REDUCING CONTAINER INVENTORY MANAGEMENT COST: THE SMART USE OF INTERNET OF THINGS (IOT)

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ABSTRACT -Since shipping derives its demand from international trading, the quantity of containers imported and exported to a country rarely match. As a result, shipping lines (SL) incur an additional cost: namely, the empty container reposition cost. This refers to either the export of excess containers to another country where they are needed or import of empty containers from a port where they are in abundance. Given that Internet of things (IoT) is gaining momentum, this paper proposes a method to enhance the effectiveness and efficiency of container inventory management (CIM) using IoT. The specific CIM tool to which the paper refers is the virtual container yard (VCY): an online tool that follows the fundamentals of collaboration between L). It operates through an algorithm to exchange containers between SLs. The paper examines the process of the VCY and ascertain how IoT could improve its ability to reduce CIM cost while improving service quality. It is identified that IoT could play a key role in identifying potential SLs for exchange, in determining the quantity of containers based on type, size, and other factors, and in exploring port pair option for the most economical exchange.

Keywords: Containers; Shipping; Transport, Logistics, IoT; Container Inventory Management

1. INTRODUCTION

The objective of this paper is to evaluate the possibilities of reducing CIM cost using IoT under the VCY approach. CIM received industry attention recently due to its role in increasing costs incurred by SL. Before containerisation, cargo were loaded directly onto ships. However, in container ships, the transport operation cannot be fulfilled without containers because now the cargo should first be placed in containers before they are loaded onboard ships. After consignees unload their cargo at the destination, empty containers are returned to the container yard nominated by the SL. These are stored in the yard pending export cargo to other ports. Well-planned, accurate, and realistically-forecasted container flows could ensure materials and goods are supplied and delivered on time and in a cost-efficient way. However, industry data reveals that substantial cost is incurred to manage container inventory. While most components in the cost structure of containers have already been controlled through technical and operational optimisation some costs are still beyond SL control. In recent times, a key factor identified as requiring research was container inventory imbalance (CII); this is because it accounts for almost one fourth of total CIM cost.

Information and communication technology solves problems, manages, and controls many processes systematically across industries. This makes life easier. Key tools used in this respect include the internet of things (IoT), big data, and artificial intelligence (AI). The term IoT is mainly used for devices that wouldn't usually be expected to have an internet connection, but do. These can communicate within a network independently of human action. For this reason, a computer isn't generally considered an IoT device, and neither is a smartphone—even though the latter is crammed with sensors [1]. Given the substantial cost incurred on CII, much research is found about empty container reposition methodologies. Transporting containers from excess locations to deficit locations is called repositioning. While empty container reposition is a widely used mechanism, there is a fundamental difference between the two approaches. In other words, empty container repositioning is a reactive solution to CII problem. Having containers to be transported without any cargo in them is an environmental hazard [2]. However, there is a serious vacuum of literature pertaining to container exchange (CE) between carriers [3]. The handful of previous literature discusses a mechanism to decrease the container imbalance [4] [5]; feasibility of sharing of containers between carriers [6]; key factors that influence the container interchange by carriers [7] and CIM strategies [8]; container supply chain of a CSL [9]; carriers' perception towards VCY [10]; VCY approach [11]; expected payoff through container interchange [12]; CIM strategies [13]; calculating the cost savings of exchange [14]; benefits of exchange and savings for major types of containers [15]; electronic complexity of one-to-one connectivity [16]; and strategies used by carriers to optimise the utilisation of container inventory [17]. The empty container inventory problem can be appraised under three key perspectives. These are (i) minimising the ship space (slots) used for repositioning, (ii) minimising the unit cost incurred on empty container reposition including port handling charges, and (iii) reducing the number of containers that need reposition [3]. Carriers optimise this activity through research and development. They use mathematical models to ensure the containers are repositioned in the most economical way. In contrast, this paper focuses on reducing the quantity of containers needs repositioning. This mechanism is called VCY, and it facilitates carriers to exchange containers between them on equal benefit sharing. If the saving of the VCY is allocated to benefit the exporters, the freight rates could be reduced. For example, export freight from Sri Lanka could be reduced by USD 85 per TEU [3]. The main objective of this paper is to evaluate the possibility of adding value to the VCY using IoT and reducing CIM cost. Therefore, the paper covers three main aspects: (i) container inventory management, (ii) VCY to reduce CIM cost, and (iii) IoT. The VCY considers existing container inventory data and forecasted data of all participating shipping lines to make "matching" of demand and supply more realistic. When each shipping line declares their estimated stock position in all ports in the VCY, this declaration will be evaluated based on set criteria using IoT and exchange will be materialised.

2. MATERIALS AND METHODS

The study has followed qualitative research methods. Researchers have conducted desk research to collect secondary data while primary data was collected using interviews. Accordingly, 17 publications pertaining to various aspects of CIM have been referred. Primary data was obtained through interviews. A cross section of senior management involved in container shipping were included in focus group discussions. Unstructured interviews have been conducted with three chief executive officers, two operations managers and four ICT managers. Two out of the three chief executive officers suggested that their ICT managers also should be present at the discussions as they are not very familiar with IoT in VCY. A prior art search was carried out using Scopus to ensure the comprehensiveness of the literature survey.

3. RESULTS AND DISCUSSION

Under these circumstances, it is proposed that a dynamic solution for the CII problem should be developed using IoT. IoT refers to billions of physical devices around the world that are now connected to the internet, all collecting and sharing data [1]. IoT can deliver insights into everything from the performance of machines such as processors, sensors, and communication hardware, to collect, send and act on data they acquire from their environments. IoT provides business solutions with a real-time look into how systems really work. Because an IoT ecosystem consists of web-enabled smart devices that use embedded systems in any supply chain and logistics operation, finding a timely solution to this complicated problem becomes MORE realistic. By amalgamating the outcome of desk research and respondents' feedback, the most suitable method was derived. The unit of measurement in the VCY is calculated by multiplying number of containers exchanged and number of days transported (transit times between ports after exchanging). Accordingly, the VCY can be efficiently operated using IoT. It is the view of the researchers that the CIM mechanisms used by container SL at present are evaluated against possible IoT options. Then its application should be extended to the VCY. Accordingly, the technical aspects of container inventory management and theoretical context of IoT should be equally considered in the analysis. It is also reiterated that IoT recommendations should be compatible with the existing CIM process used by SL.

4. CONCLUSION

This paper analysed fundamental issues pertaining to CIM and proposed VCY in a IoT environment as a potential solution to minimise the cost of empty container reposition. The researchers suggest the need for extended research on big data and artificial intelligence to enhance the value of the tool.

REFERENCES

1. S. Ranger , "www.zdnet.com," 2020. [Online]. Available: https://www.zdnet.com/article/what-is-the-internet-of-things-everything-you-need-to-know-about-the-iot-right-now/. [Accessed 31 05 2021].
2. L. Edirisinghe, H. Edirisinghe and S. Dissanayake, "Assessment of Environmental Impact of Reducing Container Reposition throughAlgorithms Based Virtual Container Yard: A Case Study," Colombo, 2019.
3. L. Edirisinghe, Z. Jin and A. Wijeratne, "The Reality of Container Exchange between Shipping Lines: Clearing the Pathway to Virtual Container Yard," Transport Policy, vol. 72, no. December, pp. 55-66, 2018.
4. L. Edirisinghe, Z. Jin and A. Wijeratne, "The Factors that Influence the Collaborative Behaviour of Shipping Lines with Respect toContainer Interchange," in 14th International Conferenece on Busuness Management, Colombo, 2017.
5. L. Edirisinghe, "Smart Container Inventory Management: A Conceptual Approach," CINEC Academic Journal, vol. 2, no. 1, 2017.
6. L. Edirisinghe, Z. Jin and A. Wijeratne, "Minimizing the Global Container Inventory Imbalance through Collaboration among Carriers," in 14th World Conferenece on Transport Research, Shanghai, 2016.
7. L. Edirisinghe, Z. Jin and A. Wijeratne, "Container Inventory Management: Factors influencing Container Interchange," in 13th International Conference on Business Management, Colombo, 2016.
8. L. Edirisinghe, Z. Jin and A. Wijeratne, "The Global Impact of Container Inventory Imbalance and the Factors that Influence Container Inventory Management Strategies," in 13th International Conference on Business Management, Colombo, 2016a.
9. L. Edirisinghe, Z. Jin and A. Wijeratne, "Factors that Influence Container Inventory Management Strategies," in 6th International Conference on Management and Economics, Colombo, 2017.
10. H. Edirisinghe and L. Edirisinghe, "Using an Algorithm to Optimize the Utility of Container Inventory through Virtual Container Yard (VCY)," in 2019 International Conference On Business Innovation (ICOBI), Colombo.

11. L. Edirisinghe, Z. Jin and A. Wijeratne, "Container Interchange: the 6 R Model Approach," in 4th International Conference on Logistics Operations Management (GOL 2018), Le Havre, 2018.
12. L. Edirisinghe, A. Wijeratne and Z. Jin, "Evaluation of expected payoff through container interchange between shipping lines: a solution to container inventory imbalance in Sri Lanka," Int. J. Logistics Systems and Management, vol. 21, no. 4, pp. 503-533, 2015.
13. L. Edirisinghe, Z. Jin and A. Wijeratne, "Container inventory management: introducing the 3F model," Int. J. Logistics Systems and Management, Vol. 31, No. 3, 2018, vol. 31, no. 3, pp. 363-386, 2018.
14. L. Edirisinghe, "Virual Containr Pool: Solution to Container Inventor Imbalance," Sri Lanka Navy Logistics Conference Jounal, vol. 1, no. 1, pp. 179-204, 2016.
15. L. Edirisinghe, "The virtual container yard: A complimentary tool to optimize collaboration in shipping," Journal of Sustainable Development of Transport and Logistics, vol. 3, no. 2, pp. 74-81, 2018.
16. L. Edirisinghe, "Internet: A Paradox in Shipping," Economic Review, vol. June/July, no. 1, pp. 35-36, 2010.
17. L. Edirisinghe, Container Inventory Management: should the Present Practices be Regulated, Colombo: Ceylon Association of Shipping Agents, 2018.