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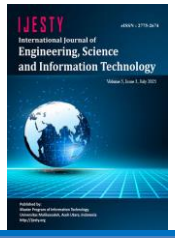

Comprehensive Risk Analysis in Cargo Transportation by Land: Implications for Safety and Operational Efficiency

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Abstract

Land transportation is a key pillar in the freight transportation system that is often faced with various operational risk events. This study aims to identify risk agents and develop mitigation strategies for transporting goods through land transportation. The House of Risk (HOR) method identifies risks, determines priority risk agents, and formulates effective mitigation strategies. Based on observations and questionnaire analysis, 14 risk events caused by 21 risk agents were identified, of which 12 agents were categorized as priority and nine as non-priority. Delays in issuing delivery notes or bills of lading (A4) were identified as the risk agent with the highest priority index of 3954.71. Of the 16 risk-handling strategies formulated, periodic inspection and maintenance of vehicles (PA2) has the highest Effectiveness to Difficulty (ETD) value of 63755.2. The results of this study provide a systematic framework for risk management in land transportation to improve the effectiveness and reliability of freight operations.

Keywords: *Land Transportation, Freight Transportation, House of Risk, Risk Events, Risk Agents*.

1. Introduction

In the ever-evolving era of globalization, the need for freight forwarding services for individuals and businesses has increased significantly [1]. Changes in the social environment, behaviour, and human activities have driven a higher demand for the transportation of goods in a business context, which in turn drives the growth of the logistics industry that facilitates the delivery of goods to remote locations [2], [3]

Land transportation is a key pillar in the global supply chain, enabling the efficient and effective movement of goods from producers to end consumers. In this context, transporting goods becomes a crucial stage affecting the operational safety and efficiency of the entire transportation system [4], [5]. However, the success and safety of this process is often jeopardized by various risks associated with infrastructure conditions, technology, operational management, as well as external factors such as weather and road conditions [6]

Express delivery services play an important role in supporting the smooth running of the national economy [7]. The importance of shipping services is reflected in its role as a means of supporting distribution and transportation that facilitates the movement of goods quickly and efficiently in domestic and international trade activities [8], [9]. Currently, the delivery of goods is generally carried out through third-party service providers such as freight forwarders, which use various modes of transportation such as ships, planes, and trucks [1]. Although various efforts have been made to improve safety and operational efficiency in the transportation of goods on land transportation, complex and dynamic challenges remain [10].

Every activity in the transportation process carries risks that need to be managed systematically and holistically [11], [12]. Risk analysis is an effective approach to understanding and addressing potential hazards in the freight transportation process [13], [14]. By conducting a comprehensive risk analysis, transportation companies can identify weaknesses in their operations and reduce the incidence of accidents [15] . Observations show that transportation activities often use a variety of equipment and human labor at freight terminals[8]. However, failure in these activities due to unmanaged risks can lead to shipment cancellation [10]. Therefore, risk management is very important to minimize potential losses [16]

While the importance of risk analysis is widely recognized, there is a lack of literature that addresses a comprehensive and integrated approach to addressing risks in freight transportation [12]. This research aims to conduct a comprehensive risk analysis using the House of Risk method to identify risk agents and evaluate their impact and develop effective mitigation strategies [17], [18]. Thus, this research is expected to make a significant contribution to the understanding of risk management in the process of transporting goods in land transportation [8], [16].

Although many studies have been conducted on risk analysis in the context of land transportation, there is still a lack of a systematic approach that covers all risk aspects of the transportation process. This research will fill this gap by focusing on a comprehensive analysis of the safety and operational efficiency implications of risk management in freight transportation.

2. Method

Risk analysis of freight transportation activities was conducted through direct observation at the Freight Terminal [10], [18]. The main objective of this research was to understand the transportation process, identify the associated risks, and find solutions to the risks involved in the activity [12], [14]. The research method also involved filling out a questionnaire focusing on the risk events and risk agents associated with the freight transportation activity [8]. The research respondents consisted of various related parties, including trucking company leaders, freight drivers, warehouse administration, warehouse loaders, company owners, and branch heads [16]. The selection of respondents was based not only on their job titles, but also on their work experience in the transportation of goods in land transportation.

The survey and interviews were conducted in April 2023 at the Denpasar City Freight Terminal. During this process, questionnaires were completed by the leaders of trucking companies operating at the terminal to evaluate the relationship between risk events and risk agents. Once the prioritized risk agents were identified, a questionnaire regarding risk mitigation for each risk agent was provided. Furthermore, an interview survey was conducted again at the Denpasar City Freight Terminal to assess the difficulty level of the risk mitigation proposed by the respondents.

Risk analysis was conducted using quantitative and qualitative methods through the House of Risk (HOR) approach applied in the SCOR (Supply Chain Operations Reference) modeling stages. This approach allows researchers to systematically identify and evaluate risks and formulate effective mitigation strategies.

3. Result and Discussion

3.1. Freight Activities on Land Transportation

The process of transporting goods in land transportation consists of a series of steps that must be followed to ensure the goods reach their final destination safely and efficiently. Based on the results of the survey conducted, the activities of transporting goods have been analyzed and incorporated into the Supply Chain Operations Reference (SCOR) model. The following are general steps in the process of transporting goods using land transportation as shown in Figure 1 and as follows.

Fig. 1 Freight Activities on Land Transportation.

1. Transportation Selection: The shipper must select the most appropriate type of ground transportation for the goods to be shipped. This choice may include trucks, trains, or other specialized vehicles, depending on the type and volume of goods to be transported.
2. Packaging of Goods: Goods must be properly packaged to avoid damage during transportation. Proper packaging involves the use of appropriate packaging materials, such as cardboard boxes, pallets, or special containers.
3. Labels and Documents: Each item needs to be labeled with clear information regarding its origin, destination, tracking number, as well as special handling instructions if required. In addition, shipping documents must be prepared and submitted to the logistics service provider.
4. Goods Loading: The process of loading goods into a vehicle must be done carefully. This often involves the use of heavy equipment such as forklifts or cranes to ensure that the goods are loaded safely.
5. Route and Trip Planning: Transportation must be carefully planned, including the selection of the best route, arrangement of stops if needed, and calculation of estimated arrival time.
6. Monitoring and Tracking: During the journey, transportation should be continuously monitored using GPS tracking technology or sophisticated logistics management systems to ensure safety and timeliness.
7. Safety and Insurance: The safety of goods during shipment is a top priority. This includes security arrangements for the goods as well as appropriate insurance if required to protect the value of the goods during transportation.

8. Receiving and Unloading: Upon arrival at the destination, the goods must be unloaded with care. The receiver is responsible for checking the condition of the goods to match the shipping documents before completing the receiving process.
9. Reporting and Administration: Receiving documents must be updated and reported to the shipper. This includes recording the quantity, condition of the goods, as well as other details regarding the transportation process.
10. Payment Settlement: After the transportation process is completed and the goods are received in good condition, the payment process must be completed according to the agreement between the shipper and the receiver.

The process of transporting goods in land transportation involves close cooperation between the shipper, logistics service provider, and consignee to ensure that the goods reach their destination safely and on time. Careful supervision, efficient route selection, and good planning are the keys to success in this process.

3.2. Identifying Risk Events and Risk Agents

Events that have the potential to occur in the process of shipping goods that cause losses or reduce company performance can be said to be risk events. Once the risk is identified, the impact or severity value will be determined. A severity scale has been established to determine how much impact the risk has. Table 1 below lists some risk events along with the severity scale that has been set.

Table 1. Risk Event for Goods Transportation Activities.

Code	Risk Event	Respondent						Severity
		1	2	3	4	5	6	
E1	Inability to deliver goods in accordance with the predetermined quantities	2	4	8	4	8	10	5.23064
E2	Delays in delivering goods to consumers	2	4	8	7	8	10	5.74198
E3	Delays in the delivery process due to unfavorable weather	2	3	6	7	8	8	5.02647
E4	The occurrence of an error in the location of delivery of goods	8	10	10	8	10	10	9.28318
E5	Errors in the delivery of goods to the recipient	5	10	10	6	10	8	7.88319
E6	Delivery location cannot be reached by the vehicle used	2	8	10	5	8	10	6.32456
E7	Goods that arrive at the destination are not in accordance with the quantity	5	4	8	4	8	8	5.8712
E8	Not able to make deliveries optimally	5	6	6	6	8	8	6.4062
E9	Inability to pass the route that is passed	2	8	8	5	8	8	5.8712
E10	The occurrence of damage to goods in the process of shipping goods	10	10	10	5	10	10	8.90899
E11	No budget to cover damaged goods	8	10	10	7	8	10	8.74741
E12	The delivery process cannot be monitored	7	6	6	8	8	9	7.24943
E13	The occurrence of returned goods that are not in accordance with the provisions	8	6	10	6	10	10	8.12641
E14	Cancellation of shipment of goods	5	8	10	5	7	8	6.94283

Source: Analysis

Based on Table 1, there are 14 risk events identified in land transportation. These risks are generated from the process of shipping goods, from planning to canceling the implementation. An assessment of the severity level for each risk event was conducted by two company leaders, two employees, and two drivers, according to the company's experience in transporting goods through land transportation.
The factors that arise from each risk event are known as risk agents. Once the risk agents are identified, an occurrence value will be assigned. This value is used to determine the level of probability or likelihood of occurrence of each risk factor that could lead to failure during the operational process. Table 2 lists some of the risk agents and their occurrence values related to land transportation. Based on Table 2, there are 21 risk agents in land transportation, which are obtained from 14 risk events that have been identified. The assessment of occurrence values is carried out by company leaders and drivers who understand the performance of the goods delivery process in the company, so that each value given reflects the real conditions that occur.

Table 2. Risk Agent for Goods Transportation Activities.

Code	Risk Agent	Respondent						Occurance
		1	2	3	4	5	6	
A1	Errors in planning the number of fleets needed for the delivery process	5	5	8	5	10	8	6.5642
A2	Error in scheduling the delivery of goods	5	5	8	7	8	10	6.94283
A3	Delays in issuing delivery notes/load certificates	5	8	9	7	6	8	7.03246
A4	The occurrence of congestion and accidents on the way of delivery of goods	10	9	9	10	9	10	9.48683
A5	Delay in the delivery of goods by the sender	5	8	10	7	8	8	7.50855
A6	Discrepancies in weather forecast planning	3	4	8	5	7	8	5.47316
A7	Error in writing the delivery address by the sender	10	10	10	10	8	8	9.28318

Code	Risk Agent	Respondent						Occurance
		1	2	3	4	5	6	
A8	Errors in the data collection system, leading to mix-ups in the delivery of goods	10	8	10	8	8	8	8.61774
A9	Mistakes made by the driver to the delivery address	10	10	8	10	8	10	9.28318
A10	Error in planning the use of the fleet to the delivery location	5	8	8	6	10	8	7.3181
A11	Goods are dropped or stolen in transit due to lack of optimal protection	10	10	10	8	10	10	9.63492
A12	Inability of human resources to optimally arrange cargo according to vehicle capacity	10	10	8	8	10	10	9.28318
A13	The loading of goods that are too high, so that they are not able to pass through uncertain travel conditions	10	10	8	8	10	8	8.94427
A14	No packaging according to the standard based on the characteristics of the goods loaded	10	10	8	8	8	8	8.61774
A15	No labeling as information related to packaged goods	10	8	8	10	8	8	8.61774
A16	No insurance system in place	5	10	8	7	5	8	6.94283
A17	The occurrence of GPS damage to the vehicle used	10	10	10	8	7	7	8.55489
A18	Driver indiscipline that intentionally turns off the GPS	10	10	8	8	6	10	8.52554
A19	The sender's ignorance regarding the type of goods that can be sent and the packaging standards required according to the type of goods	8	6	8	5	8	8	7.05094
A20	The inability of the freight forwarder to deliver the goods handed over to the shipper	10	8	8	8	8	8	8.30313
A21	The sender's indiscipline to meet the applicable shipping standards	6	8	8	8	10	8	7.91441

Source: Analysis

Based on Table 2 above, it is known that there are 21 risk agents in land transportation. The risk agent is obtained from 14 risk events that have been identified. For the occurrence value given, it is filled in by the company leader and the driver who knows the process of the performance of shipping goods in the company. So that each value given is in accordance with the circumstances that actually occur.

3.3. House of Risk Phase I

House of Risk phase I is the initial stage in the application of the House of Risk method, aiming to identify and determine the sources of risk that need to be prioritized for preventive action. At this stage, data was collected including 14 risk events with their respective severity assessments, as well as 21 risk agents with occurrence assessments for each agent. Next, the correlation between risk events and risk agents was calculated to determine the Aggregate Risk Potential (ARP). The classification of the correlation between risk events and risk agents is divided into four categories based on the resulting correlation value:

1. A value of 0 indicates no correlation between risk agents and risk events.
2. A value of 1 indicates a weak correlation between the risk agent and the risk event.
3. A value of 3 indicates a moderate correlation between the risk agent and the risk event.
4. A score of 9 indicates a strong correlation between the risk agent and the risk event.

Table 3 below details the results of the data analysis, including the assessment of the correlation between risk events and risk agents, the Aggregate Risk Potential (ARP) value, and the ARP ranking in the context of the first phase of the House of Risk framework, applied to the freight forwarding process.

Table 3. House of Risk Phase 1.

RISK EVENT	RISK AGENT																					Severity
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19	A20	A21	
E1	3	0	0	9	3	3	0	9	0	3	9	0	0	0	0	0	0	0	0	0	0	5.230 64
E2	3	9	9	9	0	0	9	9	9	3	9	3	3	0	0	0	3	0	0	0	0	5.741 98
E3	0	3	0	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.026 47
E4	0	0	0	0	0	9	9	9	9	0	0	0	0	0	0	0	9	0	0	0	0	9.2

E5	0	3	0	0	0	0	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	8318 7.883 19
E6	0	0	0	9	9	0	3	3	0	9	0	0	3	0	0	0	0	0	0	0	0	6.324 56
E7	0	0	0	0	0	3	0	3	0	0	9	0	0	0	3	0	9	0	0	0	0	5.871 2
E8	0	3	3	9	0	0	9	9	9	3	9	9	3	3	1	9	3	0	3	9	9	6.406 2
E9	0	0	0	9	9	3	1	1	0	9	0	0	3	0	0	0	0	0	0	0	0	5.871 2
E10	9	0	0	3	0	3	1	0	0	3	9	3	3	9	0	0	0	0	3	0	0	8.908 99
E11	9	0	0	9	0	3	0	0	0	0	0	0	0	0	1	9	9	0	0	0	1	8.747 41
E12	3	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	9	0	0	3	7.249 43
E13	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	9	9	9	8.126 41
E14	3	0	3	0	0	3	1	3	0	3	0	0	0	0	0	0	0	0	3	9	9	6.942 83
Occurance	6.5642	6.94283	7.032466	9.486883	7.508555	5.473166	9.283188	8.617744	9.283188	7.3181	9.634922	9.283188	8.944227	8.617744	8.617744	6.94283	8.554889	8.525554	7.050944	8.303133	7.914441	
ARP	1538.66	761.11	645.051	3954.71	1281.65	1387.47	3028.88	32 24.7	2449.19	1532.8	2788.65	943.252	892.269	1486.88	282.379	946.88	2152.07	556.248	986.509	1604.82	1771.04	
RANK	9	18	19	1	13	12	3	2	5	10	4	16	17	11	21	15	6	20	14	8	7	

Source: Analysis

Based on Table 3 presented above, it can be seen the results of the correlation between risk events and risk agents that have Aggregate Risk Potential (ARP) values from the largest to the smallest in the House of Risk phase 1. To identify the dominant risk agent, the application of Pareto diagrams is used. The results of the calculation of the House of Risk phase 1 model are then arranged in rank order using a Pareto diagram, as illustrated in Figure 2 listed below.

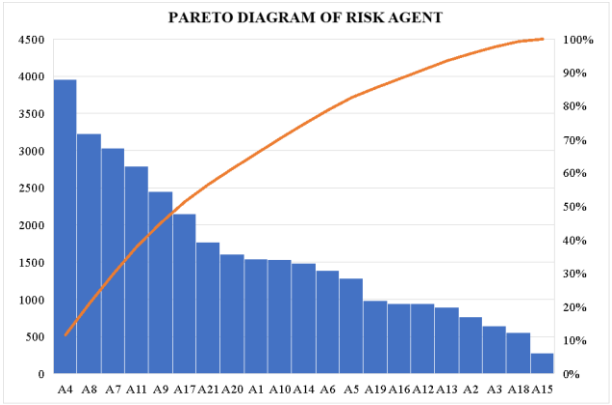

Fig. 2. Pareto Diagram of Risk Agent for Freight Transportation.

Based on Figure 2, which displays the Pareto diagram above, 12 dominant risk agents were identified. In the context of the 80:20 Pareto principle, the analysis results show that 80% of the risk agents can be represented by the highest ARP values, so these 12 risk agents are the top priority in terms of risk sources at the loading and unloading stage in the process of transporting goods using land transportation.

Detailed information on these 12 risk agents, including their respective ARP values and the percentage of risk contribution from each risk agent, can be found in Table 4 listed below.

Table 4. Risk Agent Percentage of Goods Transportation Activities.

Rank	Risk Agent	ARP	ARP Cumulative	%ARP	%ARP Cumulative	Category
1	A4	3954.710553	3954.710553	12%	12%	PRIORITY
2	A8	3224.702674	7179.413227	9%	21%	
3	A7	3028.876699	10208.28993	9%	30%	
4	A11	2788.646241	12996.93617	8%	38%	
5	A9	2449.188986	15446.12515	7%	45%	
6	A17	2152.073083	17598.19824	6%	51%	
7	A21	1771.044317	19369.24255	5%	57%	
8	A20	1604.819594	20974.06215	5%	61%	
9	A1	1538.662622	22512.72477	4%	66%	
10	A10	1532.803607	24045.52838	4%	70%	
11	A14	1486.880373	25532.40875	4%	75%	
12	A6	1387.466274	26919.87502	4%	79%	
13	A5	1281.649883	28201.52491	4%	82%	NON-PRIORITY
14	A19	986.5089456	29188.03385	3%	85%	
15	A16	946.8803722	30134.91423	3%	88%	
16	A12	943.2516614	31078.16589	3%	91%	
17	A13	892.2693929	31970.43528	3%	93%	
18	A2	761.109965	32731.54524	2%	96%	
19	A3	645.050992	33376.59624	2%	98%	
20	A18	556.2476863	33932.84392	2%	99%	
21	A15	282.3792286	34215.22315	1%	100%	

Source: Analysis

Table 4 reveals that there are 12 risk agents that fall into the top priority category for follow-up. The risk agent with the highest ARP is "Occurrence of congestion and accidents in the course of shipping goods" with an ARP value of 3954.710553, which also contributes 12% to the overall risk level. Meanwhile, the lowest-ranked risk agent is "Discrepancies in weather forecast planning" (A6) with an ARP value of 1387.466274, which contributes 4% to the overall risk level.

3.4. House of Risk Phase II Goods Delivery Activity

After identifying the risk agents with the highest ARP values in the first phase of the House of Risk (HOR phase I), the next step is to establish the HOR phase II. This second phase aims to design a set of mitigation strategies to reduce the risk-causing factors stemming from the selected risk agents. This phase involves several key steps:

1. Establish the relationship between risk causes and mitigation strategies.
2. Design mitigation strategies to address identified risks.
3. Evaluate the level of correlation between the mitigation strategies and the selected risk agents.
4. Calculating the Total Effectiveness (TEk) value of each mitigation strategy.
5. Determining the Degree of Difficulty (Dk) for each strategy to be implemented.
6. Calculating the Effectiveness to Difficulty (ETDk) value.

Table 5 below illustrates the relationship between the selected risk agents and the mitigation strategies to be implemented in the context of land transportation. The above text has been paraphrased to provide a better understanding without losing the original meaning, while retaining the structure of the essential information of the original text.

Table 5. Correlation between Risk Agent Causes and Mitigation Strategies for Freight Transportation.

Rank	Code	Risk Agent	Mitigation Strategy (PA)
1	A4	Traffic jams and accidents in the course of shipping goods	Proper route planning and selection of the right delivery time to avoid traffic jams. Regular checks and maintenance of vehicles are also carried out so that they are always in good condition.
2	A8	Errors in the data collection system, leading to mix-ups in the delivery of goods	Use better and more accurate technology in the data collection system, such as barcodes or RFID to ensure that the goods sent are as ordered.
3	A7	An error in writing the delivery address by the sender	The company can provide address writing guidelines that are clear and easily understood by the sender. In addition, companies can verify the delivery address with the recipient of the goods before the delivery process is carried out.
4	A11	Goods fall or experience theft in transit due to the absence of	Companies can use goods tracking technology such as GPS and provide additional protection such as insurance to reduce the risk of

Rank	Code	Risk Agent	Mitigation Strategy (PA)
		optimal protection	loss.
5	A9	The occurrence of errors by the driver to the delivery address	Companies can provide guidance and training to drivers on delivery routes and destination knowledge. In addition, companies can ensure that the vehicles used are in good condition and maintained to minimize the risk of technical errors.
6	A17	The occurrence of GPS damage to the vehicle used	Conduct routine maintenance and periodic battery replacement to ensure the GPS is functioning properly. In addition, the company can have a backup GPS to anticipate in case of damage to the main GPS.
7	A21	The sender's indiscipline to meet the applicable shipping standards	The company can provide guidance and training to shippers on shipping procedures and sanctions for violations.
8	A20	The inability of the freight forwarder to deliver the goods handed over to the sender	The company can ensure that its fleet and human resources are sufficient to meet delivery demands. In addition, companies can cooperate with transportation partners to ensure that deliveries can be made effectively.
9	A1	Error in planning the number of fleets required for the delivery process	The company can conduct careful analysis and planning based on historical shipment data and estimates of future shipment demand.
10	A10	Error in planning the use of the fleet to the delivery location	Evaluate the delivery route and ensure that the selected fleet can pass the route smoothly. Implement a tracking system to ensure that the selected fleet has arrived at the destination location on time.
11	A14	Not doing packaging according to standards based on the characteristics of the goods loaded	Conduct careful planning before delivery to ensure that the fleet used meets the needs of the number of goods to be shipped. Check the type of goods to be shipped and determine the appropriate type of packaging. Provide training or education to shippers on the type of packaging that is suitable for the characteristics of the goods being shipped. Establish clear packaging standards and strictly supervise their implementation.
12	A6	Inconsistency in terms of weather forecast planning	Monitor weather conditions and update delivery plans if necessary. Provide a fleet that is suitable for the weather conditions, such as a fleet equipped with anti-skid features in case of rainy weather. Make contingency plans in case of delivery delays due to bad weather.

Source: Analysis

After obtaining the mitigation strategy results for each selected risk agent in Table 5, the next step is to rank the mitigation strategies. For each mitigation strategy, a weighted difficulty value (Dk) will be assigned to determine whether the mitigation strategy is easy or difficult to implement, as shown in Table 6 below:

Table 6. Mitigation Strategies to be Impleamented

Code	Mitigation Strategy (PA)	Dk
PA1	Proper route planning and selection of the right delivery time to avoid traffic jams.	3
PA2	Regular checks and maintenance of vehicles are also carried out so that they are always in good condition.	1
PA3	Use better and more accurate technology in the data collection system, such as barcodes or RFID to ensure that the goods sent are as ordered.	3
PA4	The company can provide address writing guidelines that are clear and easily understood by the sender. In addition, companies can verify the delivery address with the recipient of the goods before the delivery process is carried out.	2
PA5	Companies can use goods tracking technology such as GPS and provide additional protection such as insurance to reduce the risk of loss.	3
PA6	Companies can provide guidance and training to drivers on delivery routes and destination knowledge. In addition, companies can ensure that the vehicles used are in good condition and maintained to minimize the risk of technical errors.	1
PA7	Conduct routine maintenance and periodic battery replacement to ensure the GPS is functioning properly. In addition, the company can have a backup GPS to anticipate in case of damage to the main GPS.	2
PA8	The company can provide guidance and training to shippers on shipping procedures and sanctions for violations.	3
PA9	The company can ensure that its fleet and human resources are sufficient to meet delivery demands. In addition, companies can cooperate with transportation partners to ensure that deliveries can be made effectively.	2
PA10	The company can conduct careful analysis and planning based on historical shipment data and estimates of future shipment demand.	2
PA11	Evaluate the delivery route and ensure that the selected fleet can pass the route smoothly.	2
PA12	Implement a tracking system to ensure that the selected fleet has arrived at the destination location on time.	3
PA13	Conduct careful planning before delivery to ensure that the fleet used meets the needs of the number of goods to be shipped.	1
PA14	Check the type of goods to be shipped and determine the appropriate type of packaging.	2
PA15	Provide training or education to shippers on the type of packaging that is suitable for the characteristics of the goods being shipped.	1

Code	Mitigation Strategy (PA)	Dk
PA16	Establish clear packaging standards and strictly supervise their implementation.	3
PA17	Monitor weather conditions and update delivery plans if necessary.	2
PA18	Provide a fleet that is suitable for the weather conditions, such as a fleet equipped with anti-skid features in case of rainy weather.	2
PA19	Make contingency plans in case of delivery delays due to bad weather.	2

Source: Analysis

After obtaining the Degree of Difficulty (Dk) value for each mitigation strategy, as listed in Table 6, the next step is to determine the relationship between the mitigation strategy and the selected risk source. Once this relationship is identified, a Total Effectiveness (TEk) calculation is performed to evaluate the extent of the effectiveness of the mitigation strategy if implemented.
Furthermore, the Effectiveness to Difficulty (ETD) ratio is calculated by dividing the Total Effectiveness (TEk) of each mitigation strategy by the Degree of Difficulty (Dk) value. Thus, the ETD results of each mitigation strategy enable the prioritization of the ranking of mitigation strategies to be implemented. Details of the calculations in the second stage of the House of Risk method (HOR phase 2) are presented.
The results of the correlation calculation between risk mitigation strategies and risk sources resulted in Effectiveness to Difficulty (ETD) values sorted from highest to lowest. These ETD values are used as the basis for prioritizing the implementation of mitigation strategies. The sequence of mitigation strategies to be implemented can be seen in Table 7 attached below.

Table 7. Sequence of Mitigation Strategies to be Implemented

Rank	Code	Mitigation Strategy (PA)	ETD
1	PA2	Regular checks and maintenance of vehicles are also carried out so that they are always in good condition.	63755.2
2	PA6	Companies can provide guidance and training to drivers on delivery routes and destination knowledge. In addition, companies can ensure that the vehicles used are in good condition and maintained to minimize the risk of technical errors.	52284
3	PA13	Conduct careful planning before delivery to ensure that the fleet used meets the needs of the number of goods to be shipped.	50452.5
4	PA4	The company can provide address writing guidelines that are clear and easily understood by the sender. In addition, companies can verify the delivery address with the recipient of the goods before the delivery process is carried out.	34552.1
5	PA18	Provide a fleet that is suitable for the weather conditions, such as a fleet equipped with anti-skid features in case of rainy weather.	33371
6	PA15	Provide training or education to shippers on the type of packaging that is suitable for the characteristics of the goods being shipped.	29321.3
7	PA8	The company can provide guidance and training to shippers on shipping procedures and sanctions for violations.	27935.4
8	PA11	Evaluate the delivery route and ensure that the selected fleet can pass the route smoothly.	27101
9	PA19	Make contingency plans in case of delivery delays due to bad weather.	26321.3
10	PA17	Monitor weather conditions and update delivery plans if necessary.	21506.9
11	PA9	The company can ensure that its fleet and human resources are sufficient to meet delivery demands. In addition, companies can cooperate with transportation partners to ensure that deliveries can be made effectively.	21043.3
12	PA7	Conduct routine maintenance and periodic battery replacement to ensure the GPS is functioning properly. In addition, the company can have a backup GPS to anticipate in case of damage to the main GPS.	17542.2
13	PA3	Use better and more accurate technology in the data collection system, such as barcodes or RFID to ensure that the goods sent are as ordered.	17021.7
14	PA12	Implement a tracking system to ensure that the selected fleet has arrived at the destination location on time.	14854.7
15	PA14	Check the type of goods to be shipped and determine the appropriate type of packaging.	14660.7
16	PA1	Proper route planning and selection of the right delivery time to avoid traffic jams.	11864.1
17	PA10	The company can conduct careful analysis and planning based on historical shipment data and estimates of future shipment demand.	11630.4
18	PA5	Companies can use goods tracking technology such as GPS and provide additional protection such as insurance to reduce the risk of loss.	11590.6
19	PA16	Establish clear packaging standards and strictly supervise their implementation.	9773.77

Source: Analysis

Based on Table 7 above, it can be concluded that there are 19 mitigation strategies that will be applied to the delivery of goods. Based on the priority of mitigation strategy planning, the strategy with the highest ETD value of 63755.2 is found in code PA2, which is also carried out periodic checking and maintenance of vehicles so that they are always in good condition. While the strategy with the smallest ETD value of 9773.77 is found in code PA16, namely Establish clear packaging standards and strictly supervise their implementation.

This study provides an in-depth analysis of risk management in land cargo transportation, focusing on the implementation of the House of Risk (HOR) method for risk identification and mitigation. The research conducted at the Denpasar City resulted in significant findings in transportation risk management.

The implementation of the HOR method was conducted in two phases. The first phase resulted in the identification of key risks including traffic congestion, GPS malfunction, and data collection system errors, which were then prioritized using the Aggregate Risk Potential (ARP) calculation. This approach is in line with the findings of [19], [20] that emphasized the effectiveness of data-driven mitigation strategies in reducing freight risks.

In the second phase of HOR, the study developed a comprehensive mitigation strategy, which included periodic maintenance of vehicles, driver training, and implementation of tracking technology. [10], [18] supported this approach by asserting the superiority of the HOR method in the identification and prioritization of supply chain risks. [11], [12]The mitigation strategies developed proved effective in improving efficiency and reducing potential operational disruptions.

The technological aspect is a crucial component in the mitigation strategy, as expressed who emphasize the importance of real-time tracking and advanced logistics information systems, especially in handling last-mile delivery [13], [14]. This is reinforced by the findings of [10] on the effectiveness of automated tracking systems in minimizing the risk of goods damage and improving delivery accuracy.

The integration of modern technologies such as IoT and big data analytics, as emphasized by [21] provides better capabilities in risk identification and improved risk management responses. In addition, in another article IOT big data analytics [22] also explains that there is a significant data spike in the rapid growth of IoT. Network sensors that continuously collect and transmit data to be stored and processed in the cloud include logistics transportation data [23].

In [24] added the importance of route planning with the use of IoT sensors and big data analytics can improve traffic management by providing real time data in route planning. Accuracy and flexibility in choosing alternative routes are needed to reduce the risk of traffic congestion and accidents [25].

The aspect of human resource development also receives special attention, [21] emphasized the importance of driver training and implementation of safety protocols to reduce human error. This approach is an integral part of the second phase of the HOR mitigation strategy [26].

This research makes a significant contribution to the development of inland cargo transportation risk management by presenting a structured approach that not only identifies risks but also provides a clear roadmap for mitigation. The integration of technology, training, and strategic planning creates a comprehensive framework that complies with international best practices in logistics risk management.

In this research enriches the understanding of risk management in land transportation through a systematic methodological approach and the implementation of measurable mitigation strategies. The combination of data-driven risk analysis, modern technology integration, and HR competency development creates an adaptive and effective risk management model for the ground cargo transportation industry.

4. Conclusion

In this section you should present the conclusion of the paper. Conclusions must focus on the novelty and exceptional results you acquired. Allow a sufficient space in the article for conclusions. Do not repeat the contents of Introduction or the Abstract. Focus on the essential things of your article.

Research on risk analysis in the transportation of goods by land transportation resulted in several important findings through the implementation of the House of Risk (HOR) method. The analysis identified 14 risk events evaluated based on severity and 21 risk agents analyzed based on occurrence value, 12 of which are dominant risk agents that are prioritized for handling.

Phase I HOR analysis with the calculation of Aggregate Risk Potential (ARP) and the application of Pareto diagrams resulted in significant findings. Using the 80:20 Pareto principle, the analysis showed that 80% of the risk causes were represented by the highest ARP values, which resulted in 12 dominant risk agents. These risk agents were then determined as priorities in handling risk sources in the loading and unloading process of land transportation freight transport.

Furthermore, the HOR Phase II analysis resulted in 19 mitigation strategies specifically designed to address the 12 identified priority risk agents. These strategies were evaluated using Effectiveness to Difficulty (ETDk) values, which allow for prioritization of treatment strategies based on their effectiveness and difficulty of implementation. This approach ensures that resources can be efficiently allocated to address the most significant risks.

Based on the results of this study, it is recommended to conduct a more detailed risk mapping based on the type of goods and cargo being transported. This will enable the development of more specific mitigation strategies according to the characteristics of the goods being transported. In addition, it is necessary to improve the supervision and control system in the transportation process, as well as optimize route planning and delivery schedules to improve operational effectiveness.

This research has provided a systematic framework for risk management in land transportation, with particular emphasis on structured risk identification, analysis and mitigation. The implementation of the strategies resulting from this research is expected to significantly improve the effectiveness and reliability of the process of transporting goods through land transportation.

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