

Real Time Visibility in a Transportation Network of a Complex Supply Chain

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Abstract— This study is novel as it expands the understanding of factors affecting real time visibility compliance. The article responds to calls for an in-depth identification of the reasons for the gap between expectations on real time visibility and successful implementations. Strong impact of subcontracting on compliance suggests availability of resources within freight forwarders network including systems for storing data on truck and trailer plate numbers, interfaces amongst subcontractors IT systems are of immense importance for achieving real time visibility Drivers' digital skills and privacy concerns have been found to be an obstacle to achieve real-time visibility. For the supply chain theory contribution is the identification of weakly penetrated so far factors affecting both data sharing and connectivity. The study should help supply chain managers to decide whether implement real time visibility platform or wait.

Keywords— *supply chain visibility, transportation visibility platform, supply chain, complexity, freight forwarders, digitization.*

1. Introduction

Supply chains are becoming more complex and the real-time visibility is increasingly viewed as essential criteria to the long-term competitiveness of the supply network [5]. Real time control in supply chain paves the way to minimize costs and increase productivity. Organizations operating in complex supply chains having real-time information available about product, customers, and order fulfilment across the supply chain can improve customer service, increase operating efficiencies and effectiveness [13], create resilience [6].

Although visibility has been discussed for years there is lack guidance to operationalize this phenomenon in complex supply chains [31]. Literature lacks compelling cases for practitioners to leverage on [16]. The term visibility itself is

misunderstood [10] and there is hardly consensus on what visibility in supply chain is.

In literature to what is understood as supply chain visibility it is attributed many benefits including improvements in supply chain performance [22], operations [3], inventory management [33], transportation [17]; reduced distribution and inventory costs [5], [4]; better responsiveness [4] and flexibility [23].

[7] presented a method and the tools to support an evaluation of the benefits related to the visibility of information regarding supply chain partners. Whilst the benefits of supply chain visibility have generally been identified, research is still scarce in terms of identifying what the critical building blocks, or antecedents, of supply chain visibility concept are [21].

High expectations on the benefits of supply chain visibility are not reflected with successfully implemented cases. One of the concerning areas of supply chain visibility is transportation shipments which might be attributed to changes in transport service providers [13].

When it comes to real time visibility on transportation shipments there is a gap in literature as existing contributions focus on track and trace solutions [27]. The research on real-time visibility platforms in the complex transport network is limited in scientific sources and discussed in what can be called grey literature [18], [19].

The goals of the research was to answer following questions:

What are the factors affecting real time visibility compliance? How do these factors affect compliance?

What factors managers should consider when making a decision regarding the implementation of the real time visibility transportation platform?

The article is organized as follows: first, it is defined understanding of real time visibility concept, secondly the resources needed to achieve the real visibility of the supply chain with support of a transportation platform are discussed, third, findings from research of the fast moving consumer goods supply chain are presented, the final section encompasses the implications for theory and recommendations for supply chain managers.

2. Literature review

For the purposes of this article, the following definition of supply chain visibility was adopted: “identity, location and status of entities transiting the supply chain, captured in timely messages about events, along with the planned and actual dates/times for these events” [10]. Supply chain visibility should not be confused with “track and trace”. Although there is no universally accepted definition of tracking and tracing in the logistics literature the term tracking can be identified as the collecting and managing the information of the present location of a product(s) or delivery item(s) whereas tracing system signifies to storing and retaining the life cycle history of the manufacturing and distribution of product(s) and its components [28].

In the light of adopted definitions, the main difference between supply chain visibility and track and trace is a matter of proactive adaptation which can be achieved with calculation of expected time of arrival.

For supply chain visibility quality of information is crucial. Quality of information is reflected by characteristics such as timeliness, accuracy, and completeness [29]. The most demanding is achieving the continuous monitoring reflected with real time visibility.

Two critical resources in the development of supply chain visibility are supply chain connectivity and information sharing [8] which reflects two groups of research on supply chain visibility: 1) related to information technology as an enabler to acquire and distribute information among SC members; 2) related to supply chain visibility is an outcome of information sharing [29].

Connectivity is related to the technological infrastructure through which information is

conveyed to supply chain partners [6]; [21] and is mainly a technology area [11].

Information sharing relates to the nature, speed, and quality of the information being conveyed to supply chain partners [6]; [21].

The utility of supply chain connectivity is dependent on the nature and quality of information shared [34]. Information sharing and connectivity may be seen as complementary resources [6].

As for real time visibility on transportation shipments which is subsegment of the supply chain visibility enabling technologies that support real-time logistics requirements include mobile communication, global positioning system (GPS), geographical information system (GIS), radio frequency identification (RFID) and embedded real-time system design and implementation technologies [26]. For continuous tracking in real time mode the main technologies used embrace satellite tags with GPS [30],[16]; GSM [14].

It is proposed to combine GPS technology with other technologies for the maximization of the efficiency of the system and the reduction of the application costs [20].

Real-time location systems are fully automated systems that continuously monitor the location of objects [28]. GPS tracking uses elements of real-time and location to provide data points for the company which it received from the satellite navigation system in the airspace [1]. GPS technology is designed to track and records the trips comprehensively [1].

Vehicle telematics systems integrate largely GPS, GIS and web-based systems, and is mainly used for trailer, tractor and container tracking [3].

Real time visibility requires integration of data from telematics systems and enterprise resource planning, transport management systems as well warehouse management systems.

As a result of incompatibilities of vendors, rules, processes, timeliness, and so forth, it is difficult to share the useful information externally, sometimes even internally. Having disparate systems makes it difficult to coordinate with partners, and differences by vendors and a lack of compatibility

of the applications that are used prevent access to valuable external data [15].

Because most systems have typically evolved over the years, often on a functional basis, various supply chain processes are disconnected [25]. Own different systems standards makes the interoperability a major concern however [31], [2].

Supply chain actors can be connected by technology such as EDI [13] FTP, API, blockchain.

Asymmetry of benefits for shippers, carriers hinders willingness of information sharing. With fear of being watched and heavy investment in telematics kit, their adoption is largely driven by the motive in keeping existing customers satisfactory, and seeking mainly economic benefits [31].

Sharing commercially sensitive information is risky [5]. Cooperation and coordination among stakeholders are fundamental for building visibility of information [9]. A low degree of collaboration complicates the goal of achieving the desired state of visibility [29], [31].

The leveraging of an internet-based platform to facilitate the exchange of information between supply chain partners has shown itself to be a powerful approach to avoid the complexities of trying to integrate IT systems across the partner organisations [5]. [4] suggest that information sharing is an activity and visibility is an outcome.

Integration platforms to enable real time tracking and synchronized logistics are discussed by [11]. Federated infrastructure is also pointed as the alternative to a single platform [12].

[24] proposed an architecture based on a common data model for an integration platform for 4PL service providers, which ideally manage the whole supply chain for their customers by interfacing with different 3PL service providers. The common data model facilitates the integration of different data types, mainly collected from web pages and through the platform, and this information is made available to stakeholders. The reported benefits include tracking of shipments in real time, and increasing the efficiency of the use of the physical infrastructure.

In the literature there is a gap in regard to a discussion on real time transportation visibility platforms per se however and publications that concern this research area include, for example [30] where integration of information from the physical layer, the transaction layer and the governance layer is discussed.

Real time transportation visibility platforms are integrators of resources from carriers, telematics systems into capabilities whereas obtain data through integration via FTP, API or EDI connection with carrier systems, direct feeds from telematics or other devices for example smartphone. They provide real-time tracking, status updates, expected time of arrival calculation, analytics and reporting. Whilst statuses can be updated in agreed time intervals, calculation of expected time of arrival is impacted by data quality and machine learning model [18], [19].

3. Methodology

The research was broken down into the following stages:

- 1) identify a supply chain where there is perceived need for real time visibility;
- 2) participate in the implementation of real time transportation visibility platform in a selected supply chain.

The analysis is carried out from the perspective of fast moving consumer goods company which is called a focal company.

The scope of a study encompasses fully outsourced primary shipments managed by control tower located in Poland within the network of 45 factories, 260 co-packers, 100 warehouses, about 280 thousands orders.

A narrative literature review was conducted in order to analyse the existing contributions on real time transportation visibility platform and identifying gaps which can be filled out with in-depth research conducted from the focal company perspective.

Primary sources for this work have been searched through the main academic databases and available web resources (e.g., Scopus, Google Scholar, and Research Gate). It have been also included online

reports on real time transportation visibility platform.

The cycle of selected supply chain research embraced diagnosis, planning, taking, evaluating actions.

As for diagnosis the method used was reason codes analysis. On the one end of the thought process on content of reason codes was feedback from stakeholders especially transport service providers and on the other end was literature review. The assumption was that application for smartphones should fill gaps in compliance understood as the number of tracked shipments divided by total number of shipments.

Emails containing reason codes have been sent to about 110 transport service providers over the period of 40 weeks. They should attribute reason code to each untracked shipment. Responses have been coded in weekly trackers wherein was the number of week, reason code number, meaning of a reason code, the number of shipments with attributed reason code, and finally percentage of shipments attributed to reason code in total number of responses/shipments. On a weekly basis the compliance per transport service provider has been discussed with internal stakeholders including teams of procurement, planning, internal customers service and external stakeholders team from real time transportation visibility platform owner. During weekly meetings, actions have been agreed and planned in order for improve compliance. The execution of planned actions and its impact on compliance has been checked in a following week. If the action was not executed, it was carried over to the next week. The impact of agreed actions on compliance was checked in the following weeks, and if no improvement has been observed the case was escalated to senior management.

Information has been coded in a weekly tracker where compliance per transport service provider was updated, actions entered and status attributed accordingly.

4. Findings

The figure number 1 shows a progress in implementation of real time visibility transportation platform measured with the indicator calculated as percentage of tracked shipments both in pick-up and delivery locations.

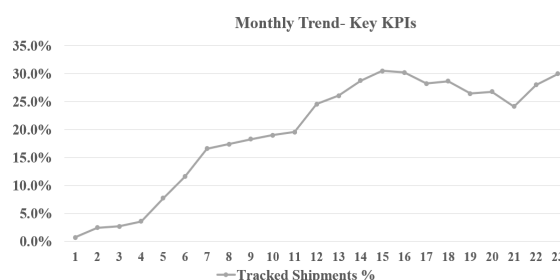


Figure 1. Percentage of tracked shipments.

Following the figure number 1 the compliance has been on the growth path until month 15 after the deployment start whereas the percentage of tracked shipments reached 30%.

Subcontracted shipments accounted for 60% of total number of shipments throughout the period under review. Per every 10 subcontracted shipments about 8 was untracked. Out of intermodal shipments which account for 7% of the total number of shipments no load has been tracked in real time over the review period.

Reasons behind not tracked shipments are: 1) drivers did not have a smartphone to use application - 35%, 2) drivers not being able to use the application for smartphones correctly - 23%, 3) technical problems within integration of IT systems - 19%, 4) drivers' phone had roaming disabled - 12%, 5) data privacy concerns to be resolved - 8%, 6) others - 3%.

The most common reason behind not tracked shipments was lack of a smartphone. Drivers were only allowed to use application with company-owned smartphones. They have either private smartphones or old fashioned phones on which installation of application was not doable.

When it comes to subcontracted shipments, for a significant part of them carriers were allocated only 1 or 2 times a year. Due to the small number of shipments, drivers showed little willingness to use the smartphone application. In addition, insufficient digital skills of drivers made downloading and operating the application too time and effort consuming. Freight forwarders pointed also to disabled roaming as a blocker to usage of application on international routes.

As a next reason behind not tracked shipment was given privacy concerns. It was claimed that usage of application is against drivers privacy and can break General Data Protection Regulation if drivers are tracked in the private time.

The risk of tracking drivers when they carry shipments of other customers and there are goods from at least two shippers inside a trailer has also raised concerns among carriers.

Within multi-level subcontracting network there are gaps in sharing information needful for use of

application with a driver. Apart from that willingness to use smartphones is low amongst drivers as it means additional effort. Since manual data entry is error prone, it affects data quality which can prevent real time tracking. Low saturation of company-owned smartphones combined with disabled roaming because of cost factor reflects low technological maturity level in this regard. The reality is that drivers would use their own, private smartphones to enable shipments for tracking if they have benefits from it however. Information sharing is impacted by hauliers privacy concerns which reflects fears of how new technology works, contractual agreements with their other customers on data access restrictions.

Problems with connectivity of systems of the focal company, real time transportation visibility platform, freight forwarders, GPS service providers, was the next reason behind untracked shipments.

Because of lack of a system for storing track and trailer plate numbers about 15% of carriers entered the truck and trailer plate numbers manually on the real time transportation visibility platform web page. The vast majority of carriers uses file transfer protocol for sending excel files to real time transportation visibility platform owner. Application interface programming was deployed by about 15% of carriers. Frequent updates of planned pick up time by focal company resulted in amendments of trucks and trailers by the transport service providers. Track and trailer plate numbers were not updated accordingly in the system both of transport service providers and focal company which was a reason behind lack of real time tracking.

From the point of view of real time transportation visibility platform owner application for smartphones should be only a complementary solution to integration of systems of involved supply chain partners. Real time transportation visibility platform owner divided carriers into two groups: onboarded (44%) and pending to be onboarded (26%) on the platform. Out of onboarded carriers the biggest issues were because of systems integration (31%), and was followed by problems with application (6%) and carriers behaviour (7%). As regards carriers pending to be onboarded lack of connectivity of a system for storing track and trailer plate numbers as well not updated data were main constraints to have shipments tracked in real time.

Regardless of adopted point of view either focal company or a real time transportation visibility platform owner the main pain point was

subcontracted shipments. Focal company was not able to enforce from its partners deployment of the resources and capabilities needful for real time tracking.

Due to the multi-level subcontracting, data needful for tracking had to be fetched either directly from the carrier system for storing track and trailer plate numbers or freight forwarder that fetched data from a haulier. Because of the highly fragmented transport market, most carriers were not connected to a network that had been built for real-time tracking, which resulted in shipments not being tracked. Subcontracted shipments accounted for 60% of total number of shipments throughout the period under review. Out of intermodal shipments which account for 7% of the total number of shipments no load has been tracked over the period of research.

Because of low compliance the accuracy of expected time of arrival amounted to 40% in the week number 23. On a top of that, expected time of arrival of high accuracy was not achieved in a repeated manner. As a result, both the low compliance and inaccurate expected time of arrival kept internal customers from using the real time transportation visibility platform.

Expected time of arrival was calculated by dividing number of loads delivered in 1 month by number of loads delivered within the time predicated at the pick-up in the range of +/- 1 hour and multiplied by 100%.

5. Conclusion

The study responds to calls on in-depth identifying what the critical building blocks, or antecedents, of supply chain visibility concept are [23] and how to bridge the gap between expectations on real time visibility and successful implementations. This work specifically fills a gap in literature contributions on supply chain visibility in regard to decline in visibility on transportation shipments [15].

Strong impact of subcontracting on compliance suggests resources available within freight forwarders network are crucial for compliance measured with percentage of tracked shipments. This research provides empirical evidence that freight forwarders network complexity of relationships acts as a constraint to supply chain visibility.

Both insufficient connectivity resources including systems for storing data on truck and trailer plate numbers, interfaces amongst IT systems but also digital skills of drivers, privacy concerns are identified as factors affecting achieving real time visibility with a platform owner.

Study results provide some useful implications for supply chain managers who face a dilemma: invest in real time transportation visibility platform or to wait. Trade-offs between usage of transport service providers with own fleet for which achieving visibility is more controllable and freight forwarders for which there are rotating carriers should be calculated with regards to both customer service and costs performance indicators. Benefits from achieving real time visibility should be clear, realistic and compensate costs difference between using transport service providers which can provide real time tracking in repeatable manner and freight forwarders of a network of highly rotating carriers.

From a managerial perspective, these findings are important for companies trying to determine how to prioritize their efforts and resources for purposes of improving visibility

In further research, it should be analysed relationships within the network of subcontractors which impacts behaviours and motivations towards enabling shipments for real time tracking.

Although the study is on the focal company from the fast moving consumer goods sector findings can be replicable for the other companies which follow a model wherein all shipments are outsourced and freight forwarders carry out a large share of shipments.

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