factor (Turkpandi, 2015). The RB was another main factor to focus on as a result of the evaluations. Although reliability is being tried to be eliminated with blockchain technology, the parties involved in the transportation process are concerned about the presence of the customer and commercial information in the databases of 3rd party service providers regarding the eBL technologies currently in use. In this group, it was revealed that the concerns of the sender/receiver of the commercial product are a sub-factor that should be emphasized more than the concerns of the carrier. Therefore, efforts of the firms which are providing eBL services should be canalized more on customers of the carrier firms to alleviate their trust issue rather than carrier firms.

As a result of the opinions of the expert group, it has been evaluated that the effects of the main factors of TB, BCB, and SB and their sub-factors may be seen as insignificant compared to the main factors listed above. However, the fact that the importance degrees obtained from the combined joint decision matrix of the expert group are 0.00 does not mean that these factors do not affect the eBL transition process. It is known in the literature that this is a handicap arising from the fuzzy-AHP application and if one factor is not considered more important than the other, it is known that it occurs because the evaluators focus on the factors that are

considered more important (Beşikçi *et al.,* 2016). From this perspective, it would be a mistake to think that the transition to the eBL, which is one of the steps of digitalization in maritime transport, will not be affected by the TB factor. It is also obvious that a change and transformation process in which TB is effective will cause some adaptation problems arising from the business cultures of those working in that sector. The SB, on the other hand, will be a problem that may be faced by countries and parties in order to make widespread use of the new developing situation. The fact that the current eBL technologies are different platforms causes some problems and prevents the eBL application from becoming widespread.

The results of the sub-factors of the technologic barrier point out that cyber security risk is given the highest importance. Therefore, under thetechnological barrier, the utmost importance should be given to the elimination of the cyber security risks by the firms which are providing eBL services. On the other hand, the outcomes of the sub-factors of the business culture barrier indicate that resistance to change is given less importance. The fact that newly employed personnel graduates familiar with digitalization makes it possible to minimize their resistance to change in adopting new technologies such as eBL compared to the personnel who come from a relatively low educational background and build their experience in the company over time. This personnel is called “alaylı” in Turkish and they have more resistance to adopting new technologies, and their share among company employees is constantly decreasing in today’s business environment. When it comes to the sub-factors of the standardization barrier, it is revealed that utilization of different eBL platforms appears as the highest barrier. In this context, it should be indicated that there are many different service providers such as edoxOnline, Wave, Tradelens, essDocs, and Bolero, hence there should be standardization in these systems established (Kamal, 2021a). According to Oswald Kuyler, managing director of the Digital Standards Initiative of the International Chamber of Commerce, achieving a standardized eBL is a foundational part of the digital transformation process (Global Trade Review, 2020). In this context, the DCSA initiative published eBL standards for data and process in 2020 as part of a larger effort to standardize shipping paperwork and enable end-to-end digitalization of trade (Digital Container Shipping Association, 2020).

5. CONCLUSION

Bill of lading is the most crucial document used in maritime transportation since it establishes that goods were taken over by carriers in the specified condition. The bill of lading is still predominantly used in paper form in maritime transportation. In recent years, however, technological advancements have resulted in the paper-based bill of lading being replaced with an eBL since trading is massively accelerated, made more cost-effective, and several stakeholders participating in the supply chain may benefit from the eBL. This digitalization initiative can provide a vital source for maritime transportation firms for differentiation and competitive advantage. In line with this, efforts to employ eBL systems have been increasing and some major container shipping lines have started to announce their eBL systems recently. On the other hand, it was observed that Türkiye origin container shipping lines have not started to utilize this system yet. In this regard, this paper focused on revealing these barriers to the transition of eBL systems in Türkiye and prioritizing the importance of them among each other quantitatively. To achieve this, the Fuzzy AHP method was exploited. It was revealed that the legal barrier among the main barriers appeared as the most important barrier to the transition to eBL systems followed by adaptation of external stakeholders and reliability barriers, respectively. This study is limited and carried out with the participants only from container shipping lines and in a further study, this research can be extended by including experts from the different segments of the shipping industry such as dry bulk and tanker shipping and also the customers of the carriers to reflect a broader perspective.

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Ozan BAYAZİT: Conceptualization, Methodology, Validation, Formal Analysis, Resources, Writing-Original Draft, Writing-Review and Editing, Visualization, Supervision.
Bünyamin KAMAL: Conceptualization, Methodology, Validation, Formal Analysis, Resources, Writing-Original Draft, Writing-Review and Editing, Visualization, Supervision.

CONFLICT OF INTERESTS

The author(s) declare that for this article they have no actual, potential or perceived conflict of interests.

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