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INVESTIGATION OF THE EFFECTIVENESS OF MARITIME SUPERVISION SERVICES IN SHIP SOLID BULK CARGO HANDLING OPERATIONS

Deniz Gözetim Hizmetlerinin Gemi Katı Dökme Yük Elleçleme Operasyonlarında Etkinliğinin Araştırılması

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ABSTRACT

In this study, the effectiveness of the supervision, inspection and control stages of the cargo survey services, which are included in the maritime supervision services, are investigated by taking into account the international rules. In the study, in-depth interview technique was used as the data collection method. Open-ended questions were asked to experts working in the maritime supervision companies operating in the sector and the answers were analyzed. As a result of the analysis, important indicators that need to be emphasized in order to increase the efficiency of cargo survey operations were reached. The relationship structure among these indicators was revealed using the DEMATEL method. When the findings are examined, it is seen that education and communication have an important place among the factors affecting the efficiency of cargo survey services. As a result, it has been observed that the efficiency of cargo survey services given to ships varies depending on many factors and these factors are connected with each other by a causal link.

Keywords: Maritime supervision service, Cargo survey, Supervision and control, Unloading supervision, Loading supervision.

ÖZET

Bu çalışmada, deniz gözetim hizmetlerinin içerisinde yer alan yük sörvey hizmetlerinin uluslararası kurallar göz önünde bulundurularak uygulanan gözetim, denetim ve kontrol aşamalarının etkinliği araştırılmıştır. Çalışmada, veri toplama yöntemi olarak derinlemesine mülakat tekniği kullanılmıştır. Sektörde faaliyet gösteren deniz gözetim şirketlerinde çalışan uzmanlara açık uçlu sorular sorulmuş ve verilen cevaplar analiz edilmiştir. Analiz sonucunda yük sörvey işlemlerinin etkinliğini arttırabilmek için üzerinde durulması gereken önemli göstergelere ulaşılmıştır. Bu göstergeler arasındaki ilişki yapısı DEMATEL yöntemi kullanılarak ortaya konmuştur. Elde edilen bulgular incelendiğinde yük sörvey hizmetlerinin verimliliğini etkileyen faktörler arasında eğitim ve iletişimin önemli bir yere sahip olduğu görülmektedir. Sonuç olarak, gemilere verilen yük sörvey hizmetlerinin etkinliği birçok faktöre bağlı olarak değişmekte olduğu ve bu faktörlerin birbirleri arasında nedensellik bağı ile bağlı oldukları gözlenmiştir.

Anahtar Kelimeler: Deniz Gözetim Hizmeti, Yük Sörveyi, Denetim ve Kontrol, Tahliye Gözetimi, Yükleme Gözetimi.

1. INTRODUCTION

Technological developments have increased the variety of cargo transported by sea, as maritime transport has a significant advantage thanks to the economy of scale. The safe handling and transportation of these cargoes to the ship is an important issue in order not to disrupt the trade cycle. At the same time, the suitability of the cargo to the ship in terms of quantity and type is also important in terms of navigational safety. With the development of the maritime industry, the formation of ship management branches, the diversification of the services provided to the ship, and the careful implementation of each of these services by taking into account the sustainability factor are of great importance.

The concepts of ship and cargo constitute two important elements of maritime transport. In this context, supervision services are an important service element for ships and cargo. The large variety of cargo carried and the unique handling and transportation conditions of each cargo reveal the importance of the cargo surveys given by the supervision companies. Cargo survey contributes to the continuity of trade by protecting the cargo in a commercial sense and minimizing the safety and security weaknesses caused by the load. In this respect, it is seen as an important service in terms of maritime trade that cargo surveys take responsibility for the control of the cargo. Due to the importance of the supervision service for the cargo and the ship, the surveyors in charge of the supervision organizations pay attention to the international rules and implementation stages during the audit.

IMSBC (International Maritime Solid Bulk Cargoes Code) has been adopted by The Maritime Safety Committee (MSC) in order to ensure safe handling, stacking and transportation of solid bulk cargoes. The main purpose of IMSBC, which has replaced the Code of Safe Practice for Solid Bulk Cargoes (BC Code), is to provide safe stacking and shipment of solid bulk cargoes by providing information on the hazards associated with the transportation of solid bulk cargoes and the instructions on the procedures to be applied. The main hazards associated with shipping solid bulk cargoes are those associated with improper cargo distribution, loss or reduction of stability during a voyage, and structural damage due to chemical reactions of cargoes. Therefore, the main purpose of the IMSBC Code is to facilitate the safe stacking and shipping of solid bulk cargoes by providing information on the hazards associated with the transport of certain types of solid bulk cargoes. Compliance with the Code complies with the International Convention for the Safety of Life at Sea (SOLAS) Convention by harmonizing the practices and procedures to be followed in loading, trimming, transporting and unloading solid bulk cargoes transported by sea and the appropriate precautions to be taken.

In this study, the factors related to the inspections and controls carried out by taking into account the international rules in cargo survey operations were determined by taking expert opinions. The causal relationships among these factors and the effectiveness of the applications made using the DEMATEL method were revealed.

2. LITERATURE RESEARCH

The fact that there is no study in the literature review about the maritime supervision services and the effectiveness of cargo survey services, which has an important place among these services, makes this study unique. When the literature is examined, it is seen that studies are mostly carried out on cargo handling equipment, approaches to visual inspection of ships, visual inspection of ship holds, draft survey and new approaches to draft reading. Some of these studies are given below.

Anastassios and Anastassios (2008), in their study, conducted a research on the increase in cargo diversity and the use of cargo handling equipment in short sea transportation. In the study, the development and positive effects of short sea voyages were examined. Using the SWOT analysis technique, they also revealed the positive and negative effects of the ships on the cargo handling system (Anastassios and Anastassios, 2008).

Bonnin-Pascual et al. (2021), in their studies, made a suggestion to create observation and control possibilities with robots for the holds of the ships. Plans are given for system installation and management for the class surveys of cargo holds and their control with drones before cargo operations. A method called the Supervised Autonomy system was used (Bonnin-Pascual et al., 2021).

In their work, Bonnin-Pascual and Ortiz (2019) reveal the detection of cracks or corrosion in images and robotic platforms that can be used for visual inspection of ships. For this, it is investigating approaches that

can contribute to the restructuring process of ship visual inspection, which focuses on two main topics, computer vision algorithms (Bonnin-Pascual and Ortiz, 2019).

Ivče et al. (2011) worked on making ships with the help of optical sensors as an alternative to the draft reading method during the survey and made suggestions about how it should be. Optical fiber technology is proposed as a new system for draft readings in the study. In addition, suggestions have been made on the control of these automatic reading systems in the shipbridge, machinery and cargo handling areas (Ivče et al., 2011).

Matti (2021) conducted a study on the inspection of the cargo holds of the ship. In particular, what is the hold inspection in bulk carriers and its requirements, how to prepare for the inspection and what should be considered before the hold inspection are emphasized. The study includes general information about hold inspection, inspection company instructions and requirements. The aim of the study is to give an overview of the bulk carrier hold inspection and requirements and how to determine the critical points when preparing the ship for inspection hold (Matti, 2021).

Ortiz et al. (2019) conducted a research on the use of equipment for ship hold and external inspections. The aim of the study is to provide remote control of unmanned aerial vehicles and ship tanks and holds. Robins targets were used as a method (Ortiz et al., 2019).

Patil et al., (2019) conducted a visual inspection of ship surveyors in their study. In the study, a robotic system that can access many areas of a ship's cargo hold and perform visual inspection without any scaffolding is presented. The study also explains how the position of the acquired data is estimated with an optical 3D tracking unit and how critical points on-board can be marked with a remote controlled marker device. In addition, the first results of on-board tests with the system are given (Patil et al., 2019). Studies in the literature are given in Table 1.

Table 1. Some studies in the literature.

References	Implementation Area	Technique Used
Anastassios N. P. ve Anastassios D.,(2008),	Short Sea Shipping	SWOT
Bonnin-Pascual F at al. (2021),	Ship Cargo Hold/Surveying	SA (Supervised Autnomu)
Bonnin-Pascual F. ve Ortiz A.(2019)	Ship Cargo Hold/Structure Surveying	Robotic Method
Renato Ivče R at al. (2011)	Ship and ships draft	Fibre Technology
Heinonen M. (2021)	Cargo ship, Holding Area	Check List, Survey
Ortiz A. at al. (2019)	Shipping sector	Remote Robotic device
Patil H. at al. (2020)	Cargo Holding Area, Shipping sector	Controlled Marker Device

3. MARITIME SUPERVISION SERVICES

According to the Maritime Trade Inspection Services Regulation published in the Official Gazette dated 16.12.2016 and numbered 29920, the marine supervision service “requires commercial and technical expertise within the framework of maritime trade; means the control, supervision, monitoring, measurement, and certification services performed by independent enterprises at sea, on the ship, in cargo, in the coastal facility or the relations between them. As can be understood from this expression, it is seen that marine supervision services are integrated with the concepts of control and inspection. According to Fayol (1917), the purpose of the control function is to reveal the faults and deficiencies in the functioning of the organization and to prevent their recurrence. Henri Fayol, who contributed to scientific management and revealed the universality of the management principles that are still valid today, accepted control as a part of managerial work and defined it as the verification of whether the work in an enterprise is carried out according to the program, given instructions and accepted principles. Supervision, on the other hand, can be defined as setting standards to ensure that the results of an activity comply with the plans as much as possible, comparing the results obtained with these standards, and determining corrective measures at the points where the implementations differ from the plan (Sanal, 2002).

Service areas related to marine supervision appear as supervision services for ships and services for cargo handling operations. Of these, the supervision services provided to the ship are provided on subjects such as ship chartering, ship purchase, and sale. Supervision services about cargo handling operations are the services provided for issues such as ship loading, unloading, and transfer, load quantity, load stacking, and

safety. Likewise, quality determination and analysis are performed by taking samples from dry bulk cargoes such as wheat, barley, coal, and fertilizer (URL-1). The cargo needs to reach the port safely and on time to ensure the cycle in trade. Persons performing marine supervision services are called marine supervision officers. These people, who carry out works related to cargo operations in the field, are also known as cargo surveys. The word survey means to monitor, measure, review, and control. Cargo surveys are the people who provide services in matters such as the stacking and condition of the cargo in the ship holds before the discharge, the condition of the holds before loading, the supervision of loading and unloading, the inspection of the weighbridge, and the determination of damages.

3.1. Survey Trainings and Professional Experience

Survey training has an important place in the maritime industry. The safety of maritime trade and the suitability of transport operations depend on the inspection and certification of survey companies. Basic survey training is given by experts affiliated with various supervision organizations. The training of these people is provided by the courses and training programs given by the authorized classification societies. However, there is also expertise gained based on experience. Considering the career history of the supervision company employees, it is seen that most of them are scattered in survey jobs according to the field they work in the maritime sector. For example, it is seen that officers working on liquid or solid bulk carriers work in these areas where they are experts in marine supervision operations after sea services. In addition to the training activities, the fact that these people who will do the survey work in the fields in which they have experience and expertise is an effective factor in increasing the effectiveness of the marine supervision services.

Türk Loyd is one of the leading educational institutions. Türk Loyd operates in maritime, ship and yacht construction, energy, manufacturing, transportation, logistics, defense industry, etc., in line with its establishment purpose and areas of expertise. It organizes training programs in sectors (URL-1). By Türk Loyd, which is the focal point of our subject, dangerous goods transportation, load safety, safe stacking and lashing training, application code training for packaging of cargo transport units, fumigation operations, IMDG code training, sampling, and preparation from bulk dry cargo. Training, shipping, and marine insurance damage training and draft survey calculation are provided (URL-1). Thanks to this training, employees are informed about the loading and fastening conditions and their implementation by the rules, and possible risks are tried to be minimized.

4. INSPECTION OF DRY BULK CARGOES

Dry cargoes that are not easy to pack and are in bulk such as grain, ore, or scrap metal are transported by bulk carriers. These are also called bulk carrier ships or bulk carrier ships. Bulk cargoes can be too large to be transported on a single platform. The main bulk dry cargoes transported include grains, legumes, paddy, wheat, soybeans, lentils, rice, rapeseed, fertilizer, cement, clinker, coal, salt, sand, iron ore, and similar cargoes.

Loading, transporting, and unloading of solid bulk cargoes are carried out by the rules of the Regulation on Safe Loading and Unloading of Bulk Cargo Ships published by the Ministry of Transport, together with internationally accepted standards (URL-2). According to the legal regulation in the regulation, bulk carriers must be designed and prepared to allow the safe loading, stowage, balancing, and discharge of solid bulk cargoes. Holds should be of sufficient size for the volume and quantity of the cargo. Inspection during the handling of solid bulk cargoes takes place as preloading inspection, draft survey, loading and unloading supervision surveys.

4.1. Pre-Loading Survey Inspection

Before loading, cargo officers who want to be sure of the quality and quantities of the cargo to be transported may request supervision service. Before loading a ship, cargo surveys working in marine inspection companies check the ship's holds to determine whether the hold is suitable for the load. Briefly, the preloading survey is carried out to determine whether the cargoes to be sent comply with customer demands, relevant standards, and legal regulation principles. Preloading survey studies include product controls, compliance controls with legal regulations, sampling and distribution controls, hatch cover tightness tests, functional controls and performance tests, packaging and packaging controls, document controls, security controls, and compliance with standards (URL-3).

Such supervision works to be carried out before the cargo transfers are important in terms of detecting any unsuitable situation beforehand and taking the necessary precautions. In this way, the cargo owners can see the damages that may arise later promptly. In today's world where competition conditions are so difficult, preloading supervision is important so that businesses do not lose time and effort due to damaged production, shipment and do not lose their image.

4.2. Loading and Unloading Supervision Surveys

It is important to determine whether the goods subject to trade are in the amount, quality, and quality determined between the parties. If the goods do not comply with the terms of the contract, the losses that will arise for the purchaser companies that are far from the vendor company and cannot control their goods will be quite high. For this reason, it is important to supervise the loading and unloading of goods. During the loading and unloading supervision, ship hatch cleaning controls, quantity controls, hatch sealing and unsealing operations, product quality control, marking controls are carried out. Documenting the damages that may occur during loading and unloading, and photographing the loading and unloading activities, is also an influential point. Cargo surveys supervise loading and unloading operations and issue a report after technical inspections. Some issues should be considered, especially during installation. The first of these issues is the trimming process. The trimming process can be defined as the flattening of the constructions formed in the storehouse during the loading of bulk cargoes and the homogeneous distribution of the cargo inside the warehouse. If a ship's hold is not full, additional measures called strapping should be taken in addition to the pilling process. Thus, risks such as shrinkage and slippage of the bulk cargo are minimized. Also, for some cargoes, it may be necessary to spray the hold of the ship against insecticide or to remove the seen insects. Spraying on the ship before or after loading is determined according to the type of cargo carried, and these activities are recorded by the cargo surveys. Another monitoring process during loading and unloading operations is weighing inspection. Weighing inspections carried out by international supervision and inspection organizations and marine supervision enterprises and weighbridges are followed for quantity and weight controls during loading and unloading operations. In addition, with the supervision service provided, it is possible to detect any damage or deterioration that occurs during the loading, unloading, and transportation of the goods, to analyze and report the products, and to reduce the possible financial losses to the parties (Sügen, 1996).

4.3. Draft Survey

A draft survey is a technical calculation method to determine the weight of the load loaded or discharged on the ship. Accordingly, the difference between the amount of water carried by ship before loading or unloading operations and the amount of water carried by ship after loading and unloading the cargo gives the weight of the loaded or unloaded cargo. Starting from the principle of the buoyancy of the water, the ship's unloaded and loaded weights are calculated by using the ship's stability charts, and the weight of the loaded goods is calculated.

5. METHOD

In the study, the factors affecting the determination of the effect of maritime supervision companies on dry cargo operations were determined by taking literature research and expert opinions. In-depth interviews and survey techniques were used as data collection methods. The sample of the study consists of experts working in 5 different international supervision and audit companies. The five experts working in supervision and inspection companies are specialized in dry cargo handling and have at least 10 years of industry experience. First, in-depth interviews were conducted with the experts and factors related to dry cargo supervision and inspection activities were obtained. In the second step, the obtained factors were surveyed and the correlation matrix between the factors was determined using the DEMATEL method. The stages of the study are given in Figure 1.

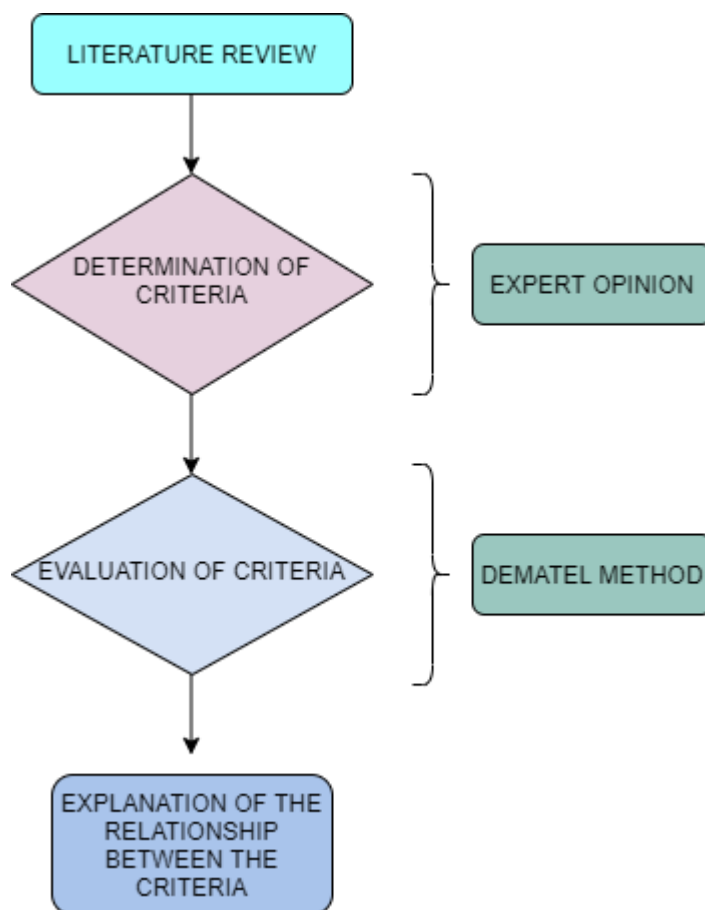


Figure 1. Flow Chart of the Study.

Open-ended questions suitable for the purpose of the study were asked to the experts participating in the application. The answers given by the experts were analyzed and the factors for the purpose of the study were determined. In the interviews, it was seen that the experts especially emphasized factors such as communication, education, management and teamwork. The criteria obtained by using the in-depth interview technique from the experts are explained and given in Table 2.

Table 2. Criteria and Explanations Obtained as a Result of Expert Opinions.

Criteria	Descriptions
C1 Education level and experience of cargo surveyors.	Increasing the professional development based on practice by training the supervision activities of the experts.
C2. Identification of inspection and control stages	Tying, stowing and transporting each load in accordance with its specifications and predetermining inspections and controls.
C3.Safety and risk management criteria of the maritime supervision firm	To act in accordance with the security level of the port, to prevent the loads to be loaded on the ship from mixing with other loads and to prevent the loading of other loads other than the ship's cargo. Increasing the frequency and detail of visual and physical inspection. Using scanning devices when necessary.
C4.The cargo surveyor's teamwork and organizational management ability.	Experts working in cooperation and coordination with other employees who have come together for a common purpose. Provision of tools and equipment necessary for the planned supervision.
C5. Work environment awareness and port safety	Before starting the loading or unloading, creating a ship / shore safety checklist, checking the entry and exit points of the ship, checking and approving the loading documents. Carrying out cargo handling operations safely in high-risk ports, especially within the scope of International Ship and Port Facility Security (ISPS).
C6. The maritime supervision firm's safety priority and commitment to the ISM system	To prioritize the safety of the personnel during the supervision, to carry out inspection and control in a way that will not endanger the port personnel and ship personnel during the supervision. Not to endanger the safety of the cargo and the ship. To act in accordance with international rules and ISM practices in the handling of dangerous goods, primarily.

C7. Establish written and verbal communication	Written and verbal transfer of feelings, thoughts and information between employees. Establishing an effective communication system between the ship and the port during the loading or unloading process and maintaining it until the end of the operation.
C8. Determination of the state of the load before loading	Checking the cargo before loading, if any, damage to the cargo, verifying the definition of the cargo, checking the suitability of the ship's holds for the cargo.

5.1. DEMATEL Method

The DEMATEL (The Decision Making Trial and Evaluation Laboratory) method was developed to be used in the solution of complex and intertwined problem groups in research. It was developed by the Geneva Battelle Memorial Institute, science and human relations program between 1972 and 1976 (Fontela ve Gabus, 1974). Dematel is a structural model analysis that reveals causal relationships between a set of factors with the help of diagrams and matrices. Method; It defines the relationships between the components with diagrams and matrices, and makes quantitative definitions between these relationships, revealing the power between the relationships (Bai ve Sarkis, 2013). The method allows us to plan and solve problems as a draft by dividing the relevant factors into cause and effect groups, which will enable us to better understand the causal relationship (Li and Tzeng, 2009). The DEMATEL method is an effective method that examines the relationships, structure or alternatives between system components. The DEMATEL method is applied in 5 steps and the solution is reached with the effect-direction graph diagram, which is the last step (Aksakal&Dağdeviren, 2010; Fontela & Gabus, 1976). These steps are;

Step 1: Creating the direct relationship matrix. The pairwise comparison scale in Table 3 was used to construct the direct relationship matrix.

Table 3. Rating Effect Values

Numerical Value	Definition
0	Ineffective
1	Low Impact
2	Medium Impact
3	High Impact
4	Very High Impact

The relationships between the determined factors are determined by the subject experts using pairwise comparison scales. By taking the arithmetic average of the data obtained from the participants in the research, a direct relationship matrix (A) in nxn dimension is formed to represent the number of criteria. The a_{ij} i. criterion, which constitutes the elements of the A matrix, shows the degree to which the j. criterion affects the criterion.

Step 2: Determination of normalized direct-relation matrices. Depending on the matrix A, the normalized direct relationship matrix (M) is obtained by taking the smallest value (k) in the rows and columns by using the equations 1 and 2 The main diagonal value of matrix A is 0.

$$M = k \times A \quad (1)$$

$$K = \text{Min} \left[\frac{1}{\max_{1 \leq i \leq n} \sum_{j=1}^n |a_{ij}|}, \frac{1}{\max_{1 \leq j \leq n} \sum_{i=1}^n |a_{ij}|} \right] \quad (2)$$

$$i, j \in \{1, 2, 3, 4, \dots, n\}$$

Step 3: Obtaining the Total Relationship Matrix. After the normalized direct relationship matrix is created, the total relationship matrix (S) is obtained by using the 3 equation. Subtracting the created relationship matrix from the unit matrix (I), the results are inverted and multiplied by the normalized relationship matrix found before, to obtain the total relationship matrix.

$$S = M + M^2 + M^3 + \dots = \sum_{i=1}^{\infty} M^i \quad (3)$$

$$= M(I-M)^{-1}$$

Step 4: Calculation of the sender and receiver group. The sum of the columns in the S matrix (R) is the sum of the rows in the S matrix (D), but after calculating the 4 equations, calculating the 5 and 6 equations, using the D-R and D+R values, determining the level of influence of each criterion on the others and the level of relationship with the others. Some criteria have positive values for the D-R value. Recognizing that these criteria have higher influence over others and have higher priority. Such criteria are called senders. Criteria with a negative value for the D-R value are more affected than other criteria. These criteria, which are considered to have lower priority, are called recipients. On the other hand, D+R values show the relationship between each criterion and other criteria, and criteria with high D+R values are more related to other criteria, while low ones have less relationship with others.

$$S = [S_{i,j}]_{n \times n} \quad i, j \in \{1,2,3,4,\dots,n\} \quad (4)$$

$$D = \sum_{j=1}^n S_{i,j} \quad (5)$$

$$R = \sum_{j=1}^n S_{i,j} \quad (6)$$

Step 5: Setting the threshold value and obtaining the effect-direction graph diagram. To obtain an appropriate effect-direction graph, decision makers need to set a threshold value for the effect level. Some elements with influence values greater than the threshold value in the S matrix are selected and transformed into an influence-directional graph diagram. Influence-direction graph diagram is obtained by showing points (D+R, D-R) on a coordinate plane with horizontal axis D+R and vertical axis D-R.

6. FINDINGS

While determining the direct relationship matrix, which is the first stage of the DEMATEL method, the relationships between the factors were created as in Table 4 by taking the arithmetic average of the data obtained from the participants.

Table 4. The matrix calculated by taking the arithmetic mean of the experts' values.

Impact Degrees	C1	C2	C3	C4	C5	C6	C7	C8
0: No effect								
1: Very little effective								
2: Less effective								
3: Too effective								
4: Too much effective								
C1	-	2	3	3	3	3	4	2
C2	3	-	3	3	2	3	3	3
C3	3	2	-	2	3	3	2	2
C4	3	2	3	-	3	2	3	2
C5	3	3	3	3	-	2	3	2
C6	2	1	3	2	3	-	1	2
C7	4	3	2	3	3	3	-	2
C8	3	3	2	2	2	2	3	-

The total relationship matrix was reached by applying the stages of the DEMATEL method to the data obtained from the experts participating in the research. Here, the values in Table 5 were obtained by using the row (D) and column (R) values.

Table 5. Matrix row and column sum and difference values.

Criteria	D+R	D-R
C1. Education level and experience of cargo surveyors	22,01655	-0,46901
C2. Identification of inspection and control stages	19,50939	1,945253
C3. Safety and risk management criteria of the maritime supervision firm	19,59917	-1,05583
C4. The cargo surveyor's teamwork and organizational management ability.	19,73472	0,024155
C5. Work environment awareness and port safety	20,78363	-0,00499
C6. The maritime supervision firm's safety priority and commitment to the ISM system	17,58759	-2,1169
C7. Establish written and verbal communication	21,15306	0,5158
C8. Determination of the state of the load before loading	17,69429	1,16152

It is seen that there are negative and positive effects in the column and row difference-summation results created in Table 5. It shows that the factor with the highest positive value seen in the total part is more effective on other factors. The factors here are called senders. In the difference part, it was seen that there were negative values besides positive values. This shows that the factors with negative values are the most affected by the factors with positive values. Negative values here are called receivers.

When the relationship between the factors in Table 5 is examined;

- In the sender group, the education level and experience of the cargo surveyors (C1) was the most influential factor of all other factors.
- It is seen that the factor with the lowest value in the sender group is the maritime supervision firm's safety priority and commitment to the ISM system (C6). This factor has the least effect on other positive senders.
- The lowest of the factors with negative values in the recipient group was firm's safety priority and commitment to the ISM system (C6). According to the matrix, this factor is the most affected by the factors with positive values in the receiver group.
- Factors with negative values in the receiver group are affected by factors with positive values. Here, it is seen that factors safety and risk management criteria of the maritime supervision firm (C3), Education level and experience of cargo surveyors (C1), work environment awareness and port safety (C5) and the maritime supervision firm's safety priority and commitment to the ISM system (C6) are negative and affected by other positive factors.

In the next step, the effect-direction graph diagram in Figure 2 was obtained by making use of the sum and difference of the rows and columns.

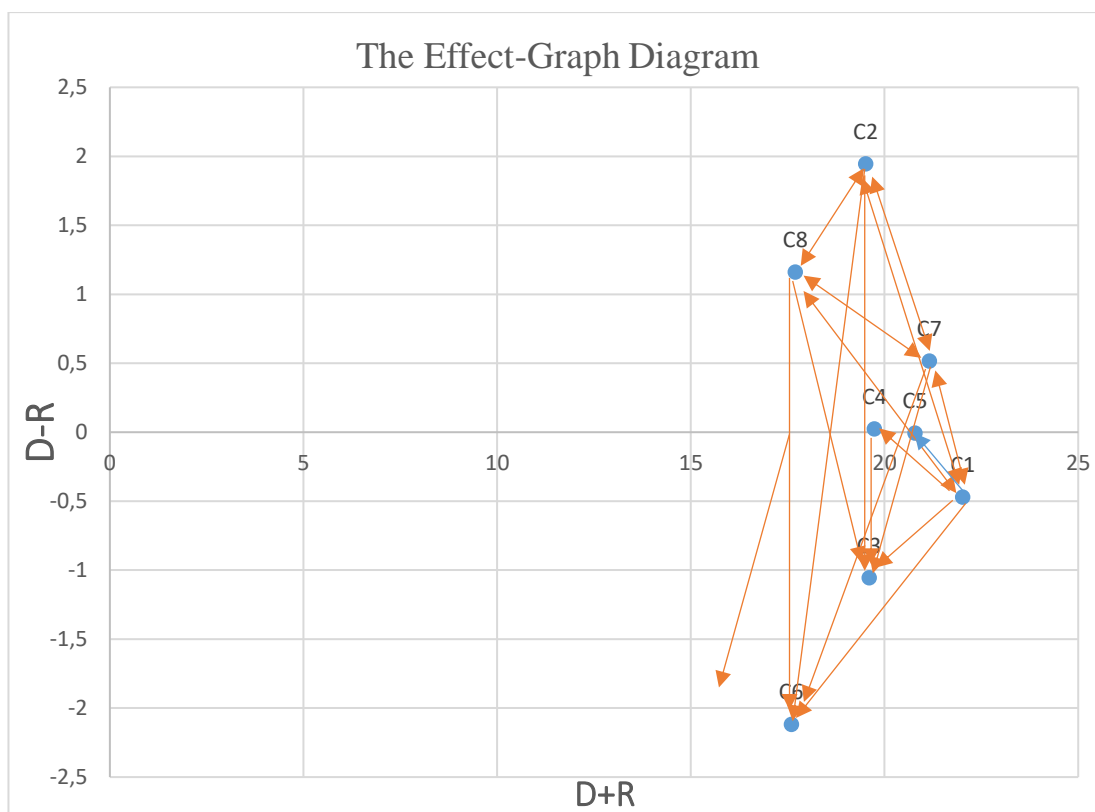


Figure 2. Effect-direction diagram graph among factors.

In the effect-direction diagram, factors such as “identification of inspection and control stages (C2)”, “establish written and verbal communication (C7)”, “determination of the state of the load before loading (C8)” and “the cargo surveyor's teamwork and organizational management ability (C4)” which are in the receiver group matrix and have positive values, affect each other. At the same time, it is seen that they affect the factors that have a negative effect. In the sender group, the education and experience of cargo survey (C1) factor has the highest value and has the greatest effect on other factors.

7. CONCLUSION

In the study, the factors that are important for the effective control and inspection of solid bulk cargoes in maritime transportation were determined by consulting expert opinions. When the answers obtained by asking open-ended questions to the experts are analyzed, "the education level and experience of the cargo survey (C1)", " identification of inspection and control stages (C2)", " safety and risk management criteria of the maritime supervision firm (C3)", " the cargo surveyor's teamwork and organizational management ability (C4)", " work environment awareness and port safety (C5)", " the maritime supervision firm's safety priority and commitment to the ISM system (C6)", "establish written and verbal communication (C7)" and finally, "determination of the state of the load before loading (C8)" were determined as important factors.

The intensity and direction of the relationship among these factors were revealed by using the DEMATEL method. When the findings obtained as a result of the analysis are examined, the most powerful factor that positively affects the inspection and control practices in maritime supervision operations is the "education level and experience of cargo surveyors C1". Inspection and control processes of solid bulk cargoes require different applications and different expertise depending on the type of cargo and the mode of transportation. The availability of specialized trained and experienced cargo surveyors plays a major role in the effectiveness of maritime supervision operations so that different cargoes can be handled safely and correctly with different ship types. In addition, factors such as identification of inspection and control stages (C2)", "establish written and verbal communication (C7)", the cargo surveyor's teamwork and organizational management ability (C4)" and "determination of the state of the load before loading (C8)" were the factors with the most causal relationship among each other according to the results of the analysis. Therefore, these factors are mutually influenced by each other. It turns out that these factors are important in increasing the effectiveness of the control and implementation processes of the load.

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