A systematic method to foster the adoption of logistic 'control towers' in a multi-actor environment

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Abstract: A supply chain control tower is an inter-connected and personalized dashboard of data, business metrics and events to support the logistic flows and the decision-making process. In particular, outbound logistic control towers produce information about the state of orders along the downstream distribution channel(s). Their recent introduction and adoption by industrial players is related to their need of guaranteeing top service level to the end customers by fully tracking and tracing the chain between production and consumption. To reach good service level, it is mandatory for all actors to cooperate. At the same time, due to their multitude and different interests and priorities, major challenges rise. This working paper introduces a systematic method to approach the initial stages of the adoption of a logistic control tower, further proposing insights from an industrial use case of the food and beverage sector. The method encompasses the mapping of the orders, both from a physical and informative perspective, taking advantage on the use of lean tools as the Value Stream Mapping (VSM). Best practices that companies should embrace to address the occurring obstacles, such as technical issues with IT systems, lack of awareness, high costs, data quality and data timeliness are presented, classified and discussed.

Keywords: Control tower, Logistics 4.0, Supply Chain Visibility, Order to Delivery.

1. Introduction and research questions

Logistics 4.0 embodies the digital transformation of supply chain management (SCM), leveraging advanced technologies like Internet of Things (IoT), artificial intelligence (AI), and big data analytics to enhance efficiency, visibility, and responsiveness in logistics operations. The relevance of these technologies combined with themes such as market globalization, high competition and strong emphasis on customer satisfaction are generally considered to be the main reasons of the growing interest in SCM (Gunasekaran et al., 2001; Webster, 2002). To optimize SCM, establishing strong relationships with business partners becomes essential. Visibility is necessary in SCM, providing real-time insights into the movement and status of goods throughout the supply chain (SC), ensuring efficiency and informed decision-making. Williams et al. (2013) provided the following definition of supply chain visibility (SCV): "Access to high quality information that describes various factors of demand and supply. In order for information to be of high quality, it must be accurate, timely, complete, and in useable forms."

It is undeniable how the effort toward the adoption of visibility systems within SC originates from multiple sources. As example, De Oliveira and Handfield (2019) determined that a competitive pricing advantage and increased purchasing power can be achieved by improving the visibility of contracts, Klueber and O'Keefe (2013) contended that firms in highly regulated industries need to exhibit at least a minimum level of SCV to achieve compliance objectives, and aspects of economic, environmental, and social sustainability will require higher levels of SCV.

The emerging technological solutions in the industrial environment that ensure visibility over SC processes are known as control tower (CTs). CTs incorporate shared database management systems, network integration systems, decision support systems and flow identification systems. The primary purpose of CTs is to satisfy the need for tracking and tracing orders. That is because without proper and suitable tracking and tracing system, efficient co-ordination of logistic flows would be impossible to acquire. The term "tracking" can be defined as the collection and management of information regarding the current location of product(s) or delivery item(s). On the other hand, "tracing system" means to storing and retaining the life cycle history of the manufacturing and distribution of product(s) and its components (Shamsuzzoha et al., 2011). Through the implementation of CTs, it is possible to detect and react to any uneven situations in the logistics chain and, where needed, significant problems can be solved or at least the damage can be minimized.

CTs extend beyond this scope. Indeed, Vlachos (2023) argued that a CT combines and exploits functionalities of Advanced Planning Systems (APS), Manufacturing execution systems (MES), Transportation Management Systems (TMS), Geographical Information Systems (GIS) and Advanced Analytical Systems (AAS). Thanks to the aforementioned systems, CTs can provide an extensive list of features, that Liotine (2019) and Baumgraß et al. (2015) outlined in their work:

- Provision of information on the availability of transportation resources and infrastructures;
- Automated detection and prediction of disruptions of issues related to the delivery of goods;
- Offline and online planning (before and while the transportation is executed);
- Visibility on inventory and shipments status;
- Live calculation of the monetary and environmental cost of a shipment;
- Event based alert system;
- Analytical and optimization engine process;
- Reporting system.

Despite the several advantages that CTs promise to deliver, as summarized by Capgemini (2011) in Figure 1, their adoption within companies remains notably limited.

Area of Benefits	List of Benefits
General	• Integrated Supply Chain with an ability to retrieve information • Reduced compliance Penalties • Improve decision-making capabilities • Reduced network failures, increased network visibility and responsiveness • Respect customer commitment: schedule, costs, quality and Improved customer satisfaction
Inbound	• Optimal inventory levels and reduced buffer inventory • Synergies in procurement transport carriers leading to reduction in Transportation Expense • Reduction in total landed costs & increase On Time & In Full deliveries • Helps to change sourcing strategies, shift supplier allocations, modify commercial terms, re-engineer a logistics process or swap out a logistics partner
Manufacturing	• Awareness of WIP & improved productivity • Manufacturing in optimal way over plants operating globally • More accurate demand planning, better scheduling, reduction in cycle times, reduced inventory levels and timely and complete management information
Outbound	• Improved load efficiency in Outbound • Improve transport efficiency using best-in-class carriers and redesigning transport solutions • Ability to predict right ETA for customers

Figure 1: List of CTs benefits (Capgemini, 2011).

Furthermore, according to a report by Gartner (2021), approximately 50% of logistic CT initiatives fail to meet their objectives due to challenges in implementation, integration, and scalability.

Starting from this background, this working paper addresses two main research questions (RQs):

RQ1 – "What are the primary barriers hindering the adoption of logistic CTs by companies and what are the current proposal to overcome them?"

RQ2 – "What could be a systematic method to foster the adoption of logistic CTs in a multi-actor environment during the first stages of implementation?"

This paper aims to answer RQ1 through the literature review reported in section 2 of this paper. In the section 3, a case study of Gruppo Montenegro (GM), a prominent company in the Italian food and beverage sector, is introduced to exemplify how to systematically structure the process of adopting a CT system by proposing a structured method for the adoption of CTs. The method is designed to overcome the challenges that hinder companies from acquiring the available software solutions on the market during the first stages of implementation. This approach integrates lean tools like Value Stream Mapping (VSM) and encompasses the mapping of orders both from physical and informative perspective, providing guidelines to facilitate successful implementation. Section 4 answers RQ2 illustrating the aforementioned method and presenting examples of the outcomes achieved through its application to GM. Finally, section 5 concludes the paper with final remarks and future research opportunities.

2. Literature review

Despite the several advantages that CTs promise to offer businesses, their adoption is still limited. Freichel et al. (2022) defined a framework to categorize into three groups most of the barriers that emerged from the recent literature (Figure 2).

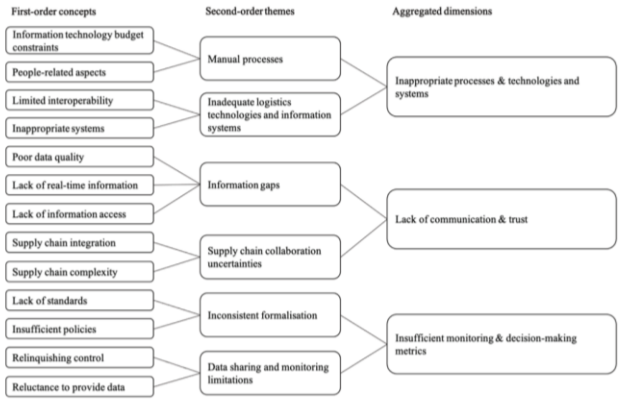

Figure 2: barriers to CTs adoption (Freichel et al., 2022)

Liotine (2019) states that in numerous companies, a multitude of activities are still conducted manually, whereas CTs necessitate a robust technological infrastructure to gather data. Many actors have not yet established interfaces for the exchange of data among themselves. Then, owing to the complexity of modern SC, a central theme deals with the quality of data in terms of accuracy, timeliness, consistency and completeness (Hazen et al., 2014). Multiple studies highlighted that poor information quality limits the extent of SCV, resulting in lack of communication and trust. For instance, Kalaiarasan et al. (2022) found that the quality of master data is a limiting factor for visibility and information quality. Data quality is a concern both for the collection of external and internal data and it is affected also by lack of standardization among traceability systems, resulting in heterogeneous output records and poor alignment between acquisition hardware solutions and several data sources (Gallo et al., 2021). Furthermore, a multi-actor environment with numerous stakeholders, siloed thinking, autonomous decision-making, and divergent objectives hinders companies from establishing SCV and sharing information with SC partners (Kalaiarasan et al., 2022). Insufficient monitoring and decision-making metrics come from the absence of standards and policies and from hesitancy in sharing data. Indeed, cyber-security risks (and lack of trust) threaten information sharing, which is pivotal in SC collaborations (Annosi et al., 2021), and most of small medium companies suffer from unbalanced bargaining power, which prevents them from serving as the primary drivers of innovation in the SC (Gallo et al., 2021). In addition to the barriers depicted in Figure 2, lack of knowledge, skills, and resources also prevent companies from adopting technologies for SCV (De Oliveira and Handfield, 2019). Vlachos (2023) sustained that other barriers are: (I) firm complacency, i.e. sunk investments in prior technologies and existing (rigid) structures and process, which act as the root cause of inertia; (II) lack of standardization in new technologies, that often are not compatible to legacy systems or with supply partners' system; (III) social factors like lack of strategic vision and leadership. Hardt et al. (2017) emphasized that although traceability could be beneficial for sustainability, no significant incentive mechanisms have been introduced so far.

To the best of our knowledge, it appears that the only proposition in the literature that adequately addresses RQ1 is the one advanced by Vlachos (2023). Vlachos (2023) illustrated an industrial use case, where the company implemented a CT in three phases: (I) initiation, (II) live, and (III) continuous improvement. During phase (I), the first step is to design the CT processes. The author discovered that this phase could be problematic if processes are re-designed only from the experience of employees who had cooperated with 3PLs. Phase (II) is mostly focused on system integration and, particularly, integrating the company systems with stakeholders which run a multitude of different systems and platforms. This phase consists of three stages:

1. Project establishment: during this stage, the company and its partners decide on terms of business, including payment, documentation preparation, contractual penalties, KPIs such as delivery times, and other terms;
2. Connections: in this stage the company connects its ERP and other systems with the stakeholder systems;
3. SC digitalization: this stage involves document exchange and establishing custom requirements such as shipment adjustments, prebilling, and interface updates. This stage is time-consuming because of the alignment between master data of all internal and external systems in order to execute (near) real-time information exchange smoothly.

Throughout Phase (III) the company began to expand its SC digitalization to include as many stakeholders as possible. However, there is a step-by-step progression to full automation of SC analytics which requires standardization and trust.

It is evident that Vlachos' objective was not to devise a systematic method for a specific phase of the CTs implementation. Consequently, the author confines himself to offering best practices for each phase, avoiding detailed elaboration, a gap this paper intends to fill specifically with respect to the initial stages of implementation.

Vlachos (2023) concluded his paper underlying that only few companies have recently developed a CT and the proposed case study possesses idiosyncratic characteristics which limit generalization of the study results. The Author also suggested further studies to examine CTs in more industries and countries to benefit from comparison among them.

To contribute to address the open issue by Vlachos (2023), the following section illustrates the initial stages of GM business case, highlighting that many challenges faced by the company align with those of the literature.

3. Case study

GM is a leading company in the Italian food and beverage sector. The company sells both spirit and food products. GM also manages the distribution of agency products, i.e. other companies rely on it for the distribution of their products within Italy.

3.1 Network structure

GM is composed by four business units: Vitalia, Cannamela, Cuore and Montenegro. Solely contemplating the breadth of the product range managed and the differences between them, one can readily envision the complexity of the SC of GM. Indeed, GM sells nearly a thousand codes, encompassing 31 distinct brands. Furthermore, GM provides the option of delivering its products directly to customers. The Market is wide and heterogeneous, ranging from large retailers and distribution centers to wholesalers, cafeterias, restaurants, and nightclubs. For each category, the methods and, most important, the service level to be offered are different. Although the company also markets its products internationally, the current project is focused on the Italian market. GM aims at fully tracking and tracing the chain between production and consumption, by developing a logistic CT that will produce information about the state of orders along the downstream distribution channel(s). GM production strategy is Make To Stock (MTS), and the company has four warehouses to store its ready to deliver products:

- A warehouse in San Lazzaro, Bologna, Italy (SL), dedicated to storing spirits and Cuore products, managed by a 3PL who nonetheless employs the company's WMS;
- A warehouse in Sala Bolognese, Bologna, Italy, dedicated to storing food products, completely outsourced to a 3PL, who utilizes it also as a Transit Point (TP) for the distribution;

- Another warehouse in Dolzago, Lecco, Italy, located near the Vitalia production site and dedicated to food products. It was recently insourced, but it's still employing an external WMS;
- A warehouse in Zola Predosa, Bologna, Italy, dedicated to overstock management or for short-term storage of Cannamela products, at insourcing phase.

The complexity of the logistic network is depicted in Figure 3.

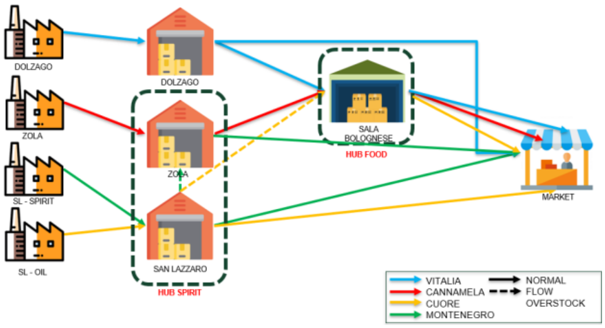

Figure 3: GM logistic network.

GM relies on five primary carriers for the distribution of goods:

- A carrier (carrier 'α') for distribution in the northern Italy. Carrier α is the same logistic operator who manages the warehouse in Sala Bolognese;
- A carrier (carrier 'β') for distribution in the central Italy;
- A carrier (carrier 'γ') for distribution in the southern Italy, Sicily and Sardinia.
- A national express carrier (carrier 'δ') mostly utilized for important deliveries in southern Italy, Sicily and Sardinia.
- A national express carrier (carrier 'ε') mostly utilized for important deliveries in northern Italy.

3.2 GM Order to Delivery flow

All the orders enter into the Customer Relationship Management (CRM) of GM. However, the creation of orders comes from various methods. As example, an order could be created by an agent on field, sent via mail/telephone by a customer and subsequently entered by an operator of Customer Service (CS), transmitted via Electronic Data Interchange (EDI), or entered by a GM store specialist. In the CRM, the set of the delivery date and the order management are conducted by the CS. The CRM enables the tracking of the date and time of any event occurring to an order. Then, orders are transferred into the ERP of GM, where deliveries are grouped into transportations and assigned to a specific carrier. Despite the number of warehouses and implemented systems, the ERP of GM is interfaced with all the WMSs. During warehouse preparation, deliveries are transferred into the WMS and subsequently become visible again on the ERP upon invoicing. Throughout this phase, communications among different business functions, with 3PL and carriers are via mail/telephone. Similar to the CRM, also the ERP and the WMSs enable the tracking of events, but a system cleansing would be necessary to optimally leverage the provided functionalities, because some data are redundant, wrong or misleading. Figure 4 shows a summary of the previously delineated concepts.

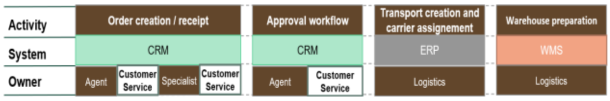

Figure 4: GM orders management.

Problems in terms of visibility and communication regarding the status of orders arise from the moment the goods are handed over to the carriers. GM established interfaces with carriers α, β and γ, through which the ERP of GM dispatches the delivery notes and information to the carrier's ERPs, and the carriers subsequently relay the pertinent data back to the ERP of GM. Consequently, there is no exchange of information until post-delivery, as example when goods arrive to a TP. Each time an issue arises within a delivery, a cascade of calls and emails occurs, resulting in time wastage and additional errors. Furthermore, the quality of the data received by GM frequently proves subpar, occasionally arriving late, sometimes failing to arrive altogether, and at times being incorrect. Carrier δ is not interfaced with GM already, but this lack is counterbalanced by its online platform, which provide delivery info to GM. Carrier ε is not interfaced with GM at all.

Currently, the structure and the level of digitization among the different carriers varies significantly; however, a strategy must be outlined to standardize procedures notwithstanding this disparity. It has been observed that most issues arise when a carrier depends on third parties to manage TPs and/or the last mile (the so-called owner-operators), as this circumstance amplifies the complexity of the logistic chain and, usually, systems are not interfaced, resulting in poor data quality and extended Lead Times (LT). Table 1 summarizes the present status of many of the barriers faced by GM, that align with those discussed in the literature and collected in figure 2.

Table 1: Carriers current status.

Carrier	α	β	γ
Network structure	3PLs on around ½ network	All TP owned	3PLs except for 1 region
Data quality	Good	Poor	Poor
Data timeliness	Almost real time	Up to 1 day of LT	Up to 1 day of LT
Level of digitization	High	Low	Medium
Insertion of delivery info into systems	Through labels and application	Manual driver input upon return	Manual driver input upon return

Express carriers are less problematic: carrier δ provides an optimal visibility service with fairly reliable data through their online platform, while carrier ε is in close collaboration with the company.

Manual processes are present, and they hinder the adoption of the CT. Interoperability needs to be established among several systems, some of which are ill-suited for performing these tasks. Data quality and information access, as well as SC collaboration uncertainties are further challenges. Some carriers are showing signs of reluctance to provide data and a method to force them is needed.

Section 4 sheds light on the analysis and modification of processes to align them with the CT, in an endeavour to furnish companies with a structured approach to tackle initial project barriers. Consequently, a method intertwining technological/IT innovation with the optimization of underlying processes is introduced. In this way, an answer to RQ2 will be provided.

4. Proposed method

The proposed method is designed to prevent a CT project from stagnating in its preliminary phases. The focus lies in mapping and possibly modify order flows. Many companies overlook or base this crucial step only on the experience of employees who had collaborated with 3PLs (Vlachos, 2023), resulting in inevitable discrepancies between company operations and software functionalities, leading to inefficiencies and the incurring of additional costs. Beyond the novelty of being a topic rarely explored in depth by the literature, its innovative aspect lies in its ability to make processes compatible with software, and vice versa.

The proposed method can be split into three steps as in Figure 5.

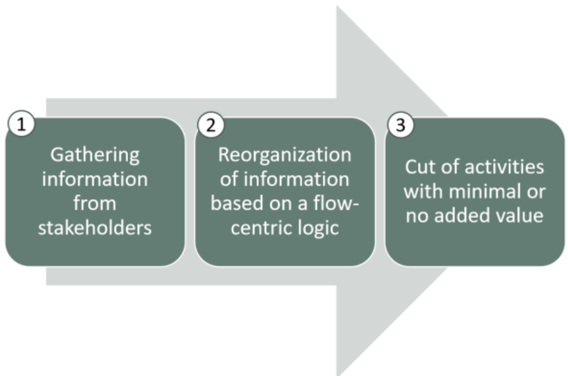

Figure 5: Steps of the proposed method.

During step 1 information from stakeholders are collected through direct interviews. The interviews are conducted with the objective of comprehending all the processes and their variants that underpin both physical and information flows. Each stakeholder is interviewed individually/in groups multiple times to ensure a comprehensive and accurate understanding of its area of expertise. Furthermore, to verify the accuracy of the gathered information, reports are proffered to the interviewees and the collected information are matched with each other looking for discrepancies. The outcome of this phase consists of a series of flow charts, each delineating a specific branch of the flow. The lack is the absence of a unifying thread that could link all elements in a coherent flow. Establishing this connection is essential. Without a comprehensive understanding of the flow, there is the potential risk of overly prioritizing the needs of dominant stakeholders or addressing requests that are almost impossible to integrate. Therefore, step 2 involves consolidating information into a cohesive flow. To achieve this, swim lane diagram (SLD) is the utilized tool. It is apt for consolidating the information from each individual function and stakeholder. Owing to the SLD, it becomes evident which departments/actors are overstretched and the complexity of the company's flow. The case of GM underscores the complexity of the flow between CS, logistics, sales and carriers, which frequently exhibits opportunities for simplification. Particularly, when addressing issues, each function is engaged multiple times, even involving manual activities, thereby resulting in considerable redundancy and time inefficiency. An additional advancement is made in the third phase. Numerous companies primarily seek to align the CT with business processes without attempting to seek a compromise by also adjusting the processes to accommodate the CT. The version of the VSM for IT processes is utilized to analyze processes and underscore not only the imbalance of activities but also other aspects such as the absence of added value or the redundancy of certain practices. In this instance, it is employed to map and quantify these elements around the progression of an order. For instance, production activities are replaced by office tasks, and buffers are substituted by waiting times for physical activities related to orders or by simple delays. To achieve this, it was essential to adapt the conventional interpretation of certain symbols of the VSM.

As VSMs are typically associated to a single product, multiple VSMs are developed for this project, one for each type of order and one for each identified issue leading to deviation from the primary flow. The management of an order varies from others primarily depending on the commercial organization of the ordered products and the location/type of the customer. For example, an order from the Vitalia commercial organization intended for a large-scale retail customer originates from a distinct warehouse and is allocated to a different carrier compared to a Montenegro order for a nightclub. Consequently, they undergo different processes and separate VSMs.

Figure 6 exemplifies, through a VSM, the stages from delivery creation to order closure for an order of the Montenegro commercial division, managed by carrier α. The VSM shows that several activities, characterized by minimal added value, consume significant time, such as the manual exchange of emails between GM logistic department and α traffic control. Such activities pose obstacles if integrated into the CT project. The two companies are now aware that they need to establish an interface to manage this activity prior to incorporating the process into the CT. Indeed, as the situation currently stands, GM dispatches a daily email to α, containing all the

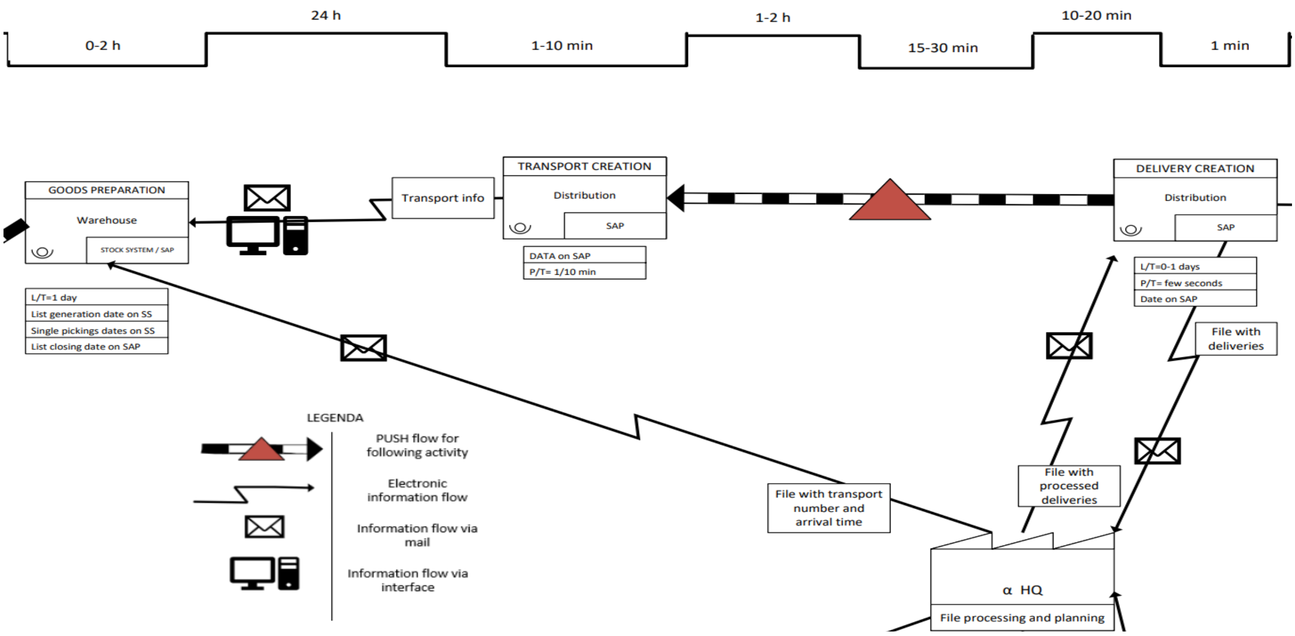

Figure 6: VSM of the stages from delivery creation to order closure with carrier α for a Montenegro product.

new deliveries intended for assignment. During trip planning, α manually adjusts the file and subsequently forwards it to GM via email, enabling GM to initiate transport creation. Even though the duration of the aforementioned activities may fluctuate considerably from day to day, within the VSM framework it can be noticed that an activity like trip planning, which should ideally take a maximum of thirty minutes, incurs a daily loss of approximately 10-20 minutes due to file transmission and manual processing. An interface, besides diminishing time and errors, would enable GM to gather data from activities, a crucial element for an effective CT. Thanks to the adopted method other inefficiencies have been highlighted and GM is working to overcome them developing interfaces with carriers and modifying processes.

5. Conclusions and future research

While many companies offer excellent software solutions, the adoption of control towers (CTs) in the market has proven to be sluggish due to numerous barriers and a limited number of companies have recently implemented CTs. This paper tackles this issue by presenting a systematic method, a real-world case study and a preliminary literature analysis, offering insights into the challenges and opportunities associated to CT adoption.

The literature analysis addresses RQ1 by delineating a set of constraints impeding the adoption of a CT, which can be categorized into three main groups: (I) inappropriate processes, technologies, and systems; (II) lack of communication and trust; (III) insufficient monitoring and decision-making metrics. Further, a collection of best practices from the literature is done. It is important to emphasize that the latter theme has received only marginal attention in existing literature. This paper endeavors to contribute to this underexplored research area.

Consequently, the paper addresses RQ2 by proposing a systematic method to facilitate the adoption of logistic CTs during their initial phases. To avoid potential cost or feasibility issues, it is advisable to comprehensively map and optimize the logistic and informative flows. Swim Lane Diagrams (SLDs) are of help to consolidate all information gathered from pertinent stakeholders into a unique flow perspective. They facilitate the visual identification of the level of utilization of each department prior to implementing any change. Undertaking this is crucial to ensure that the CT enhances the daily operations of these departments rather than impeding it. Value Stream Mapping (VSM) sheds light on IT activities lacking added value, suggesting their exclusion from the CTs. By adopting this method, a company gains full awareness of necessary process modifications to mitigate inefficiencies that might compromise the performance of a CT or hinder its adoption.

Next steps from this paper should involve collecting project requirements while implementing the changes recommended by SLD and VSM. Consequently, it would be pertinent to examine the deployment of a prototype and debug it via a pilot program.

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