



IoT Sensors used for Marine Cargo Shipments

Nik Tehrani, Jahan Ghofraniha

California State University Maritime Academy
Saint Mary's College of California

Abstract Shipping containers are an essential part of the manufacturer supply chain, and are used to ship all types of goods, such as food, automobile parts, and pharmaceuticals. These containers are often returned late or not returned at all, which results in a loss of money for manufacturers. Theft and pilferage of container contents leads to losses. Refrigerated shipping delays result in spoiled goods that do not make it to their destination in acceptable condition. Changes in temperature or pressure can lead to losses of perishable goods, such as seafood. When goods are not delivered for any reason, somebody is responsible for the loss. The shipping process may involve rail and/or trucks at either end, workers from each of the shipping methods, and events that happen anywhere along the transit. When there is a loss, it is difficult to determine which of the many insurance policies must pay the loss claim. Containers that have been fitted with the Internet of Things (IoT) smart sensors can identify if a change in temperature should occur. Sensors can analyze inventory and cycle times of containers as they travel through the supply chain to identify where and when something and unforeseen marine situation occurs, allowing a loss and insurance claim to be settled immediately, eliminating the need for in-person container checks.

Keywords IoT Sensors, marine cargo, shipping containers, inventory loss, insurance claims

Introduction

Vast quantities of goods are shipped in standardized containers across the ocean in over 34 million containers worldwide [1]. Shipping containers are an essential part of the manufacturing supply chain. However, while in transit, a lot of things can happen to the containers. Goods go missing, are lost, or are spoiled, either by accident, theft or pilferage, or a combination of events [2]. Sometimes containers are returned late or not returned at all [3]. Refrigerated shipping delays result in spoiled goods that do not make it to their destination in acceptable condition [4]. Changes in temperature or pressure can lead to losses of highly perishable goods, such as seafood. When goods are not delivered for any reason, somebody is responsible for the loss. The shipping process may involve rail and/or trucks at either end, workers from each of the shipping methods, and events that happen anywhere along the transit [2]. Up to 12 parties may be involved along the way, each with its own insurance coverage [2], so when there is a loss, it is difficult to determine which of the many insurance policies must pay the loss claim. Pirated cargo cost companies billions of dollars internationally [5]. Early warning systems can detect a container's movement and door activity [4].

The term Internet of Things (IoT) is a network of sensors used to monitor and track real-world objects that are connected to the Internet, such as goods in a shipping container. The use of sensors can analyze inventory and cycle times of containers as they travel through the supply chain [2, 3, 6]. Containers that have been fitted with the Internet of Things (IoT) smart sensors can identify a change in temperature [4]. They identify where and when something and unforeseen marine situation occurs, allowing a loss and insurance claim to be settled immediately, eliminating the need for in-person container checks [4].



Types of IoT Sensors used for Monitoring of Marine Cargo Shipments

Cargo monitoring technologies, such as Arviem's IoT device, can track shipments in real-time to accelerate claims payments and compile predictable data which would alleviate risk and reduce losses paid by insurers. Arviem has created an independent cargo tracking and monitoring service that is independent from third party integration with other providers and is 100% reliable. Arviem is a real-time beginning-to-end cargo monitoring and supply chain service provider providing visible carrier monitoring services using independent accurate tracking location and monitoring of cargo condition [5]. Using Arviem's monitoring, analyses and reports on every aspect of a cargo shipment, delays or disruptions, supply chain issues can be immediately mitigated. With this IoT system, working capital management can be improved, transport insurance premiums and administrative costs reduced, while assuring product safety and quality while in transit. Data can be accessed using cloud-based platform or it can be integrated with a clients' system via an API. All global shipments can be tracked on one platform [5].

Blackberry's portable sensor units using GPS and cellular modem technology can be retrofitted to existing containers to provide real-time data on container temperature, humidity, pressure and movement [4]. Transportation Management Systems (TMS) uses data combined with software solutions to monitor shipping times, routes, and logistics. Management systems formerly tracked shipping containers using a unique barcode for each container scanned when entering and exiting transport. Until now, between barcode scans, shipping containers could not be monitored, even when there was a problem with the container [4]. Maersk Line, a Danish shipping company, has completely redesigned its refrigerated containers with built-in smart sensors that monitor container conditions 24/7. If any changes happen, such as a power loss, containers transmit an alert to a central system describing the problem and exact location, so a crew scan be sent out to alleviate problems before goods spoil [7].

IBM's Returnable Container Management uses the Internet of Things to track and measure the usage of shipping containers [3]. The automotive industry uses IoT sensors to track container inventories, such as car parts, components and sub-assemblies. A sensor with a unique serial number is attached to each container, so that it can be tracked in real-time as it travels along the supply chain [3].

Cargo monitoring sensors are commonly used by companies in industries where shipments are temperature and light sensitive, such as pharmaceuticals. The goal is to reduce or replace the implementation of expensive marine insurance claims using teams of adjusters to survey costs at the location. Insureds will benefit because claim-related fees, such as lawyers, travel costs, and billable hours, are reduced [14].

Maersk uses the IoT (Internet of things) and blockchain technology for transparency, safety, and cost efficiency improvement for its sea freights [8]. Maersk's Remote Container Management (RCM) system monitors its fleet of 300,000 refrigerated containers by transmitting data, such as temperature and location, to reduce spoiled goods for perishable commodities that must be shipped within a strict range of humidity and temperature [7, 9]. RCM has economic value because suboptimal shipping conditions are responsible for the loss of nearly half of U.S. fresh produce [10-13]. By using RCM, a shipment of bananas could be saved from mold by intervention from detecting a higher temperature inside a container [10]. Since 60 percent of containers are visually inspected upon arrival, RCM also allows for a reduction of time and cost spent inspecting containers [10-12].

Theft

(LI) IoT solutions now address cargo theft [7]. Pilferage detection is difficult as there is no way to know whether losses are unintended, theft, or overt insurance fraud. Without technology, there's no reliable way to know what, when, and where, and by whom theft occurs, so there is no way to know which insurance company is responsible. If just 10% of a container's contents are stolen, it is not obvious enough to set off alarms when it occurs, but it is still enough for the thieves to make money and theft worthwhile [7].

Governments support new IoT security innovations because they make security checks of containers passing through customs and collection of detailed cargo information easier [5]. Arviem sensors also collect data about temperature, humidity, geolocation along the entire route, as well as intrusions into the container or if a door is opened or closed.



Conclusion

IoT solutions are becoming more sophisticated for improved security, logistical data, temperature monitoring, and connectivity. Real-time information and logistics improves transportation management due to the ability to track goods throughout a journey, and to find lost or misrouted containers. With a better understanding of losses through the use of sensors, insurance premiums should decrease, leading to savings that would be the ROI for the expense of implementing sensors.

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