Dr Sławomir Wyciślak
Uniwersytet Jagielloński
ORCID: 0000-0002-8913-1634
e-mail: slawomir.wycislak@uj.edu.pl

# Real-time visibility transportation platform deployment. Evidence from business practice and insights for theory

## *Problem wdrożenia platformy transportowej zapewniającej widoczność w czasie rzeczywistym. Wnioski z badań i rekomendacje dla teorii*

*Abstract*

The aim of the study is to contribute to supply chain visibility literature by addressing a gap between the expectations on the benefits of supply chain visibility and the successfully implemented cases. Determinants of a real--time transportation visibility platform implementation were identified and explained and the reasons for not achieving the expected real-time visibility benefits from a platform in the transportation network with a predominant share of subcontracting were ranked. A complex network of fast-moving consumer goods companies was chosen for the research because of their greater need for visibility; visibility improvement is also more challenging for such companies. Asymmetry of risk, rewards, and benefits for freight forwarders and a real-time visibility platform hinder information sharing willingness. The in-depth analysis of entities involved in the platform deployment shows the tensions that platform governance can address. This study also provides insights on information utilization, including automating, informational, and transformational characteristics. This paper contributes to the supply chain visibility theoretical field by focusing on the practical development of real-time visibility from the standpoint of supply chain professionals.

*Keywords:*
supply chain visibility, transportation visibility platform, supply chain, complexity, digitization

*Streszczenie*

Celem artykułu jest wniesienie wkładu w rozwój dyskusji naukowej dotyczącej widoczności łańcucha dostaw poprzez dociekania na temat luki między oczekiwaniami dotyczącymi korzyści z widoczności łańcucha dostaw a pomyślnymi wdrożeniami. Zidentyfikowano i wyjaśniono czynniki warunkujące wdrożenie platformy widoczności transportu w czasie rzeczywistym. Uszeregowano przyczyny nieosiągnięcia oczekiwanych korzyści z widoczności w czasie rzeczywistym za pomocą platformy w sieci transportowej z przeważającym udziałem podwykonawstwa. Do badań wybrano złożoną sieć z branży produktów szybko rotujących. Uczyniono tak dlatego, że w przypadku takiej sieci istnieje większa potrzeba widoczności, a jej poprawa jest trudniejsza. Asymetria ryzyka i korzyści dla spedytorów oraz platformy zmniejszają gotowość do wymiany informacji. Dogłębna analiza zachowań podmiotów zaangażowanych we wdrażanie platformy wskazuje na napięcia, które może rozwiązać zarządzanie platformą. Przeprowadzone badania skupiają się na analizie wykorzystania informacji w kontekście automatyzacji, informatyzacji i transformacji cyfrowej. Niniejszy artykuł przyczynia się do rozwoju rozważań dotyczących widoczności w łańcuchu dostaw.

*Słowa kluczowe:*
widoczność w łańcuchu dostaw, platforma widoczności w sieci transportowej, łańcuch dostaw, złożoność, cyfryzacja

JEL: L22, L23, L66, L9

## Introduction

Supply chain complexity has been increasingly recognized as one of the critical areas of managerial concern (Dubey et al., 2020). Real-time visibility has been viewed as an essential criterion to the long-term competitiveness of the increasingly complex supply network (Bartlett et al., 2007).

Organizations operating in complex supply chains with real-time information about products, customers, and order fulfillment can improve customer service (Yang et al., 2021), responsiveness (Barratt & Oke, 2007), agility (Dubey et al., 2018; Brusset, 2016), flexibility (Prajogo & Olhager, 2012), increase operating efficiencies and effectiveness (Holcomb et al., 2011), reduce distribution and inventory costs (Barratt & Oke, 2007), reduce waiting time, create resilience (Brandon-Jones et al., 2014), (Mubarik et al., 2021; Sá et al., 2019; Dubey et al., 2018; Jain et al., 2017; Mandal et al., 2016; Christopher & Peck, 2004; Al-Talib et al., 2020) and sustainability (de Vass et al., 2020), (Brun et al., 2020; Kim & Shin, 2019), fight counterfeiting (Munuzuri et al., 2016), shrinkage of all forms including theft, damage, and delay (McKinney et al., 2015), help to detect quality issues proactively (Anitha et al., 2021). Despite many articles, research on the actual benefits of visibility is still mainly theoretical (Caridi et al., 2014).

Although real-time visibility has been discussed for years, it is hard to find guidance for operationalizing visibility in complex supply chains (Wang & Potter, 2007) compelling cases for practitioners to leverage (Leung et al., 2017). The cause-effect relationship between supply chain visibility and business performance can be ambiguous (Somapa et al., 2018). The term visibility itself is misunderstood (Francis, 2008). Little consensus is on what visibility in the supply chain means (Somapa et al., 2018). Scholars call for a better understanding of how visibility within a supply chain emerges, develops, and must be implemented to be successful (Somapa et al., 2018). One of the concerning areas of supply chain visibility is transportation shipments (Holcomb et al., 2011). A gap in the literature regarding antecedents, factors affecting real-time visibility on shipments in the network where subcontracting is in the majority persists.

Theoretical contributions regarding real-time visibility in supply chain and platform design are fragmented. They can be identified within the Internet of Things (de Vass et al., 2020; Fahim et al., 2021; Lee & Lee, 2015), track and trace (Hajdul & Kawa, 2015), (Papatheocharous & Gouvas, 2011; A. Shamsuzzoha et al., 2021), synchronized logistics (Giusti et al., 2019). The discussion on the general phenomenon of digital platforms is broad and diverse (Hein et al., 2020); however, there is a lack of clear definitions of what is meant by the terms "digital platform" and "digital ecosystem" (de Reuver et al., 2018). The next gap in the literature regards understanding the design and governance of a platform for real-time visibility in the network where subcontracting predominates.

The research objectives of the paper include:

RO1: To understand antecedents regarding deployment of a real-time transportation visibility platform.

RO2: To explain and rank reasons for not achieving real-time visibility with a platform in the transportation network.

RO3: To identify conditions under which a real--time transportation visibility platform can meet expectations and provide benefits.

Therefore main research questions encompass:

RQ1: What are the antecedents of successful deployment of real-time visibility platforms?

RQ2: What are the most critical blocking factors in achieving real-time visibility with a platform in the transportation network?

RQ3: Under what conditions should managers decide on implementing a real-time visibility platform?

The article is organized as follows: first, it is defined understanding visibility and real-time visibility and related concepts from a supply chain perspective. Secondly, it discusses antecedents of visibility in a supply chain; third, it presents digital platforms ecosystems. The following section presents the methodology, whereas the next part includes findings from the action study, in other words, a case study in the form of action research. The final part encompasses conclusions for theory and recommendations for supply chain managers.

## Literature review

### Understanding visibility, traceability, track and trace, and transparency in a supply chain

The concept of supply chain visibility has been studied by many authors including: Barratt & Oke (2007), Brandon-Jones et al. (2014), Francis (2008), Wei & Wang (2010), Tse & Tan (2012), Holcomb et al. (2011); however, conceptualized and defined differently (Caridi et al., 2010). There is still a lack of a well-defined common understanding of visibility in a supply chain and how it can be applied in practice (Leung et al., 2017).

Somapa et al. (2018) analyzed 27 articles and synthesized the key concepts of supply chain visibility from a process-based perspective, and characterized supply chain visibility by automation (the ability to access information), informational (the quality of the information), and transformational (the utilization of information) characteristics. Automational characteristics refer to capturing and transferring the necessary information on time by using ICT in diverse forms and methods. Automated information capturing is prominent in tracking products during shipment and determining the status of inventory in the pipelines. Informational characteristics are determined by the accuracy, timeliness, and completeness of the information. Real-time or near-real-time information is frequently used as a proxy for the highest quality of timeliness. Transformational characteristics are determined by the actual utilization of the exchanged information, either to improve decision-making in business processes or to increase strategic competencies.

Visibility is often used interchangeably with traceability (Roy, 2021). For example, Tse & Tan (2012) define supply chain visibility as "traceability and transparency of the supply chain process." However, visibility appears to be the superset of traceability (Roy, 2021). Supply chain traceability is the prerequisite for superior supply chain visibility. Traceability is defined as the ability to identify and trace the history, distribution, location, and application of products, parts, materials, and services (Shou et al., 2021) and operates under the logistical unit of analysis (Roy, 2021). The term "track" is added to "trace", and "track and trace" phrase is used (Pizzuti & Mirabelli, 2015; Shamsuzzoha et al., 2013; Jakobs et al., 2001; Montecchi et al., 2021; Brun et al., 2020). The term "track" can be identified as the collecting and managing the information of the present location of a product(s) or delivery item(s) (Shamsuzzoha & Helo, 2011; Shamsuzzoha et al., 2013).

Transparency in process control has emerged as an advanced traceability emphasis. It is a highly emerging area to strengthen inter-firm integration by demanding information management that enhances the extent to which the information is readily available to supply chain partners and in real-time. Transparency is defined as the disclosure of information (Nilsson et al., 2019). Therefore, transparency can expand visibility and traceability boundaries by highlighting newer information acquisition areas via technological integration in supply chain processes (Roy, 2021).

The notions of traceability and visibility operate in a highly abstract space, and non-qualitative approaches can only capture peripheries by answering straightforward questions such as when does it pay with traceability/visibility or what advantages can traceability/visibility ensue (Roy, 2021).

In the light of discussed terminological nuances and interpretations, the real-time visibility in a supply chain is understood in this paper as the ability to receive information automatically in requested time intervals completely and accurately to use information retrospectively and proactively in decision-making.

## Antecedents of visibility in a supply chain

**Connectivity.** Real-time visibility is perceived as the capability (Wei & Wang, 2007) which is information-based (Barratt & Oke, 2007) generated from bundling technological and non-technological resources. Two critical resources in the development of supply chain visibility are supply chain connectivity and information sharing (Dubey et al., 2018). Connectivity relates to the technological infrastructure through which information is conveyed to supply chain partners, and information sharing links to the quality of the information being shared (Brandon-Jones et al., 2014; Nguyen et al., 2019). Technology may provide a medium for supply chain visibility, but it does not mean that information is shared because the use of the supply chain connectivity depends on the existence and quality of popular data (Anitha et al., 2021).

Enabling technologies that support real-time visibility include Global System for Mobile Communications (Kandel et al., 2011), a global positioning system (GPS) (Wang & Potter, 2007; A. H. M. Shamsuzzoha et al., 2013; Kandel et al., 2011; Klumpp & Kandel, 2011), geographical information system (GIS), radio frequency identification (RFID) and embedded real-time system design and implementation technologies (Wang & Potter, 2007). The maritime sector uses the Automatic Identification System (AIS), which automatically provides information about a ship's identity, type, position, course, speed, and navigational status. This information can then be used to enable improved tracking within the supply chain and to predict the ETAs of shipments (Anitha et al., 2021). Smart sensors, such as temperature, impact, and humidity sensors, are used to detect changes in the environment and the condition of goods (Anitha et al., 2021).

Smartphones provide integrated communication and processing features as integrated sensors, such as digital compasses, accelerometers, gyroscopes, and GPS systems. Functions including Quick Response (QR) code reading, real-time GPS monitoring, automatic reply warnings, and a multiple-level data access control can be made available from these sensors (Anitha et al., 2021). All technologies enabling visibility should be combined to maximize efficiency and reduce costs (Mintsis et al., 2004). Often the two RFID and GPS technologies are used by different parties as separate entities with their own features and purposes. If both technologies can be combined to become one integrated system to track and trace goods in the supply chain, greater gains can be achieved. In particular, GPS mapping systems, when linked to enterprise resource planning, could facilitate inbound and outbound logistic scheduling (He et al., 2009).

Automated information transfer includes connectivities such as EDI (Electronic Data Interchange), APIs (Application Programming Interfaces), FTP (file transfer protocol) (Giusti et al., 2019; Somapa et al., 2018; Holcomb et al., 2011). Own different systems standards make interoperability a significant concern (Wang & Potter, 2007). In many cases, current I&CTs supporting the various activities of the supply network process are diverse and disconnected because they have typically evolved throughout the years based on local — often functional — and companywide requirements that were rarely integrated (Romano, 2003).

The utility of supply chain connectivity is dependent on the nature and quality of information, and information sharing and connectivity may be seen as complementary resources (Brandon-Jones et al., 2014). For the successful development of visibility within the supply chain network, connectivity is a prerequisite for sharing information (Anitha et al., 2021).

**Information sharing.** The value of information-sharing can be defined as the benefits derived from sharing information minus the associated costs (Kaipia & Hartiala, 2006). Information integration refers to sharing information and knowledge among the supply chain members (Mujuni Katunzi, 2011). The focus of visibility development should be on sharing information that can be used to improve performance. The shared data should enable the best business decisions to be made on the basis of the best available information (Kaipia & Hartiala, 2006). Information integration refers to the sharing of information and knowledge among the members of the supply chain. Building good communication and trust are essential for information sharing information (Prajogo & Olhager, 2012). Cooperation and coordination among stakeholders are fundamental for sharing information (Dubey et al., 2020; Wang & Potter, 2007).

However, asymmetry of risk, rewards, and benefits for shippers, carriers hinder information sharing willingness (Wang & Potter, 2007). Silo mentality, lack of time, lack of rewarding systems, lack of trust, lack of knowledge, and increased levels of work are the primary concerns when sharing information (Somapa et al., 2018; Mujuni Katunzi, 2011; Kaipia & Hartiala, 2006). Usually, the organizations distrust their supplier, primarily on information sharing (Pradhan & Routroy, 2018). What is more, sharing commercially sensitive information is perceived as risky (Bartlett et al., 2007).

A problem of trust that hinders information sharing can be addressed by blockchain. A blockchain can certify information sharing across a network of different entities, even when two parties never met and do not trust each other, and without the need for a trusted middle or central entity. For this reason, blockchains are credited to be able to create trust and greater collaboration among potential partners that may be far away from each other (Astarita et al., 2019).

## Visibility in a supply chain in the context of the platform

Real-time visibility requires integrating data from telematics systems and enterprise resource planning, transport management systems, and warehouse management systems. As a result of incompatibilities of vendors, rules, processes, timeliness, and so forth, it is challenging to share helpful information externally, sometimes even internally (Lee & Rim, 2016). Having disparate systems makes it challenging 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.

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 integrating IT systems across the partner organizations (Schreieck et al., 2017).

Digital platforms utilize an ecosystem of autonomous agents to co-create value (Hein et al., 2020). The term platform ecosystem refers to the platform and all stakeholders interacting on the platform. (Schreieck et al., 2017). A digital platform ecosystem comprises a platform owner that implements governance to facilitate value-creating mechanisms on a digital platform between the platform owner and an ecosystem of autonomous complementors and consumers (Hein et al., 2020). Three aspects can characterize platform organizations: (1) they coordinate actors who can both compete and innovate, (2) make use of economies of scope in both supply and/or demand, and (3) consist of modular technological architecture with a core and peripheral components. As for supply chain platforms, interfaces are selectively open; interface specification is shared exclusively across the supply chain, the coordination mechanism should be between supply chain member organizations (Gawer, 2014).

Digital industrial platforms are platforms as (1) collect and integrate data from a heterogeneous set of industrial assets and devices, (2) provide this data and additional technical support to an ecosystem of third-party organizations who develop and enable complementary solutions that (3) affect the operation of industrial assets and devices, and (4) provide a marketplace to facilitate interactions between platform owner, third-parties and business customers (Pauli et al., 2021).

Depending on the ownership status of platforms, the platform owners establish governance mechanisms that define the ground rules for orchestrating interactions in the ecosystems (Hein et al., 2020). These platforms need tools to orchestrate the interactions between the different sides involved, so-called platform governance mechanisms (Schreieck et al., 2017). This emergent form of digital platforms in the business-to-business (B2B) context requires a profound holistic perspective encompassing the co-evolution of platform architecture, platform services, and platform governance (Jovanovic et al., 2021).

The likelihood of competition amongst platforms constitutive agents is higher when innovative agents are more autonomous (Gawer, 2014). Mini & Widjaja (2019) identify 21 tensions that are relevant when platform owners want to manage their digital platform business model.

Out of theoretical concepts on digital platforms, the multi-sided (de Reuver et al., 2018) digital industry (Pauli et al., 2021) supply chain platform with contractual relationships is a model following which real-time visibility platforms can be classified.

## Methodology

### Background

Understanding of factors affecting the deployment of a real-time visibility platform in the transportation network represents uncharted territory. There is still an insufficient understanding of the reasons behind a gap between expectations on real-time visibility and successfully implemented cases. As a result, the author adopted the action research case study approach, which is in line with the postulates regarding the implementation of action research (Näslund, 2002) ). A complex network was chosen for research because there is a greater need for visibility, and visibility improvement is also more challenging.

The author was a Logistics Research and Development center team member in the European Control Tower of the fast-moving consumer goods company. The company is part of a multi-national group. Its role was to support researching, designing, and executing digitalization projects. The first area which should unlock opportunities in the transportation network of a supply chain was achieving real-time visibility. The real-time visibility platform deployment scope encompassed the transportation network of 45 own factories and 260 co-packers, 60 warehouses from which Logistics Service Providers managed the vast majority. Yearly the number of full truckloads amounted to 260 thousands whereas the number of companies provided transport services accounted for 110.

Logistics Control Tower acts as a focal company and coordinator from the point of view of material and information flows. The role of an integrator of data necessary to achieve real-time visibility belongs to a real-time transportation visibility platform. From the perspective of a platform design, a focal company is a customer, whereas transport service providers, GPS providers, IT providers are complementors.

The research program was divided into three parts. The first phase was devoted to understanding antecedents of a real-time visibility platform deployment. The second phase, the case research, is based on a research project to deploy a real-time transportation visibility platform. The cycle of research in the second phase encompassed diagnosis, planning, taking, and evaluating action. The literature study concerning real-time visibility platforms, real-time visibility, and supply chain visibility was carried out in parallel with the first and second phases. The literature review is organized into three sections. The first one presents a review of scientific contributions to understanding visibility in a supply chain and its part of a transportation network, its benefits, and antecedents. The second one discusses papers on factors affecting achieving visibility in a supply chain. Finally, the third section describes digital platform papers as such and related to the supply chain.

### Information collection and coding

The data for this study came primarily from a few sources: business and technical documents, reason codes form, transport management system, real-time transportation visibility platform, and observations. Process maps and flows are in technical documents. Trackers show progress on digitization projects. One-pagers and presentations prepared for governance meetings encompass synthesis of "as-is" situation and next steps recommendations for senior management.

Reason codes form was a tool to gather information from transport service providers on reasons behind not tracked shipments. The idea of reason codes is to simplify data collection by giving interviewees a limited choice of responses. More importantly, reason codes facilitate internal communication and reporting to ensure repeatability and reproducibility. A brainstorming session with onboarding team members helped to create the reason codes. The procurement team provided its input to ensure consistency of reason codes. The email containing reason codes has been sent to about 110 transport service providers weekly over 40 weeks (between months 13 and 23). An effective response rate was nearly 35%. Transport service providers should attribute a reason code to each untracked shipment and had the option to add comments. The author coded responses in weekly trackers wherein the number of weeks, reason code number, the meaning of a reason code, the number of shipments with attributed reason code, conclusions from transport service providers comments, and the number of shipments ID with attributed reason code divided the total number of shipments.

Every week, the compliance per transport service provider has been discussed with internal stakeholders, including procurement, transport planning, internal customers service, and external stakeholders, i.e., the real-time visibility platform team. During weekly meetings, actions have been agreed and planned to improve compliance. The onboarding team has been checking the execution of planned activities and their impact on compliance the following week. If the responsible entity did not execute the action, the onboarding team carried it over to the next week. The effect of agreed actions on compliance has been checked in the following weeks. If no improvement in terms of compliance has been observed, the onboarding team escalated the case to senior management. The control tower should decide whether to take further actions, including decisions on the business reduction or termination against transport service providers that did not improve compliance. If the activities from the director of the control tower did not provide any improvement transport service provider has been still considered in a weekly tracker, and its progress has been still monitored. The researcher coded information in a weekly tracker where compliance per transport service provider was updated, transport service providers attributed to one of three groups — "freight forwarders," "asset-based," "mixed"; actions entered and statuses including "completed," "in progress," "on hold," "escalated" attributed accordingly as per transport service provider. Under "freight forwarders" was understood transport service provider with 100% of subcontracted shipments whereas "mixed" status meant transport service provider of both subcontracted shipments and shipments executed on own fleet, "asset-based" status was attributed to transport service providers with only own fleet. The author coded information from participatory and non-participatory observations in weekly trackers where the roles of involved persons are available in the first column. The number of weeks is present in the consecutive columns. Participatory and non-participatory observations encompassed experiencing, which involves seeing, hearing, remembering, imaging.

Data from the transport management system including parameters shipment ID, A lane ID, source location name, source location vendor Id, destination location name, destination location vendor ID, carrier name, carrier ID, destination city, carrier ID, carrier name, GPS carrier, category, cancellation, week number, source city, and destination city and mode of transport was extracted to calculate compliance.

Data regarding expected time of arrival per transport service provider, pick-up, and destination cities was extracted from the real-time transportation visibility platform.

## Data and information analysis

As the first step, senior management accepted KPIs as-is performance. The compliance was measured by the number of tracked loads (both in the pick-up and delivery locations) divided by the total number of loads. The other crucial KPI was regarding the expected time of arrival accuracy. The latter indicator was calculated by dividing the number of loads delivered within the time predicated at the pick-up in the range of +/– 1 hour by the number of loads delivered and multiplied by 100%. The expected time of arrival of high accuracy was assumed if the result of the calculation was equal to or greater than 80%. Data on the expected time of arrival calculated at the pick-up location was compared to the planned arrival time data extracted from the transportation management system of a focal company.

In the second step, senior management accepted the performance gap identification. The performance gap is the difference between the current performance level and the target. More importantly, the steering committee decided on the identification of the causes of the gap. Responses of transport service providers should explain the performance gap, and reason codes analysis was, respectively, categorized by a transport service provider and A-lane. To identify causes behind a gap performance on the accuracy of the expected arrival time, tracking consistency and geofence zone accuracy should explain. Tracking consistency was divided into three categories: high, medium, and low quality, for which criteria were the frequency of received pings which the real-time visibility platform should receive every 15 minutes by default. The number of received pings was divided by the number of theoretical pings which should be received during a trip. If the KPI was over 80%, tracking consistency was classified as of high quality. If in the range between 60–80% and 40–60%, tracking, respectively, was ranked as of medium and low quality.

Authors' reflection of content, process, and premises drove the synthesis of information collected in trackers. Interpretation of information should answer the following questions: 1) What do we get? 2) Why do we do what we do? 3) How do we decide what is right? Is this the best solution? What haven't we thought of?

Experiencing as a part of the research was because of participatory and non-participatory observations with which the author was involved and embraced seeing, hearing, remembering, imaging. The author combined inductive and deductive methods composing an abductive approach (Kovács & Spens, 2005). As recommended by Yin (2018), case studies are valuable in the first stages of theory development, primarily when they are aimed at examining phenomena with a bit of or theoretical background.

## Literature search

The author conducted a narrative literature review to describe and critically evaluate a body of work regarding the real-time visibility transportation platform. The criteria to choose database was open-access. Selected databases encompassed scholar.google.com, iEEEXplore, Arxiv, ScienceDirect. Google Scholar is a mighty open-access database that archives journal articles and "gray literature," including conference proceedings, thesis, and reports. (Norris et al., 2008) compared Google and Google Scholar to other open-access search engines. They found that Google and Google Scholar performed the best. These two sources combined could discover more than three-quarters of open access publications identified in their study. The assumption was also to use researchgate.net and academia.edu to contact authors when papers are not available in the open-access.

Research questions were the drivers for the selection of keywords. The author started the literature search using the keywords "real-time transportation visibility platform" and "transportation visibility platform." The outcomes of the research suggested no contributions regarding searched keywords in the chosen databases. As a result, the author used the Google database to find any indications on selected keywords. The outcome from Google suggested 4,150 records. After checking pages with results, it turned out that only eight of them were available, which translated into 73 results. Screening the results suggested reports from research company Gartner were the only sources encompassing real-time visibility transportation platforms per se apart from blogs and web pages of real-time visibility providers.

As searched terms were too narrow, keywords encompassing more general keywords combined with the word "platform" constituted the next literature search phase (Table 1).

The number of found records showed substantial variations per keyword, with the predominance of the results found for the searched term "supply chain visibility." In the case of google.scholar.com, the author decided to review the ten first pages of found results. The number of found records as per the "supply chain visibility" keyword suggested narrowing searched terms.

Refined keywords were "transport track and trace," "logistics track and trace," "supply chain track and trace," "logistics Internet of Things," "supply chain Internet of Things," supply chain "track and trace," transport "track and trace," platform "track and trace," "Internet of Things platform," "track and trace platform" and combinations of these terms (Table 2).

The author also used more open searched terms without quotes as per Table 3. Reviewing a maximum of ten first pages of the found results was the applied rule.

After the initial screening of the titles, a total of 117 studies were identified. The author read the abstracts of them to decide their relevance to the research topics further. A total of 80 studies were deemed relevant. The author skimmed through the full-text articles to further evaluate the quality and eligibility of the studies. After review, a total of nineteen studies were excluded. Four were excluded because they lacked clear guidance on methodology; nine studies were excluded because they were too general, out of a topic, reviewed a specific topic, the author could not find the full text for six articles. The latter is although the author wrote the messages to authors of papers via researchgate.net and academia.edu platforms. Overall, sixty-one studies

Table 1
The number of found records in databases with the second step of literature search

| Database | Keywords | | | |
|---|---|---|---|---|
| | Transportation visibility | Supply chain visibility | Transportation platform | Supply chain platform |
| Scholar.google.com | 184 | 8 720 | 1 500 | 838 |
| iEEEXplore | 2 | 57 | 28 | 9 |
| Arxiv | 0 | 2 | 5 | 1 |
| ScienceDirect | 6 | 478 | 131 | 76 |

Source: own study.

Table 2
The number of found records in databases with the third step of literature search

| Database | Keywords | | | | | | |
|---|---|---|---|---|---|---|---|
| | Transport track and trace | Logistics track and trace | Supply chain track and trace | Logistics Internet of Things | Supply chain Internet of Things | Internet of Things platform | Track and trace platform |
| Scholar.google.com | 14 | 35 | 87 | 264 | 183 | 3 620 | 27 |
| iEEEXplore | 94 | 81 | 138 | 787 | 783 | 7 629 | 176 |
| Arxiv | 18 | 24 | 5 | 24 | 30 | 373 | 18 |
| ScienceDirect | 0 | 1 | 5 | 5 | 13 | 147 | 1 |

Source: own study.

Table 3
The number of found records in databases with the fourth step of literature search

| Database | Keywords | | | | |
|---|---|---|---|---|---|
| | Supply chain "track and trace" | Transport "track and trace" | Platform "track and trace" | Supply chain platform | Freight forwarders transport platform |
| Scholar.google.com | 11 200 | 9 630 | 7 310 | 127 000 | 14 700 |
| iEEEXplore | 36 | 94 | 176 | 983 | 1 |
| Arxiv | 0 | 18 | 18 | 40 | 0 |
| ScienceDirect | 883 | 792 | 1 | 77 009 | 1 918 |

Source: own study.

Table 4
The number of the reviewed papers as for used methodology

| The type of thereviewed papers | The number of the reviewed papers |
|---|---|
| Case study | 33 |
| Conceptual model | 13 |
| Literature review | 9 |
| Mathematical model | 3 |
| Simulation model | 1 |
| Protype | 2 |

Source: own study.

from the initial search were included in the next stage of text analysis. The difference between the number of studies in the bibliography, which accounts for 67, is because of including papers on methodological matters.

Case study methodology plays the predominant role in the included papers and is followed by conceptual studies (Table 4).

As supply chain visibility is a developing field, the research using case studies is in the majority.

## Findings

### Antecedents

The global IT procurement team from Bangalore, which conceptualized the global solution for real-time visibility, chose a supplier of a real-time visibility platform also for the focal company European transportation network. Although real-time visibility should be an enabler of the digitalization of supply chain operations deploying real-time visibility on shipments was assumed to deliver measurable benefits.

The transportation visibility platform's deployment goals were to improve internal customer service and reduce waste like demurrages by understanding where the shipment is. The single version of data should reduce workload amongst all stakeholders involved in tracking and tracing shipments by sending emails and making phone calls. Transport planners from the European Control Tower received 200 emails and 50 calls a day on average asking where the truck with a shipment is, whereas 1.5 hours was the average time to find out from transport service providers where a truck with a load is. Accurate delivery and on-time collection data should also be indicated during transportation tenders and help resolve tensions among involved stakeholders, including demurrage calculations. The calculation of demurrages thanks to real-time updates on the on-time delivery and on-time collection should be automated. For factories, notifications on the entry geofence zone should help to manage deliveries and avoid production blockages.

Thanks to the updated expected time of arrival, teams responsible for loading and unloading can manage their time more efficiently. Updated expected time of arrival should also enable automation of slots and dock booking management which consumes the time of customer service specialists. In the "to-be" processes changing time slots should be automated and based on the expected arrival time (Table 5).

The steering committee encompasses European Supply Chain Vice president, Logistics Director Primary & Inbound Europe and Control Tower Director, Procurement Director Manufacturing Partners, Logistics and Capex, IT Director Make & Deliver. They set an ambitious goal to reach 60% of full truckloads tracked in real-time mode after three months and, respectively, 90% after nine months. The implementation team of 2.5 Full-Time Equivalents should onboard carriers, monitor compliance, and quickly escalate any deployment issues. A focal company onboarding team was located in the European control tower. In contrast, a transportation visibility platform owner's geographical locations' onboarding team witnessed changes amongst the US, India, and Poland. Teams from the European control tower should provide support in relations with transport service providers. In contrast, enterprise technical support from Bangalore should deliver IT support.

Regarding direct communication to transport service providers, the conversation should be led depending on a case either by a focal company or transport service provider team. Once no intervention from a focal company, the real-time transportation visibility platform team should lead the onboarding process. A focal company only ensures that the transport service provider delivered the required contact details to data suppliers encompassing the GPS provider and IT provider if

Table 5
Expected benefits from a deployment of a real-time visibility transportation platform

| Who | What | How | Benefits |
|---|---|---|---|
| Control Tower | Information flow improvement | Transport planners have no need to share truck locations to requesting stakeholder | Workload reduction and deliberate resources from non-adding value activities |
| | Carrier performance management | On-Time Delivery/On-Time Collection from notifications when the truck enters geofence and leaves geofence zone | Reduction of demurrages<br><br>Reliable input data for the tender for transport lanes |
| Distribution Centres | Time slots and docks utilization improvement | Notifications are sent via email to the distribution center for every early or late transport two hours before the expected time of arrival<br><br>Automated changes in booked time slots based on updated expected time of arrival | They know if it makes sense to wait for the missing load, not losing time, combining shipments differently<br><br>Reduction of costs related to demurrage charges thanks to early information about the truck delay and the possibility to free up this slot for another truck already waiting at the distribution center |
| Factories | No pending deliveries | Notifications are sent when the truck enters the geofence<br><br>Notifications are sent when the truck should have reached the geofence by a specific time and didn't | No production blockages |

Source: own study.

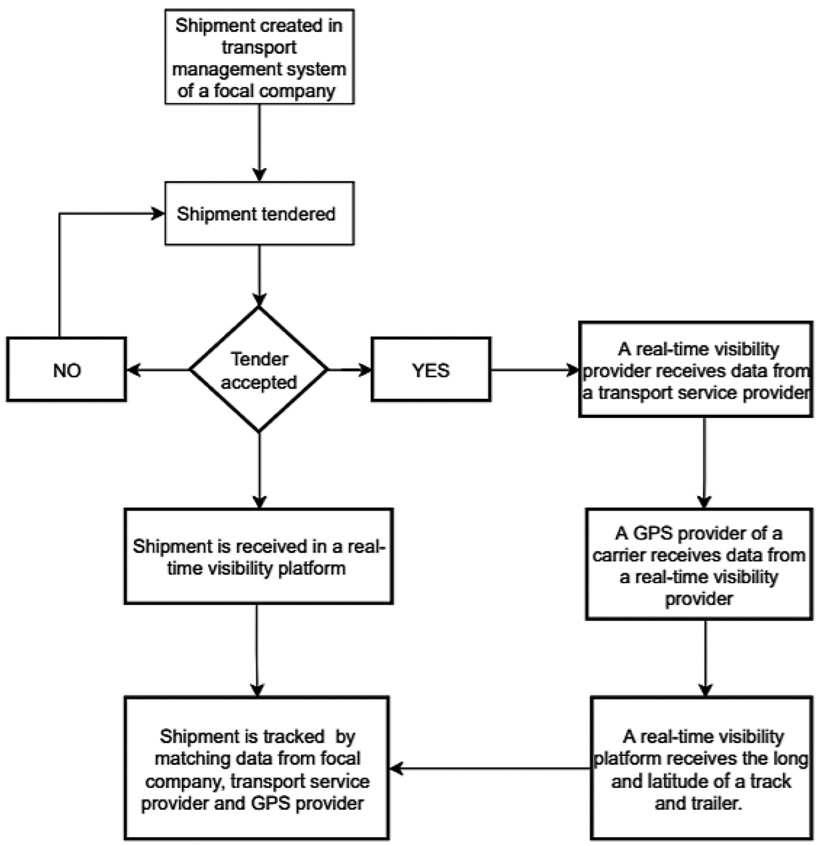
necessary. The obligation of the transport service provider was to streamline communication with data suppliers and chase them if necessary. Once issues occurred, the procurement business team should be involved in a conversation with carriers. The business transport team with designated project champions should support the onboarding team to resolve potential operational issues. The latter encompasses setting geofence zone boundaries around focal company sites in Europe, potential cases occurring with transport operations because of real-time transportation visibility platform deployment, and monitoring benefits from a deployment. The data flow process to have real-time visibility on the shipment of a focal company is presented in Figure 1.

The first step is a creation of a shipment in a transport management system of a focal company. Afterward, the TSM of a focal company automa-tically tenders a load. If transport service providers accept a shipment, a focal company calls a real-time visibility platform via API with a shipment ID. Transport service providers start sending a file from their transport system management two hours before the planned pick-up every 15 minutes. The automated file must contain: a) unique to the carrier identification number in TMS of a focal company, b) shipment number, c) trailer plate numbers. There are possibilities to send a file in CSV, XLS, or XLSX format and sent via FTP, or information is sent in JSON format via a call to real--time visibility provider API.

Real-time visibility provider connects directly with carrier GPS providers via API web service REST or SOAP. If a carrier does not want to share a GPS provider name, they can send all data through their TMS. They can send it through API in JSON format only if the TMS and GPS data are integrated. The GPS provider sends data on the long and latitude coordinates of track and trailer. Real-time visibility provider matches a shipment number and trailer plate numbers. The position of a truck is visible on a dashboard (Figure 1).

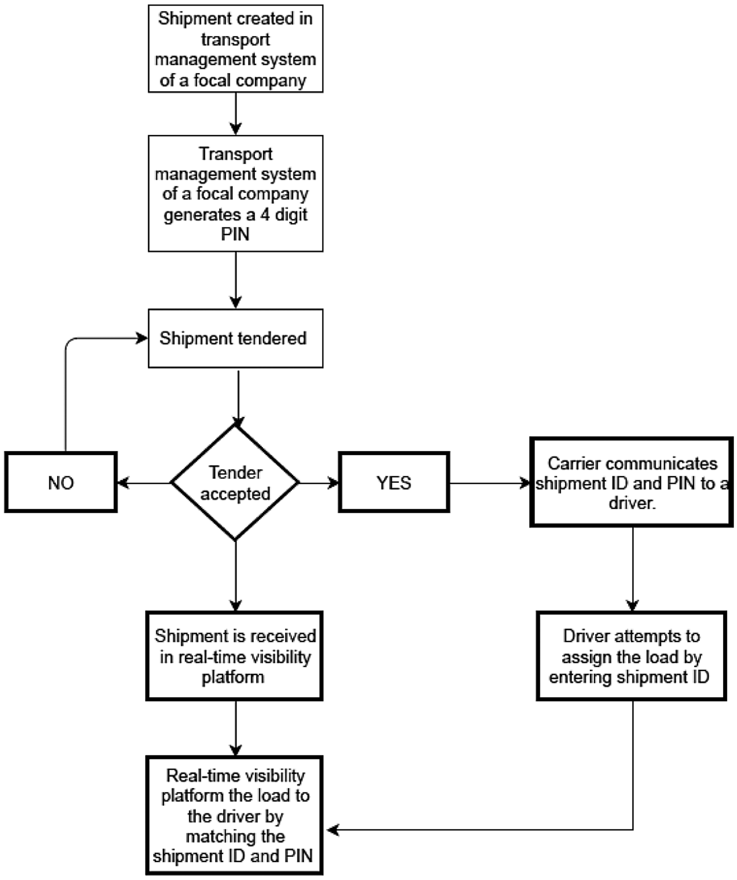
Using an application for smartphones was the other method of assigning shipments (Figure 2). The driver had to download the application and enter the shipment number and PIN to assign shipments. PIN was sent in the email containing order details. The application can be downloaded for free in the GoogePlay (Android) store or the App Store

Figure 1
Data process flow to have real-time tracking




Source: own study.

Figure 2
Data process flow to use application for real-time tracking




Source: own study.

(iPhone). With the application, data usage is less than 1MB per day; no data roaming charges within EU countries; the driver can turn off tracking.

The assumption was to deploy a real-time visibility platform over six months using two solutions: 1) integrating information systems of focal company, transport service provider, and Global Positioning System provider 2) smartphone application for drivers. The deployment should encompass two steps: 1) carriers on-boarding 2) achieving compliance of 60% of tracked shipments. In senior management's view, compliance of 60% should be high enough to make the platform usable in practice.

## Factors affecting onboarding and compliance

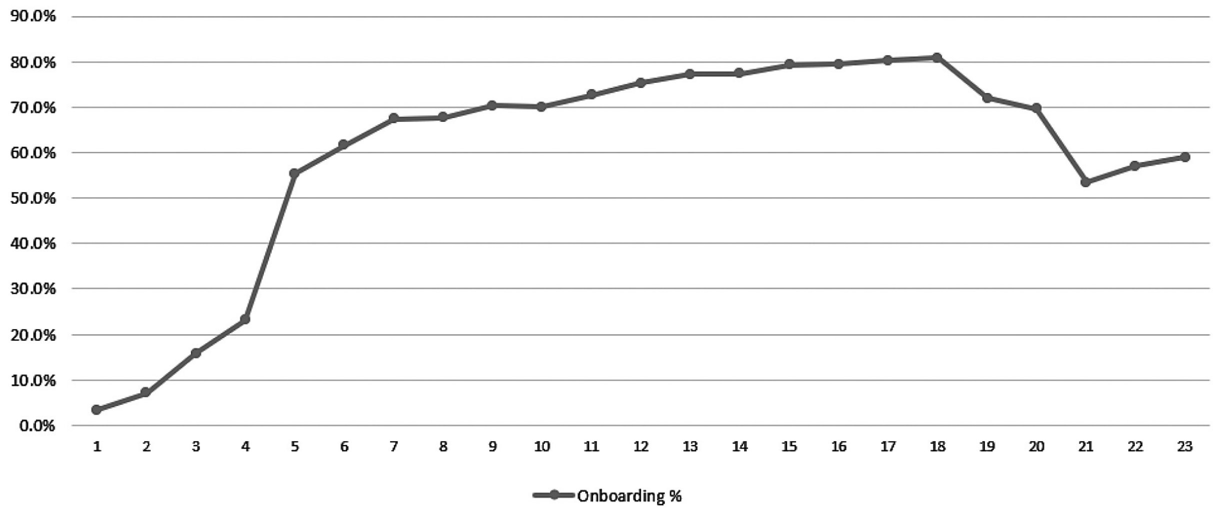
The average time for onboarding a transport service provider on a transportation visibility platform was about 90 days. The median was hardly above 80 days and recorded the longest time of 250 days, whereas the shortest was about ten days.

Longer than expected by the senior management time of onboarding can be attributed to miscommunication because of cultural differences in corporate and national specifics. Confusions resulted from shortcuts used in communication because corporates specifics were multiplied by diverse mindsets due to national cultures. Discussing the same agreed topics consumed 40–50% of communication time.

For the onboarding of transport service provider, it was required 30 emails on the average, out of which almost 20% was on account of the need for further clarification and fix misunderstandings in elementary vocabulary like transport management system, GPS, fleet management system. Subcontractors should be included in a communication loop depending on the process flow, GPS provider, external IT system supplier, and other transportation visibility platforms that provided carriers' services.

Due to business and contractual relationships issues, transport service providers withdraw from sending data, which explains the decrease in the percentage of onboarded transport service providers (Figure 3).

Figure 3
The percentage of onboarded carriers




Source: own study.

Silo mentality, lack of time, lack of rewarding systems, lack of trust, lack of knowledge, and increased levels of work are the primary concerns when sharing information (Somapa et al., 2018; Mujuni Katunzi, 2011; Kaipia & Hartiala, 2006; Somapa et al., 2011). Usually, the organizations distrust their supplier, primarily on information sharing (Pradhan & Routroy, 2018). What is even more interesting, sharing commercially sensitive information is perceived as risky (Bartlett et al., 2007).

Before a transportation visibility platform deployment, the steering committee ignored that 65% of all shipments are subcontracted, resulting in low compliance. Complexity because of the large scale of subcontracting was propagated with a fragmented group of transport service providers. The most significant transport service provider accounted only for a 5% share in the total number of shipments. As a solution for subcontracted loads, the application for a smartphone was developed. On top of that, tracking was unstable with gaps during transit; hence expected time of arrival cannot be calculated accurately.

Figure 4 shows the real-time visibility transportation platform implementation dynamics measured with the indicator calculated as a percentage of tracked shipments in pick-up and delivery locations.

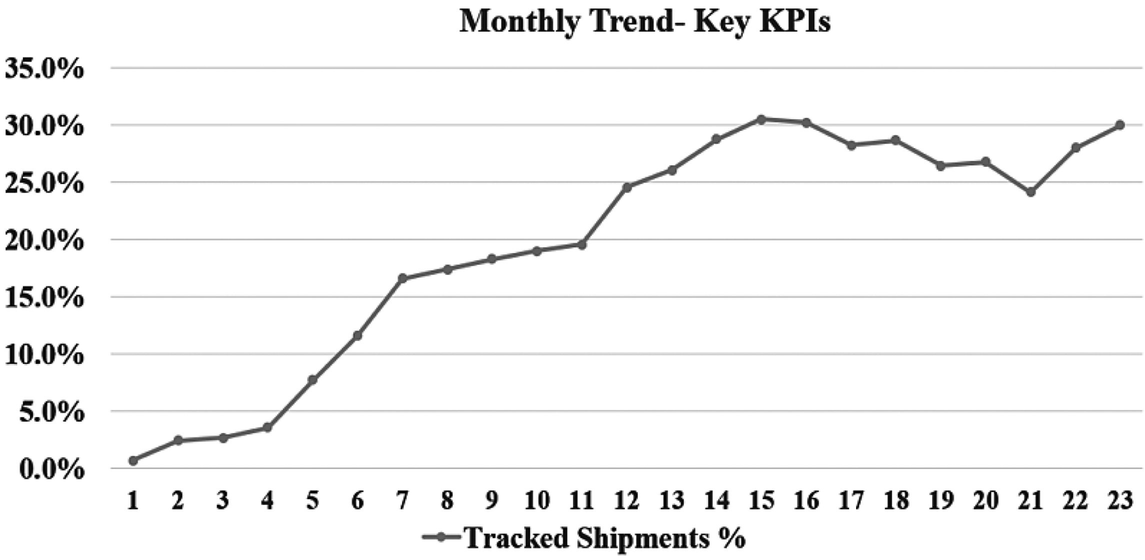
The compliance has been on the growth path until month number 15 after the deployment started, and the percentage of tracked shipments reached 30% (Figure 4). Reasons behind not tracked shipments are:

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 the integration of IT systems — 19%,
4) drivers' phone had roaming disabled — 12%,
5) data privacy concerns to be resolved — 8%,
6) others — 3%.

The lack of a smartphone was given as the most common reason behind not-tracked shipments. Drivers have either personal smartphones or old-fashioned phones on which installation of applications was not doable. What is more, according to the General Data Protection Regulation, drivers were only allowed to use applications developed to enable tracking in real-time with company-owned smartphones.

Many drivers did take only a few shipments per year. Because of the small number of shipments, drivers showed little willingness to use the smartphone application. Moreover, carriers did not effectively transfer the user manual and personal identification number to drivers within a multi-level subcontracting network. Insufficient digital skills of drivers and low willingness made downloading and operating the smartphone application very time and effort-consuming. Moreover, since manual data entry is error-prone, it affects data quality, preventing real-time tracking. Low saturation of company-owned smartphones combined with disabled roaming because of cost factor reflects low technological maturity level amongst transport service providers in a scope. Drivers use personal

Figure 4
Compliance — interpreted as the percentage of tracked shipments




Source: own study.

smartphones for the other shipments' execution-related activities like confirmation of delivery, however.

Freight forwarders also pointed to disabled roaming as a blocker to the usage of applications on international routes. Subcontractors turned off roaming because they feared that costs would increase due to unjustified use by drivers.

Problems with the connectivity of systems of the focal company, real-time transportation visibility platform, freight forwarders, Global Positioning System service providers, was the following reason behind untracked shipments.

Because of the 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 use file transfer protocol for sending excel files to real-time transportation visibility platforms. 15% of carriers used application interface programming. Frequent updates of planned pick-up time by the focal company resulted in the fact that plate numbers of amended trucks and trailers plate numbers have not been updated accordingly in the system both of transport service providers and focal company. The latter was a reason behind the lack of real-time tracking.

Due to the subcontracting, data needful for tracking had to be fetched either directly from the subcontractor's system for storing track and trailer plate numbers or freight forwarder that fetched data from a subcontractor system.

Freight forwarders reflected on the value of data shared with a transportation visibility platform can overreach the associated costs. Asymmetry of risk, rewards, and benefits for freight forwarders and a real-time visibility platform started to hinder information sharing willingness. Freight forwarders realized that they could have control over data they share with a real-time visibility transportation platform. Freight forwarders integrated subcontractors within their own platform. They started to be indirect competitors to the transportation visibility platform and also collaborate by sharing data on the real-time position of loads of a focal company. The latter resulted in coopetition tensions.

Freight forwarders can be real-time transportation visibility platform owners and gain a position of a network integrator. Willingness to earn a role of a network integrator triggered tensions between autonomy and control. Both needs for autonomy and aspiration to be a network integrator are reasons behind competition between freight forwarders and the real-time transportation visibility platform.

Some freight forwarders requested from a focal company financial compensation for developing infrastructure needful for capturing and sending data to have real-time visibility. However, these costs would overreach benefits for a focal company.

Transport service providers gave privacy concerns as the following reason behind the not tracked shipment. Transport Service Providers claimed that application usage is against drivers' privacy and can break General Data Protection Regulation if an application follows drivers in private time. The risk of tracking drivers when they carry shipments of other customers and goods from at least two shippers inside a trailer has also raised concerns among carriers. Information sharing is impacted by carriers' privacy concerns, which reflect fears of new technology and contractual agreements with their other customers on data access restrictions.

When it comes to "others," issues with data quality, including incomplete, incorrect timestamps, delayed updates of pick-up time and delivery times, inefficient shipment planning processes, have been highlighted by transport service providers.

Because of low compliance, the average accuracy of the expected arrival time amounted to 40% in month number 23. On top of that, the expected time of arrival of high accuracy has not been achieved in a repeated manner. The reason for that was gaps in tracking between pick and delivery locations and frequent change of drivers on subcontracted shipments with different driving patterns, making it difficult to calculate the exact time of arrival in a repeatable manner.

Internal customers of a focal company first gave the low compliance and then not accurate enough expected time of arrival as reasons behind not using the real-time transportation visibility platform.

## Conclusion

This paper provides theoretical and practical implications. It responds to calls for a better understanding of how visibility within a supply chain emerges, develops, and must be implemented to be successful (Somapa et al., 2018) and in-depth identifying the critical building blocks, antecedents, supply chain visibility concept (Nguyen et al., 2019). This article also responds to calls for more studies that identify the transformational effects of supply chain visibility as metrics tracing the utilization of information in business processes under research. (Somapa et al., 2018). The paper also provides insights on understanding the governance and behaviors of supply chain members involved in a real-time transportation visibility platform in the network where subcontracting is in the majority. This work fills a gap in literature contributions on supply chain visibility regarding the decline in visibility on transportation shipments (Holcomb et al., 2011).

From a theory-building perspective, the propositions provide insights on automational characteristics, informational and transformational characteristics. When it comes to transformational characteristics, it is discussed how a focal company should utilize information. However, informational characteristics that determine the accuracy, timeliness, and completeness in terms of low compliance and not accurate enough expected time of arrival are reasons behind not commercial using the real-time transportation visibility platform.

There is also evidence of why the compliance is low and the expected arrival time is not repeatedly accurate. Factors affecting not achieving real-time visibility with a transportation network platform are related to connectivity and willingness to share information. Asymmetry of benefits and risks affect the willingness of subcontractors to share information both by smartphones and integration of systems for storing trucks and trailers plate numbers. Dependence on drivers' willingness towards sharing information is a risky and not efficient approach. As for connectivity, the lack of a system for storing track and trailer plates and common standards for data transmission affect compliance by far. What is more, own different systems standards and communication protocols make interoperability a deployment blocker.

The in-depth analysis of entities involved in the platform deployment points to emerging developing tensions. There is a tension between governance costs and the tangible and intangible benefits resulting from the combination of resources of the partners as well as platform complexity and development costs. The internal complexity of partners is multiplied by the number of involved entities, including subcontractors. For example, complexity because of the large scale of subcontracting was propagated with a fragmented group of transport service providers. Freight forwarders as complementors can become competitors to a real-time transport visibility platform, resulting in coopetion and control versus autonomy tensions. Bonus malus system for carriers can compensate risks and costs as partners of real--time visibility transportation platforms.

The value of a real-time transportation visibility platform network grows exponentially in line with an increasing number of members. They benefit from a platform customer and complementors data, information, and knowledge. By adding the successive carriers as well as GPS providers, they develop its network.

When it comes to platform governance: the onboarding process should be led by the real-visibility transportation platform, operational teams must be involved from the start and accept key performance indicators, the key to success is to sustain compliance after onboarding the carriers, operational teams should have easy access to dashboards and access to reliable and repeatable information. When it comes to internal governance for strategic stakeholders of a focal company, there is evidence against attributing decision capabilities of choosing a transportation visibility platform to the hands of the IT global team. The final decision should make the European Supply chain advised by logistics procurement. The deployment scope should be narrowed to transportation lanes where short lead time, high gross margins, and repeated operational issues would justify deploying a transportation visibility platform. Supply chain managers should consider trade-offs. The latter should be between transport service providers with own fleet in which achieving real-time visibility is more controllable and freight forwarders of multi-level subcontracting and frequently changing subcontractors wherein compliance is low. Over-optimistic assumptions on a quick win based on an oversimplified approach do not sit with a deployment of a real-time visibility transportation platform in the network where subcontracting is in the majority.

Further research should analyze relationships within the network of subcontractors, which impacts behaviors and motivations towards enabling shipments for real-time tracking. The in-depth analysis should focus on freight forwarders' strategies for building a competitive advantage to provide real--time visibility. There should also be investigated the strategy of other complementors as partners of a real-time visibility transportation platform.

In future studies, recommendations for theory building, the relationships, and causal loops among partners of a real-time transportation visibility platform need to be investigated from a dual theoretical perspective of system approach and network theory. Therefore, future research could investigate context specifics of tensions and the manifestation of tensions as paradox on digital platforms.

A problem of trust that hinders information sharing can be addressed by blockchain. However, the full implementation of real-time visibility requires machine-machine relations. New infrastructure with autonomous trucks and interoperable connections is needful to unlock a total potential of real-time visibility and enable no-touch processes. Like during the previous technological revolutions, an increase in productivity will occur if new infrastructure is ready.

As with any inductive study, this study suffers from a lack of external validity has some pronounced limitations. The issue of generalizability is because of the focal company's supply chain model in the fast-moving consumer goods industry.

Nonetheless, the study offers valuable insights for directing future research into a digital platform for real-time visibility.

## Bibliografia/References


Al-Talib, M., Melhfem, W. Y., Anosike, A. I., Garza Reyes, J. A., Nadeem, S. P., Kumar, A. (2020). Achieving resilience in the supply chain by applying IoT technology. *Procedia CIRP*, *91*, 752–757. https://doi.org/10.1016/j.procir.2020.02.231

Anitha, K., Palaksha Reddy, K., Krishnamoorthy, N., Jaiswal, S. (2021). IoT's in enabling the supply chain visibility and connectivity and optimization of performance. *Materials Today: Proceedings*, S2214785320400598. https://doi.org/10.1016/j.matpr.2020.12.343

Astarita, V., Giofre, V. P., Mirabelli, G., Solina, V. (2019). A Review of Blockchain-Based Systems in Transportation. *Information*, *11*(1), 21. https://doi.org/10.3390/info11010021

Barratt, M., Oke, A. (2007). Antecedents of supply chain visibility in retail supply chains: A resource-based theory perspective. *Journal of Operations Management*, *25*(6), 1217–1233. https://doi.org/10.1016/j.jom.2007.01.003

Bartlett, P. A., Julien, D. M., Baines, T. S. (2007). Improving supply chain performance through improved visibility. *The International Journal of Logistics Management*, *18*(2), 294–313. https://doi.org/10.1108/09574090710816986

Brandon-Jones, E., Squire, B., Autry, C. W., Petersen, K. J. (2014). A Contingent Resource-Based Perspective of Supply Chain Resilience and Robustness. *Journal of Supply Chain Management*, *50*(3), 55–73. https://doi.org/10.1111/jscm.12050

Brun, A., Karaosman, H., Barresi, T. (2020). Supply Chain Collaboration for Transparency. *Sustainability*, *12*(11), 4429. https://doi.org/10.3390/su12114429

Brusset, X. (2016). Does supply chain visibility enhance agility? *International Journal of Production Economics*, *171*, 46–59. https://doi.org/10.1016/j.ijpe.2015.10.005

Caridi, M., Crippa, L., Perego, A., Sianesi, A., Tumino, A. (2010). Do virtuality and complexity affect supply chain visibility? *International Journal of Production Economics*, *127*(2), 372–383. https://doi.org/10.1016/j.ijpe.2009.08.016

Caridi, M., Moretto, A., Perego, A., Tumino, A. (2014). The benefits of supply chain visibility: A value assessment model. International Journal of Production Economics, 151, 1–19. https://doi.org/10.1016/j.ijpe.2013.12.025

Christopher, M., Peck, H. (2004). Building the Resilient Supply Chain. *The International Journal of Logistics Management*, *15*(2), 1–14. https://doi.org/10.1108/09574090410700275

Dubey, R., Altay, N., Gunasekaran, A., Blome, C., Papadopoulos, T., Childe, S. J. (2018). Supply chain agility, adaptability and alignment: Empirical evidence from the Indian auto components industry. *International Journal of Operations Production Management*, *38*(1), 129–148. https://doi.org/10.1108/IJOPM-04-2016-0173

Dubey, R., Gunasekaran, A., Childe, S. J., Papadopoulos, T., Luo, Z., Roubaud, D. (2020). Upstream supply chain visibility and complexity effect on focal company's sustainable performance: Indian manufacturers' perspective. *Annals of Operations Research*, *290*(1–2), 343–367. https://doi.org/10.1007/s10479-017-2544-x

Fahim, P. B. M., An, R., Rezaei, J., Pang, Y., Montreuil, B., Tavasszy, L. (2021). An information architecture to enable track-and-trace capability in Physical Internet ports. *Computers in Industry*, *129*, 103443. https://doi.org/10.1016/j.compind.2021.103443

Francis, V. (2008). Supply chain visibility: Lost in translation? *Supply Chain Management: An International Journal*, *13*(3), 180–184. https://doi.org/10.1108/13598540810871226

Gawer, A. (2014). Bridging differing perspectives on technological platforms: Toward an integrative framework. *Research Policy*, *43*(7), 1239-1249. https://doi.org/10.1016/j.respol.2014.03.006

Giusti, R., Manerba, D., Bruno, G., Tadei, R. (2019). Synchromodal logistics: An overview of critical success factors, enabling technologies, and open research issues. *Transportation Research Part E: Logistics and Transportation Review*, *129*, 92–110. https://doi.org/10.1016/j.tre.2019.07.009

Hajdul, M., Kawa, A. (2015). Global Logistics Tracking and Tracing in Fleet Management. In: N. T. Nguyen, B. Trawiński, R. Kosala (eds.), *Intelligent Information and Database Systems* (Vol. 9011, 91–199). Springer International Publishing. https://doi.org/10.1007/978-3-319-15702-3_19

He, W., Tan, E. L., Lee, E. W., Li, T. Y. (2009). A solution for integrated track and trace in supply chain based on RFID & GPS. In: *2009 IEEE Conference on Emerging Technologies Factory Automation*, 1–6. https://doi.org/10.1109/ETFA.2009.5347146

Hein, A., Schreieck, M., Riasanow, T., Setzke, D. S., Wiesche, M., Böhm, M., Krcmar, H. (2020). Digital platform ecosystems. *Electronic Markets, 30*(1), 87–98. https://doi.org/10.1007/s12525-019-00377-4

Holcomb, M. C., Ponomarov, S. Y., Manrodt, K. B. (2011). The Relationship of Supply Chain Visibility to Firm Performance. *Supply Chain Forum: An International Journal*, *12*(2), 32–45. https://doi.org/10.1080/16258312.2011.11517258

Jain, V., Kumar, S., Soni, U., Chandra, C. (2017). Supply chain resilience: Model development and empirical analysis. *International Journal of Production Research, 55*(22), 6779–6800. https://doi.org/10.1080/00207543.2017.1349947

Jakobs, K., Pils, C., Wallbaum, M. (2001). Using the Internet in transport logistics — The example of a Track Trace System. In: P. Lorenz (ed.), *Networking — ICN 2001* (Vol. 2093, 194–203). Berlin Heidelberg: Springer. https://doi.org/10.1007/3-540-47728-4_20

Jovanovic, M., Sjödin, D., Parida, V. (2021). Co-evolution of platform architecture, platform services, and platform governance: Expanding the platform value of industrial digital platforms. *Technovation*, 102218. https://doi.org/10.1016/j.technovation.2020.102218

Kaipia, R., Hartiala, H. (2006). Information-sharing in supply chains: Five proposals on how to proceed. *The International Journal of Logistics Management*, *17*(3), 377–393. https://doi.org/10.1108/09574090610717536

Kandel, C., Klumpp, D. M., Keusgen, T. (2011). GPS based track and trace for transparent and sustainable global supply chains. In: K.-D. Thoben, V. Stich, A. Imtiaz (eds.), *Proceedings of the 17th International Conference on Concurrent Enterprising, 20–22 June 2011*, 252–259. Aachen: RWTH Aachen University.

Kim, C., Shin, K. (2019). Developing Fair Investment Plans to Enhance Supply Chain Visibility Using Cooperative Games. *Sustainability*, *11*(11), 3209. https://doi.org/10.3390/su11113209

Klumpp, M., Kandel, C. (2011). GPS-based real-time transport control for production network scheduling simulation. In: P. Navais, J. Machado, C. Analide, A. Abelha (eds.), *The 2011 European Simulation and Modelling Conference, Conference Proceedings, October 24–26, 2011*, 235–239. Guimaraes (Portugal): University of Mino.

Kovács, G., Spens, K. M. (2005). Abductive reasoning in logistics research. *International Journal of Physical Distribution Logistics Management*, *35*(2), 132–144. https://doi.org/10.1108/09600030510590318

Lee, I., Lee, K. (2015). The Internet of Things (IoT): Applications, investments, and challenges for enterprises. *Business Horizons*, *58*(4), 431–440. https://doi.org/10.1016/j.bushor.2015.03.008

Lee, Y., Rim, S.-C. (2016). Quantitative Model for Supply Chain Visibility: Process Capability Perspective. *Mathematical Problems in Engineering*, 1–11. https://doi.org/10.1155/2016/4049174

Leung, J., Chu, S.-C., Cheung, W. (2017). A Design Theory for Supply Chain Visibility in the age of Big Data. *PACIS 2017 Proceedings*, 218.

Mandal, S., Sarathy, R., Korasiga, V. R., Bhattacharya, S., Dastidar, S. G. (2016). Achieving supply chain resilience: The contribution of logistics and supply chain capabilities. *International Journal of Disaster Resilience in the Built Environment*, *7*(5), 544–562. https://doi.org/10.1108/IJDRBE-04-2016-0010

McKinney, J. H., Radford, A., Stathacopoulos, A., Aifadopoulou, G., Giannopoulos, G. (2015). The business value of supply chain visibility and monitoring. Transportation research record. *Journal of the Transportation Research Board*, *2479*(1), 86–92. https://doi.org/10.3141/2479-11

Mini, T., Widjaja, T. (2019). Tensions in Digital Platform Business Models: A Literature Review. In: *Proceedings of the 40th International Conference on Information Systems* (ICIS 2019), Munich.

Mintsis, G., Basbas, S., Papaioannou, P., Taxiltaris, C., Tziavos, I. N. (2004). Applications of GPS technology in the land transportation system. *European Journal of Operational Research*, *152*(2), 399–409. https://doi.org/10.1016/S0377-2217(03)00032-8

Montecchi, M., Plangger, K., West, D. C. (2021). Supply chain transparency: A bibliometric review and research agenda. *International Journal of Production Economics*, *238*, 108152. https://doi.org/10.1016/j.ijpe.2021.108152

Mubarik, M. S., Naghavi, N., Mubarik, M., Kusi-Sarpong, S., Khan, S. A., Zaman, S. I., Kazmi, S. H. A. (2021). Resilience and cleaner production in industry 4.0: Role of supply chain mapping and visibility. *Journal of Cleaner Production*, *292*, 126058. https://doi.org/10.1016/j.jclepro.2021.126058

Mujuni Katunzi, T. (2011). Obstacles to Process Integration along the Supply Chain: Manufacturing Firms Perspective. *International Journal of Business and Management*, *6*(5), p105. https://doi.org/10.5539/ijbm.v6n5p105

Munuzuri, J., Onieva, L., Escudero, A., Cortés, P. (2016). Impacts of a tracking and tracing system for containers in a port-based supply chain. *Brazilian Journal of Operations Production Management*, *13*(3), 352. https://doi.org/10.14488/BJOPM.2016.v13.n3.a12

Näslund, D. (2002). Logistics needs qualitative research — especially action research. *International Journal of Physical Distribution & Logistics Management*, *32*(5), 321–338. https://doi.org/10.1108/09600030210434143

Nguyen, T. T. H., Taskin, N., Scahill, S., Pauleen, D. (2019). Antecedents of Supply Chain Information Visibility: The Complementarity Effect of IT Integration Capability and Interpersonal Communication Capability. *25th Americas Conference on Information Systems, AMCIS 2019*, August 15–17, 2019, Cancún, Mexico. https://aisel.aisnet.org/amcis2019/enterprise_systems/enterprise_systems/5

Nilsson, F., Göransson, M., Bath, K. (2019). Models and technologies for the enhancement of transparency and visibility in food supply chains. In: *Sustainable Food Supply Chains* (219–236). https://doi.org/10.1016/B978-0-12-813411-5.00015-6

Norris, M., Oppenheim, C., Rowland, F. (2008). The citation advantage of open-access articles. *Journal of the American Society for Information Science and Technology*, *59*(12), 1963–1972. https://doi.org/10.1002/asi.20898

Papatheocharous, E., Gouvas, P. (2011). eTracer: An innovative near-real time track-and-trace platform. *2011 15th Panhellenic Conference on Informatics*, 282–286. https://doi.org/10.1109/PCI.2011.54

Pauli, T., Fielt, E., Matzner, M. (2021). Digital industrial platforms. *Business Information Systems Engineering*, *63*(2), 181–190. https://doi.org/10.1007/s12599-020-00681-w

Pizzuti, T., Mirabelli, G. (2015). The Global Track&Trace System for food: General framework and functioning principles. *Journal of Food Engineering*, *159*, 16–35. https://doi.org/10.1016/j.jfoodeng.2015.03.001

Pradhan, S. K., Routroy, S. (2018). Improving supply chain performance by Supplier Development program through enhanced visibility. *Materials Today: Proceedings*, *5*(2), 3629–3638. https://doi.org/10.1016/j.matpr.2017.11.613

Prajogo, D., Olhager, J. (2012). Supply chain integration and performance: The effects of long-term relationships, information technology and sharing, and logistics integration. *International Journal of Production Economics*, *135*(1), 514–522. https://doi.org/10.1016/j.ijpe.2011.09.001

Reuver, M. de, Sorensen, C., Basole, R. C. (2018). The Digital Platform: A Research Agenda. *Journal of Information Technology*, *33*(2), 124–135. https://doi.org/10.1057/s41265-016-0033-3

Romano, P. (2003). Coordination and integration mechanisms to manage logistics processes across supply networks. *Journal of Purchasing and Supply Management*, *9*(3), 119–134. https://doi.org/10.1016/S1478-4092(03)00008-6

Roy, V. (2021). Contrasting supply chain traceability and supply chain visibility: Are they interchangeable? *The International Journal of Logistics Management*, *32*(3), 942–972. https://doi.org/10.1108/IJLM-05-2020-0214

Sá, M. M. de, Miguel, P. L. de S., Brito, R. P. de, Pereira, S. C. F. (2019). Supply chain resilience: The whole is not the sum of the parts. *International Journal of Operations Production Management*, *40*(1), 92–115. https://doi.org/10.1108/IJOPM-09-2017-0510

Schreieck, M., Hakes, C., Wiesche, M., Krcmar, H. (2017). Governing Platforms in the Internet of Things. In: A. Ojala, H. Holmström Olsson, K. Werder (eds.), *Software Business* (Vol. 304, 32–46). Springer International Publishing. https://doi.org/10.1007/978-3-319-69191-6_3

Shamsuzzoha, A., Ehrs, M., Addo-Tengkorang, R., Helo, P. (2021). Tracking and tracing of global supply chain network: Case study from a Finnish company: *Proceedings of the 23rd International Conference on Enterprise Information Systems,* 118–125. https://doi.org/10.5220/0010515401180125

Shamsuzzoha, A. H. M., Ehrs, M., Tenkorang, R. A., Nguyen, D., Helo, P. T. (2013). Performance evaluation of tracking and tracing for logistics operations. *International Journal of Shipping and Transport Logistics*, *5*(1), 31. https://doi.org/10.1504/IJSTL.2013.050587

Shamsuzzoha, A., Helo, P. T. (2011). Real-time Tracking and Tracing System: Potentials for the Logistics Network. In: *Proceedings of the 2011 International Conference on Industrial Engineering and Operations Management*, January 22–24, 2011, Kuala Lumpur, Malaysia.

Shou, Y., Zhao, X., Dai, J., Xu, D. (2021). Matching traceability and supply chain coordination: Achieving operational innovation for superior performance. *Transportation Research*. *Part E: Logistics and Transportation Review*, *145*, 102181. https://doi.org/10.1016/j.tre.2020.102181

Somapa, S., Cools, M., Dullaert, W. (2011). Real-time supply chain visibility — the business values and the antecedents of successful implementation — a conceptual framework. *Proceedings of the Vervoerslogistieke Werkdagen*, December 1–2, 2011, 349–375.

Somapa, S., Cools, M., Dullaert, W. (2018). Characterizing supply chain visibility — a literature review. *The International Journal of Logistics Management*, *29*(1), 308–339. https://doi.org/10.1108/IJLM-06-2016-0150

Tse, Y. K., Tan, K. H. (2012). Managing product quality risk and visibility in multi-layer supply chain. *International Journal of Production Economics*, *139*(1), 49–57. https://doi.org/10.1016/j.ijpe.2011.10.031

Vass, T. de, Shee, H., Miah, S. J. (2020). Iot in supply chain management: A narrative on retail sector sustainability. *International Journal of Logistics Research and Applications*, 1–20. https://doi.org/10.1080/13675567.2020.1787970

Wang, Y., Potter, A. (2007). The application of real time tracking technologies in freight transport. In: *2007 Third International IEEE Conference on Signal-Image Technologies and Internet-Based System*, 298–304. https://doi.org/10.1109/SITIS.2007.65

Wei, H.-I. Wang, E. T. G. (2007). Creating strategic value from supply chain visibility — the dynamic capabilities view. In: *2007 40th Annual Hawaii International Conference on System Sciences (HICSS'07)*, 7–7. https://doi.org/10.1109/HICSS.2007.157

Wei, H.-L., Wang, E. T. G. (2010). The strategic value of supply chain visibility: Increasing the ability to reconfigure. *European Journal of Information Systems*, *12*.

Yang, M., Fu, M., Zhang, Z. (2021). The adoption of digital technologies in supply chains: Drivers, process and impact. *Technological Forecasting and Social Change*, *169*, 120795. https://doi.org/10.1016/j.techfore.2021.120795

Yin, R. K. (2018). *Case study research and applications. Design and methods*. Sage Publications.

*Dr Sławomir Wyciślak*

PhD, currently works at the Institute of Economics, Finance and Management of the Jagiellonian University. He has almost 20 years of experience in working with companies of various sizes. Over the last seven years, he has been involved with digitization projects in the European research and development center of one of the supply chains.

*Dr Sławomir Wyciślak*

Obecnie pracuje w Katedrze Zarządzania Jakością Instytutu Ekonomii, Finansów i Zarządzania Uniwersytetu Jagiellońskiego. Ma prawie 20-letnie doświadczenie we współpracy z firmami różnej klasy wielkości. Przez ostatnie 7 lat był zaangażowany w prace nad projektami w zakresie cyfryzacji w europejskim centrum badawczo-rozwojowym łańcucha dostaw jednej z firm międzynarodowych.