# Agile Approaches of Businesses in Logistics and Supply Chain

Dr. Kübra Göksu Köstepen Özbek 0000-0002-9092-8616

## Abstract

Modern logistics requires companies which implement ease of access, quick information processing, and security conditions in their enterprises. The foundation of this transformation lies in transportation processes that prioritize customer demands for reduced transit times, product availability, and efficient delivery. Modern systems encompass transportation exchanges, as well as tools like TMS (Transportation Management Systems), ERP (Enterprise Resource Planning), and Truck & Tracing systems. These systems enable logistics professionals to navigate the entire logistics process chain. In the present day, companies are adopting a project management approach to develop innovative solutions for their operations. According to the Project Management Institute (PMI) market research, project management practitioners widely embrace agile principles as an effective project management technique. By utilizing TMS, ERP, warehouse control systems, and other automated planning, organizing, and control tools for logistics activities, businesses can drive operational improvements. In the future, businesses will establish global networks that leverage cyber-physical systems encompassing machinery, warehouse systems, and production facilities. This research aims to explore how companies are implementing new agile approaches in their logistics and supply chain services, as well as the impact of logistics 4.0 and logistics 5.0 on businesses and customer service. In this research, more samples from the industries are examined and a comprehensive literature review regarding logistics and supply chain are presented.

## 1 Introduction

Over the last few decades, globalization has resulted in competitive business environment. This competition drives from change in customer demands and technological change in market. Companies are also met with decrease in product life cycles and uncertainty in the growth and dynamics of markets. Fluctuant market conditions in the twenty first century have increased the requirement of competitive strategies for businesses (Mehralian et al., 2013). For such reasons, nowadays agile supply chain becomes crucial, and businesses try to respond quickly and effectively to market changes.

To respond the demands of today's business environment, companies alter their supply chain structure and implement new technologies. By forming supply chain agility, businesses react more quickly and efficiently to uncertainties in the market. An agile supply chain can react to changes in the workplace in an appropriate way (Agarwal et al., 2007).

Projects that are managed using an agile approach are characterized by a significant level of uncertainty, ambiguous project goals, and the presence of incomplete and unpredictable requests throughout the project lifecycle. Agile methods provide a framework for addressing these challenges and driving improvements. In the realm of agile project management, the competitive landscape compels supply chain participants to continually evolve and offer new services that meet the demands of their customers or end users (Gunasekaran, 1999). Agility embraces organizational structures, logistics processes and information systems (Christopher, 2000). Through the emergence of industry 4.0 and its reflections to logistics and supply chain operations of companies (called logistics 4.0), agile approaches are applied by companies to respond business environment. Trends such as digitalization, the internet of things (IoT), cyber-physical systems (CPS) and cloud-based manufacturing and smart factories are becoming more relevant. Major implications of agile approaches are applied in the field of logistics 4.0 (Bauernhansl et. al, 2014). By integrating agile approaches into the logistics field, companies can benefit from real-time tracking of material flows, enhanced transport handling, and the ability to deliver customer-customized products at the lowest production costs possible (Dasilveira et. al., 2001). This integration empowers businesses to optimize their supply chain operations and improve overall efficiency and responsiveness.

Agility at the organizational level encompasses a wide-ranging concept.; in this research it is aimed to focus only on agility in businesses' logistics and supply chain. Previous studies have examined the agility and industry 4.0 as a term, agile project management approach, effect of agility on business performance. However, this study evaluates and determines supply chain and logistics agility approaches in businesses. In this study first, the emergence of industry 4.0 and its components are presented. Second, logistics 4.0 and implications in businesses are discussed. Third, how businesses can achieve agility in supply chain by implementing logistics 4.0 is discussed. Furthermore, another objective of this study is to address area of usage regarding agile approaches of companies. This will give an insight to companies that are willing to apply new agile approaches. To conclude, logistics 4.0 potentials and suggestions for future research are presented.

## 2 Industry 5.0 in the light of Industry 4.0

In Europe, the industrial sector plays a crucial role. The European manufacturing landscape has increased dramatically. Eastern Europe and Germany grow in industrial sector; however, the market shares of many Western

European countries like Great Britain or France diminish in the last two decades. Emerging countries have successfully expanded their share, accounting for approximately 40% of global manufacturing. Recognizing the need to maintain its position in the industrial sector, Germany initiated efforts several years ago. The term "Industry 4.0" was introduced at the Hanover Trade Fair in 2011 as a component of Germany's high-tech strategy to address future production requirements (Mittermair, 2015). This term was presented at the fair, highlighting Germany's commitment to leveraging advanced technologies and innovative approaches in manufacturing.

Industry 4.0 is a transformative process that fundamentally alters the dynamics of production and consumption. It represents a paradigm shift where production systems adapt to evolving consumer needs and maintain constant communication and coordination with each other.

Can and Kıymaz (2016) define Industry 4.0 as the collaboration of all units directly or indirectly involved in production and the integration of information technologies. Batista et al. (2017) describe it as a stage of further development in organizing and managing the entire value chain process, particularly focusing on sensor and actuator substructures in the manufacturing industry.

Schumacher et al. (2016) refer to Industry 4.0 as the integration of internet technologies, physical objects, intelligent machines, production lines, and processes. The recent definition by Mrugalska and Wyrwicka (2017) describes it as the integration of complex physical machines and devices with sensors and software, enabling better prediction, control, and planning of commercial and social outcomes.

In the context of Industry 4.0, the emergence of smart products has been observed. These products incorporate sensors, components, and processors that provide functional guidance to customers (Jian et al., 2016). Industry 4.0 encompasses a wide range of technologies and associated paradigms, including Radio Frequency Identification (RFID), Enterprise Resource Planning (ERP), Cyber-Physical Systems (CPS), Internet of Things (IoT), Cloud-Based Manufacturing (CBM), and smart factories (Andreas et al., 2016; Thames and Schaefer, 2016).

Industry 5.0 is the new society vision that was initiated in Japan and puts people at its center (Yacan, 2021). Industry 5.0 is defined as the introduction of artificial intelligence into people's lives, increasing human capacity, and cooperation between humans and artificial intelligence in order to place the human model at the center of the universe (Akın et. al., 2021).

In this way, it is aimed for a society that can respond to a large audience by providing the necessary goods and services to people, giving them exactly the goods they need in the required time and in the amount.

### 2.1 Logistics 4.0 and Logistics 5.0

Logistics has passed four stages until now. These stages can be sorted as logistics 1.0, logistics 2.0, logistics 3.0, logistics 4.0 and logistics 5.0. In the part of logistics 1.0, manual warehouse processes, transportation modes with steam engine were used. In Logistics 2.0 era global resource planning, automatic warehouse processes, vendor management were available. When logistics 3.0 is introduced, the computing system to manufacturing began (Göçmen and Erol, 2018). The Internet of Things (IoT) has caused the fourth industrial evolution. Autonomous inventory management, autonomous forklift, communication in vehicles and transportation operations, automated warehouses have emerged in “Logistics 4.0” era. The main topics of logistics 4.0 are CPS, IoT, Internet of Services (IoS), Big Data and Data Mining (DM). CPS uses sensors in order to provide the integration of digital and physical world. IoT offers interaction and communication with other systems and users. Different providers constitute IoS and it involves business models, users and services. DM includes huge volume of data and speed of computation; therefore, it is really hard to manage carefully (Barreto, 2017).

Smart products and services are important elements of this era as smart products have ability to communicate, control the processes and to capture time. Radio Frequency Identification (RFID) is used to determine logistics objects. Identity numbers of load and load information are provided by RFID. In addition, finding the location where loads are determined is possible via RFID labels (Sun, 2012).

Jeschke (2016) describes the term “Logistics 4.0” from two perspectives. From one perspective logistics 4.0 is described as company and mutually related processes using large amounts of data among independent members. From another perspective, logistics 4.0 is defined as autonomous, selforganising systems within other systems. Logistics 4.0 consists of smart plants that are organized with warehouses, shelves, production processes. In these plants, in order to feed information on stock levels, disruptions and damaged goods, smart machines are used. Furthermore, technological applications play crucial role. Resource planning, warehouse management systems and information security are instances of such applications in logistics sector (Hofmann and Rüsch, 2017). Hybrid approaches are possible with logistics 4.0. For instance, combination of Global Positioning System (GPS) and RFID are available. It is accepted that RFID is applied for indoors and GPS is applied for outdoors.

Since logistics 4.0 focuses on digitalization and visualization, integration of processes via internet and mobile applications are created. Businesses place emphasis on cloud computing and communication technologies, simulation, and robotic systems.

Logistics 5.0 represents the effective utilization of society-oriented unmanned technologies introduced by Industry 5.0 in the logistics sector. It strives to maximize the benefits derived from both machines and human

resources within the supply chain. While Logistics 4.0 focused on harnessing technology to generate knowledge and intelligence through human involvement, Logistics 5.0 takes it a step further by leveraging artificial intelligence to generate information and intelligence, ultimately serving the needs of individuals (Unimar, 2022).

Logistics 5.0 introduces a collaborative working system between humans and robots. Its objectives include establishing an unmanned supply chain, reducing supply chain risks and waste through real-time data analysis, enhancing supply chain integration for more strategic partnerships, and automating third-party logistics (3PL) operations like never before. This new approach enables robots to undertake tasks that are difficult, time-consuming, and potentially hazardous for humans.

## 3 Agility

### 3.1 Supply Chain Agility

Nowadays, to sustain competitive advantage, businesses' ability to respond is a key element. Companies place emphasis on ability to meet the needs of customers for shorter delivery time. Therefore, becoming more responsive and flexible to the demands of the market is a necessity. "Agile supply chain" is determined as "the ability to deal with unexpected events, to survive threats of business environment and to get advantage of changes" (Sharifi and Zhang, 1999). Businesses with supply chain agility can give response to unexpected challenges. Agile supply chains are more market oriented since companies deliver customer-customized products (DaSilveira et. al., 2001).

Figure 1 illustrates various characteristics that a supply chain must possess to be considered agile. According to Christopher (2000), one key characteristic of an agile supply chain is its market sensitivity. This means that the supply chain has the capability to quickly sense and respond to real-time demand. Information technology plays a crucial role in facilitating data sharing among supply chain members, thereby creating a virtual supply chain. As a result, virtual supply chains are often regarded as information-based systems. Another important characteristic of an agile supply chain is the achievement of process integration. This occurs through collaborative efforts between buyers and suppliers, including joint product development initiatives. By fostering cooperation and coordination across the supply chain, process integration enhances the overall agility of the system. Since companies focus on their core competencies and outsourcing activities, this form of collaboration is common in the supply chain. Christopher (2000) also indicates that, network constitutes other component of an agile supply chain. Better structure and coordination in relationships of supply chain partners can create better, closer and agile communications with their customers.

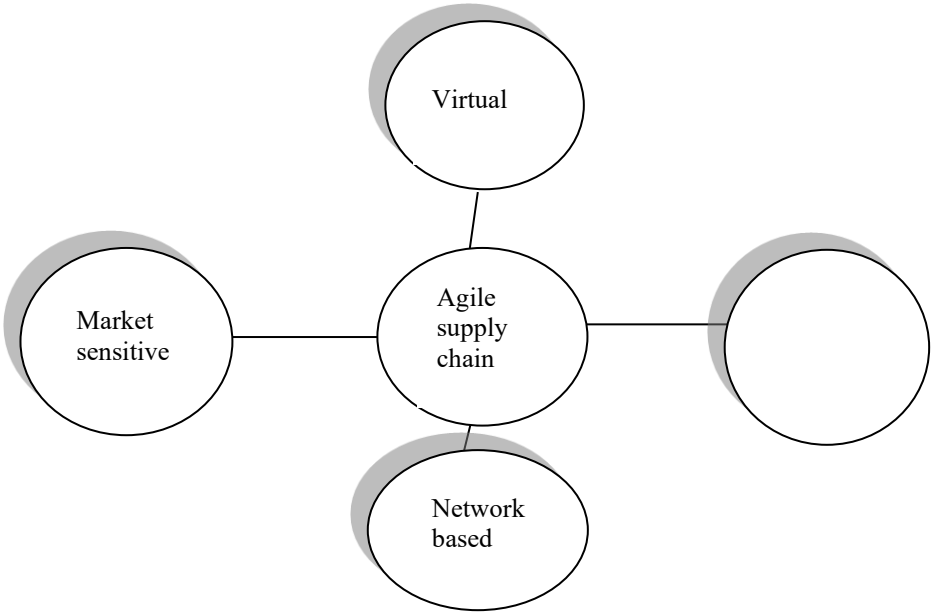


***Figure 1.*** *Agile Supply Chain*

Agarwal et al. (2007) propose a set of 15 variables that contribute to an agile supply chain. These variables include market sensitivity, delivery speed, data accuracy, new product introduction, process integration, lead-time reduction, cost minimization, quality improvement, trust development, centralized and collaborative planning, utilization of IT tools, customer satisfaction, uncertainty reduction, service level improvement, and minimizing resistance to change. These variables encompass different aspects that enable a supply chain to be agile and responsive to dynamic market demands.

In addition, regarding responsiveness recent agile supply chain model includes emerging technologies (Sinha et. al, 2015). In today's business environment, it is required to be ready for unexpected events such as sudden changes in demand, technology updates and responding to challenging issues of global supply chain. Also, with the rise of new digital industrial technology, companies are willing to respond such events and get competitive advantage by focusing on industrial technological advancements. In this study, current applications of companies regarding supply chain agility under the logistics 4.0 perspective are presented.

### 3.2 Agile Implications for Logistics and Supply Chain

Businesses apply agile approaches by controlling dynamic supply chain and sharing information currently. New technological developments can optimize supply chain management. Since transparency is provided, the whole supply chain is visible. This allows companies to use resources efficiently.

Businesses' agile approaches which are based on logistics-oriented 4.0 applications are affected by fourth industry revolution (Warfield, 2007). Agile applications consist of two dimensions which are physical supply chain and digital supply chain dimension. This logic is described in Figure 2. In the physical supply chain, the implementation of autonomous and self-controlled logistics systems, such as autonomous trucks for transportation, trailer unloading or piece picking robots for turnover handlings, and smart contracts utilizing blockchain technology for order processing, has a significant impact on various aspects of the supply chain. These autonomous systems interact and influence each other's operations, leading to enhanced efficiency and productivity.

On the other hand, in the digital supply chain, data collection occurs throughout the entire physical end-to-end supply chain, primarily through machines and sensors.

The integration of physical and digital supply chain elements allows for real-time information sharing, increased visibility, and enhanced coordination among different stakeholders in the supply chain network. This integration enables organizations to make more informed and proactive decisions, leading to improved overall supply chain operations.

In the cloud, whenever connectivity is provided for any kind of analytics, value-added business activities come to exist (Fleisch et. al., 2014).

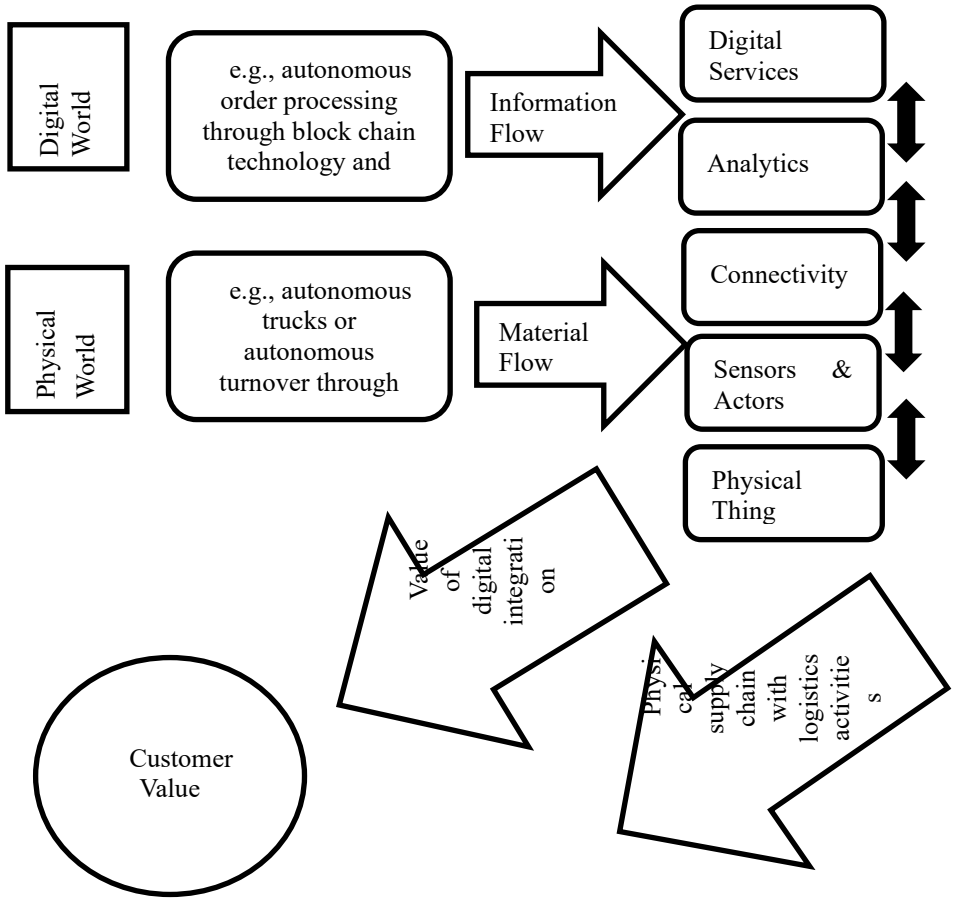


***Figure 2.*** *Logistics-oriented Industry 4.0 Approach*

Figure encompasses customer value elements. The concept of the "value of availability" in logistics refers to the ability to make products and services readily accessible to customers through autonomous delivery systems. This

represents a primary source of added value in logistics activities, as it ensures timely and efficient delivery to meet customer demands.

The "value of digital integration" is derived from the transparency and traceability achieved throughout the supply chain. By leveraging digital technologies and data sharing, organizations can track and monitor the movement of goods, enabling better visibility and coordination across the supply chain. This enhanced integration leads to improved efficiency and responsiveness.

Companies that would like to achieve agility in logistics and supply chain, perform recent technologies in logistics 4.0. Enterprise Resource Planning (ERP) solutions have been dispersing to involve more logistics management functions. Thanks to these solutions, companies are acquiring their own technology to promote Transportation Management System (TMS), Warehouse Management System (WMS) and supply chain processes. Businesses prefer to use Electronic Data Interchange (EDI) which eliminates paper-based exchange of business documents. Major benefits of EDI are reduced cost, increased processing speed, reduced errors, and improved relationships with supply chain members. Logistics companies use EDI to ensure that both data interchange and data transfer with TMS. TMS provides many ways to save money or drive value. It helps firms move freight from point of origin to point of destination in efficiently, effectively and reliably manner (Robinson, 2013).

To capture time, real time notifications such as load, unloading arrivals and departures are necessary. Information of Delivery (IoD) is used via navigation devices in trailer and semi-trailers. Thanks to Proof of Delivery (PoD), the delivery driver hand over a handheld device to sign on, instead of a paper document (Ghani, 2013).

Automation technologies which are defined above have begun to be used by companies. They involve automation components associated with logistics 5.0. Also, voice and light guidance systems increase human and machine interaction. Industry 5.0 strengthens communication between physical space and virtual space, connecting people, objects, and systems all in a virtual space. A few application areas used in Industry 5.0 are: drone, automated vehicles, use of cloud technology, and remote-controlled robots.

Automated Storage and Retrieval Systems (ASRS) is used by logistics companies. Storage and retrieval operations are generated by simultaneously offering positioning signals to a conveyor transport, a runner, and a storage transport. This enables companies' high traceability and transparency. ASRS system stores up products to their destinations and unloads from shelves.

Pick-to-Light systems, also known as Pick-to-Light systems, are valuable applications employed in warehouses to enhance order picking efficiency. These systems utilize light displays to guide operators to specific stock locations. Each product location is equipped with an individual numeric or alphanumeric display, along with a light and an acknowledgement button. Alternatively, some variations may incorporate simpler displays to reduce overall costs (Dematic Supply Chain Solutions). The Pick-to-Light system provides staff with real-time information regarding product quantities and order details displayed on a screen (Göçmen and Erol, 2018).

In addition, Geo-Fencing is one of the software programs that are used by the companies. Geo-Fencing determines a specific route for the vehicles. This is a feature in a software program and uses the GPS or RFID to define geographical boundaries. The system gives an alarm when the vehicles arrive or not arrive to the determined location. Many geo-fencing applications use Google Earth program, allowing administrators to specify boundaries on top of a satellite view of a determined geographical area. Other applications designate boundaries via user-created and Web-based maps (Rouse, 2016).

Indeed, blockchain technology represents a prominent example of the application of Industry 5.0 technologies in logistics systems. Choi and Siqin (2022) highlight the significance of blockchain in logistics, emphasizing the need for careful consideration of internal and external organizational factors to ensure successful integration of blockchain technologies in manufacturing processes.

Blockchain is a vital component of digital production systems and has found extensive use in the agri-food supply chain, often in conjunction with other Industry 5.0 technologies such as the Internet of Things (IoT), big data, and RFID (Radio-Frequency Identification). Bhat et. Al, (2022) attest to the usefulness of blockchain in this context, as it enhances transparency, traceability, and trust among various stakeholders in the supply chain.

As a result, processes can be optimized via integrated IT systems along the supply chain. This leads to virtual production processes and production automation designs. As another agile supply chain component determined by Christopher (2000), integrated processes via the collaboration of producers and suppliers are achieved. Because today's manufacturing cells will be replaced with fully automated production lines. Industrial technologies allow businesses a faster response to customer expectations. It creates market sensitivity for companies to be agile. Via digitalization in production, prototypes will be reduced, and manufacturing processes will be improved and allow production in small lot sizes. Robots, smart factories, and programs make decisions of supply chain partners more flexible. Thanks to this, network-based communications are enhanced and closer and better relationships between supply chain members and their customers are created.

## 4 Conclusion and Future Research

In the contemporary era, advancements in technology have sparked a complete revolution in the comprehension of business. Logistics enterprises have grown increasingly adaptable to prevailing business dynamics, encompassing digital transformation, inventive practices, ecological consciousness, adaptability, and enhanced efficiency. It is considered that the logistics 5.0 activities, which will integrate the society and technology in the future, will also guide the applications to be designed in terms of increasing logistics performance. With the advent of the fifth industrial revolution known as Industry 5.0, the fundamental principles of logistics have undergone a redefinition.

Challenges such as container scarcity, workforce replenishment, implementation of new security protocols, and delays amid the COVID-19 pandemic have exposed vulnerabilities in certain logistics processes. These circumstances have expedited the shift towards Logistics 5.0. At this juncture, enterprises must prioritize investments in technology and innovation to bolster their competitive edge and cultivate robust, data-driven insights, thereby ensuring their longevity in the future.

Weaknesses of the logistics industry were revealed, and this accelerated the transition of logistics to 4.0. Companies in this industry have had to invest in innovation and technology to increase resilience and competitiveness in the future.

As the pandemic is about to end, the production system will be transformed to meet sustainability and digitalization at the same time. This is where Logistics 5.0 comes into play. With both sustainability and digitalization, companies need to evolve to Logistics 5.0.

The investigation is mainly focused on logistics 4.0 and 5.0 from the supply chain agility point of view. Companies that concentrate on agility in logistics and supply chain, perform current technologies in logistics 4.0. Businesses operating in Turkey, which has become a strategic focal point where international trade transactions take place intensively, need to manage customer relations dynamically and efficiently for problems that may arise in the supply chain network to keep up with global competition. As a result, agility allows companies a faster response to customer expectations.

The future studies should focus on more academic and practical studies about logistics 5.0 and supply chain agility. It is planned to make future research that investigate the supply chain agility operations of a logistics service provider company.

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