Digital Supply Chain Management - New Competitiveness Imperative for Economic Development

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***Abstract*—The study introduced the concept of countries' digital development in the field of supply chain management (SCM) from the perspective of participation in global supply chains (GSC). A SWOT analysis of the proposed concept was performed, according to which, strengths, weaknesses, opportunities, and threats of the nation's involvement in GSCs were denoted. This research outlined the necessity for creating approaches and programs to ensure the logistics sector's digital growth for developed and developing nations and reduce modern unlevelled threats. The present study statistically verified the hypothesis that the improvement in the country's digital development contributes to the increase in its participation in GSCs. Within the research, indicators that determine the country's digital development in the context of SCM were selected. On their basis, digital profiles of the Russian Federation, Switzerland, Azerbaijan, and Cambodia were created and compared. As a result, the study disclosed competitive strategies in international trade for the countries under consideration. This research presented ways to strengthen the nations' competitive position in the world market and increase their digital competitiveness.**

***Keywords*—** *supply chain management, digitalization, globalization, information and communication technologies, economic development.*

1. Introduction

Nowadays, the digitalization of the economy is changing the approach to doing business as well as the requirements for financial, information, labor, and material flow management. It develops integrated supply, personnel, and accounting management systems, resulting in the development of many modern technologies like *BlockChain, Digital marketing, CRM&BPM, Virtual Reality & Digital Twins, GRID technology, Retail Tech*, *FinTech, Unmanned Aerial Vehicles, Big Data, Internet of Things, Bionic Enhancement, Cloud Computing, Autonomous Robots, Self-driving Vehicles, 3D-printing, Low-cost Sensor Technology, Augmented Reality, Next-generation Wireless*, *etc*. Globalization and widespread adoption of digital technologies have made supply chains more complex and spawned a new approach to the management of logistics processes – Supply Chain Management (SCM). In the framework of SCM, individual supply chain links are connected into financial, material, labor, and information flows towards the common goal of the supply chain. Global supply chains (GSCs) provide an opportunity to offset the effect of geographical, industry, and intra-corporate barriers by increasing integration and cooperation, and reducing uncertainty and risks.

Despite the significant advantages of economy digitalization, numerous countries are faced with the possible negative consequences of this process, such as lack of control over global corporations' activities. Modern logistic research shows that the high competitiveness of individual nations is directly connected with high rates of the *Logistics Performance Index (LPI)* and the *ICT Development Index (IDI)*. Thus, many states that pay sufficient attention to digital technologies' introduction gain competitive advantages, despite the possible negative effects of the digitalization.

Notwithstanding the previous information, the influence of digital technologies in SCM on the competitiveness of countries and regions is studied insufficiently. The assessment of the competitiveness of countries and regions remains multifaceted. It requires the justification of those indicators and

assessment methods that are determined by the functions of the particular territory.

This study focuses on regions and countries, rather than individual enterprises, due to the expensiveness of modern digital technologies and the impossibility of their implementation without targeting government policy and special mechanisms.

2. Literature review

An essential aspect of logistics systems functioning in a digital economy is customer focus and individualization. Modern-day supply chains become more and more adaptive so that each client can independently form a supply chain, choose delivery methods, intermediaries, delivery time, means of communication, and use Internet tools [1]. Equal importance has last-mile delivery (delivery from the last logistics center to the consumer) [2] and the combination of logistics services with smart appliances, smart home systems, and related technologies [3]. At the same time, one of the tools to better meet customer needs is the continuity of interaction, where the "seamlessness" of communication is realized through omnichannel supply chains. Another essential element of logistics systems' functioning is environmental responsibility. Supply chains are to be optimized to reduce harmful emissions associated with delivery through the use of such digital technologies as the *Internet of Things, Cloud Computing, Autonomous Robots, Self-driving Vehicles, 3D-printing, Low-cost Sensor Technology, Augmented Reality, Unmanned Aerial Vehicles,* and *Next-generation Wireless* [4]. In addition to the above, successful functioning of a logistic system is assured by a change in the role of personnel from an executor to the controller [5] and the emergence of new forms of supply chains – Extended Supply Chain, Closed-Loop Supply Chain, Circular Supply Chain, and Back Supply Chain Management [6]. Modern SCM is also characterized by enlargement of logistics centers, the emergence of high-level logistics operators, changes in approaches from Human to Human (H2H) to Machine to Human (M2H), Human to Machine (H2M) or Machine to Machine (M2M), as well as the introduction of various Business Process Management Systems (BPMS), namely ELMA, EMC Business Process Manager, IBM WebSphere Business Integration Modeler, ARIS Business Architect, Intalio, JBoss jBPM, Lombardi Teamworks, Microsoft BizTalk Server, Oracle BPM Suite, SAP NetWeaver, Ultimus BPM Suite, Unify NXJ, etc. [7].

In the context of SCM, the competitiveness of individual enterprises and supply chains is defined as the ability to carry out individual deliveries of products at low cost, high quality and short lead time while possessing high reliability [8]. In the process of the study of SCM competitiveness, many researchers focus on specific aspects of the digital economy and supply chains of a particular enterprise. However, the influence of digital technologies on the SCM and competitiveness of individual countries and regions has not yet been properly examined.

These days, the competitiveness concept itself has various interpretations. It is usually defined as the ability to ensure a high standard of living of the population [9] as well as a high level of labor productivity [10], national price [11], and the ability to ensure economic growth as a factor in increasing the share of national output in the structure of the world economy [12]. It has been determined that many methods are used to analyze the competitiveness of different countries and regions [13]. The scientific literature presents theoretical models of cities' competitiveness in terms of qualitative and quantitative characteristics [14]. Several studies assess competitiveness by a multilevel system of index indicators, for example, the level of human capital [15], cluster development [16], and the growth rate of gross domestic product (GDP) [17].

Competitiveness factors differ across the nations. Thereby, if for efficiency-driven countries, GDP, inflation rate, trade, labor productivity, and costs are important determinants of competitiveness, for innovation-driven countries, these factors include GDP, inflation rate, tax rate, foreign direct investment, trade, and costs. As regards the nations with economies in transition, only GDP, inflation rate, and labor productivity are determinants of competitiveness [10].

Identification of the competitiveness factors during the evaluation of the country's competitive capacity enables choosing the most effective methods for the introduction of state programs [18]. Among the ways to implement such programs is the recognition and support of leading sectors and enterprises as well as export goods or services that create the highest share of domestic value-added or are promising for economic growth and sustainable development of the nation. Participation in GSCs increases the competitiveness of an individual enterprise and indirectly improves the competitiveness of the country. Such participation is possible if the state attracts high-tech foreign investors, helps national companies to find trading partners and technologies, improves infrastructure, and introduces industrial and scientific parks and free economic zones [19].

Thus, the following issues remain unsolved:

- examination of the impact of digital technologies in SCM on the competitiveness of countries and regions;
- identification of promising areas of digital development of countries and regions to increase their competitiveness.

2.1. Problem Statement

The study aimed to examine the impact of digital supply chain technologies on the countries' competitiveness. To achieve this goal, the following tasks were solved:

- analyze the dependence between the country's participation in GSCs and its digital development;

- select indicators that determine the level of SCM digital development of the country;
- create and compare digital profiles (this refers to the state of digital development in the SCM context) of the Russian Federation, Switzerland, Azerbaijan, and Cambodia;
- determine competitive strategies in the field of international trade of various countries;
- develop measures to strengthen the competitive position of countries and increase their digital SCM competitiveness.

3. Methods and materials

The study aimed to develop the SCM scientific foundations using digital technology as a factor influencing the degree of involvement of countries and regions in world trade. In particular, the following indices characterizing the countries' participation in GSCs and the level of their digital development were analyzed:

1. The Global Enabling Trade Index (GETI) is calculated according to the World Economic Forum's methodology and determines the rating of a particular state, taking into account the government institutions, politics, and infrastructure. The index is used to evaluate national institutions' performance in interstate economic cooperation and trade.
2. ICT Development Index (IDI) is calculated according to the International Telecommunication Union methodology and includes 11 different development indicators of countries in the field of information and communications technology (ICT).

Besides, the data retrieved from several other indices determining the country's digital development in the field of SCM was also selected to compare the digital involvement of considered nations in the global SCM.

The present research included several stages to accomplish the stated tasks. At the first stage, the relationship of the indices characterizing the country's participation in GSCs and the level of the country's digital development (GETI [20] and IDI [21]) were determined. The regression dependence for these indicators was constructed, and the degree of connection between them was analyzed. At this stage, the hypothesis that the improvement of the country's digital development contributes to the increase in its engagement in GSCs was accepted.

The second stage of the study involved the creation of an author's definition of the level of digital development of the country in the SCM context. As a part of this stage, the indicators determining the digital development of SCM were selected as well as SWOT analysis of digital development was carried out. During the examination, the authors compared the digital profiles of the Russian Federation, Switzerland, Azerbaijan, and Cambodia based on the data retrieved from the United Nations Agency "International Telecommunication Unit" and the World Economic Forum (Global Financial Inclusion Database).

The third stage presented the created strategies for selected countries in the international SCM market aimed at strengthening their positions in the digital SCM.

The research object was a set of processes for managing the supply chains of goods and services using digital technologies. The subject of the study was the impact of such processes on the competitiveness of reviewed nations and regions.

4. Results

A regression dependence between the indices characterizing the country's participation in GSCs and its digital development was constructed to determine the relationship between the GETI [20] and IDI [21] values.

Table 1. Initial data for building the relationship between the Global Enabling Trade Index and ICT Development Index (based on data retrieved from [20] and [21] for 2020)

Country	The Global Enabling Trade Index	ICT Development Index	Country	The Global Enabling Trade Index	ICT Development Index
Australia	4.9	8.29	Cameroon	3.2	2.19
Austria	5	7.67	Canada	5	7.76
Azerbaijan	3.9	5.79	China	4.3	5.05
Albania	4	4.73	Colombia	4	5.32
Algeria	3.2	3.71	Portugal	4.5	6.93
Angola	2.8	2.32	Russia	3.5	6.91
Argentina	3.7	6.4	Rwanda	4.1	2.04
Bhutan	3.5	3.35	Romania	3.9	6.11
Great Britain	5.2	8.75	Serbia	3.7	6.45
Hungary	4.3	6.82	Singapore	5.9	8.08
Vietnam	4	4.28	Slovakia	4.3	6.82
Hong Kong	5.5	8.52	Slovenia	4.4	7.23
Greece	4	7.09	USA	5	8.19
Georgia	4.5	5.25	Switzerland	5.2	8.56
Denm	5	8.88	Swed	5.1	8.67

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Israel	4.7	7.19	Sri Lanka	3.8	3.64
India	3.6	2.69	Ecuador	4.1	4.81
Indonesia	4.2	3.94	Estonia	4.8	8.05
Jordan	4.4	4.75	Ethiopia	3.2	1.45
Spain	4.8	7.66	South Africa	4.2	4.9
Italy	4.3	7.12	South Korea	4.7	8.93
Kazakhstan	3.7	6.2	Japan	5.1	8.47
Cambodia	3.7	2.74			

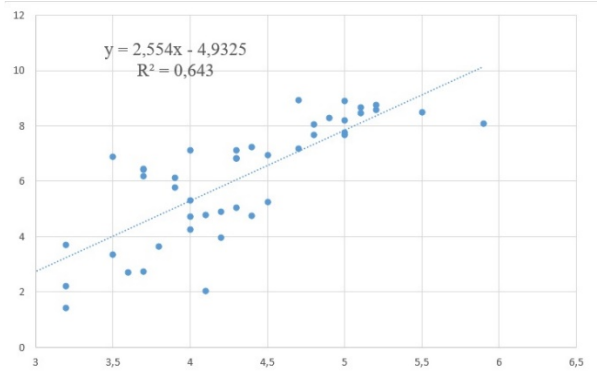

Figure 1. The relationship between the Global Enabling Trade Index and ICT Development Index

According to the presented data, the dependence y = 2.554x - 4.9325 with a correlation coefficient R^2 = 0.643 was obtained. It confirms the hypothesis that an enhancement in the level of digital development of the country contributes to the increase of its participation in GSCs.

In this regard, the concept of evaluating the country's digital development in the context of SCM is of scientific interest. According to the authors, the decisive factor, in this case, is the nation's engagement in GSCs, management of which is impossible without the application of digital technologies. This concept allows characterizing the country's digitalization as a set of processes for managing the supply chains of goods and services with the use of advanced digital technologies. The SWOT analysis results made it possible to recognize the following characteristics of the created concept.

Strengths:

- products' and services' compliance with international standards;
- involvement in the global labor, resources, and capital markets;
- high controllability of the supply chain;
- benefits of cheap local currency;
- introduction of innovative technologies;

Weaknesses:

- increase in the share of part-time employment;
- decrease in social security of citizens;
- dependence on supply chain policies;
- dependence on cheap labor;
- dependence on currency fluctuations;
- Opportunities:
- broader range of goods and services for consumers;
- creation of new jobs;
- meet the preferences of individual consumers;
- improvement of the standard of living
- increase in the country's competitiveness;

Threats:

- lack of concepts and digital development programs for logistics and supply management in both developed and developing countries;
- lack of mechanisms for managing complex digital processes, in particular for cooperation with global corporations;
- growth of cybercrime and emergence of its new types;
- lack of state protection and support for the implementation of digital processes in the regions;
- increase of tax evasion risk;
- lack of responsibility to consumers;
- violation of consumer rights related to online trade;
- growth of technological unemployment.

With the purpose of providing a more accurate analysis of the impact of digital technologies on the country's competitiveness, the dependence of digital participation of a country in GSCs on the level of its digital development was examined on the example of the Russian Federation, Switzerland, Azerbaijan, and Cambodia. For this aim, the data from the United Nations Agency "International Telecommunication Unit" and information on the values of the corresponding indicators from the World Economic Forum (Global Financial Inclusion Database) were used.

Table 2. Digital profiles of the Russian Federation, Switzerland, Azerbaijan and Cambodia (data as of 2019)

Index	Azerbaijan	Cambodia	Russian Federation	Switzerland
ICT	5.79	2.74	6.91	8.56
Internet Development	54.20	4.94	63.80	85.20
The UN E-Government Development Index	0.5472	0.2999	0.7296	0.767
Networked Readiness Index	4.3	3.3	4.5	5.7
The Globa	30.2	26.6	37.6	67.2

l Innovation Index				
Human Development Index	0.754	0.581	0.824	0.946

The data presented in Table 1 indicate that the rate of digital engagement in GSCs varies among the countries under consideration (Figure 2). According to the ICT development level, a group of countries stands out – Switzerland, the Russian Federation, and Azerbaijan, which are characterized by high values of ICT, Internet Development, and The UN E-Government Development indices. Switzerland is a country with the highest Global Innovation Index, which demonstrates the significance of innovations in its global development.

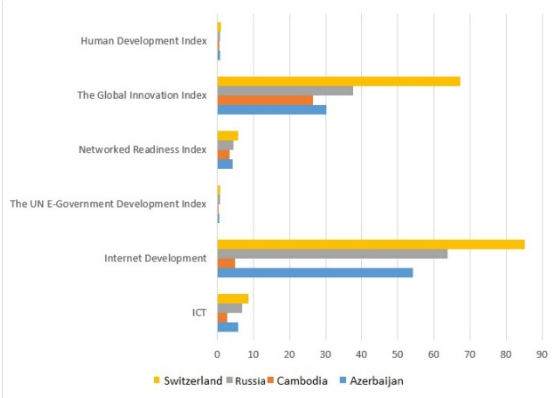

Figure 2. Digital profiles of the Russian Federation, Switzerland, Azerbaijan and Cambodia (data as of 2019)

An outsider in terms of the Internet Development index is Cambodia. This fact may also explain the low value of The UN E-Government Development Index and Human Development Index.

E-business technologies provide additional benefits for both the manufacturer and the client in the classic transaction valuation categories (costs, time, turnover, risk). For the manufacturer, operational information regarding actual demand is the first and foremost that gains value and allows applying the pull concept. In turn, the client can expect quality service in cost optimization, lead time, and risk predictions.

Thus, given the increasing introduction of digital technologies in the SCM sphere, it should be remarked that, together with globalization, digital technologies can become a boost for the development of the country's economy. For developing nations, the digitalization of GSCs makes it possible to enhance economic growth, narrow the digital divide, introduce new technologies, produce goods according to modern standards, improve the level of education of the population, and reduce corruption. More deep engagement of participants in the supply chain allows the manufacturer to save time and resources, increase the efficiency of the entire supply chain, create conditions for state control of all transactions, and simplify documentation within the supply chain.

5. Discussion

While discussing the presented results, it should be noted that most researchers focus on the benefits of implementing supply chains at enterprises. In general, scholars note that GSCs are characterized by open and transparent management policy and increased control of compliance with international standards. These factors are deemed to contribute to the country's GDP growth more than the reduction of import and increase of the domestic value-added in gross exports [22-25].

The current study revealed that the improvement of the country's digital development leads to an increase in its participation in GSCs. It may be explained by the fact that the involvement of local companies in GSCs enhances their competitiveness, employment, standards, and the level of employees' competence.

The obtained results are consistent with the work of In [23], which has proposed the following steps for governments of developing countries:

- identification of highly competitive sectors and enterprises;
- analysis of the positions of exported goods and services in international markets;
- definition of goods and services that create the most significant domestic value-added or are promising for the country's economic growth and sustainable development.

The conducted study makes it possible to supplement these measures with the following:

- create maximum favorable conditions for the introduction of digital technologies in SCM;
- introduce e-government technologies;
- improve the digital literacy of the population.

The present paper introduced the author's concept of the country's digital development as a set of processes for managing the supply chains of goods and services using digital technologies and proposed its SWOT analysis. The study established that the fundamental indicators determining the nation's digital development in the SCM are those associated with the use of the Internet and the level of individual and state development.

Within the examination, the authors determined quantitative characteristics of the digital profile of countries, participating in the GSCs (ICT, Internet Development, The UN E-Government Development Index, Networked Readiness Index, The Global Innovation Index, and Human Development Index). Moreover, on their basis, they created digital profiles of the Russian Federation, Switzerland, Azerbaijan, and Cambodia. It was noted that the proposed quantitative characteristics of the country's digital profile successfully correlated with other indexes used by rating agencies (for example, competitiveness), which indirectly corroborates the research idea.

The study results helped identify that countries involved in GSCs are characterized by a high level of digital technology and logistics infrastructure.

Concurrently, it was revealed that the improvement of transport capacities is of innovative value only if information and communication technologies are introduced. With the purpose of increasing the overall competence in SCM, the public and private sectors should be considered jointly at the national level. State institutions create legal support for activities and conditions for attracting investments, while private firms (logistics service providers) improve their strategies and create competitive advantages on the world markets. Therefore, as a result of better services, an increase can be seen in trade volumes and the country's competitiveness.

It was established that in the leading countries of the world digital SCM is a high-tech industry that actively uses the latest achievements of scientific and technological progress: driverless vehicles; cloud and smart technologies; systems for the accumulation, processing, and transmission of large data arrays; electronic document management; e-commerce, and the like. As a consequence, insufficient government attention to the digitalization of SCM leads to the country becoming an outsider in the global trading market.

Being focused on digitalization, today's SCM faces the following challenging issues:

- insufficient control of digital processes;
- lack of concepts and digital development programs for logistics in developed and developing countries;
- lack of mechanisms for managing the implementation of digital technologies;
- lack of a digital protection system and state support for the implementation of advanced technologies in the regions.

The role of the state in the engagement of national enterprises in GSCs is in providing policies to support information and communication technologies, reducing corruption, and provision of infrastructure according to the specific features of the region [24, 25]. Such an approach involves the use of various technological solutions for the development of information and communication infrastructure and stimulates the introduction of digital technologies.

6. Conclusions

Digital SCM is a set of processes for managing supply chains of goods and services with the use of digital infrastructure. This study provides the confirmation that the increase in the country's digital development causes an enlargement in its participation in GSCs, management of which is impossible without the application of digital technologies. The *strengths* of such a concept are products' and services' compliance with international standards; involvement in the global labor, resources, and capital markets; high controllability of the supply chain; cheap local currency; and the introduction of innovative technologies. Nevertheless, the digitalization of supply chains poses significant *threats* that are currently not neutralized due to the absence of digital development programs for logistics and supply management for both developed and developing economies. Such *threats* include a lack of mechanisms for managing integration processes in the digitalization context, growth of cybercrime, and low security of digital processes.

The principal indicators that determine the state of digital development of the SCM are indicators related to the use of the Internet and the development level of a particular individual and the whole country. In this regard, the role of the state in the field of digital SCM is growing not only as a guarantor of infrastructure and the macro environment but also as a controller, and SCM should be based on multilateral cooperation between the industry, governmental and non-governmental organizations.

Investments in digital SCM ensure the availability of complete and reliable information for effective implementation of logistics activities at all levels. They activate the development of market relations, ensure the functioning of state structures and, in general, contribute to positive qualitative changes in the living standards of the country.

The practical significance of this study lies in the creation of a scientific and methodological approach toward determining the nation's digital development in the context of SCM, defining the competitive positions of countries in terms of SCM, and creating a list of measures to increase the states' competitiveness in the global scale. The scientific value of the collected results is in the development of the scientific foundations for the supply chain functioning from the digital economy's perspective as a factor in influencing the level of involvement of countries and regions in world trade.

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