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Control towers in supply chain management – past and future

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Abstract

The global economy requires global supply chain management which relies on visibility and responsiveness. Determinants such as: information technology tools, process knowledge, sales and operations planning experiences, etc., enable the formation of theory and practice for the supply chain control tower concept. The goal of the research paper is to identify business examples of different approaches to the supply chain control tower in the past and initiate a discussion on their future. This paper synthesizes past control tower practices and identifies possible future trends. The author performed: literature analysis, three selected companies' case studies and comparative analyses. As the control towers evolve, while supply chains are transforming continuous, update from the market is needed. The research findings showed the selected companies, in the future, perceived control tower's activities as a potential source of revenue not just solely a source of cost and time optimization as well as a source of value added to customer. The researched control towers were built and still they are developed. The business frequently changes and requires control towers to be adjusted, reengineered and adaptive. The researched control towers are needed to keep control over supply chain while it is transforming. There is a differentiation between the supply chain control towers, logistic services control towers and reverse supply chain control towers. An integration mechanism between the control towers would be necessary to assure entire supply chain visibility and orchestration. The research also shows the knowledge gap regarding the control towers in supply chain, specially their possible configurations and future.

Keywords: supply chain management, supply chain control tower, logistic control tower.
JEL Classification: L22, L63, L87.

Introduction

The global economy requires global supply chain management, which engages many partners, processes, resources and a lot of information. In such conditions, competing means implementing and maintaining agile, adaptive and aligned supply chain [Lee 2004]. Dynamic alignment [Gattorna 2008] and agility requires visibility and responsiveness, both driving the need for real time information available to all decision makers with operation's synchronization mechanisms and feedback loops. The visibility and responsiveness could be achieved by implementing supply chain event management (SCEM) consisting of: "[…] monitoring the planned sequence of activities along a supply chain and the subsequent reporting of any divergence from that plan to enable a proactive, even automatic, response to deviations from the plan" [Christopher 2011]. The business reports, IT solutions providers' reports shows that the supply chain event management is delivered by supply chain control towers. The author hasn't found any research publications regarding practical applications of control towers. Therefore the understanding how the control tower system delivers the supply chain event management in business practice became the author's research challenge.

The goal of the research paper is to identify business examples of different approaches to the supply chain control tower in the past and initiate a discussion on their future. The author also aims to examine the current state of the supply chain literature in terms of a knowledge gap regarding the control towers operations and their future. Through selected case studies and comparative analyses in the high-tech industry this paper brings an update from the market. The results could be used in a further supply chain research and modelling. This paper also delivers to the supply chain managers up-to date practical knowledge regarding possible trends in configuring and developing supply chain control towers.

The remainder of the paper is organized as follows. The Section 1 contains review of theoretical and practical background for the supply chain and supply chain control tower. The supply chain control tower is analyzed in three dimensions: organization, IT solutions and processes.

In Section 2 the research methodology is presented. The author selected three companies that operate in the high-tech market and are engaged in after-sales service. The methods used were both case studies and in-depth interviews with management representatives followed by comparative analysis and enriched by literature data directly related to the researched companies.

In Section 3 the research results are presented. The past of the researched control towers operations and their expected future are characterized. The article finishes with the results discussion and overall conclusions regarding the past and future practices in supply chain control tower operations.

1. Literature review

According to Poirier and Reiter [1996] a supply chain is a system through which organizations deliver their products and services to their customers… a network of the interlinked organizations, that have a common purpose: the best possible means of affecting that delivery. Similar approach was taken by Aitken [1998] followed by Christopher [2011] saying supply chain is a network of connected and interdependent organizations mutually and co-operatively working together to control, manage and improve the flow of materials and information from suppliers to end users.

The supply chain requires management. Following the Council of Supply Chain Management Professionals (CSCM 2016), it could be stated: supply chain management (SCM) encompasses the planning, organizing and controlling all activities involved in sourcing and procurement, conversion, and all logistics activities. It also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, supply chain management integrates and balances supply and demand within and across companies. Christopher [2011] defines SCM as the management of upstream and downstream relationships with suppliers and customers in order to deliver superior customer value at less cost to the supply chain as a whole. Lee [2002] underlines that supply chain management has emerged as one major area for companies to gain a competitive edge. The task is complex and challenging due to the business trends of: expanding product variety, short product life cycles, increasing outsourcing, the globalization of business, and continuous advances in the information technology.

Currently, the key challenge for supply chain managers is the risk associated with the uncertainty of supply and demand (including the chaos and nervousness that are consequences of that risk) [Christopher, Lee 2004]. There is a specific spiral effect driving market risk. Therefore, there is a critical need for building visibility and control mechanism increasing confidence of supply chain management teams. Supply chain visibility is defined by Heaney [2014] as the awareness of, and control over, specific information related to product demand forecast, orders and product supply and inventory plus physical shipments, including transport and other logistic activities, and the status of events and milestones that occur prior to, and in transit.

According to Debra Hofman, an analyst with AMR Research Inc. [Blanchard 2007, pp. 14-27], best-in-class companies share these three traits: aim for balance, increase demand visibility, isolate high costs. The answer to that visibility and control requirement is the Supply Chain Control Tower. Building control

tower is one of the five key steps to manage supply chain [Mena, Christopher, van Hoek 2014]. Global risk management through control towers is one of the top ten emerging trends which are shaping supply chain operations worldwide. The trends are: The rise of regional theatres of supply, Global risk management through control towers, Customer segmentation, Real demand realization, Omnichannel retailing challenges, Demand swing alignment with production and distribution, Customer of one service, Sustainability challenges, Collaboration vs. competition in the new economy, Financial dynamism [Cooke 2014].

"The Supply Chain Control Tower is to provide brand owners with a centralized, panoramic view of demand and supply-side trading network operations. Business events such as: supply disruptions (e.g., global part shortage), demand spikes or troughs (e.g., a new product is a hit), and natural disasters (e.g., flood, tsunami, earthquake), have demonstrated the need for not only cross-network visibility, but also the ability to execute supply chain plans across multiple tiers of the trading network" [E2open 2014]. The concept is built on the supply chain event management (SCEM): "[…] process of monitoring the planned sequence of activities along a supply chain and the subsequent reporting of any divergence from that plan. Ideally SCEM will also enable a proactive, even automatic, response to deviations from the plan" [Christopher 2011]. The need for visibility in supply chains grows with their complexity related to e.g.: complex products with shorter life cycles driving to unreliable supply sources and processes, shorter customer expected lead times while increased replenishment lead times, complex organizations and complex information systems [Christopher 2011]. "Control Tower acts […] utilizing technology, organization and processes that capture product movement visibility…" [Greene, Caragher 2015]. The key function of control towers is to provide enhanced visibility for short and long term decision making that is aligned with strategic objectives [van Doesburg et al. 2011]. The value added from such solution is the minimized time to problem resolution and easy leader's access to the across the board performance metrics [Ball, Monroe 2012]. For supply chain chiefs charged with risk management, control tower allows company to go from reacting to anticipating [Cooke 2014].

A control tower monitors, measures and reports timing, efficiency and service data in real-time and it assists the customer in aligning and realizing strategic objectives [Greene, Caragher 2015]. Therefore, building control tower requires: technology, using the appropriate metrics [Mena, Christopher, van Hoek 2014], engaging the right skilled expertise team, design processes and organization with its interfaces to all partners in supply chain [van Doesburg et al. 2011].

The IT interfaces are necessary because the control tower uses real-time data from existing transactional systems in order to integrate processes and tools

across the end-to-end supply chain [Bleda 2014]. Control Towers use standard operating procedures. There could be different geographical locations with distributed team in different cultures and time zones, but they would communicate following exactly the same processes. The value here is that one system and one process are being managed in a way that is standard across the supply chain [Greene, Caragher 2015].

The typical functionalities offered in the IT tools supporting control tower are: KPI dashboard, alert to action, task and case management (also named as "ticket management system") and global visibility of mainly demand and supply [Manning 2015]. The key capacities of the tool are: real-time access to information across the entire supply chain, event management and alerting, powerful analytics tools, including predictive analytics, and streamlined processes driven via workflows [Bleda 2014]. The analytics tools should apply business intelligence to support problem and crisis detection using the 'management by exception' as well as suggest problem resolution scenarios [Cooke 2014].

The choice of IT solution for control towers is very wide with over 10 globally recognized providers such as e.g. JDA Agile Control Tower, One Network, E2Open etc. The leading solution concentrates on providing intelligence to decision makers through functionalities – e.g. sensing unexpected events across the supply chain, diagnosing the root cause and offering a choice of corrective actions. They also provide possibilities to conduct 'what if' analysis, then make optimal guided choices that balance short-term responsiveness with long-term strategic goals [Cooke 2015].

In order to: collect, store, analyze data, diagnose problems, optimize solutions plus trigger and control actions the entire system should consist of five basic layers [Shou-Wen et al. 2013]:

1. Supply chain perception layer: Internet of Things technology to achieve real time sensing and transmitting.
2. Supply chain business layer: supply chain members, processes, workflow.
3. Information operation control layer: the supply chain information storage and control including control principles and feedback loops, with ongoing interaction between the storage and control part of the system.
4. Information service platform: provides transparency and visualization real time as well as retrospective including feedback.
5. Information manpower layer: the supply chain manpower control center and the decision making center including the early warning alerts and help detect plus act on risk.

The supply chain control tower as well as their IT solutions have got applications in many different industries. After the literature and business practices

studies the author proposes a supply chain control tower definition as follows: planning and execution system, that effectively deals with resource constraint and/or contention as well as process deviation in order to execute corrective and preventive actions in real-time. Its purpose is to regulate the supply chain by maximizing service, minimizing cycle time, while optimizing resources.

The control tower system consists of a human organization, processes and IT solutions. It enables proactive and/or automatic response to any deviation or any constraint, or contention. It provides enhanced visibility for short and long term decision making aligned with strategic objectives.

In order to further understand the up-to date experiences with supply chain control towers and recognize future trends, the following research questions were formulated: How supply chain control towers operate in business practice? How are they developed? What is the future for supply chain control towers? Is there a knowledge gap regarding the control towers?

The research questions became important to managers and researches as control tower is attracting a wider interest. In the 2012 Annual Supply Chain Study by Capgemini Consulting, 57% of 350 companies taking part in the research said that visibility improvement such as control tower were high on the list of supply chain projects to undertake [Li, Koperdraat 2012; Cooke 2014]. Moreover 10 companies of Gartner Supply chain top 25 list (Unilever, Procter & Gamble, Samsung Electronics, Cisco, Colgate-Palmolive, Coca-Cola, Walmart, Lenovo Group, Kimberly-Clark and Caterpillar) have a global Control Tower in place [Bhosle et al. 2015].

2. Research methodology

Three companies were studied between March and July 2016. The companies operate within the high tech industry and they are present on global markets. However, they represent different tiers in the supply chains and play different roles. The companies have built their supply chain control tower organizations. The company's management agreed to share documentation regarding the control towers and participate in the in-depth interviews. Due to PR and sensitive information policies they did not provide permission to use their company names in this paper. For the purposed of this paper, the organizations are referred to as company 'A', company 'B' and company 'C'.

The key sources of information were: the internal training and project presentations regarding control tower goals, organization, processes and tools provided by management and/or available on Internet. Additionally, there were four

in-depth interviews performed with senior managers responsible for supply chain organizations and in two cases specifically Heads of the control towers.

The interview questions were standardized open-ended and documented in the questionnaire, kept consistent from interview to interview. The interviewer played a neutral role, acted casual and friendly, but did not insert her comments or opinions. However, many answers received required further in-depth questions to gain deeper knowledge and understanding of the company's past and future situation.

In addition to the three company researched, there was also a secondary sources' study performed [Scholtz 2004; Blanchard 2007, pp. 14-27; van den Bovenkamp 2011; Johnson, Lauritzen 2015] in order to further understand the practices, experiences and trends of the researched supply chain control towers. The author also used Aberdeen Group, Capgemini Group and Accenture research reports and presentations to further analyze the market knowledge and experience regarding supply chain control towers and use them in the literature review section.

The source materials and interviews indicated the information regarding the control towers presented in the Table 1 below.

Table 1. The researched company's characteristics

The gathered information	Company 'A'	Company 'B'	Company 'C'
1	2	3	4
The industry the company operates in	Telecommunication	Electronics	Logistics
The company's operations	Telecom network solution provider managing integrated supply chain. Outsourcing virtually all of its manufacturing, and associated supplier management, became responsible for the orchestration of an extended multi-tier supply chain [Scholtz 2004]	World-class provider of end-to-end reverse supply chain solutions to some of the world's leading OEMs and ODMs [Underwood 2009]	Provider of simple, efficient, controllable services: transport management, warehouse management and data management [www 1-4]
The company's products and services	Solutions for telecom operators, governments and enterprises: Mobile Networks Fixed Networks IP/Optical Networks Applications & Analytics [www 1-4]	After market services for consumer electronic equipment (telecom and computer): collecting, repairing and delivering electronic equipment + call centre	Logistic services for electronics, automotive, medical electronics, etc.: 4PL, freight forwarding, warehousing, Value Added Services as well as critical spare parts storage globally
The company's demand markets	Global market	Global market	Global market

Table 1. cont.

1	2	3	4
The company's supply markets	Global – mainly low cost country sourcing	Global – mainly determined by customers	Global market – logistic service providers
The company's supply chain partners	EMSs, sub-assembly and ready solution manufacturers OEMs*, components suppliers, installation services companies, logistic services providers, service companies	Spare parts suppliers, other company's locations, e.g. central EMEA warehouse, curriers, logistics services providers, customers, consumers (known as reverse supply chain)	Transport companies, storage depot agents, customs, customs brokers, our clients, chamber of commerce and a transport insurance company
The company background and transitions	Originally telecom equipment manufacturer, after many transitions, outsourcing, merges and acquisitions as well as spin offs	Originally EMS (Electronic Manufacturing Services) after many transitions, insourcing, merges and acquisitions	Originally Europe based transport and freight forwarding company, grew after intensive development through strategic partnerships globally
Control towers defined in supply chain	Global Control Tower created as an organization c.a. 16 years ago [Scholtz 2004]	Planned three regional control towers, one implemented in Europe with some services also for USA	One control tower controlling all global processes and partners set up c.a. 10 years ago

* OEM – Original Equipment Manufacturer, company owning the brand and the proprietary rights to the product/solution.

The three companies described in the Table 1 were studied in order to understand the supply control tower practices as well as the future directions of their development and future trends as identified by those interviewed (management).

3. Research findings

3.1. The past control tower practices

The researched companies created their supply chain control towers as a response to a specific business need, and the scopes of their tasks were different and adjusted to the current requirements. In case of company 'A', the widespread tantalum capacitor shortages and allocation of supply, that faced the industry in the second half of 2000, led the head of the global purchasing office to create a 'global control tower' organization to measure, consolidate and manage demand planning across company's facilities world-wide [Scholtz 2004]. In case of company 'B' the first organization of control tower was created as a dedicated solution for a new customer project in 2007. At that time, the key activities focused on monitoring few

thousands shipments a month, sensing exceptions and so call 'no-activity'[1] cases. In case of company 'C', the control tower organization was created approximately 10 years ago. The transport and freight forwarding company started to build global presence through many logistic partners, while having only one local organization in the Netherlands. They needed a dedicated team and processes to collect data from many geographically distributed partners and react in case of any exceptions from the desired processes and its' parameters, e.g. lead time, cost.

In all three cases, in the opinion of respondents and the secondary sources, supply chain control tower organizations brought value added to the companies and delivered the expected results in the projects they had been set up for. For example company 'A' after introducing new supply chain management organization, including control tower, it dropped its on-hand inventory from more than $7 billion down to less than $3 billion by 2002, and by 2003 inventory was just shy of $1 billion. It took better control of its cash expenditures, dropping them from $2.2 billion per quarter to $130 million. Over the same period of time, company 'A' reduced its total number of suppliers in half – from roughly 3,000 to less than 1,500 [Blanchard 2007, pp. 14-27].

In consequence the control towers have been developed. They built organizational structures with defined responsibilities, processes and business goals. Company 'A' created the interface to the sales teams via global demand planners within the global control tower team, then focused on Central Coordination of Supply Planning and Execution. The organization consisted of specially trained planners responsible for driving one feasible supply plan (both material and capacity availability), coordinating purchasing and production to realize the supply plan and manage inventory. The concept of the company 'A's' control tower assumed four coordination mechanisms between: (1) order processing, (2) demand management, (3) material purchasing, (4) production scheduling. As a result of key merges and acquisitions in 2006 and 2016, the whole organization was reshaped twice and completely reengineered.

The company 'B' supply chain control tower organization is focused on shipments flows rather than demand and supply flows (as it is at company 'A'). There are three basic job roles: supervisor, analyst and operator. The analysts focus on: network performance key metrics analysis, failure analysis, process improvements, ad-hoc reporting, supporting partner QBR[2]. The operators focus on: exception management, case management, claims management, partner interfaces e.g. 3PL operations, repair operations. The control tower organization is managed by the supervisor function.

[1] „No activity" – name used to describe shipment without information from logistics partners about its current status, lack of information about reaching planned destination on its route.

[2] QBR – quarterly business review, a process for partner relationship management organized around quarterly meetings focused on past quarter results and future quarter plans

The company 'C' control tower is also focused on shipments and inventory including value added services. The Control Tower monitors all the shipments closely and proactively, 24 hours a day and 7 days a week. A department within a logistics service provider monitors shipments and manages them proactively. The Control Tower is available at all times, and focuses on identifying anomalies in the delivery process, in order to intervene immediately where necessary. The organization is based on a function named a control tower agent, who is responsible for: integrator checks (TNT, UPS, FedEx, DHL shipments), non-integrator checks (groupage), critical spare parts monitoring, storage location on time inbound processing check, support ticket responsiveness management, certain back-office chores.

In general, the researched supply chain control towers are responsible for process monitoring, measurement, assessment, corrective and preventive actions, responding to customer tickets and/or issues as well as reporting to the internal and external partner's organizations to initiate the improvement processes. The control mechanism relies on the key performance indicators (KPIs). The below Table 2 presents the KPIs implemented in the research organizations.

Each control tower uses KPIs – however they are aligned with the control tower focus. In the three analyzed cases the KPIs are different as the three control towers concentrate on different processes and areas of the supply chain. However, all KPIs measure process parameters related directly or indirectly to time, cost and customer satisfaction.

Table 2. KPIs implemented in the researched supply control towers

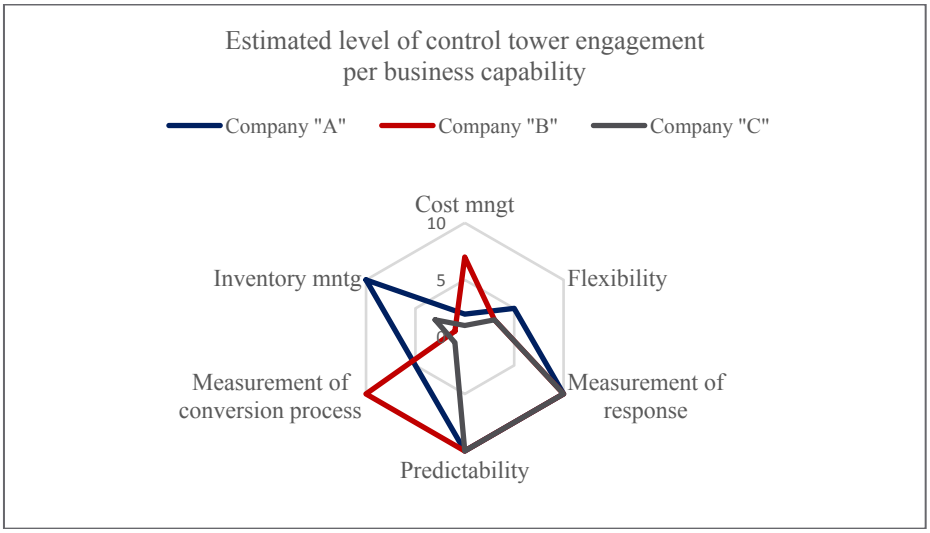
Company	'A'	'B'	'C'
Process	Delivery	End-to-end performance	Communication performance
KPIs implemented	− Delivery performance − Delivery reliability − Confirmed Line Item Performance (CLIP) − Requested Line Item Performance (RLIP)	− Logistic delays, − Shortage delays, − Repair line delays − On time performance (carriers) − Weekly volumes reports	− Responsiveness to customer tickets − Call center − Availability
Process	Operations	Service Operations	Shipment / delivery performance
KPIs implemented	− Order Lead Time − Production Throughput Time − Production adherence to schedule	− Re-repair − Not trouble found − Parts usage	− On-time performance (carriers and customers)
Process	Inventory management		Control Tower Self Productivity
KPIs implemented	− Inventory Turnover / / Inventory Reach − Aging Stock / Blocked Stock		− Number of exceptions not covered yet

The performed study showed that the control tower primary functions could be focused on controlling:

- supply base performance,
- conversion processes,
- balance between supply and demand,
- inbound logistics,
- outbound logistics,
- procurement.

The control towers have evolved with the business. The author summarizes the different approaches on the radar diagram in Figure 1. It shows, for the three companies, the estimated control tower's engagement level in the chosen business capabilities. The scale 1-10 has been developed by the author and the values assigned to the companies base on the answers from the respondents. The researched companies have put a different focus on the business capabilities and their service is not balanced between them.

Figure 1. Estimated level of control tower engagement per business capability



In author's opinion the control tower system should aim to balance its engagement in business dimensions specified in the Figure 1.

In all analyzed cases, the supply chain control towers are and were supported by a dedicated IT solution enabling integration and coordination as well as orchestration of partners in the operations' processes. In case of the company 'A', a supply chain portal was developed. The mission defined for that portal was: "Enable the most flexible and efficient supply chain by leveraging strategy,

processes and technology that integrate company's organizations, trading partners, and eMarketplaces to create real-time, global visibility and decision making control over the virtual supply chain" [Ronchi 2003].

Company 'B' implemented a system called LOGIXS, which is a tool designed to manage all shipments the Control Tower was dealing with and to ensure that real time solutions were provided in the Service Logistic Chain to achieve the highest level of customer satisfaction. The solution based on courier scans, assured: availability of automatic pro-active updates via email and/or sms, communication with carrier for exception resolution as well as the customer call center agents, early signs of exception that may impact customer TAT and flags them to the control tower. Currently, the company 'B' control towers are supported by a network of IT tools. Besides LOGIXS a tool called iKnow is used, providing customized metrics (KPIs) available for the customer via an online web link. The control tower also is supported by TRAX (an IT system used in distribution for label print, collections, denied party screening, license management, trade documents). A supporting source of information is SL (ERP system) with dedicated functionalities for aftermarket services in the reverse supply chain.

Company 'C' uses a tool named Klairy – a unique in-house built WMS/TMS system, that provided so-called billboards based on exception management. In other words, the billboards showed only those shipments that (may) require attention because a status was wrong, a due-date was missed, an exception scan from carrier was noticed, etc. Klairy is a comprehensive software solution for global logistics management that allows traffic flows across the supply chain to be monitored and controlled in real time, a web-based service, with integrated transport, warehouse and financial management modules, at a fraction of the cost of traditional supply chain software [www 1]. Additionally the company uses Live-Chat (online communication), Support Tickets (for order-related communication and complaints registration), MS office tools (Outlook, Excel and Word primarily), call center tool to distribute calls and provide management information.

In summary the researched supply chains are evolving and adapting to the changing markets: products, customers and competitors. The partners are transforming the relations though merges, acquisitions, spin off, strategic alliances, green field investments etc. The changes require appropriate adjustments of control tower functions, processes, organizations. The question is: What's the future for the supply chain control towers?

3.2. Future trends for supply chain control towers

There were three companies researched and different views regarding future trends were presented. Company ‘A’ after recent merge has been focused on the synergy and transformation program targeting EUR 900 million of operating cost synergies to be achieved in full year 2018. At the same time, the company ‘A’ is taking steps to adapt to challenging market conditions and to shift resources to future-oriented technologies such as 5G, the Cloud and the Internet of Things. As part of the program, the company also continues to target worldwide savings in procurement, supply chain and manufacturing [www 1-4].

“[…] The new supply-chain capabilities has been implemented, such as comprehensive performance dashboards that allow senior leaders to monitor all relevant supply conditions in real time […] The spike in demand volatility – pushed us from flexibility to agility. Our investments further optimized our processes by intensifying our internal collaboration and creating a culture of continuous improvement” [Johnson, Lauritzen 2015].

The representative from Company ‘B’ outlined future minor and major changes for the control tower. The control tower provides its’ service to Business Units Leaders (BUL) and Project Managers (PM) whose requirements evolve with the market, product and competitor changes. Therefore, the control tower activities and organization adjust to those changes and processes and IT tools functionalities are also adjusted. These are the minor changes.

From a tactical and strategic perspective, the responder perceives an advantage in the strength arising from the last merge. One of the merging companies gathered experiences in after-market services and specialization in controlling reverse logistics shipments while the second company specialized in call center services. Considering those capabilities, in the future, the control tower analysis and reporting together with call center’s technical support and debt collection could be included in one integrated package offered as a commercially available service to external partners. A specialized team, advanced technology and know-how regarding processes and its control mechanisms could be unique and a desired service specially for middle size but also for globally expanding companies.

The Company ‘C’ representative pointed to the following determinants as being important in the future:

- globalization of sales and operations for small & medium sized enterprises,
- further it developments, and
- specialization of companies and people.

The representative also explained: "As smaller companies are taking a leap abroad, they often miss expertise, time and volume to use and manage (or ride along with) a cost-effective, high quality transport solution. Bigger service companies, representing many different size companies, already have business contacts, infrastructure and experience. Besides low-cost, control towers also provide quality assurance, troubleshooting, etc. Control Tower (CT) is just one part of our service offering and outsourcing benefits to clients. For instance: IT platform, purchase power, vendor management, logistics partner's invoice verification, and so on. As IT continues to innovate, control towers grow stronger" [E2open 2014].

In summary, the companies perceive control tower's activities as a potential source of revenue not just solely a source of cost and time optimization in the future. The control tower also differentiates the company's offerings from others on the market – it is treated as a source of value added to customer. Such a perspective could accelerate the trend of building and developing control towers.

Company 'A' s control tower focused on balancing supply and demand belongs to the second group, and company 'C' belongs to the first (logistic control tower focusing on shipments). Interestingly, the company 'B' control tower focused on reversed supply chain and is a kind of a hybrid because on one hand it controls shipments from and to customers, but at the same time it controls KPIs for service and repair technological processes. It is worth to point out that it does not control the inventories and demand.

The fact the types can be distinguished unveils the truth: the entire supply chain processes are not fully integrated. Some control towers focus on the integration of internal company processes and some on its' interfaces to tier-one partners. In order to build the integrated control tower for logistics and supply chain management there is a requirement for reengineering across the entire corporation.

In summary it could be stated that all three analyzed supply chain control towers have got the following similarities and differences shown in Table 3 below.

Table 3. The researched control towers' similarities and differences

Company	'A'	'B'	'C'
Area of comparison	SIMILARITIES		
Creation & development	– created as a response to a specific business need – brought value added to the companies and have been developed		
Organization	– the organizational structures built with defined responsibilities, processes and business goals		
Control tower responsibility and task	– process monitoring, measurement, assessment, corrective and preventive actions, responding to customer tickets and/or issues as well as reporting to the internal and external partner's organizations to initiate the improvement processes		
Control mechanism	– relies on the key performance indicators (KPIs) and the control limits, once KPI values are over or below the control limit then the correction and preventive actions are initiated		

Table 3. cont.

Company	'A'	'B'	'C'
IT solution	– supported by a dedicated IT solution enabling integration and coordination as well as orchestration of partners in the operations processes.		
Business environment	– the supply chains are evolving and adapting to the changing markets: products, customers and competitors; the partners are transforming the relations though merges, acquisitions, spin off, strategic alliances, green field investments, etc.; the changes require appropriate adjustments of control tower functions, processes, organizations		
Future	– potential source of revenue not just solely a source of cost and time optimization		
Area of comparison	DIFFERENCIES		
Business focus	– demand and supply flows balancing, network performance key metrics analysis	– shipments flows – exception management, case management, claims management, partner interfaces	– shipments and inventory including value added services
Working time	– regular business hours	– regular business hours	– 24 hours a day and 7 days a week
Future	– after recent merge the focus is on transformation and synergies – monitor all relevant supply conditions in real time – targeting agility to replace flexibility – creating a culture of continuous improvement	– minor changes: adjust processes and IT tools to meet the internal customer's changing needs e.g. Business Unit Leaders, Project Managers – major change potential: take an advantage from the strength arising from the last merge – control tower as a commercially available service for external customers	– control tower growing stronger as one part of service offering creating outsourcing benefits to customers – bringing competitive advantage
Name used in some sources showing the differentiation in operation's focus	– supply chain control tower	– logistic control tower (covering also service operations)	– logistics control tower

For the future practical applications, the author proposes that, the control tower service could operate at different levels. Starting from the performance monitoring using KPIs, through controlling the interparty processes and further to the level of configuring partnerships and up to executing dynamic network changes. In the author's opinion the development of the control tower service could focus on integrating data and control mechanisms between the primary function areas mentioned above as well as adding new levels of operations.

In order to make the service attractive to users and competitive on the market overtime, there is a higher level of data and process integration required be-

tween different processes in supply chain e.g. supply and inbound logistics and outbound logistics. At the same time, operating at a higher level is needed to allow, for example, dynamically changing the network.

Discussion

The research finding fit in the current knowledge in the area of supply chain, supply chain management and supply chain event management as presented in the literature review section. However the control tower system is not yet described and defined in literature while it is in business practice. There are organizations, job functions, IT tools and processes named with "control tower" phrase in business environment. This is confirmed not only with the three case studies but also with analyzed reports and Internet materials research.

Additionally the author proposes to recognize the logistic control tower and supply chain control tower as well as integrating them. It corresponds well with some of the business reports. The top requirements regarding supply chain visibility, collaboration and network redesign [Koperdraat, Dietaren 2012] drive a need for end-to-end visibility and direct action with efficiency feedback [Piest 2014] for demand, supply as well as shipments and reverse processes. In order to achieve cross chain, cross enterprises integration a step forward is required allowing to connect control towers into a collaborating network named by Piest [2014]: 'Cross Chain Control Center'. Similar requirement was already defined in Polish literature by Chaberek [2000] named as 'integration function of logistic center'. Also van Doesburg [2011] concludes his research that many control towers still have a limited scope from supply chain and/or functionality perspective. Benefits can be increased by expansion of the supply chain scope, adding more supply chain partners and/or upgrading of the concept from an operational to a more tactical level. It also needs to be marked that the researched companies have put a different focus on the business capabilities and their service is not balanced between them (see Figure 1).

Base on studying company 'B' case, the author proposes name: a hybrid control tower as it plays functions of logistic and supply chain control tower. This type of practices are not noted in the studied publications.

The author also wondered why the control tower is not involved in demand-supply processes and purchase processes? Such an integration of control function for logistic and supply chain management could bring a synergy effects in costs and time reductions. Further in-depth interview showed that the teams managing those two different areas have got:

– distributed decision centers,
– split of responsibilities,
– different skills and knowledge,
– different external business relations, and
– separately set business goals.

The author recognizes a knowledge gap regarding the different configurations of supply chain control systems named control tower.

Conclusions

The reviewed literature and business source materials showed that the name 'control tower' is used and received positively in business. However, companies tend to use it in different circumstances, and with different functions. There is a trend towards developing control towers in order to increase the visibility and achieve supply chain collaborations and agility. Control towers are built in different types of business but they reflect the value added of the corporate business. They are placed to give visibility to corporate business process and allow decision making aligned with business strategy. The case studies and interviews' conclusions fit in the above theoretical statements.

The researched cases showed examples of different types of businesses (e.g. service, logistics, manufacturing). All of them need a dedicated system and processes to control the main flow of conversion process within the supply chain. The control system needs to be supported by IT solutions realigned to specific business requirements. Therefore, the control tower is a system consisting of: collaborating teams equipped with adequate knowledge and experience following and using defined processes supported by advanced IT solutions.

As the business frequently changes the control towers need to be adjusted, reengineered and developed. In future, the business requires adaptive control towers in order to keep control over the supply chain while it is transforming. The brand owners could choose for their product's supply chain one of three options:
– develop their own control tower to control own conversion processes,
– offer control towers as a service (e.g. within 4PL service package), and
– purchase the control tower service from a specialized service provider.

The researched companies, who have got a good experience in running control tower (its value is well recognized by customers and the corporate business), consider it as a service to be sold to third parties and to generate some revenue. It could be sold as a part of service package e.g. 3PL service or sold as a single service.

To achieve the goal of the study, all activities specified in the research methodology have been implemented. The main challenge was to get access to the right representatives and the right source materials.

Presenting the current processes, tools and organizations in supply chain control towers the article brings a valuable update from the market about experiences, possible solutions and practices. It also confirms that, despite the fact there are not many literature publications (e.g. non in Poland), the control towers exist, function and develop on the market. The unique value of the research are the results showing:

- the possible levels of control tower's engagement per business capability,
- possible mechanisms of control tower role' transformation,
- possible further development directions for control towers.

The research results, by identifying how control towers function, bring ideas to managers and researchers regarding possible solutions to improve control over supply chain processes. Additionally it provides ideas on the control tower development directions. The research also shows the knowledge gap regarding the control towers in supply chain, specially their possible configurations and future.

The research bases on literature analyses and the selected case studies and comparative analyses in the high-tech industry only. Therefore it cannot provide conclusions and represent trends on the global market in the industry or other industries.

In order to conclude on the global trends the research should be continued and extended to a bigger sample of companies. The author sees a need to define and separate three areas of research focus: a) brand owners supply chain control towers; b) logistics services companies' control towers; c) reverse supply chain control towers. In author's opinion it would be important to perform a further research to verify if the proposed idea to create Cross Chain Control Centre integrating control towers is or could be successfully implemented in a business environment.

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