

Smart Containerization as a Determinant of Supply Chain Visibility in Sea Freight Cargo: A Case Study of Apparel Industry in Sri Lanka

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ABSTRACT

As a prominent exporter, the apparel sector draws considerable attention in the Sri Lankan economy. As most apparel supply chain occurs through sea freight, there is a significant demand for more visibility for end-to-end movements. Due to technological innovations, smart containerization has become popular with the prevailing problems in apparel supply chains to enhance its visibility, reliability, and efficient demands. The study aims to understand the concept and the related influencing factors in enhancing the supply chain process performance. The study followed the qualitative approach, and the case study strategy was used by conducting in-depth interviews selecting six experienced professionals from the logistics & supply chain sector in the selected leading apparel export organization in Sri Lanka. NVivo software assisted in the transcript coding process of the analysis while deriving the influencing factors. The study explored technological, financial, and social avenues and influences as contributions to the inbound and outbound logistics process of the apparel industry.

Keywords: Apparel Industry, Sea Freight, Smart Containerization, Supply Chain Management, Supply Chain Visibility

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INTRODUCTION

As one of the largest contributors to the Sri Lankan economy, Sri Lanka's apparel and textile industry has succeeded in overcoming global challenges to become a sustainable, and ethical suppliers of apparel, textile, and its' finishing services to leading international brands and buyers while adhering to the best practices (Apparel & Textiles Sri Lanka , EDB, 2022). Sri Lanka caters the demand of branded apparel retailers especially in United States, United Kingdom, and many Europe countries majorly along with China and Australia (Export Performance of Apparel - EDB Sri Lanka, 2022). The Apparel industry continuously demands for higher efficiency in all the areas including supply chain day by day to compete with the changing market trends. Majority of the apparel manufactures export apparel to the basis of 'speed to market' where raw material imports to delivering final garments to the buyer are highly time sensitive. Out of these imports and exports majority of cargo moved via sea mode of transportation as "sea freight". Hence, there are many challenges experiencing by the apparel industry Sri Lanka and one of the major challenge is to serve with shorter lead times (Dheerasinghe, 2009).

Caridi et al. (2013) elaborated current weaknesses exist on Apparel supply chains based on main causes as late delivery of raw materials, work in progress and finished goods. Further, Internal logistics delays, inadequate quality and bureaucracy which can be controlled and minimized if visibility within the supply chain can be improved from order status to delivery.

The study focused on exploring factors influenced on a leading apparel exporter in Sri Lanka which serves to many international buyer brands for more than 10 countries by catering flawless and faster supply, with optimal pricing, intimate service, and phenomenal products. With the complexity of the supply chain network across more than 20 production plants in Sri Lanka, more than 100 raw material, machinery & spare parts suppliers from around 25 countries and serving more than 20 international brands which demands different requirements, its supply chain network is quite complex. End to end visibility articulated by Somapa et al. (2018) as accessibility, quality, and usefulness of information is a highly demanding factor in a complex supply chain network where the selected company requires to minimize practical challenges they experience as delays of sea cargo movements while in transit, to avoid pilferage, damage, reduce import demurrage due to unloading delays

of raw materials at production plants, maintain on-time delivery and international security standards for buyer demands, enable track and traceability of cargo with live data for protection, planning and faster connections at origins and transshipment hubs etc. As majority of import and export cargo moves via sea freight, this company requires more visibility for their sea movements to overcome said challenges since air cargo perform faster due to the shorter lead times from own nature & characteristics of the mode.

90% of all international cargo is transported by ocean freight, and the most common sort of shelter for goods as they move over currents, rails, and roadways inside a shipping container, where it initially started as conventional steel container which was not evolved or changed for decades but the growth and complexity of e-commerce delivery combined with technological advancements in sensors, connectivity, and materials will most likely lead to a new wave of containers in near future which started over “smart containerization”(Smart Containerization - DHL, 2022).

The case analysis based on six supply chain and logistic professionals’ transcripts on exploring factors relating to the smart containerization and supply chain visibility. The rationale findings of this research will assist leading manufacturing and trading companies in apparel sector in Sri Lanka on enhancement of the supply chain visibility for their sea cargo to drive the industry towards world standards and after the Covid-19 pandemic the significant importance of supply chain resilience through smart technology as smart containers, block chain, artificial intelligence etc. also affirmatively can be fulfilled in apparel sector supply chains to stabilize operations as other sectors executed (Nanayakkara, 2022). Further, the study will support to develop economy of Sri Lanka as there is limited literature based on the concepts in the selected context. The study findings converged on the following research question.

Does smart containerization have an influence on Supply chain visibility in the apparel sector in Sri Lanka?

LITERATURE REVIEW

The apparel Industry is one of the outstanding, fast-moving industries in the world which has had a growing complexity in its supply chain during

last decades (Caridi et al., 2013). The globalization process, market dynamicity and the competitiveness, pressure has become more hostile in apparel sector (Kilduff, 2001). Köksal et al. (2018) further articulates consumers of apparel industry, expect constant changes and new products on frequent basis, which increases pressure on apparel retailers to achieve lower cost and shorter lead times. With the rapid growth of container volumes and demand, container ship sizes were evolved, and industry strongly needed easier methods to handle the increasing volumes where smart containers play a vital role (Becha, 2017). Hence, the concept of smart containerization has become one of the popular factors within most of the exporters in supply chain studies.

Smart Containers

“*Smart container*” defines as a dry container, permanently equipped with a cutting-edge technology than the conventional container which transmits real time data on containers’ movement with more transparency, safety and cost efficiency and it acts as the missing link in digitalization of supply chain (Becha, 2017). Giermanski, (2016) further describes “Smart containers” use sensors and systems to track and report where the smartest container says who supervised its stuff. The developments of smart containers come up to that extent to monitor cargo totally in all aspects. Smart containers connect entire maritime routes towards a fully digitalized & connected platform to a global network to enhance transparency of the respective processes (Fruth & Teuteberg, 2017). CMA CGM, a leading shipping line, has identified Smart containers as real time containers, more visible than a standard container as it has advanced technology on it presented (Traxens Logistics Excellence Now Just a Touch Away, 2018). Gattuso and Pellicanò (2014) elaborate many methods using Information Technology for tracking shipping containers by means of satellite systems, RFID (Radio Frequency Identification) and GSM (Global system for mobile communications) and further argues this increase visibility which industry needs where Becha (2017) stated the main elements of a smart container as Geo positioning facility (GPS), GSM connectivity with 3G technology, embedded sensors to capture shock, movement, temperature, door open/close status and vibration which provides visibility. RFID technology, Container E- seals and Container security devices (CSDs) are the important technological devices a secured smart container can use to track and trace their cargo and to get information (Scholliers et al., 2016). Embedded GPS tracks down the movement, Carn

(2011) presented a smart container's journey which was loaded on deck by enabling wedge device to maintain a cellular signal throughout the journey and reported its location with accurate GPS (2D or 3D fix) whenever it was in range of a shore-based facility. GSM is another unique element, further articulated by Carn (2011) described the way containers tracked under Smart container management project through a device which is equipped with GSM and proved that GSM mobile communication supports for track and trace along with notification system in Smart containers. Smart containers are equipped with a special sensor system. Yanjie et al. (2011) discussed special sensors which record temperature and moisture out of tolerance, the sensor signal information will be written to the RFID tags on the container to alert someone later in the supply chain. The exploration of Becha (2017) stated special features of a smart container as providing door open/close status, temperature, shock, movement and vibration changes with live information through embedded sensors to the smart container and this further clarifies by Scholliers et al. (2016) stated that sensors can provide data about environmental conditions in the container while transportation such as temperature, humidity, light, pressure and shock.

E-seals also another feature, attached to the container door to simplify the process by providing a wire-less and automated alarm and tracking feature (Yanjie et al., 2011). The most significant element which smart container shares is real time data, developed through information technology and shares through the internet supports to share the real time information for different parties within the supply chain (Yanjie et al., 2011). Maspero et al. (2008) describes after the 11th of September attack in America, all transport modes must follow strict security measures and based on same the container security measures they have taken, fulfills by smart containers by providing secure and traceable containers.

In manufacturing industries, "Reverse logistics" is the latest sustainability practice to gain a secondary value for used or defected objects and for that Information communication technology (ICT) future trends are the best solution where smart containerization proved to be among mostly preferred (Starostka-Patyk & Grunt, 2022). According to Becha (2017) smart container technology is embedded with the facilities and elements as location tracking and positioning, sensor driven data with online updates, temperature and live environment details of cargo, container door open and close status updates, real time data from anywhere and live alerts, cargo scanning and live

footage, embedded advance technology as Internet of things (IoT) and special security breach alerts. In the latest findings by Becha et al. (2020) articulate about the added electronics to the traditional sea container which enables tracking and monitoring of the container trip and its cargo with condition updates in every circumstance.

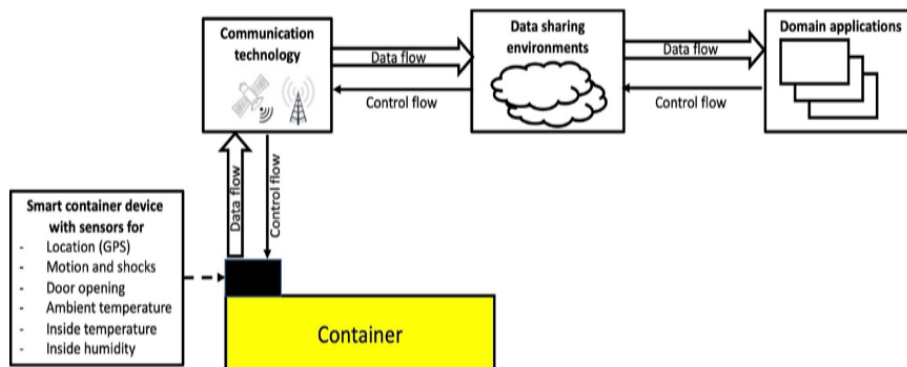


Figure 1: The Smart Container Device and its Main Data Functioning Process (Becha et al., 2020)

“*Container*” being the center link in global production networks which brought a whole new paradigm shift for production and distribution (Notteboom & Rodrigue, 2009), it should embed with latest technological developments which ultimately literature proves smart containerization is completely transformed with cutting edge technological innovations towards compatibility to best suit for current supply chain demands.

Supply Chain Visibility

Pounder et al. (2013) state that the concept of supply chain has been the subject of much debate and research since the 1980s. Londe et al. (1997) defined supply chain as a set of firms that pass materials forward. Supply chain management (SCM) assists the business organization to compete in the dynamic international market as the objective of SCM is to incorporate activities across and within organizations for providing customer value (Habib, 2011). Somapa et al. (2018) articulates visibility as actors within the supply chain getting access to the timely and accurate information that they consider to be key or useful to their operations in a visible supply chain. Bartlett et al. (2007) further states supply chain management as managing upstream and downstream relationships with suppliers and customers in order to create enhanced value in the final marketplace at less cost to the supply

chain as a whole.

In that supply chain management process, Butner (2007) in the IBM, Blueprint confirms that a customer driven supply chain has several objectives along with speeding new, high-margin products to customers while obtaining real-time visibility to supply chain and enabling real-time collaboration and data exchange as the key requirements as visibility of a supply chain. McKinney et al. (2015) presents the importance of visible supply chains as a substantial portion of industry still lacks correct information about their supply chains. Therefore, entire industry requires better visibility of Supply Chain to achieve business performance and to mitigate supply chain risk. When supply chain connects to digital platforms, connectivity among parties is convenient as Klievink et al. (2012) explains further through a pipeline of supply chain in international trade systems which have connected with technological, internet related things which collaborate with every party together. According to various literature digital platforms connected to supply chain enhances visibility and there are main abilities of supply chain visibility which the author has further discussed in the next paragraph.

Automated information in tracking products during shipment is a main characteristic of the supply chain visibility which captures shipment information to trace, maintain stock and to check lead times (Somapa et al., 2018). Caridi et al. (2013) also elaborates supply chain visibility as the ability to access or share information across the supply chain which affirmatively presents “*continuous information flow*” as a main requirement. Somapa et al. (2018) explains supply chain visibility means that each partner within the supply chain gets other’s information in real time where it proves the accessibility and real time data availability plays a major role in visible supply chains. Visibility for a supply chain is important for accurate and fast delivery of information where inaccuracy can cause certain negative consequences such as the “*bullwhip-effect*” in supply chain (Lee et al., 1997). This is further confirmed by Caridi et al. (2013) stating that accuracy and freshness of the visible information are essential elements of a visible supply chain.

Smart Containerization and Supply Chain Visibility

There is literature that directly articulates the relationship between two concepts of smart containers and supply chain visibility which the authors

have analyzed in this segment.

A suitable networking of single information systems can fully digitize and connect global network of the entire maritime transport in order to render transparency and Smart containerization which consist of a suitable networking mechanism towards a positive impact on Supply chain visibility as the smart equipped container contributes to the sustainability of sea transport and significantly improves the transparency and security of international intermodal container traffic (Fruth & Teuteberg, 2017). Fazi et al. (2015) declares in the last decade in global trade movement of large quantities of goods are more and more associated with container supply chains and therefore a smart and quick planning is required to improve performances and flexibility of the transport where Fruth and Teuteberg (2017) presented Smart container offers an end to end visibility of shipment execution which proves the relationship with supply chain visibility. Yanjie et al. (2011) confirms, secure smart container is considered to have automatic identification function, ensuring security, track & trace function, information service function, recording environmental information function and intelligent management function, etc. where McKinney et al. (2015) further argues that today technologies and brainpower applied to supply chain performance improvement is greater than ever before and devices like scanners, seals, RFID, Container Security Devices (CSDs) etc. allow companies to get a better picture of the customer's requirements and needs by giving this information to all parts of the supply chain in order to respond quickly, efficiently, accurately and in mass which acts as a technological solutions provider for visibility. The concept of smart ports aims to adopt modern information technologies to enable better planning and management within and between ports (Heilig et al., 2017). The movement of freight in containers increases the efficient handling and storage of products using containers ranging from international standards to technologically improved smart containers (Govender & Mbhele, 2014). Above said facilities and elements of a smart container equipped with technology creates more visibility to supply chain according to literature by sharing continuous, real-time information.

The major findings of Becha et al. (2020) explaining the direct connection of creating more visibility through smart containers stating the smart container as the common data source achieves real time data visibility of cargo and shares same in between all stakeholders throughout the entire

container journey. This enhances collaboration and coordination within supply chain where enhance visibility aggregated over time enables actors to improve their processes, resulting in the reduction of transport lead time and costs (Becha et al., 2020).

METHODOLOGY

This study followed the qualitative approach and case study strategy selecting leading apparel industry's one of the largest manufacturer and exporter in Sri Lanka. In depth interviews were conducted focused on shipping and cargo operations to explore comprehensive knowledge by the study. Six prudential expertise selected based on purposive sampling method that represents selected context direct supply chain operations internally and externally and conducted interviews using unstructured open questions. The participants were directly involved to handle apparel sector sea freight cargo and they are well experienced in the industry with more than 10 years of experience and they deal with the selected apparel manufacture's sea freight cargo covering largest container handling port terminal, transport service provider for all imports and exports of sea containers, largest container volume handling freight forwarder, largest sea imports generating supplier, largest export volume ordering buyer and central logistics division top management covering internal aspects. The transcripts were organized with the NVivo software and conducted a thematic analysis for exploration of influences relating to the study. The model developed using the themes emerged from the study could be tested.

ANALYSIS AND DISCUSSION

The analysis explored important influencing factors relating to the visibility of supply chain management from smart containerization through embedded technology. However, most of the influencing factors are upgraded with advanced technology and many of the organizations are currently practicing in the global arena that was exemplified by respondent 3 (R3). *“To be faster in the industry smart containers will support from their real time visibility and being speed to market concept facilitators apparel manufactures can reduce lead time from smart containers.”*

The salient influencing factors emerged out of the study are technological innovations, compatibility towards demand, tracking and

tracing, freight reliability, financial feasibility, safety and security and resource planning ability.

Table 1: Cross Case Analysis

| Variables | Main Themes | Sub Themes | References |
|-------------------------|-------------------------------|---|---|
| Smart containerization | Technological Innovations | GPS, RFID, Scanners, IoT, E-seals | R1, R2, R3, R4, R5 and R6 Becha (2017); Becha et al. (2020); Fruth and Teuteberg (2017); Giermanski (2016) |
| | Compatibility towards demand | Accurate information, track and trace, more security and visibility to avoid risk | R5 and R6 Fazi et al. (2015); Fruth and Teuteberg (2017) |
| Supply Chain Visibility | Tracking and tracing | Live and real time location sharing | R1 and R2 Becha (2017); Carn (2011) |
| | Freight reliability assurance | Assurance of worthiness for the freight pay Quality and reliable data Advance updates for risk mitigation | R4 Scholliers et al. (2016) and Yanjie et al. (2011) |
| | Security and safety | Security breach alerts Security standards | R1 and R3 Becha (2017); Becha et al. (2020); Scholliers et al. (2016); Yanjie et al. (2011) |
| | Financial viability | Avoidance of additional cost generation due to problems Cost efficiency for what customer pay (freight) | R1, R2, R4, R5 and R6 Becha (2017); Nanayakkara (2022); Scholliers et al. (2016) |
| | Resource flexibility | Effective management of resources with advance visibility | R1, R3 and R5 Friday et al. (2021) |

Technological Innovations

“*Technological innovations*” embedded to smart containers were signified by the literature findings, some of the technologies are GPS, RFID, IoT, scanners, E-seals (Becha, 2017; Becha et al., 2020; Fruth & Teuteberg, 2017; Giermanski, 2016). All the respondents highlighted the fact of these innovations that emerged through the latest technology and highlighted those features contributed to the developments compared to the traditional and smart sea containers. All the respondents highlighted the importance and involvement of technology in smart containerization. Out of that the Respondent 4 (R4) stated that “*GPS, RFID and other technological elements are fitted to smart containers where easily traceable. Through these technological additions many added advantages and features are there which*

a great technological innovation.” There was a high impact to the business of apparel industry by the freight reliability in Sri Lanka and the technology upgrading helped in many ways to overcome those hindrances leading to have more orders with the reliable supplies. Apart from that there was an improvement in the operational performance and inventory controls.

Compatibility towards Demand

Smart container concept developed through identified need over the traditional container as supply chain demands for accurate information, track and trace, more security and visibility to avoid risk and complexities within world supply chain practices as literature indicates latest global trade movement of large quantities of goods with container supply chains and that demands smart and quick planning to improve performances and flexibility of the transport according to Fazi et al. (2015) where the innovation of Smart container offers an end to end visibility of shipment execution (Fruth & Teuteberg , 2017).

Respondent 5 (R5) stated *“to be faster in the industry smart containers will support from their real time visibility and systems can be linked to track and pass information about your cargo lively to be compatible with latest demand.”*

The respondent 6 (R6) affirmatively elaborates the necessity to onboard same due to the compatibility it provides through technology for apparel sector:

“Directly smart containers increase supply chain visibility. Last 5 years Sri Lankan logistics industry mainly going towards visibility enhancement and smart containers will support for that. Authorities should push Sri Lankan logistics industry to adopt smart containers especially for high value cargo like garments by initiating the same to reap the benefits”.

Tracking and Tracing

The majority of the respondents expressed about live location sharing ability of smart containerization through GPS and RFID devices as an added advantage to capture cargo real time location. That enhances the ability to track and trace relevant sea cargo in the container and its live location. This was analyzed and proved by Becha (2017) and Carn (2011) as well where

they affirmatively said the advanced technological devices embedded to smart container can track entire route and voyage of the container. GPS monitor the entire journey of a smart container as Carn (2011) elaborates same through multiple images which track down sample containers.

It was signified by the majority of respondents “Tracking and Tracing” facility through advanced technology of smart containers facilitates more visibility to monitor cargo location. Respondent 1 (R1) explained his views as follows:

“Smart containerization means an easier tracking system of your sea cargo. Anyone can track cargo location, voyage, transit points, loading/ unloading status at any time remotely and more visibility is there.”

And respondent 3 (R3) amalgamated the special advantage which smart container has through track and traceability saying, *“Smart containers share the location with live updates and if any deviations or delays other than the agreed route or voyage it even can indicate the risk in advance for supply chain teams by sharing information transparently.”* For a visible supply chain, track and traceability of cargo and movements is a mandatory requirement and smart containers are originally embedded with a cutting-edge technology to satisfy same.

Freight Reliability Assurance

“For sea cargo move within smart containers gets more reliability for the freight they paid” said by respondent 4 (R4) and that justifies the freight reliability through value additions as real time data and delivery reliability with more security caters from smart container facilities. Smart containers are equipped with a special sensor system and that system can share the total information of cargo as explained by Yanjie et al. (2011) even the respondents highlight advance sensor driven technology embedded to smart containers automatically share very lucrative advantages as it transfers container’s environment condition as temperature, humidity, shock status etc. then and there for interesting teams whom can identify and monitor whether cargo is in good condition and if inappropriate condition, they receive an advance indication through these data accurately. Based on that, supply chain professionals can take necessary actions in advance if they need to take risk mitigations and precautions for deviations to maintain the quality of cargo

lead time and status etc. Respondent 4 (R4) articulates this as follows:

“Smart containers are evolving frequently with world demands and standards. Therefore, it caters real time information accurately to supply chains and deliver more reliability and quality for their sea cargo.”

Therefore, sensor driven technology support supply chains to know whether committed controllable facilities being catered to the container with the freight reliability while voyaging and if any deviations they can pay more attention too. Accuracy of information is there for special cargo and especially it will enhance quality and reliability of supply chain. This elaborates by Scholliers et al. (2016) that embedded sensors to smart containers capture shock movement, temperature, door open/close status & vibration which provides more visibility to maintain the quality and standards of the supply chain.

Security and Safety

Respondents 1(R1) and 3(R3) expressed advantages in smart containers as sending alerts through e-mails or short messages about security breaches, special actions or changes in the container as door open/close status etc., which shares continuous information flow about sea cargo. Also, Becha et al. (2020) articulated the security breach alerts which smart container sends and other notifications with advanced IoT technology. Even the majority of participants indicate smart containers can construct an alert facility towards any registered user from cargo planner to cargo expecting buyer by allowing access for same alerts. Also, more than 75% respondents signify 24 x7 online data and updates of smart containers paved path for the supply chain to obtain information remotely and in real time. And they explained frequently these data platforms will be updated and through online web pages, links, platforms relevant cargo location, status, port, route everything will be visible. Becha (2017) and Yanjie et al. (2011) also presented how smart containers equipped with cutting edge technology which provides real time data for the supply chain teams. *“Sea cargo moves within smart containers are more visible for its supplier or consignee and there is no space of cargo pilferage, damage or missing due to advance visibility”* expressed by R1 and R3 further articulates high end cutting-edge technology of smart containers to secure cargo as *“There are E-seals which embedded with digital records and security alarm systems for smart containers that can be added and some containers even*

have live footages broadcasting the snapshots of inside the container in every minute.”

Secured smart containers incorporated with container E- seals and Container security devices (CSDs) amalgamate cargo end receiver's expectations with security standards to enhance safety for sea cargo (Scholliers et al., 2016). This accommodates safety and security of sea cargo moves within smart containers.

Financial Viability

Balance questionnaires are focused on supply chain problems and coding analysis which has identified main problems through themes within a supply chain related to sea freight cargo where majority of answers summarize problems as less visibility, lack of proper planning and lack of options due to the last-minute arrangements and demands of sea freight leads the business for unnecessary cost generated as demurrage, air freight, re-work cost, line idling cost etc.

R1 and R2 pointed out the lack of visibility with resistance to change as a common issue. This further elaborates through the verbatim given by the respondents as from pick up to delivery of a container, tracking is a challenge, lack of planning also a challenge due to less visibility because incidental issues, changes as port rotations, transit port connected delays, other delays are not visible timely. *“Especially in transport 19% vehicle running time and 81% is idle time as less proper planning when handling transportation in Sri Lanka.”* R2 expressed and therefore if more visibility occurs with data availability this additional cost can be managed. Becha (2017) highlights “cost efficiency” as a main indicator of smart containers while acting as the missing link in digitalization of supply chain. It was evident that while overseeing sea freight cargo due to these top challenges highlighted by respondents which occur based on lack of visibility and information gaps as a common challenge; apparel supply chain incurs additional costs. Respondent 6 (R6) has given an explanation.

“Optimal cost is also a requirement in supply chain for sea freight arrangements, smart container is the best solution to avoid unnecessary cost as air freight of garments or line idling etc.”

Different goods set different demands according to Scholliers et al.

(2016) and for the orders based on optimal cost with agreed lead times smart container is the best to follow as R4 clarifies.

“More financial efficiency and viability will be catered through smart containers by avoiding demurrage, detention, loading and unloading delays, prevent garment air freight and line idling as advance visibility is being given to handling parties”. The findings prove financial viability through smart containers as R5 also declares:

“Unnecessary cost avoidance can be major solutions for these multiple issues as demurrage, additional transport cost, minimizes last minute air freight cost due to sea cargo delays which can be prevented through smart container technology.”

Nanayakkara (2022) describes the importance of Smart containerization and Information Technology for supply chain resilience to avoid failures of smooth distribution process where any shortcomings will generate additional costs. This reduces transaction costs as information access and sharing is more accurate and on time for the apparel sector as the majority of cargo moves through sea freight.

Resource Flexibility

The knowledge about smart containers and how it can be supported to overcome current problems in supply chain was exemplified by the respondent 1(R1) as follows:

“Through Smart containers anyone can drill down information and it enhance visibility by sharing advance updates with real time data and manage resources effectively.”

Friday et al. (2021) also elaborated stock out issues avoidance which supply chains can perform through smart containerization and advance technology. However, respondent 3 (R3) describes facilities of smart containers as *“elements of smart containers connect with supply chain visibility confirmed by the current practitioners, therefore risk mitigation and advance awareness, accurate information creating space for advance inventory scheduling, waste management by minimize stock outs, back up plans etc. can be delivered to achieve supply chain excellence through best practices.”*

Therefore 85% respondents affirmatively said smart containers can provide more visibility to supply chains. Final findings articulate the business problem through interview questions whether smart containerization can solve apparel sector issues they face while handling sea freight cargo and there is a significant positive impact towards smart containerization from respondents saying they are confident to use smart containers to solve existing sea freight supply chain issues as it enhance ability of advance resource requirements and respondents prefer to handle apparel sector sea cargo through smart containers instead of the traditional sea container which was proven as most preferable. Respondent 5 (R5) expressed *“we can attract more orders to Sri Lanka, if we rectify lead time delays through smart containers by identifying stagnating pain points while in transit.”*

The selected company as a leading manufacturer and apparel exporter all respondents strongly recommended for the logistics management team of same to get onboard the smart containerization concept to handle all the sea cargo shipments they have. There can be an additional cost for smart containers added to freight, but it was proven to be cheaper avoiding insufficient information and high monitoring cost, preventions of line idling and lack of visibility issues, garment air freight costs when delays occurred. Also, the aforesaid positive influencing factors which smart containers create towards supply chain visibility can pave the path for a resilience supply chain as explained by Friday et al. (2021) by mitigating stock out risks and maintaining optimal cost. As R5 advice *“company should onboard smart container facility segment wise for most critical shipments and initially they can demand forwarders to provide GPS and online platform access only for a small cost and after monitoring the benefits they can go for full scale developments.”*

Study findings led to develop following model which would be convenient to the apparel industries for their future planning of the sea cargo movements through smart containerization to achieve supply chain resilience and excellence with enhanced supply chain visibility.

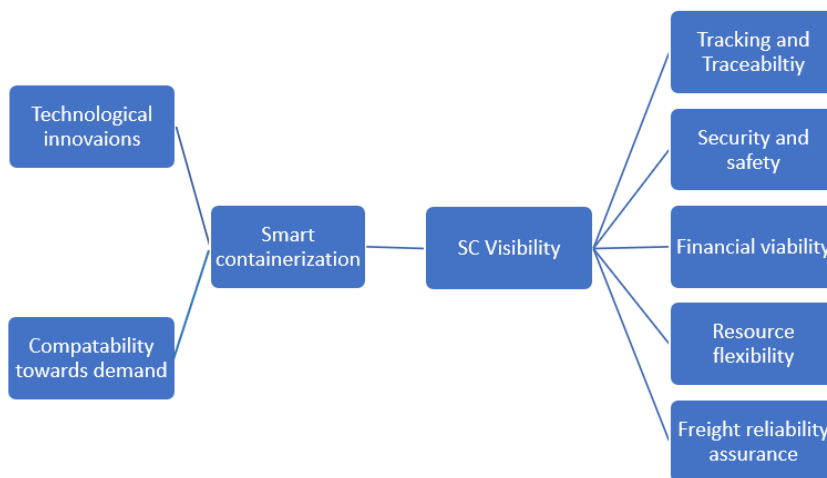


Figure 2: A Model of Smart Containerization influencing Factors towards Supply Chain Visibility (Source: Authors Developed)

CONCLUSION

Supply chain and Logistics industry becoming competitive day by day with globalization and that globalization of supply chains make its’ management and control more difficult (Saber et al., 2018). Hence, current business models of the leading apparel manufacturers and exporters also become competitive in their overall performance to maintain an end-to-end connected agile supply chain process to serve increasing demand of international apparel brands they cater. The apparel trade demands a faster lead time, high quality, and productivity along with proactive measures to serve speed to market concept to cater latest trends as E-shopping. And a highly interconnected, strong supply chain which has advanced visibility, is essential to cater to the global demand of apparel buyers. Further, it was visible especially during the Covid-19 pandemic how unstable the world supply chain and logistics industry can become if the visibility and connectivity breaks (Meester & Ooijens, 2020; Reinsch et al., 2021). Perry and Towers (2013) confirms about fashion industry that trusts and believes in cooperation between supply chain partners create strong collaborative networks which leverage the capabilities of the whole supply chain and lead to competitive advantage, by facilitating information sharing required to maximize agility in volatile markets like fashion industry. Therefore, the

necessity for advance supply chain visibility for fashion industry is certain.

The study explored imperative influences under the two themes of smart containerization and supply chain visibility such as technological innovation, track and trace, financial viabilities, safety and security, resources flexibilities, freight reliability assurance that have significantly contributed for an exponential development to the apparel industry. The important influence of technological innovations led by RFID, GPS, advance sensors enabling the system for tracking and tracing and that influenced on smooth planning of inbound and outbound logistic process of the apparel industry. The overall compatibility of smart containerization is not only for the faster, safer delivery of the cargo but also influences business development on receiving new orders from many customers as a result of reliable supply of goods to the customer which exposed by the respondent's connotations. Also "Smart containerization" concept enhances the current level of digitalization which has been closely demanded by stakeholders in the supply chain for the Port developments (Seo et al., 2022). Hence this study articulates a brand-new model in between smart containerization as a determinant for supply chain visibility to satisfy the grueling endeavor and liability of newness towards current supply chain necessities towards resilience.

Future Research Directions

The findings of the study were explored following qualitative research approach with the intention of understanding the influence of smart containerization and supply chain visibility. Hence, the findings are required to be assessed in future studies by following quantitative approach using a larger sample which can be generalized in the same context to study actual impact of smart containers towards supply chain visibility.

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