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Digital supply chains and the development of the circular economy (part 1)

Cyfrowe łańcuchy dostaw a rozwój gospodarki o obiegu zamkniętym (cz. 1)

Abstract

Nowadays one of the biggest challenge for modern business entities is the introduction of solutions and assessments of environmental optimization in the supply chain (reducing the resource-intensiveness of the economy) and the search for waste-free solutions (facing the issues of losing the status of waste, by-products or accompanying products). These challenges are built in relation to the goals and scope of the circular economy (CE), which is conducive to the implementation of solutions aimed at sustainable development. The aim of this paper is to identify the possibilities of achieving environmental optimization due to the use of digital technologies and the concept of digital supply chains in the conditions shaped by the CE. The adopted research question is: "To what extent can digital supply chains affect the development of CE?".

Keywords:

digital supply chain, digital circular supply chain, circular economy

Streszczenie

Obecnie jednym z największych wyzwań dla nowoczesnych podmiotów gospodarczych jest wprowadzanie rozwiązań i ocen optymalizacji środowiskowej w łańcuchu dostaw (zmniejszanie zasobochłonności gospodarki) oraz poszukiwanie rozwiązań bezodpadowych. Wyzwania te są budowane w odniesieniu do celów i zakresu gospodarki o obiegu zamkniętym, co sprzyja wdrażaniu rozwiązań ukierunkowanych na zrównoważony rozwój. Celem artykułu jest identyfikacja możliwości osiągnięcia optymalizacji środowiskowej dzięki wykorzystaniu technologii cyfrowych oraz koncepcji cyfrowych łańcuchów dostaw w warunkach kształtowanych przez gospodarkę o obiegu zamkniętym. Przyjęte pytanie badawcze brzmi: „W jakim stopniu cyfrowe łańcuchy dostaw mogą wpłynąć na rozwój gospodarki o obiegu zamkniętym?”.

Słowa kluczowe:

cyfrowy łańcuch dostaw, cyfrowy łańcuch dostaw o obiegu zamkniętym, gospodarka o obiegu zamkniętym

JEL: M21, Q55

Introduction

Changes in the processes of production and consumption, the nature of work, forms of employment, new business models, ways of functioning of public institutions, or access to the global economy are the result of progressive low-cost access to data. The Digital Economy, characterized by networking, "datification", personalization and platformization, intensifies and extends digitization processes to other areas of economic, social and political life, pushing them towards digital transformation. The spread of the Internet, the

increase in access to computing power and its processing in real time determine the dynamic interest in autonomous processes, planning and management based on access to data and the use of artificial intelligence (AI) to reduce the risk of doing business.

The progressive diffusion of the effects of the digital economy, on the one hand, multiplies the interest in the tools it uses (digital technologies), on the other hand, it brings with it a whole set of new challenges for political decision-makers and business related to access to data, the use of innovation, education, security, privacy, transparency or com-

petitiveness. Regardless of the scope and scale of emerging problems accompanying the development of the digital economy, this process seems to be irreversible and difficult to slow down. What's more, it is additionally stimulated by events of an unusual nature, an excellent example of which is the impact of the COVID-19 pandemic on the dynamic pace of digitalization development in all spheres of social and economic life.

An important stimulus for the development of the digital economy (or, in fact, the dissemination of the use of digital technologies, which are its key and strategic resource) is also another factor, diagnosed some time ago, which is negative climate change. It is global in nature and although not all societies will bear the costs resulting from the need to level the negative effects of human impact on the natural environment to an equal extent, the need for regulatory changes is today a key point in the discussion on the principles of doing business.

According to experts belonging to the program Climate Leadership¹ the biggest challenge for modern business entities is the introduction of solutions and assessments of environmental optimization in the supply chain (reducing the resource-intensiveness of the economy) and the search for waste-free solutions (facing the issues of losing the status of waste, by-products or accompanying products) (Kulczycka, 2020, p. 40). These challenges are built in relation to the goals and scope of the circular economy (CE), which is conducive to the implementation of solutions aimed at sustainable development.

Bearing in mind the previously indicated stimulants for the development of the digital economy and the dissemination of the use of digital technologies in management, it was assumed that the purpose of this work is to identify the possibilities of achieving environmental optimization due to the use of digital technologies and the concept of digital supply chains in the conditions shaped by the CE. The adopted research question is: "To what extent can digital supply chains affect the development of CE?"

The first part of the work focuses on defining the meaning of the concept of a digital supply chain and defining its properties that are a potential starting point for responding to the needs of the CE. An approach indicating the possibility of implementing the closed-loop concept was distinguished, with particular emphasis on the role of AI in the built platform understood as a digital supply chain. The use of an ecosystem of diverse digital technologies (including AI) enables the introduction of dynamics in the created business models. These technologies, on the other hand, can support building dynamic capabilities of a strategic enterprise (Nowicka, 2019)

and be used to achieve goals related to its sustainable development.

In the second key area of work, the focus was on the conditions shaping CE business models. The essence of achieving the adopted goal of this paper is the possibility of confronting the pro-ecological potential of digital supply chains with the assumptions of the CE. As a result, various models of digital circular supply chain are created, affecting the natural environment in a diverse way, and therefore constituting an interesting solution for promoting the development of CE in the cognitive and application perspective.

The work assumes that the micro approach stimulates the development of the macro concept by expanding and placing the main emphasis on the role of digital technologies (and platforms built on its foundations) as a key stimulant of the CE. The work is conceptual. In the research procedure, the research problem was first formulated, the research question was asked and the research goal was adopted. At a later stage, a literature review was carried out (the focus was on the latest scientific articles, but also industry reports and other sources supporting finding the answer to the research question), they were analysed in terms of the assumed research objective and conclusions were made. In the research procedure, in addition to the implementation of the adopted goal, some research gaps and areas worth further scientific exploration were also identified. Thus, the work can be a starting point for further in-depth research on the role of digital technologies in improving the sustainable development of the economy. Detailed conclusions and recommendations are included in the summary of the paper.

Digital supply chains – properties and potential

The concept of the supply chain has been widely discussed on theoretical grounds for almost four decades. Its evolution is related to factors affecting the economic environment and key areas of competition that change over the years (Szymczak, 2015). M. Christopher's approach is close to contemporary economic practice, according to which the supply chain is a network of organizations involved, through links with suppliers and recipients, in the implementation of various processes and activities that create value in the form of goods and services provided to consumers (Christopher, 2016, p. 13). The supply chain business model, on the other hand, can be understood as the way in which value is created and

delivered in specific environmental conditions through available resources that enable it to take advantage of emerging opportunities (Nowicka, 2019, p. 85–92). The delivered value proposition is in relation to the adopted strategy, as in the case of resources whose configuration should correspond to the possibility of achieving the goals of the adopted enterprise strategy. The value proposition can be understood as providing diversified solutions attractive to the consumer also due to the possibility of choice.

What seems to be additionally particularly important for the topic taken is the fact that when addressing the issues of the supply chain and supply chain management, the whole set of constructs determining the effectiveness, and thus competitiveness, of this chain and all stakeholders involved in this relationship is in fact being discussed. The main constructs of supply chain management include (Garay-Rondero et al., 2019):

- supply chain management processes, relating to activities that create specific value for the customer, e.g. customer relationship management, cooperation with suppliers, demand planning, production flow management and reverse logistics;
- participants (links) in the supply chain, referred to as member companies, and links between these companies, e.g. upstream suppliers, logistics service providers, customers;
- flows between links in the supply chain, which include flows of information, products and financial resources.

Processes dedicated to the coordination of flows between participants in supply chains are aimed at the implementation of strategic goals of the company. Their adequate implementation focuses on reducing the time of performed activities (and entire processes), costs associated with logistics activities and improving the quality of serviced customers. The indicated goals of supply chain management are aimed at improving competitiveness, mainly in the economic dimension.

It is worth noting that, due to the conditions surrounding supply chains, their models are increasingly supported by dynamic capabilities, among which digital technologies deserve special attention. They meet the possibility of a quick and flexible response to changing market expectations. Due to the properties of digital technologies, we are talking about adaptive, absorptive, innovative, integrative, co-creating, predictive and innovation diffusion abilities (Nowicka, 2019). The set of these features encourages the implementation of technology in supply chain processes also due to its cyber-physical dimension. It should be remembered that supply chain management is related to the

coordination of cargo flows between links, which in turn requires planning and synchronization of activities based on data and information from various sources.

AI is beginning to play a special role in this area. For example, Amazon on its website emphasizes that "without machine learning, Amazon.com could not grow business, improve customer experience and selection, and optimize the speed and quality of logistics" (Amazon Web Services, b.r.). According to K.-F. Lee, the development of AI proceeds in four waves (Lee, 2018):

- Internet AI – currently in common use – algorithms profiling the user and correctly matching marketing activities, personalizing products (Amazon, Alibaba), proposing music and other songs (YouTube), optimizing the level of user involvement through natural language processing and computer image processing, user labelling;
- business AI – more and more commonly used – algorithms that can connect threads in historical data, discover hidden correlations between data and events; used in banking, insurance, health care, judiciary;
- perceptive AI – thanks to which the digital world connects with the real world – sensors included in the structure of the Internet of Things will make the AI gain sense.

The indicated potential incorporated into the concept of an ecosystem of digital technologies configured to the needs of a given organization (including the supply chain) via cloud services gives a real opportunity for AI to become a practical solution supporting the functioning of enterprises from various sectors. As a result, the information exchange and flow management platforms are becoming an interesting solution based on digital technologies supporting supply chain management in the cyber-physical dimension.

It is worth noting that online platforms are a business model of virtual intermediation between at least two separate but interdependent (networked) groups of users, creating market pages within multilateral markets (Śledziwska & Włoch, 2020, p. 99). The essence of the functioning of platforms is therefore to mediate in interactions between various parties of users (connecting many parties of the market) (Doligalski, b.r.) based on a digital service available over the Internet. Market parties can be created by individual consumers, public institutions, non-governmental organizations and enterprises that are buyers, sellers or employers. The dissemination of platforms connecting consumers, producers, distributors (intermediaries) and owners of given resources changes the rules of functioning of the traditional market, understood as all relations

and coordination mechanisms between its parties, and the rules of the game that apply to it (OECD, 2019). In addition to the matching of transaction parties thanks to the advanced use of data, the main functions of the platforms include setting rules and standards that reduce transaction costs and providing functional tools and services (Moazed & Johnson, 2016, cyt. za: Śledziwska & Włoch, 2020, p. 100; Nowicka, 2021b).

The use of the platform in supply chain management can therefore support its functioning and development, e.g. by:

- expansion and diversification of the number of distribution channels (multichanneling) (Nowicka, 2020b),
- building synergies in managing multiple available channels (omnichannelling),
- managing many different points of contact and relationship with the client, shaping his cooperation along the supply chain (customer journey) and experience (customer experience) (Nowicka, 2020a),
- expanding the database of direct and indirect suppliers as well as logistics service providers,
- building a centre for managing flows in the entire supply chain system in the form of a control tower.

The platforms used to manage supply chains (including also the perspective of their constructs) can be called digital supply chains. They are based on a compilation of the properties of digital technologies being able to deliver higher values compared to traditional supply chains (Nowicka & Szymczak, 2020; Nowicka, 2021a).

In addition, the inclusion of AI in the structure of the platform, the purpose of which is to manage the supply chain, leads to a certain degree of autonomy of such a solution. Decisions are being made (usually very simple) that result from the algorithm, but also from the previously described AI characteristics. In the literature, this solution is described as a "self-thinking supply chain" (Calatayud et al., 2019, pp. 22–38). This model is based on AI, cloud computing and the Internet of Things (IoT) (indicated as the main technologies within the built ecosystem) for ongoing monitoring of flows in the supply chain. Data is created, stored and analysed through these technologies, enabling ongoing control of process performance, their optimization, early identification of potential threats and real-time management. Thanks to AI and machine learning, the decision-making process based on information from sensors is automated. Objects can "sense" the environment (via IoT) and react to it according to decisions made by AI.

Summarizing the role that digital technologies used in supply chain management can play, several

key effects that make them attractive for business can be indicated:

- shortening the time of implementation of activities and processes,
- improving the transparency of flows,
- limiting the level of resources by converting them into access to information,
- exclusion of unnecessary or dishonest intermediaries,
- managing the organization and flows between business partners in a systemic way,
- access to information on logistic resources (available places in warehouses, free places in transport, available logistic infrastructure, etc.), as well as new sources of supply, production capacity or events affecting the continuity of flows, improving the flexibility of the organization's functioning and shortening the response time to environment variability,
- reducing costs resulting from information asymmetry,
- increase in the level of innovativeness of the organization.

A particularly important role of the use of digital supply chains is the possibility of using their adaptability and configuration available through the resource platform in accordance with the adopted strategy of the enterprise (and thus also the entire supply chain). Thus, adopting, for example, a sustainable development strategy, it is predefined in accordance with its assumptions, e.g. supplier selection structure on the supply side, type of transport or its service provider meeting specific requirements, characteristics of the place where products are stored, as well as the distribution model (including the part of the so-called "last mile") in relation to the expected effects that the supply chain management process is to achieve.

Summary

The first part of the work focused on defining the meaning of the concept of a digital supply chain and defining its properties that are a potential starting point for responding to the needs of the CE. The use of an ecosystem of diverse digital technologies enables the introduction of dynamics in the created business models. These technologies, on the other hand, can support building dynamic capabilities of a strategic enterprise and be used to achieve goals related to its sustainable development.

In the second part of the work, the focus will be on the conditions shaping CE business models. The essence of achieving the adopted goal of this paper is the possibility of confronting the pro-

ecological potential of digital supply chains with the assumptions of the CE. As a result, various models of digital circular supply chain will be presented, affecting the natural environment in

a diverse way, and therefore constituting an interesting solution for promoting the development of CE in the cognitive and application perspective.

Notes/Przypisy

¹ Climate Leadership is a program that builds a community of leaders of real change in business to counteract the irreversible changes taking place on the planet, which are reflected in the climate crisis. The program supports actions taken by companies to achieve climate neutrality. www.ClimateLeadership.pl (access: 01.10.2022).

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Head of the Department of Logistics and Head of Postgraduate Studies Logistics and Supply Chain Manager at the SGH Warsaw School of Economics. She specializes in supply chain management and the impact of digital technologies on the competitiveness of the supply chain. In addition to her scientific involvement, she cooperates with the European Commission as an expert for the evaluation of H2020 and HE projects. She was the manager of the international ChemMultimodal project implemented under the Interreg Central Europe Program in 2016–2019. Currently, in the NAWA Strategic Partnerships program (Academic Partnership in the field of methods and applications of advanced data analysis), prof. Nowicka, in cooperation with Loyola University Chicago Quinlan School of Business, is implementing a project on advanced business analytics in supply chains and logistics management. She is also the head of research financed from the subsidy of the Ministry of Education and Science for the SGH Warsaw School of Economics in the years 2022–2024 on the circular economy and the issues of circular supply chains. Prof. Nowicka has over 30 years of practical experience enabling her to share knowledge in the field of supply chain management and logistics with both business and students. Her research interests include e-business supply chain management, circular supply chain management and the sustainability impact of the digital supply chain. She is the author of over 150 publications – articles in Polish and foreign scientific journals, book chapters, monographs and expert opinions.

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Kierownik Katedry Logistyki oraz kierownik Studiów Podyplomowych „Menedżer logistyki i łańcuchów dostaw” w Szkole Głównej Handlowej w Warszawie. Specjalizuje się w zarządzaniu łańcuchem dostaw i wpływie technologii cyfrowych na konkurencyjność łańcucha dostaw. Oprócz zaangażowania naukowego współpracuje z KE jako ekspert ds. ewaluacji projektów H2020 i HE. Była kierownikiem międzynarodowego projektu ChemMultimodal, zrealizowanego w Programie Interreg Central Europe w latach 2016–2019. Obecnie, w programie NAWA Partnerstwa Strategiczne (partnerstwo akademickie w zakresie metod i zastosowań zaawansowanej analizy danych), prof. Nowicka we współpracy z Loyola University Chicago Quinlan School of Business realizuje projekt dotyczący zaawansowanej analityki biznesowej w łańcuchach dostaw i zarządzaniu logistyką. Jest również kierownikiem badań finansowanych z subwencji MEiN dla SGH w latach 2022–2024 na temat gospodarki o obiegu zamkniętym i problematyki cyrkularnych łańcuchów dostaw. Prof. Nowicka ma ponad 30 lat praktycznego doświadczenia umożliwiającego jej dzielenie się wiedzą z zakresu zarządzania łańcuchem dostaw i logistyką zarówno z biznesem, jak i ze studentami. Jej badania naukowe obejmują zarządzanie łańcuchem dostaw w e-biznesie, zarządzanie łańcuchem dostaw w obiegu zamkniętym i wpływ cyfrowego łańcucha dostaw na zrównoważony rozwój. Jest autorką ponad 150 publikacji – artykułów w czasopismach naukowych polskich i zagranicznych, rozdziałów w książkach, monografiach i ekspertyz.

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RETAIL 4.0

10 zasad
handlu detalicznego
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10 ZASAD HANDLU DETALICZNEGO W ERZE CYFROWEJ

Rewolucja technologiczna ostatnich kilkadziesiąt lat zmieniła wiele założeń, na których opierał się świat handlu detalicznego. Oczekiwania klientów rozwijają się z prędkością cyfrową: kupujący pragną coraz bardziej angażujących, spersonalizowanych doświadczeń. Informacje krążą z niezwykłą szybkością, rynek stał się bardziej poziomy, integracyjny i społeczny, a podróż klienta jest coraz mniej liniowa i przewidywalna. Ten, kto wcześniej był tylko „odbiorcą” kampanii marketingowych i komunikacyjnych, dziś staje się ich twórcą. Wiele firm postrzega to jako problem, a nawet „apokalipsę handlu detalicznego”, ale inne – jako niezwykłą okazję. Książka ma na celu przedstawienie ram interpretacyjnych do zrozumienia konsekwencji transformacji cyfrowej dla handlu detalicznego i skutecznego zarządzania nią.

Tezy i zasady zawarte w *Retail 4.0* są wzbogacone o praktyczne wskazówki. Autorzy konfrontują swój punkt widzenia z prezesami i top menedżerami międzynarodowych firm, takich jak Amazon, Autogrill, Boggi, Bridgestone, Brooks Brothers, Brunello Cucinelli, Campari Group, Carrefour, Coccinelle, Disneyland Paris, Eataly, Henkel, HSBC, KIKO Milano, La Martina, Levi Strauss & Co., Marks & Spencer, Moleskine, Mondadori Retail, Natuzzi, Saffilo Group, SEA Aeroporti di Milano, Shiseido Group. W książce opisano też 11 polskich start-upów, które będą napędzać innowacje w handlu detalicznym.