Volume 2, Issue 4

Innovation Series Quarterly

https://journal.academicapress.org/aps/index.php/isq

Research Article

Cargo GripLock

Husna Humaira Fathil Anuar[1], Noor Aqilah Noor Azlan[2], Norazirah Md Lazi[3], Nur Aina Afiqah Shahrulamir[4], Nurin Adlina Jifry[5], Nurin Adlina Sufiah Zulpakah[6], Nurul Asyeera Najihah Johari[7], and Ammar Amierul Zahba[8,*]

1 Faculty of Business and Management, Universiti Teknologi MARA (UiTM) Bandaraya Melaka
2 Faculty of Business and Management, Universiti Teknologi MARA (UiTM) Bandaraya Melaka
3 Faculty of Business and Management, Universiti Teknologi MARA (UiTM) Bandaraya Melaka
4 Faculty of Business and Management, Universiti Teknologi MARA (UiTM) Bandaraya Melaka
5 Faculty of Business and Management, Universiti Teknologi MARA (UiTM) Bandaraya Melaka
6 Faculty of Business and Management, Universiti Teknologi MARA (UiTM) Bandaraya Melaka
7 Faculty of Business and Management, Universiti Teknologi MARA (UiTM) Bandaraya Melaka
8 Faculty of Business and Management, Universiti Teknologi MARA (UiTM) Bandaraya Melaka; ammaramierul@uitm.edu.my
* Correspondence: ammaramierul@uitm.edu.my

Keywords:
Cargo GripLock
Shipping container
Maritime safety
Cargo security
Global shipping

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Abstract: *In today's global shipping industry, worker safety and cargo security are major concerns, particularly during maritime transportation. Thousands of shipping containers fall overboard annually averaging to 1,382 to 1,500 causing financial losses, environmental pollution, and safety risks. Therefore, innovative solutions are needed to improve container stability and reduce cargo loss at sea. This project aims to introduce Cargo GripLock, an innovative system designed to enhance friction, shock absorption, and container stability during sea transportation. Unlike conventional steel-to-steel contact, GripLock incorporates high-friction composite pads and an enhanced locking mechanism to minimize container sliding and lateral movement. The system consists of a steel base plate attached to the container's corner fitting, reinforced fibre-rubber composite material, a polyurethane layer for grip and shock absorption, and an anti-slip surface texture. Before loading onto a cargo ship, the system would be installed at designated container contact points. Port workers and shipping operators could then follow existing loading procedures while the modified base provides additional grip and stability throughout the voyage. GripLock targets shipping companies, port operators, and container manufacturers. Manufacturers could adopt the concept and integrate the system into new containers or retrofit suitable existing units, subject to technical validation and compatibility testing. Cargo GripLock presents a practical innovation by supporting secure container stacking and reducing movement during transportation; this concept has the potential to improve operational reliability, protect cargo, and reduce environmental impacts associated with containers lost at sea.*

1. INTRODUCTION

Cargo GripLock is an innovative system designed to enhance friction, shock absorption, and container stability during sea transportation. Unlike conventional steel-to-steel contact, GripLock incorporates high-friction composite pads and an enhanced locking mechanism to minimize container sliding and lateral movement. The system consists of a steel base plate attached to the container's corner fitting, reinforced fibre-rubber composite material, a polyurethane layer for grip and shock absorption, and an anti-slip surface texture.

2. LITERATURE REVIEW

Maritime transport is very important to international trade and makes it possible for countries to move huge amounts of goods from one country to another. Shipping containers are commonly utilized in shipping, as they offer an efficient and standardized approach for transporting a variety of goods. Stability of containers through a voyage is vital to both the protection of goods, crew members and the marine environment. Equipment such as twistlocks, lashing rods and turnbuckles are used with containers to secure the containers during transportation on container ships. The International Maritime Organization (IMO, n.d.) underlines the great importance of proper cargo stowage and securing in preventing hazards at sea. Container stacks and securing devices may be subjected to significant forces as a result of vessel motions and weather conditions. Even though it is known how to secure containers, they still get lost at sea. In 2024, the World Shipping Council (WSC, 2025) reported 576 lost containers, which is an increase from 221 in 2023. The annual losses shown in Figure 1 are reported losses from 2022 through 2024. These figures fluctuate from one year to the next, but they are still significant enough to illustrate that container loss is always an issue in maritime safety. These have a potential to wreak financial loss, disruption to operations, navigational issues and marine pollution.



Figure 1. Number of Shipping Containers Lost at Sea (2022-2025)
(Source: World Shipping Council (2025, 2026))

Thus, Cargo GripLock is an innovative solution which can help to improve the security and stability of shipping containers on board ships. It aims to mitigate risks of unwanted container movements and help to make cargo safer and more reliable for sea transport. The proposed innovation is supposed to be a supplement to the overall effective securing of containers and minimising possible damage from cargo shifting at sea.

3. METHODOLOGY

3.1 Material Composition

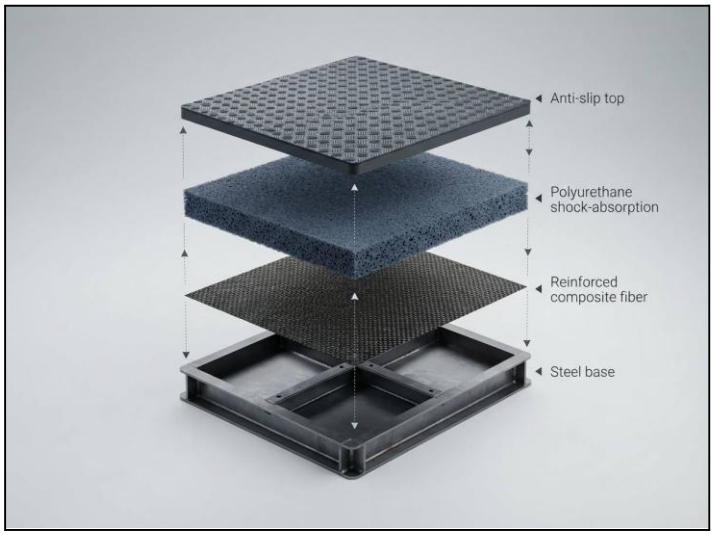


Figure 2. Four main material components of Cargo GripLock

The Cargo GripLock is made of four main material components designed to improve the stability, grip, durability, and impact resistance of shipping containers. The top layer features an anti-slip texture that increases friction between the container and the base, helping reduce unwanted movement during handling and transportation (MegahNiaga, 2025). Beneath this surface, the polyurethane layer provides high friction, abrasion resistance, and impact resistance, helping the base withstand repeated contact and mechanical stress (PESPEN, 2026). The third layer consists of a reinforced fibre-rubber composite, which combines the flexibility of rubber with the reinforcing properties of fibres to improve mechanical strength and energy absorption under certain loading conditions (Ilyas, R. A., et al., 2022). This composite layer also helps the base withstand repeated pressure and deformation, although its performance depends on the type of fibre and rubber used (Ilyas, R. A., et al., 2022). At the bottom, a heavy-duty steel base plate provides a strong structural foundation and connects to the container corner fittings to support secure positioning (Spira, N., 2024). Steel is suitable for this component because of its mechanical strength, which helps it withstand substantial loads when properly designed for the intended application (Spira, N., 2024). Overall, these four components work together to provide improved grip, structural support, and impact protection, potentially reducing container movement and improving stability during transportation.

3.2 System Workflow

Before beginning stacking operations with the GripLock system, the unit must be installed directly into the top corner fittings of the bottom container. Port operators or crane crew members place the GripLock unit's steel base plate over the bottom container's standard ISO corner casting. The unit connects effortlessly with current container infrastructure without requiring any changes to normal intermodal transport units. Once in place, the base plate firmly secures the textured high-friction composite pad face up, ready to receive and cushion the upper container during crane installation.

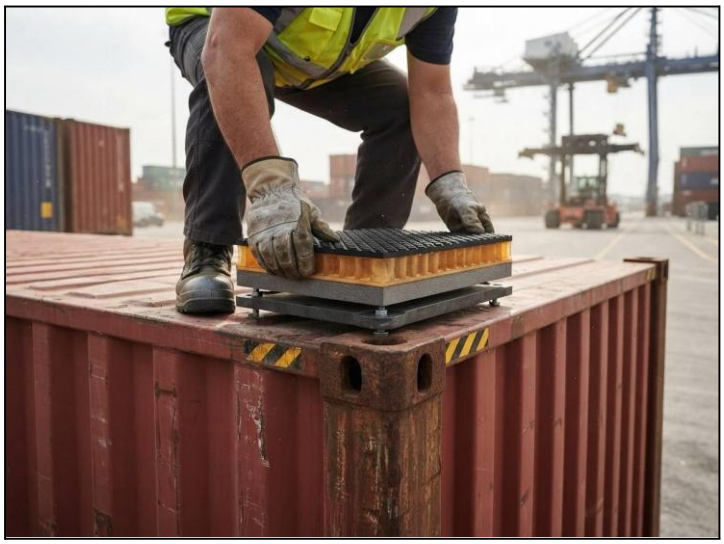


Figure 3. GripLock installation

The following step is done during the stacking process by placing the higher container onto the lower container's corner fittings. As the weight of the top container presses down on the high-friction pad, the GripLock locking mechanism activates, securing both vertical and side movement between the two containers. The anti-slip composite layer absorbs heavy vibration and stress from rough sea conditions, while the locking mechanism prevents sideways sliding and upward movement. This results in a stable, consistent stacking column, considerably lessening the chance of containers falling overboard during ocean shipping.

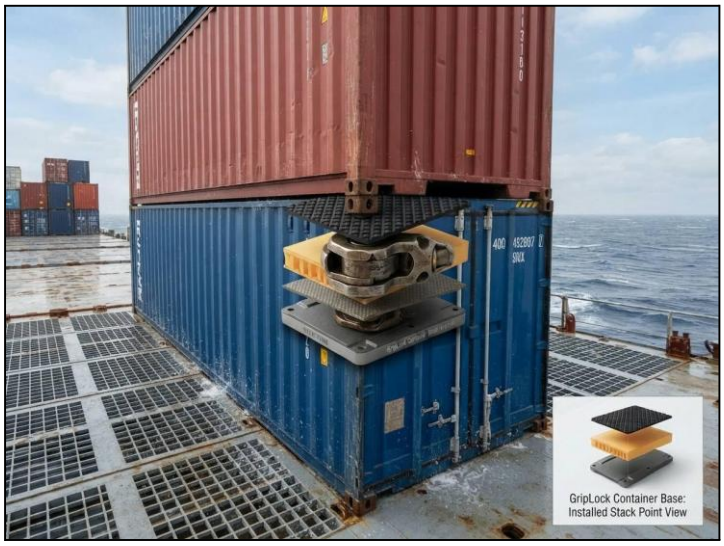


Figure 4. Stacking process

Finally, this product will be marketed directly to cargo shipping firms, maritime freight operators, and port logistics providers, replacing traditional steel-to-steel lashing methods. Cargo carriers that use Cargo GripLock units can significantly prevent the loss of expensive cargo, avoid severe financial claims, protect ocean ecosystems from container pollution, and improve overall crew and vessel safety during international maritime shipment transit.



Figure 5. Cargo shipping

4. FINDINGS

A total of 45 respondents participated in the Google Forms survey conducted to evaluate the potential of the proposed innovation, Cargo Cargo GripLock. This survey aimed to understand respondent's awareness of cargo falling incidents and their opinion regarding the effectiveness, usability of the proposed innovation.

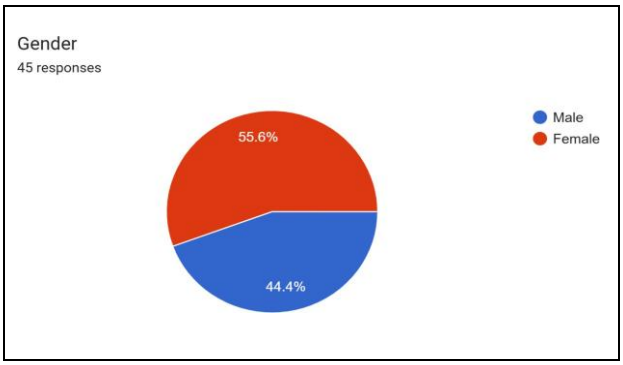


Figure 6(a). Feedback 1

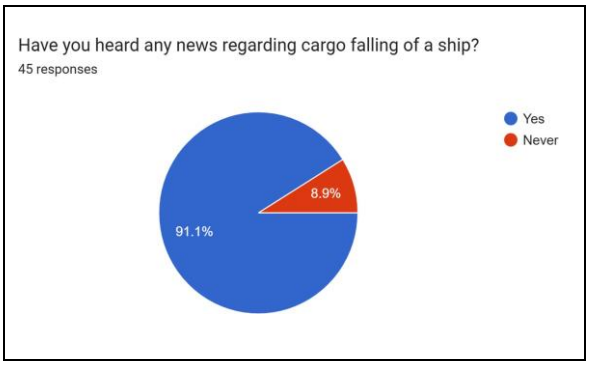


Figure 6(b). Feedback 2

Based on Figure 6(a), 55.6% of the respondents were female, while 44.4% were male. Furthermore, Figure 6(b) shows that 91.1% of respondents had heard news regarding cargo falling from ships, whereas 8.9% had never heard of the incidents. This finding indicates that cargo falling is a recognised issue among most respondents and highlights the importance of improving cargo security during transportation.

In Figure 7(a), the use of stronger locking systems and more durable materials, 80% of respondents agreed and strongly agreed that these improvements could help reduce cargo security issues. Meanwhile, 11.1% remained neutral, and 8.9% of respondents disagree and strongly disagreed. These results suggest that most respondents believe stronger and more durable cargo locking mechanisms could be beneficial in improving the cargo safety especially during transportation. In

terms of Cargo GripLock's potential as an alternative to existing cargo locking systems, Figure 7(b) shown 79.5% of respondents agreed and strongly agreed that the innovation could be useful.

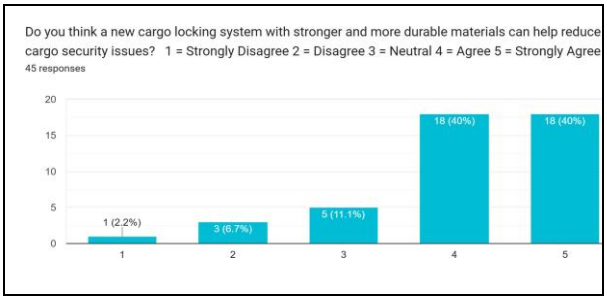


Figure 7(a). Feedback 3

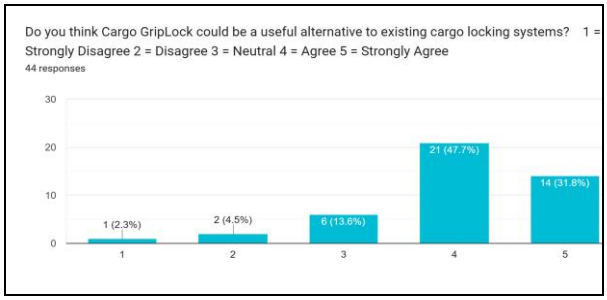


Figure 7(b). Feedback 4

Additionally, Figure 8(a) shows 71.1% of respondents agreed and strongly agreed that Cargo GripLock could be easy to install and operate during cargo loading and unloading. These findings indicate a positive acceptance of the proposed innovation, particularly in terms of its usefulness and practical application in cargo handling operations. Figure 8(b) also revealed that 82.2% of respondents agreed and strongly agreed that implementing Cargo GripLock could help logistics companies reduce cost associated with cargo damage, delays and the replacement of damaged locking equipment.

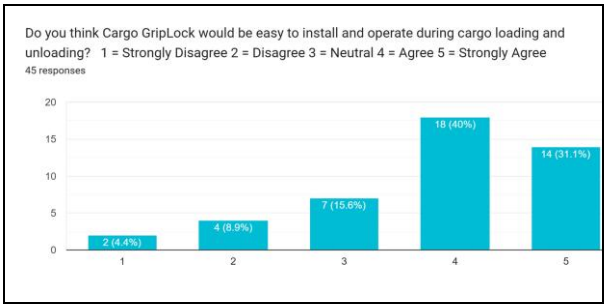


Figure 8(a). Feedback 5

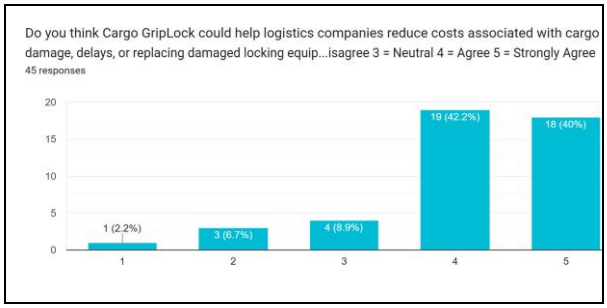


Figure 8(b). Feedback 6

Furthermore, Figure 9 stated 86.6% of respondents agreed and strongly agreed that the innovation could improve the reliability of cargo transportation by keeping cargo securely in place throughout the journey. This was the highest level of agreement among the five innovation-related questions, suggesting that respondents particularly value the potential of Cargo GripLock to improve cargo transportation reliability.

Overall, the survey results show a positive response towards Cargo Cargo GripLock, with the majority of the respondents expressing agreement with its potential benefits. The findings support the potential of the innovation.

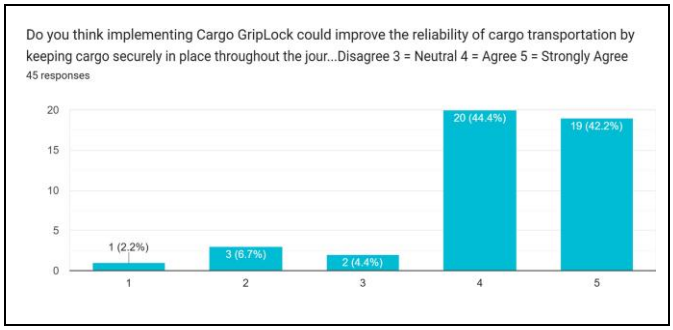


Figure 9. Feedback 7

5. DISCUSSION

5.1 Environmental and Safety Impact

The GripLock might improve maritime safety by reducing unwanted container movement during ocean transit. Studies on container stack dynamics show that proper securing arrangements and smaller gaps in locking systems can contribute to the safety of container stacks (Liu et al., 2020). GripLock uses high-friction composite pads, shock absorption and improved locking mechanism to provide more stability to stacked containers. This may decrease damage to cargo and the risk of containers falling overboard but its effectiveness must be confirmed by engineering tests. Additionally, Orkun (2024) states that lost containers at sea are a navigation hazard as well as a threat to the marine environment. Hence, if testing proves GripLock is effective in reducing container losses, it could help to cut down on marine pollution and protect marine life.

5.2 Economic and Industry Benefits

Furthermore, Cargo GripLock can also bring economic benefits to shipping companies, port operators, cargo owners and container manufacturers. By decreasing the frequency of container movements and cargo loss, financial losses from damaged goods, replacement costs, insurance claims and shipping disruptions can be reduced. The World Shipping Council (2026) reports that approximately 1,478 containers were lost at sea in 2025, highlighting the continued need for robust container safety measures. GripLock also has the potential to create commercial opportunities for manufacturers, either by integrating the system into new containers or by retrofitting compatible existing containers. If the system is effective, durable and affordable, it could form the basis for safer cargo transportation, improve operational reliability and offer a potential new product to the global maritime logistics industry.

5.3 Operational Efficiency and Commercialisation Potential

Cargo GripLock could create commercial opportunities for container manufacturers, shipping companies and maritime equipment suppliers. The system could be offered as an extra safety feature for new manufactured containers, or as a retrofit product for compatible existing containers. The International Convention for Safe Containers sets safety requirements for containers used in international transport ((International Maritime Organization, n.d.). Therefore, GripLock should undergo technical assessments and compatibility testing before entering the market. Should the product prove durable, practical and cost-effective, manufacturers may benefit from further product lines, while shipping operators may assess the product's value as part of their cargo-handling equipment. Furthermore, commercial collaborations with shipping companies and port operators can help to support the adoption of the products and expansion in international markets (Cunningham, 2026).

6. CONCLUSION

In conclusion, the Cargo GripLock provides a practical and innovative solution to solve the problem of shipping containers falling into the sea during maritime transportation. This problem can lead to serious financial ruin to shipping companies, may result in damage to valuable cargo, and create an extra source of marine pollution. The GripLock system is created to enhance the stability of the container that consists of three main layers which is a steel base plate, reinforced rubber fiber rubber and shock absorbing polyurethane layer. This kind of materials can work together to reduce the sliding, less vulnerable to shocks, and gives better stability to the containers when it is exposed to rough sea conditions. Additionally, the GripLock system can be accommodated into standard ISO container corner castings, thus facilitating the adoption of the system for shipping companies and making it easier for port operators to adopt the technology without making extensive alterations for their current equipment and operations. This makes the GripLock system the best option for both new containers and existing containers through retrofitting. Although the implementation of the system may need additional costs, the long-term benefits could reduce the cargo losses, enhance the safety for shipping activities, and reduce the expenses that are involved in container accidents. However, the Cargo GripLock has high potential to enhance the safety for shipping containers and sustain global shipping operations. By minimizing the amount of the risk for the containers being lost at sea, it will assist in ensuring the safety of the environment, enhance the crew safety, and facilitate more efficient international trade. Therefore, adopting this technology can be an important step towards building up a safer, more efficient maritime transportation industry.

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