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HUMAN CAPITAL DEVELOPMENT AT HIGHER EDUCATION INSTITUTIONS

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Abstract

Research purpose. Currently, higher education institutions (HEIs) are faced with new challenges. They have to compete globally and take into account modern trends in education and science. Human capital becomes one of the most significant resources for HEI performance. The purpose of the study is to determine which factors influence human capital development at HEI.

Design / Methodology / Approach. Selected human capital development factors were analyzed at Latvian HEIs. Factors including existing laws and conformity assessment procedures and requirements were considered. A survey was utilized to determine the most influential factors in human capital development at Latvian HEIs. The survey results were analyzed by implementing CATPCA to identify the most critical factors.

Findings. The results show that essential elements of human capital at HEI are the pedagogical competence of the academic staff, their scientific competence, and the number of professionals from industry that are part of the academic staff. The CATPCA results revealed four main factors influencing human capital development at HEI, which could be divided into 1) staff competence and motivation; 2) legislation and development strategy; 3) availability of resources; 3) cooperation.

Originality / Value / Practical implications. Human capital is one of the key factors for the sustainability of HEIs in Latvia. By accounting for the factors that influence the development of human capital in HEIs, institutions can more effectively and proactively develop human capital management strategies, which allow the institutions to achieve performance in the long term.

Keywords: human capital, higher education institutions, development.

JEL codes: J24; M12; M50.

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Introduction

The competitiveness of higher education institutions (hereinafter – HEIs) today depends on several factors. Last ten years, HEIs have faced new challenges: globalization, migration, digitalization etc. They have to compete globally and consider modern trends in education and science. The level and quality of human capital within each HEI plays a significant role in an institution's ability to not only deliver high-quality instruction to students but also in an institution's ability to create new business and organizational processes. As the context changes, the requirements that determine the quality of a HEI, such as scientific publications, art-related outputs, books, patents, study courses' content, etc., have changed as well.

By analyzing the indicators of intellectual capital development at Latvian HEIs, utilizing the available information in National Scientific Information System (NZDIS, 2019) and HEIs reports, it could be concluded that the performance of HEIs is different. A HEI is more focused

on human capital development and performs better in the fields which are regulated by the legislation and accreditation criteria. Leading HEIs (mostly universities) have more academic staff with a Doctoral degree and professors. As a result, they have better indicators of scientific activities and outcomes, for example, a larger number of scientific publications in international cited databases, such as Scopus and Web of Science.

The purpose of this study is to determine factors that influence human capital development at HEI. The following hypothesis was formulated: the most important factors influencing human capital development are legislation and the type of HEI (university, academy, university of applied sciences, college).

This study was organized around a semi-structured questionnaire. Using a general sample of respondents who are represented by rectors, vice-rectors, or college principals of 54 Latvian HEIs, the data were analyzed using quantitative statistical methods.

The factors influencing human capital development at HEI could be divided as follows: factors related and linked to conformity assessment; factors related to the quality and motivation of the HEI staff; factors related to cooperation with other institutions; and financial factors.

Literature Review

As the development trends of society change and the degree of globalization increases, the role and tasks of HEIs change. Today, HEIs need to keep pace with global trends in the digitalization of education and access to information, the free movement of people between countries, work organization (where flexible working hours and teleworking are increasingly prevalent), economic change and geopolitical processes (Segundo et al., 2018). HEIs become an ecosystem that unites several stakeholders and in which intellectual capital is accumulated and developed (Dumay et al., 2017).

Today's student is significantly different from a student who studied in higher education ten years ago. At present, HEIs have to offer study content that would be adaptable to the needs of the student and would be available remotely at any time of the day (OECD, 2020). In these circumstances, the ability of HEI staff and teachers to offer such content is significantly increasing. That is why one of the primary tasks of HEIs is the development of human capital.

Human capital is the stock of skills, knowledge and expertise of employees that plays a significant role in increasing the productivity of the organization (Kucharcikova et al., 2015). Human capital refers to the intangible value that resides in individual competencies, which includes the expertise, knowledge, and experiences of academics (Secundo et al., 2015). The European Commission's project "Measuring Intangibles to Understand and Improve Innovation Management" (Canibano et al., 2002) formulates human capital as the knowledge that an employee takes with him when leaving the job as well as the employee's abilities. Lapiņa (2010) uses the broadest definition of human capital: it is a person with his physical and mental abilities, including knowledge and skills, a way of thinking, the ability to act in a certain way, in a certain sphere and environment, which determines his place and role in the society and the socio-economic development of the country.

The research mentions knowledge, skills, experience, creativity, loyalty, problem-solving skills, motivation, ability to work in a team, etc., as components of human capital (Johanson, 2005; Hsu & Fang, 2009; Hormiga, Batista-Canino & Sanchez-Medina, 2011). Human capital is an integral part of intellectual capital is not only a valuable HEI resource but also an asset capable to create value (Lentjushenkova and Lapina, 2016). Organizational and human knowledge, and competence as a special type of investment improve the functioning of the University (Yu. Levina et al., 2019). HEI staff is able to create value for various stakeholders: both HEI and students, and the society as a whole (Sultanova et al., 2018).

Passaro et al. (2018) consider that one of the most important aspects of the development of human capital in higher education is practice-oriented entrepreneurial courses and activities for students and aspiring academic entrepreneurs (third mission) to encourage entrepreneurialism and develop human capital that will allow students to pursue entrepreneurial careers, rather than

become job seekers after graduating. Moreover, creative, highly trained, experienced, and motivated staff who are equipped with other resources and a well-structured network of customers is a key factor for innovation performance within organizations (Castro et al., 2013). Human capital can enable an organization's innovation capacity when it is combined with other components of intellectual capital. Employees' skills level and organizational learning capabilities (i.e., human capital), the codified knowledge and experience embedded in the processes (i.e., structural capital), and the network of customers and suppliers and organizational culture (i.e., relational capital) make preconditions for product innovation (Manor et al., 2007, Travica, 2013).

In the last decade, in several countries, including Latvia, increased attention has been paid to the place of HEIs in various rankings. It is used as one of the tools for evaluating the achievements of the HEI. The rankings have a high proportion of science-related criteria. Consequently, the HEI started to concentrate resources and set up development strategies, quality management systems and personnel evaluation systems, which are based on the results of scientific activities. These trends are leading to a shift from quality to quantity at many HEIs. By embedding the specific requirements of measurable performance systems, HEI modified its existing performance measures, emphasizing both the quality and quantity of research publications. Traditional responsibilities, such as teaching and administration, were considered secondary (Martin-Sardesi et al., 2017). Martin-Sardesi and Guthrie (2018) believe that it is important to pay attention not only to the results of teachers' scientific activities, such as the number of publications but also to the motivation and quality of teachers not only to perform scientific activities but also to perform teaching functions.

The quality of teaching staff and the quality of their activities, namely the results of pedagogical and research activities, also play a large role in the accreditation criteria of HEIs and study programs. In accordance with the requirements of regulatory enactments, HEIs must ensure compliance with these criteria to receive accreditation.

Taking the above-mentioned into account, in the development of human capital, HEIs must comply with a number of conditions dictated by current trends in the world, as well as the requirements of regulatory enactments.

Methodology

A semi-structured questionnaire was utilized to answer the research question: are legislation and the type of HEI (university, academy, university of applied sciences, college) the most important factors influencing human capital? The questionnaire consists of a few sections:

Section A: information about human capital elements and human capital development.

Section B: statements on the factors which influence human capital development.

Section C: respondent profile.

Section A is designed to include elements of human capital that are mentioned in the scientific literature (for example, competence, motivation, etc.) as well as specific elements that are specified in the regulations of HEI activities (e.g., number of lecturers with doctoral degrees, number of professors, number of foreign lecturers, etc.).

Section B is designed to align with the literature review. A total of 18 factors have been selected, some of which have been determined based on scientific literature and some based on regulatory requirements. All factors are grouped into seven groups: legislation, location, management processes, staff competence, staff motivation, finance, and cooperation.

To evaluate each statement, respondents have been offered to use a 4-point Likert type scale. The opportunities for evaluation are as follows: 1 – most important, 2 – important, 3 – relatively important, 4 – not important. Table 1 details the alignment of the literature review and the survey factors that indicate human capital influence.

Table 1. Factors influencing human capital development at HEI (Source: author's compilation)

Factor	Group of factors	Source
Law	Legislation	National Law on Higher Education; Concept on Higher Education Development 2020; European Standards and Guidelines in Higher Education 2015
Accreditation rules for HEI		
Reputation of HEI (incl. rankings)		
Location of HEI: Riga or region	Location	Matoushek et al., 2005
Development strategy of HEI	Management processes	Huang et al., 2005; Huang et al., 2008; Maritan et al., 2011; Travica, 2013; Kianto et al., 2014.; Iacoviello, 2019; Veltri et al., 2020
HR management practices at HEI		
Academic staff assessment system		
Administrative staff assessment system		
Organizational culture of HEI		
Academic staff competence	Staff competence	Redding, 1996; Menor et al., 2007; Boujelben et al., 2011, Castro et al., 2013; Levina et al., 2019.
Administrative staff competence		
Motivation of academic staff	Staff motivation	Castro et al., 2013; Martin-Sardesi et al., 2018, Sultanova, 2018,
Motivation of administrative staff		
Availability of financial resources	Finance	National Law on Higher Education; European Standards and Guidelines in Higher Education 2015
Collaboration with other HEI	Cooperation	Menor et al., 2007; OECD, 2013; European Standards and Guidelines in Higher Education 2015
Collaboration with employers and professional organizations		
Participation in international projects		
Participation in international programs (i.e., ERASMUS+)		

The total number of HEIs in Latvia is 54. That is why the general sample consists of 54 Latvian HEI rectors and principals. The number of respondents, who took part in the interviews, was 19 rectors or principals of HEIs. Three Universities, 3 Universities of Applied Sciences, 3 Academies and 6 Colleges took part in the survey. The most significant part of HEIs are public HEIs (10 institutions) with the number of students from 1000 to 4000 (9 institutions) and located in Riga (12 institutions).

An initial analysis was performed by calculating frequencies in the SPSS environment. The procedure of ranking was made based on the ratings "Most important (1)" and "Important (2)" frequencies. In addition, the data set was also analyzed to specifically examine part B of the questionnaire and CATPCA (Categorial Principal Component Analysis) was utilized. It was selected because it is preferable for ordinary scaled data (Linitig et al., 2017). The reliability of the scale was checked by assessing an internal consistency with the application of Cronbach's alpha. According to Cortina (1993), the critical value for the coefficient was determined at 0.7 level.

Results

Table 2 and Table 3 present the result of frequency analysis (part A data). The respondents agree that the most important elements of the human capital of HEI are the pedagogical competence of academic staff, scientific competence of academic staff and a number of professionals from industry that are part of academic staff. This result reflects the common opinion of the main issues about the academic staff of HEIs and its quality in Latvia and other countries.

Table 2. Elements of Human Capital at HEI (Source: author's compilation)

Element	Most important	Important
Pedagogical competence of academic staff	66.7%	33.3%
Number of professionals from industry as an academic staff	50.0%	50.0%
Scientific competence of academic staff	50.0%	44.4%
Competence of administrative staff	44.4%	44.4%
Organizational competence of academic staff	38.9%	50.0%
Number of academic staff with Doctoral degree	22.2%	66.7%
Number of academic staff who are experts of the Latvian Council of Science	22.2%	55.6%
Number of professors	16.7%	61.1%
Number of foreign professors	16.7%	55.6%

According to the respondents' statements, the main HEI activity for human capital development is the recruitment of academic staff. In addition, another critical element in the development of HEI human capital is the continued development of the competencies of all types for academic staff, as well as the continued involvement of professionals from the industry.

Table 3. Human Capital Development Activities at HEI (Source: author's compilation)

Element	Most important	Important
Academic staff recruitment	55.6%	44.4%
Foreign professors' recruitment	55.6%	16.7%
Development of the teaching competence of the academic staff	61.1%	38.9%
Development of the scientific competence of the academic staff	44.4%	44.4%
Development of the organizational competence of the academic staff	61.1%	22.2%
Involvement of professionals from the industry in the study process (as an academic staff)	61.1%	38.9%
Development of the competence of the administrative staff	44.4%	44.4%
Team building activities	61.1%	38.9%

The data set from part B of the questionnaire was investigated by applying CATPCA. After checking for internal consistency between the items, to ensure the reliability of the scale, Cronbach's alpha was calculated for the whole data set and was equal to 0.837, which points to the high level of internal consistency.

To determine the number of components, the author firstly applied CATPCA for the maximum number of the components (18) following Manisera, Kooij & Dusseldorp (2010). The decision criteria considered "eigenvalue greater than 1 criterion" (Fabrigar et al., 1999). Eigenvalues for the first six components are greater than 1.

The author performed CATPCA, and a scree plot was developed to see the bend of the curve (Fig.1.).

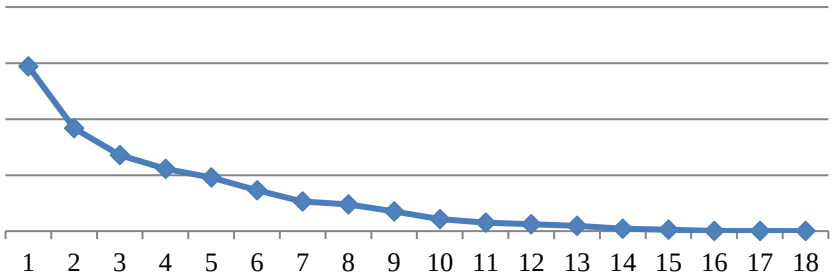

Fig.1. Scree plot of the 6-component CATPCA solution (Source: author's calculations)

Based on the "scree criterion" (Fabrigar et al., 1999), the last component that "accounts for a considerable amount of variance in the data" (Linitig et al., 2017) is either the fifth or fourth. Applying "eigenvalue greater than 1 criterion", in both cases (selecting five or four dimensions), the VAF is acceptable (80.61% and 74.29, respectively).

The third criterion is an "interpretability in the solution" that is based on factor loadings. Following Manisera et al. (2009, 2010), the author used a critical value of 0.5 for factor loading. Results for 5-dimensional and 4-dimensional solutions are presented below (see Table 4 and Table 5).

Table 4. The CATPCA results: 5-dimensional solution (Source: author's compilation)

	Dimension				
	1	2	3	4	5
Academic staff assessment system	**0.684**	0.414	-0.074	-0.208	-0.478
Law	-0.568	0.484	**0.568**	-0.327	-0.076
Accreditation rules for HEI	-0.567	0.487	**0.566**	-0.329	-0.074
Location of HEI: Riga or region	0.528	0.393	-0.283	-0.192	0.437
Development strategy of HEI	-0.562	0.489	0.570	-0.330	-0.069
HR management practices at HEI	0.162	0.285	-0.098	-0.449	**0.566**
Organizational culture of HEI	**0.582**	-0.063	-0.043	-0.517	0.418
Reputation of HEI (incl. rankings)	0.123	**0.502**	**-0.553**	-0.104	-0.110
Academic staff competence	**0.500**	-0.223	0.491	0.263	0.209
Administrative staff competence	**0.806**	-0.063	0.460	0.014	-0.089
Motivation of the academic staff	**0.756**	-0.046	**0.575**	0.157	-0.015
Motivation of the administrative staff	**0.831**	-0.012	0.480	0.022	-0.083
Administrative staff assessment system	**0.700**	0.397	-0.089	-0.190	-0.474
Availability of financial resources	**0.638**	0.491	-0.133	0.115	0.075
Collaboration with other HEIs	0.087	**0.579**	-0.402	0.319	-0.274

Collaboration with employers and professional organizations	-0.389	**0.586**	-0.036	**0.519**	0.107
Participation in international projects	0.106	**0.592**	-0.018	0.315	0.475
Participation in international programs (i.e., ERASMUS+)	-0.013	0.327	0.462	**0.608**	0.175

Table 5. The CATPCA results: 4-dimensional solution (Source: author's compilation)

	Dimension			
	1	2	3	4
Academic staff assessment system	0.485	-0.364	-0.242	0.515
Law	-0.810	**0.511**	0.095	-0.021
Accreditation rules for HEI	-0.815	**0.501**	0.109	-0.038
Location of HEI: Riga or region	0.263	-0.101	**0.734**	-0.426
Development strategy of HEI	-0.809	**0.513**	0.096	-0.020
HR management practices at HEI	0.033	0.072	0.456	-0.557
Organizational culture of HEI	**0.526**	0.134	0.181	-0.593
Reputation of HEI (incl. rankings)	-0.032	-0.589	0.440	-0.031
Academic staff competence	**0.552**	0.541	-0.039	0.177
Administrative staff competence	**0.760**	0.482	0.040	0.053
Motivation of the academic staff	**0.653**	0.621	0.089	0.228
Motivation of the administrative staff	**0.729**	0.567	0.168	0.025
Administrative staff assessment system	**0.811**	-0.342	0.006	0.225
Availability of financial resources	0.449	0.065	**0.677**	0.007
Collaboration with other HEIs	-0.162	-0.269	**0.654**	0.244
Collaboration with employers and professional organizations	-0.427	-0.150	0.414	**0.615**
Participation in international projects	-0.187	-0.045	**0.735**	0.251
Participation in international programs (i.e., ERASMUS+)	-0.023	0.387	0.301	**0.654**

According to CATPCA results, four dimensions could be distinguished:

1) Dimension 1: Staff competence and motivation;
2) Dimension 2: Legislation and development strategy;
3) Dimension 3: Availability of resources;
4) Dimension 4: Collaboration.

The first dimension includes all items related to staff (both academic and administrative), competence and motivation, and organizational culture. The second dimension consists of items that are related to law, accreditation, and quality assurance external and internal legal documents. The third dimension includes the availability of financial resources, collaboration with other HEIs, participation in international projects and location of the HEI. These items influence each other, e.g., collaboration with other HEIs allows the HEI to use its resources in the most effective way and save them. The fourth dimension is related to collaboration with industry and international organizations, including HEI.

Conclusions

The approach to higher education has changed significantly over the last decade, setting new requirements and standards for higher education. This, in turn, affects the quality of the resources required. Currently, HEIs are forced to focus not only on teaching but also on research and student support through a student-centered approach. All this has a significant impact on the formation of human capital and its development at HEI.

The scientific literature emphasizes the special role of academic staff in building human capital in higher education: both in the development of entrepreneurship in students and in the demonstration of student innovation. Researchers point out that HEI has undergone a significant shift in focus from teaching to research and innovation creation. On the other hand, considering accreditation standards and guidelines, attention must be paid to teaching methods that are able to ensure the satisfaction of students' learning needs and the achievement of learning outcomes.

The results show that the factors influencing human capital development could be divided into four dimensions. The first dimension includes the academic and administrative staff competence and motivation. This dimension is closely related to the law and quality assurance standards which are mandatory for each HEI. The second dimension consists of all items related to the law and internal rules and strategy of the HEI. According to the law and standards, each HEI should provide a certain number of professors, scientific publications etc. These requirements influence human capital development directly and describe a HEI's ability to attract and develop its human capital. The third dimension is related to resources which the HEI has and its ability to attract additional financial resources by collaborating with other institutions. The fourth dimension includes items that describe the HEI collaboration with professional organizations, employers and foreign HEIs. Such collaboration increases organizational knowledge and allows to improve the quality of the academic staff.

Despite the lack of funding and bureaucracy in the quality assurance system, factors related to the law and availability of financial resources are not most important from respondents' perspective.

The survey results confirm the common view on human capital development in the higher education sector. The most important elements of human capital are the pedagogical competence of the academic staff, the scientific competence of the academic staff and the number of professionals from industry as an academic staff. The author could conclude that Latvian HEIs focus their efforts on the quality of the staff as the main activity of human capital development.

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THE DIFFERENCE BETWEEN LEGAL CONTROL AND MATERIAL CONTROL - COORDINATION OF ACCESS RIGHTS IN SHARED WORKSPACES

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Abstract

Research purpose. Modern work is increasingly taking place in temporary workgroups embedded in decentralized work environments that transcend organizational boundaries. The first implementations of the shared workspace idea emerged in the 1990s in the CSCW research area and are now firmly integrated into the working world with systems such as Google Drive, OneDrive or Dropbox. However, when it comes to accessing documents, problems arise in terms of coordinating access to documents. Who can access the documents, modify them, and upload them back to the shared workspace? It should be noted that concurrent changes can lead to inconsistencies. Furthermore, incorrect changes to the content of documents can have economic and legal consequences. Who is responsible for this? Strict access control can avoid this problem if necessary. However, it contradicts the approach of agile cooperation, which benefits, among other things, from access to documents that is not restricted in terms of time and place.

Design / Methodology / Approach. The article proposes a semantic approach for access coordination of shared workspaces. Its basis is the legal distinction between the levels of legal control (owner) and material control (possessor). The owner of an object has the right and the duty to allow the other participants of the shared workspace to access it, i.e., to have material control. This is done through an agreement between the owner and the possessor, which specifies the conditions of material control. In addition to coordinating access, the owner is also responsible for arbitrating in case of conflict and deciding which changes are valid and which are not.

Findings. Transferring the distinction between owner and possessor leads to three possible classes of conflicts: Ownership vs ownership, ownership vs possession, and possession vs possession. Conflict schemes within these classes of conflict are analyzed in detail. On the one hand, it is possible to use strict, conflict-avoiding settings, but this tends to limit cooperation. On the other hand, greater cooperation agility can be enabled if the owner situationally controls access or if the owner has preset flexible response tactics in case a conflict arises. A closer look at possible conflict classes shows that it is necessary to adapt the legal concepts of owner and possessor to the cooperation situation.

Originality / Value / Practical implications. The concept of the legal distinction between owner and possessor has not yet been applied to the domain of access coordination in shared workspaces. This approach can introduce the previously missing semantics for access coordination, at least on an informal basis. It also improves participants' awareness of the context of cooperation.

Keywords: shared workspaces; access coordination; conflict resolution.

JEL codes: M15.

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Introduction

Decentralization of organizations and companies has become a significant success factor in today's business world. Outsourcing, offshoring, joint ventures, and international consortia have led to work environments that are geographically distributed across organizational and national boundaries. This trend toward decentralization of work processes has been manifested by the increasing availability of the Internet over the past 20 years.

In this environment, the results from the research area of computer-supported cooperative work (CSCW) from the 1990s have largely been incorporated into everyday working life: Synchronous computer-based support systems such as videoconferencing systems, virtual whiteboards, etc. are now common tools - reinforced by the digitization push of the COVID-19 pandemic. Computer-based support systems such as instant messaging, shared workspaces, etc., cover asynchronous support needs.

The idea of supporting temporally and spatially separated cooperation with the metaphor of the shared workspace emerged in the early 1990s from, among other things, research that revealed the weaknesses of workflow systems in supporting informal processes (Kreifelts et al. 1991). The approach of enabling workgroups in decentralized and cross-organizational work environments to access (shared) information objects anytime and anywhere on the basis of a minimal technical infrastructure through shared workspaces is standard today. Since the first results and implementations of CSCW research in this area (e.g., Kreifelts et al., 1993; Agostini et al., 1996; Bäcker & Busbach, 1996; Bentley et al., 1997), shared workspaces have been integrated into everyday life - albeit sometimes with reduced functionality in terms of awareness concepts (e.g., cloud-based solutions such as Google-Drive (Google, 2021) or OneDrive (Microsoft, 2021a). Essential functions of shared workspaces are the provision of information about the work itself and the exchange of data that is processed jointly. Access to data in a shared workspace is not limited by time or location. Actions are logged in so-called events, and the concepts of container (folder) and content are used to structure shared workspaces.

Access to a workspace, i.e., the container/folder, and particularly to information objects stored in the workspace, i.e., the content, must be coordinated to avoid possible inconsistencies due to concurrent, competing changes. The following scenario describes a (simple) distributed work environment. It clearly shows that unforeseen situations can arise within cooperation that require flexible reaction patterns. Using the scenario described below, we discuss aspects of collaborative work and concurrency control solutions developed in this article.

Three people - e.g. Anna, Bert, Clara - work together to create a proposal for a tender. Although Clara is responsible for the project and the documents to be created, the work packages have been divided so that each of the three participants is assigned specific documents to work on. A meeting will be held on Thursday to discuss the results and adjust as necessary. Anna realizes that she still needs to change minor text passages so that the bid can be submitted on time the next day and decides to make these changes the next morning during a business trip. To edit the documents, Anna wants to use a laptop to write back the changes online. Bert is given the task by Clara to merge the various documents and submit them by the deadline on Friday afternoon. During the business trip, a defect occurs in Anna's portable device (hard drive failure, network card failure, etc.). Anna is no longer able to make the necessary changes to the bid. What happens now? Bert takes over Anna's work. He can do this either after explicit agreement with Anna - e.g. in a telephone conversation - or simply because he cannot reach Anna and suspects technical problems. In addition to the changes discussed the previous day, Bert makes further changes because he has received information from informal sources about offers from possible competitors. However, Bert is currently unable to reach the responsible Clara to inform her of his more extensive changes to the bid. He nevertheless decides to submit the new version of the bid by the deadline on Friday. If necessary, Anna and Clara check during the next week whether and to what extent the changes they consider necessary have been made. There may be discrepancies from the participants' respective points of view. What is the "correct" version?

The scenario shows the dynamics and situational dependence of cooperation. Several people access a shared workspace that contains the information objects to be processed within the

cooperation. The question arises whether and in what way access to the information objects can and must be coordinated and controlled. Of course, the scenario describes an exceptional situation, but it is precisely such circumstances that show the problems that arise within cooperation.

The goal of concurrency control for a shared workspace must be to implement as free as possible, non-restrictive information access coordination within concurrent cooperative activities. Instead of restricting the concurrency of activities, the persons involved should be mutually informed about their actions and involved in maintaining data integrity. A situation where actions cannot be executed because data integrity is compromised from the perspective of the application's concurrency control, even though there is no conflict from the perspective of the cooperating participants, should be avoided. Instead of the classical concurrency control, cooperative access coordination has to be implemented, which allows to include information about the current working context.

In this article, an interdisciplinary approach is presented that examines the distinction between the levels of legal control (owner) and material control (possessor), following the legal system as a basis for access control. In transferring this concept from legal sciences, several questions arise, the answers to which are the focus of the article.

- How can the concept of an owner be applied to shared workspaces? What are the rights and obligations of an owner? How can owners of an information object allow or deny other participants access to material possession? How can owners of information objects that interfere with each other resolve the interference?
- How can the concept of a possessor be applied to shared workspaces? What are the rights and obligations of a possessor? Which types of possession are mutually exclusive, and which can coexist? What guarantees does the possessor have with regard to his material possession vis-à-vis the owner of the object and, if applicable, owners of other objects that correlate with his object?

In summary, the above questions relate to potential conflicts within cooperation. Understanding their nature can serve as a basis for the future development of procedures to coordinating access to shared workspaces, considering semantics on an informal basis.

Literature review: Access Coordination in Shared Workspaces

The use of cooperation support systems in general and of shared workspaces, in particular, requires distributed systems at the technical level so that cooperation partners can access documents asynchronously at any time and from any location. The main characteristic of a distributed system is that its software is installed on networked computers that exchange messages asynchronously. To the user, the system appears as a single system even though it is distributed (Tanenbaum & van Steen 2002). Since it cannot always be assumed that the computers in the network will operate without errors or that the network itself will function, replications of data or files are often used to increase availability. The data objects are stored at different locations in the network. Consequently, simultaneous changes to individual replicas by different users can lead to consistency problems similar to those described in the cooperation scenario in the introduction. At the same time, distributed systems are an enabling technology for cooperation support systems. Therefore, it is interesting to investigate to what extent distributed systems solve the problem of consistency in the presence of concurrent changes and whether this approach can be applied to the cooperation scenario.

It can be concluded that the trade-off between availability and consistency that exists in distributed systems occurs accordingly in cooperation situations. The notion of availability is more complex in distributed systems. However, the perspective of the necessary access to data - more precisely, in the context of cooperation, to information objects like documents needed for the joint processing of a task - is identical. Increasing availability can be achieved by temporarily allowing different replicas of a document using so-called optimistic techniques (Saito & Shapiro, 2005). However, this can lead to temporary inconsistencies that have to be

resolved. If one wants to avoid inconsistencies, one has to deny access to the replicas until all replicas have the same state again - pessimistic techniques (Saito & Shapiro, 2005). These procedures lead to a restriction of the availability or accessibility of documents, i.e., transferred to the cooperation context, to a reduction of cooperation possibilities. Moreover, the user is not involved in conflict resolution because conflicts are avoided a priori. Optimistic techniques assume that conflicts rarely occur in reality. If they do occur, they can be resolved after the fact. Consequently, concurrency control is low and only weak consistency is guaranteed. However, the availability of - possibly inconsistent - information objects to the user is high. Replication methods can be applied to both structured data and documents/files. Since documents play an essential role in asynchronous cooperation and the availability required for cooperation is the focus of this approach, the optimistic approaches of file synchronizers for conflict resolution in cooperation support systems are discussed below.

A distinction is made between a state-based and an operation-based file synchronizer. In state-based file synchronization, consistency between two replicas is achieved by sending all state data from one replica to the other. After all state data is received, operations are computed by taking a difference (delta) between the received state and the persistent state of the last successful synchronization. These operations are then applied by the consistency algorithm to both replicas at their respective locations to synchronize the replicas (Uppoor et al., 2010; Li et al., 2012). The operation-based file synchronizers use logs that record all operations that have occurred on each replica since the last consistency check. These operations are time-ordered and applied to the replicas to achieve a consistent state as a result (Ramsey & Csirmaz, 2001; Najafzadeh, 2018). However, both approaches can lead to conflicts since operations can be performed, or replication states can be changed simultaneously.

Conflicts can either be resolved automatically (Ng & Sun, 2016; Bjørner, 2007; Tao et al.; 2015, Bao et al., 2011), semiautomatic depending on the operation (Lindholm et al., 2005) or by the user (Balasubramaniam & Pierce, 1998; Ramsey & Csirmaz, 2001; Csirmaz, 2018). While there are approaches that attempt to take semantics into account (Tao et al. 2015), in principle, all file synchronizers operate more or less on a technical-syntactical level. Automatic conflict resolution may subsequently lead to results that do not meet consistency requirements from a cooperation point of view. When involved in conflict resolution, the user needs information about the context of the cooperation, i.e., the current goals, constraints, availabilities, intentions of the parties, restrictions, etc. However, this contextual information is not offered by file synchronizers.

Another approach to achieving document consistency is to assign access rights to files or directory systems (Dell, 2020; Microsoft, 2021b; Google, 2021b), which can be defined by the user. As with file synchronizers, however, there is a trade-off between availability and maintaining consistency. Restrictive access rights settings ensure consistency but hinder collaboration. The exceptional situation described in the scenario of the introduction chapter cannot be supported. Regardless of this, the question arises as to who sets the access rights and, if necessary, allows violations or exceptional situations.

Basically, a purely technical, syntactical level for ensuring the consistency of documents in the context of cooperation support systems does not seem to be sufficient but must be reconsidered:

... the role of the computer can thus be seen as that of providing sufficient feedback and affordances of shared objects to support ... the mediation of interactions by humans themselves (Greenberg & Marwood, 1994, page 211).

In the 1990s, research in the area of awareness in cooperation support systems intensified. Awareness is defined here as "an understanding of the activities of others that provides a framework for one's own activities"(Dourish & Bellotti, 1992, page 107). Subsequently, the term awareness was specified and differentiated into informal, social, workplace awareness, and awareness about group structure (Gutwin et al., 1996). Parallel research has been conducted in the area of document access rights in cooperative support systems that considered the aspect of awareness (Rodden et al., 1993; Greenberg & Marwood 1994; Bäcker & Busbach 1996; Busbach, 1996), which at its core is based on optimistic access control and conflict resolution

by participants of the cooperation. However, a general approach to access rights has not yet been developed, as the combination of awareness and file synchronization seems to solve the problem. However, there is not yet an approach for comprehensive integration of these two concepts. The question of who is ultimately responsible for the content of a document, or the question of traceability of responsibility, also remains open. First approaches to this aspect can be found in (Busbach-Richard, 1999). However, the aspect of access coordination has moved out of the focus of research on cooperation support systems, leaving unresolved questions such as "who is allowed to execute what, when and why, or in which context on files/documents". It is only in the context of the idea of smart contracts (Kolvart et al. 2016; Jaccard, 2017) that this question and thus the aspect of responsibility has come back into focus. Although at first glance, aspects of semantics and collaboration context are mapped in this approach, the real implementations are mostly still on a technical-syntactical level. The meaning of terms such as owner, possessor and subsequently responsibility are not defined yet. The transfer of concepts from the legal domain to the consistency maintenance of documents in distributed systems or cooperation support systems is insufficient. For example, Google Drive and Adobe use the term ownership (Google 2021b; Adobe 2021), but further research reveals that the term is not defined. The following table summarizes the advantages and disadvantages of the optimistic and pessimistic approaches.

Table 1. Overview of approaches for access coordination in shared workspaces (Source: compilation by the author)

type	optimistic	pessimistic
pros	does not hinder the flow of cooperation	consistency - at least at the syntactical level - is ensured
cons	consistency can be compromised, leading to inefficiencies and errors	can hinder the flow of collaboration and even lead to a temporary blockade
prerequisites	all participants involved in the cooperation must be aware of potential access conflicts and know about conflict resolution schemes to enable conflict resolution on a semantic level	access rights must be set appropriately to minimize interference with cooperation, and one person must be responsible for adjusting access rights to resolve a temporary blockade

Research Methodology: Legislation - Ownership vs Possession

In Western democracies, a distinction can be made between common law and civil law (UC Berkeley, 2017). Common law is generally not codified and works with precedents. In general, everything is permitted that is not expressly prohibited by law (World Bank Group, 2021). Civil law, whose origins can be found in Roman law (UC Berkeley, 2017), is, in contrast, a codified legal system (World Bank Group, 2021), whose description of legal relations is more on an abstract level (Rahmatian, A. 2010) and allows less freedom, for example, in the formulation of contracts (World Bank Group, 2021). Although the optimistic approaches have proven more advantageous here for the cooperation case, civil law - more specifically, the German Civil Code (BGB) - will be discussed in more detail below. The abstraction of civil law contains an unambiguous description of the terms of ownership and possession, which is not given in this form in the common law. Since these terms are only vaguely defined in the current implementation of shared workspaces, the consideration of codification from the field of civil law can provide valuable impulses for the cooperation context.

Both legal systems have in common that property law defines the objects of property as defined by law, regardless of whether they are tangible or intangible. Exclusive rights are conferred on these objects or "things." These rights, property rights, are socially recognized and legally protected and create (initially) exclusive powers over these objects - ownership. Thus, property law creates objects as normative concepts and assigns these objects to natural or legal persons

by conferring rights over them (Rahmatian, 2010).

A closer look at the BGB shows that the owner of an object is the person to whom the object belongs. In Germany, the constitution guarantees and protects the right of ownership according to Article 14 of the Basic Law (GG). The BGB defines the content and protection in more detail in §§ 903 ff. However, the legislator must also consider the interests of the general public as well as the interests of the persons who come into contact with third party property rights. This balancing of interests is already laid down in §§ 903(1) BGB, when it states,

" ... unless the law or the rights of third parties conflict therewith, ... ".

Property is therefore not granted unconditionally but is subject to restrictions (Van der Walt & Dhliwayo, 2017). In German law, this aspect is enshrined in §§ 14 of the Basic Law, which states that there is a social obligation of property.

Property is a right but not yet a claim against a particular person. Only from the violation of the property right, i.e. the impairment of the thing of which one is the owner, do claims arise against the violator(s) of the property (Juracademy, 2021). Property violations may include interference with property, compensation for unauthorized use, damages, protection against unauthorized disposition, and protection against deprivation of possession.

Within the scope of this article, it is not possible to deal with all infringements of property rights as defined in German law. However, of particular interest is the last point, protection against deprivation of possession, which relates to the difference between possession and ownership. In contrast to ownership, possession is understood as the actual power of disposal over a thing. That is, one can be an owner without possessing, as in the case of borrowing, renting, or even stealing. Material control (possession) is to be distinguished from legal control (ownership). Ownership and possession may coincide. However, this need not necessarily be the case.

A small example: in the case of an apartment, on the one hand, there is the owner of the apartment, and on the other hand, there is the tenant, who has concluded a rental agreement and thus becomes the possessor of the apartment. The lease gives the possessor protection of possession and the right to defend this possession against others. One also speaks of direct possession since the power of disposal is exercised. The owner is referred to as the indirect possessor. He has the legal power of disposal. One can even gain possession of a thing through a criminal act, for example, a theft, even though one has violated the law, since the crime gives one the material power of disposal. This, of course, violates property rights, which have a higher value than this so-called tortious possession. Possession can be handed over by a contract or simply using the thing.

The BGB has some regulations that also protect possession (Juraforum, 2021a). For example, there is the right of force according to §§ 859 BGB. The holder of the right of force may use force to defend himself against the opponent of the possession - the person who wants to take the thing illegally - in order to protect the possession in case of interference with the possession with his own force, provided that the means of force is suitable, necessary, and proportionate.

In addition to possession, ownership as such can, of course, also be transferred. In BGB, the transfer of ownership of an object requires an (informal) agreement between the parties that ownership of a particular thing is to be transferred (contract in rem) and the transfer of the thing (handover) as an actual act. If the thing is already in possession of the acquirer, ownership may be transferred by the mere agreement between the parties that the new owner (acquirer), who previously held the thing with the intention of possessing it for the transferor, shall now exercise possession for himself: traditio brevi manu. Thus, the possessor for another person becomes the possessor for himself and thus the owner (Rahmatian, 2010).

As a rule, the informal agreement discussed above must follow the construct of a contract. A contract is a multilateral legal transaction that establishes a debt relationship between the parties. A contract only becomes effective if there are at least two corresponding declarations of intent, namely offer and acceptance, regarding the essential content of the contract. Acceptance presupposes the submission and receipt of the offer. However, the timeliness of the acceptance in accordance with §§147 und §§ 148 BGB must be ensured. Acceptance is subject to time

constraints. However, a contract is not validly concluded despite the effective existence of an offer and acceptance if so-called objections that hinder the right stand in the way, such as legal incapacity or due to a breach of a statutory prohibition. In addition, a validly concluded contract can "lapse", i.e., the contract was void from the start if the declaration of intent made is contested by the declarant. The German Civil Code lists, for example, the following grounds for rescission (§§ 142 I, 143, 119 ff. BGB): error of content, error of declaration, error of quality, false transmission, fraudulent misrepresentation, or threat (Juraforum, 2021b).

Research results: Access Coordination in Shared Workspaces

In the following, the notions of ownership, possession and - indirectly - contract are transferred to a cooperation context.

Ownership

Several basic assumptions need to be made in order to adapt the legal concept of ownership to shared workspaces, which reflects the rights and obligations of an owner:

- It is assumed that hat transferring the notion of ownership to a cooperation context can contribute to the emergence of commitment, since individuals can be held directly responsible for information used in cooperation.
- The person who contributes information - be it in the form of a document, a discussion contribution, an email, etc. - to a cooperation is referred to as the (initial) owner and originator. However, this can only apply in relation to the cooperation-specific shared workspace. Outside of the cooperation context, the term owner loses its meaning.
- By contributing information, an owner commits to ensuring the best possible availability and consistency under the current circumstances of the cooperation. This includes resolving or mitigating conflicts regarding the information object through negotiation. This is done in analogy to the legal concept of ownership that the interests of the general public must be considered.

Against the background of the last assumption, the owner must actively prevent interference with his information. Conflicts can also arise from passive influences on the property, such as when the contents of documents contradict each other or when the content of a contribution to a discussion is interpreted and construed contrary to the owner's original intention. However, resolving passive influences requires that at least one party - not necessarily the owner himself - discovers and addresses this influence.

Ownership in a collaborative context arises from the provision of information. The person providing the information is the originator and the initial owner. Ownership can be passed on, not authorship. The importance of this separation can be illustrated, for example, by a discussion post. The discussion post itself reflects the author’s opinion, while the owner coordinates the information object that contains the author's opinion. The second way in which ownership can be acquired within cooperation is through the transfer of ownership. The transfer of ownership requires an agreement between the new and the old owner, i.e., as with a legal contract, two corresponding declarations of intent are required, namely offer and acceptance. In the time window between the submission of the offer and the acceptance of the ownership, the information must remain "unchanged" or may only be changed within clear specifications to be defined in the offer. If the defined time frame for acceptance has expired, the transfer of ownership has failed. The voluntary nature of acceptance is essential. No party to cooperation can be forced to assume the obligations of an owner. This coincides with the concept of free will from contract law.

Possession

By analogy with the legal term, the possessor of an information object is the person who accesses and/or edits the object as part of a cooperation. The operations that a possessor can perform include reading and writing the content and moving the information object. If one

transfers the legal concept of material possession to shared workspaces, further conclusions can be drawn:

- In contrast to the legal concept of possession in the German Civil Code, possession in the context of cooperation is of a more short-term nature in order to prevent a permanent blockade of the cooperation from the outset. The exercise of possession rights within the framework of cooperation is bound to a certain period of time. When the current operation ends, so does the possession. Possession is volatile.
- The possessor's guarantee to be able to execute an operation that has been started or granted is subordinate to the owner's rights and obligations, as the owner must ensure the best possible availability and consistency for all cooperation participants.
- Another limit to the transfer of the notion of material control in the context of cooperation is the fact that in German law, there can be at most one legal possessor or group of possessors at any given time. In this context, a group of possessors is homogeneous from a legal point of view. In cooperation, on the other hand, several possessors can act simultaneously and independently of each other on an information object. Material possession of information objects within cooperation need be neither exclusive nor homogeneous.

Apart from the (possible) interaction with other possessors, the actions of a possessor are, in any case, always integrated into the general cooperation context. Other cooperation participants - even if they are not possessors at the moment - can be influenced in their actions by the possession of another cooperation participant. The actions of a possessor do not only influence the possessor himself but on the entire cooperation.

At first glance, conflict resolution in access coordination of information objects appears to be straightforward as the owner, as the holder of the legal power of disposal, determines the validity of an information object and can withdraw possession - thus maintaining availability and consistency for all participants in the collaboration. However, a closer look reveals a more complex or differentiated picture. Moreover, there are additional ownership/ownership and possession/possession conflicts to consider. The following table provides an overview.

Table 2. Overview of conflict types (Source: compilation by the author)

conflict type	ownership/possesion	ownership/ownership	possession/possession - exactly one possessor at a time	possession/possession - - two possessors at one time
resolution scheme	a) explicit approval by the owner of changes made by the possessor without the appropriate consent of the owner. Time restrictions may apply b) transfer of ownership of the information object to the possessor of the information object. c) Rejection of the changes by the owner of the information object d) Rejection of changes by the owner of the parent folder (possibly cascading) - for more details on this, see ownership/ownership conflict	a) acceptance of the rules and regulations of the folder by the owner of the information object b) transfer of ownership of the information object to the owner of the folder c) removal of the information object from the folder	a) Current possessor relinquishes possession. Subsequently, another cooperation participant may gain possession (b) owner approves changes after the fact. Time restrictions may apply.	competing: a) decision about the correct object state by the owner, combining changes of both possessors if necessary b) the last change is valid (rule set transparently by owner) simultaneous: a) allow for non-modifiable access with the indication of possible inconsistencies b) allow for non-modifiable access and provision of a notification service for any change to the information object

Ownership/possession conflict

Within the ownership/possession conflict, there are different constellations. For example, the question of responsibility remains open if the possessor makes changes and then the object is further processed by third parties without the owner being able to check and approve these changes before they are passed on. In the description of the cooperation scenario in the introduction to the article, such a situation is described. In principle, this case can be solved in two ways. Either the ownership right on the information object is transferred to the possessor, and he will become the new owner. This approach corresponds to the "traditio brevi manu" of the German Civil Code. The possessor for another becomes the possessor for himself. Alternatively, the right of ownership remains with the owner. The latter bears the responsibility outwardly towards third parties, but he can claim from the possessor in the internal relationship. This corresponds to the legal approach of compensation in case of damage or compensation in case of unauthorized use if the owner has deprived the possessor of material control. Of course, the owner can also approve subsequent changes if the right of possession was originally exercised without appropriate authorization. Alternatively, the changes are rejected by the owner and the information object is restored to its original state. In this case, the other participants in the cooperation who have accessed the object in the meantime must be informed of the incident, as they may have worked on the basis of incorrect information. If necessary, their work must be undone.

In addition to direct ownership/possession conflicts that have been played out in the scenario, there are also indirect conflicts. These can occur when an owner of an information object grants a right of possession that conflicts with the ownership rights of the folder in which the information object has been uploaded. For example, the owner of the folder may have specified that the information objects stored in the folder may not be modified. The owner of the information object nevertheless allows modifying access. There is no conflict between the owner of the information object and its possessor but an indirect conflict between the owner of the information object and the owner of the folder. For resolution or avoidance, it must apply that an owner can grant to another person only those possession rights that he himself still has after restricting his ownership rights with respect to the folder’s rules. The possible material control rights must preserve the ownership rights that exist on the folder. From the possessor's point of view, this example involves a concrete ownership/possession conflict regarding the information object, although the possessor did not trigger it. The owner of the folder can either accept the changes even though the ownership was incorrect. Alternatively, he can reject the changes. Since there are folder hierarchies, this procedure can be cascading.

Ownership/ownership conflict

Looking at the above scenario more closely from the perspectives of the owner of the folder and the owner of the information object, an abstract ownership/ownership conflict arises. The rights of one owner are restricted against his will by those of another owner. In this case, however, it is not the rights of the owner of the information object that are restricted or infringed, but those of the owner of the folder. By uploading the information object in the folder, its owner has freely restricted himself to the rules set by the owner of the folder. Consequently, these restrictions did not happen against the will of the owner of the information object since the procedures were known in advance. Conversely, the owner of the information object may be affected if the owner of the folder tightens or relaxes the rules for the folder. If these options are part of the rule set for the folder and are transparently viewable, no conflict occurs because the procedures were known at the time the information object was uploaded. The changes are consistent with the original agreement. However, a conflict arises if the owner of the folder changes the ruleset after upload of the information object in a way that was not known at the time of upload. One solution, in this case, might be for the owner of the information object to remove it from the folder. Another solution could be that the owner of the folder becomes the owner of the information object.

Possession/possession conflict

The scenario in the introduction of the article contains a case for a simple possession/possession conflict. The constellation in which Anna is the possessor, Clara has the right of ownership, and Bert wants to make changes leads to a corresponding conflict since Bert has not come into

possession either through an intervention by Clara, who would first have to deprive Anna of possession and transfer it to Bert or through a release of possession by Anna. In this scenario, however, it is assumed that there is only one possessor at a time.

As described above, in a cooperation context can be more than one possessor for an object at the same time. As a result, two-possession/possession conflicts may occur, competing conflicts and simultaneous conflicts. Competing conflicts can occur when an owner grants multiple people the right to modify the information object. Possessors compete over the validity of the modifications they make to the information object. The owner of the information object decides on the correct state of the object. He can combine the changes made by the two possessors, if necessary, or decide in favor of a single change. Another solution is that the owner of the information object transparently sets a rule that the last change is valid. A simultaneous conflict can occur when a non-modifying possession right is granted concurrently with a modifying possession right. Now the problem arises as to which state of the information object is observed by the person who has been granted a non-modifying possession right. One solution is that the participant in the cooperation who is granted non-modifying access is transparently informed about the possibility that the information object may be modified during his possession. In this case, he is aware of possible inconsistencies in the state of the object and can adjust his work and decisions to this uncertainty. A second solution is to combine the allowance for non-modifying access with a notification service. Any possessor granted non-modifying access will be notified of changes of the information object so that they can tailor their work and decisions to the current state of the object. Although this seems to be a solid solution, problems related to network outages and notification overflow can occur.

It is not self-evident that both possessors can exercise their rights of possession without restriction. It depends on the owner's grant of possession whether he avoids any possible conflict or allows them to arise. In the latter case, an owner must disclose the conflict resolution rules, i.e., all persons seeking possession are informed of the rules and agree to them by accepting possession. The owner has an obligation to indicate the possibility of conflicts and their conditions. Possessors are aware that the owner is the final arbitrating and deciding authority regarding the validity of an information object.

Conclusions

If we transfer the legal concepts of the owner, possessor and - indirectly - contract to a cooperation context, innovative coordination structures emerge when accessing information objects. Availability is increased while maintaining a certain consistency since the responsibilities for an information object are clearly defined in a cooperation context. In this respect, the purely technical, syntactically oriented procedures from the field of distributed systems, file synchronizers and directory services are extended to include a semantic level for maintaining consistency. The individual participants in the cooperation are personally involved in the coordination of information objects through their consent to the cooperation. Consent creates commitment and acknowledges potential constraints. Awareness is enriched with semantics that relates to access coordination. Direct involvement of individuals leads to self-regulation, resulting in indirect enforcement of coordination structures. Each action is directly coupled to an individual. This coupling is visible to all cooperation participants. However, it can be assumed that self-regulation through personal responsibility is correlated with group size. If a too large number of cooperation partners leads to the depersonalization of responsibility, this may increase the need for institutionalized coordination structures. Testing this assumption and investigating whether and which awareness concepts for access coordination are built up among participants in detail would be an area for further research.

However, the transfer of legal concepts is far from complete. The question arises as to whether, in an even more detailed analysis, there are further areas of access coordination to shared workspaces that require an expansion of legal concepts, such as the case of concurrent and simultaneous possession, which do not exist in this form in the legal field. Furthermore, the question arises to what extent the approaches of Smart Contracts (Kolvart et al., 2016) map the legal concepts of contract from the German Civil Code and whether - after appropriate

adaptations - they can possibly be integrated into an implementation for access coordination of information objects in shared workspaces. However, the adaptation of the legal concept of the contract was only indirectly addressed in the article and requires further investigation.

Of course, access coordination of information objects within cooperation must be adapted to the changing conditions in the course of the cooperation. The adaptation is made by the participants of the cooperation. On the one hand, it can be done explicitly by changing the coordination procedures or implicitly by reinterpreting or abandoning the use of existing procedures. The second point correlates, on the one hand, again with the awareness concept. On the other hand, this point crystallizes another aspect that has always been present subliminally in the transfer of legal concepts to access coordination: semantics. Legal terms such as ownership, possession, and contract are interpreted in a particular context. Depending on the context, the interpretation may change. The same is true for the transfer of these terms to cooperation in a shared workspace. The conclusion from this is that, in contrast to the classical concept of algorithms in computer science, there can be ambiguity. Algorithms always deliver the same result with the same input. There is no interpretation. Algorithms cannot capture semantics. This is mathematically proven since semantics belongs to the so-called np-hard problems, which are not computable (Knuth, 1974). Semantics can only be emulated by artificial intelligence methods. However, these methods do not correspond to the classical notion of an algorithm because, depending on the learning state of the methods, the same input can lead to different results at different times as context changes are taken into account. Similar to a legal system, there is no uniqueness of outcomes. Transferred to the context of cooperation, this means that there is no optimal solution for the access coordination of information objects, but only an approximation. Either purely technical, syntactically oriented procedures from the field of distributed systems, file synchronizers and directory services are used, which may hinder the flow of collaboration and even lead to a temporary blockade. However, consistency at the syntactic level is guaranteed. Alternatively, a common context space can be created to avoid misunderstandings using legal terms such as ownership and possession. Nevertheless, misunderstandings cannot be excluded in principle since - as explained above - an algorithmic solution for the semantics of the concepts of owner and possessor does not exist. To improve the use of the concepts of ownership and possession in a cooperation context and to reduce possible misunderstandings, further research can investigate whether concepts from the field of design patterns (e.g., Alexander et al., 19770 can be applied to develop consistency control patterns that can support access coordination depending on the concrete problem context.

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SUPPLY CHAIN MANAGEMENT PRACTICES AND MANUFACTURING FIRMS PERFORMANCE: PROFESSIONALS' EXPERIENCE IN NIGERIA

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Abstract

Research purpose. The study aims at establishing how supply chain management (SCM) activities of manufacturing firms influence their performance optimally.

Design/Methodology/Approach. The research design adopted for the study is the survey research design; this is because we were interested in gathering information from a selected strategic fraction of a target population as it is not possible to meet them all. A structured questionnaire was used to collect data from two hundred and twenty-seven (227) professionals from the five selected manufacturing firms in Lagos. The data were analyzed by the structural equation modelling (SEM) technique to ascertain the causal effect of the latent exogenous variables on the latent endogenous variables in the study.

Findings. Based on the results of the SEM adopted in testing the research hypotheses, strategic partnership has a statistically significant positive effect on customer satisfaction of manufacturing firms. Customer relationship management was revealed to have a positive effect on firm performance from the path analysis. This is substantiated by the path coefficient (0.35) of customer relationship management on performance proxied by customer satisfaction. However, information sharing has a weak positive effect on performance proxied by manufacturing efficiency. This is substantiated by the path coefficient (0.11) of information sharing on performance though the effect is not significant as $p>0.05$ and $CR<1.96$. Material flow management has a positive effect on performance proxied by manufacturing efficiency. This is substantiated by the path coefficient (0.30) of material flow management on firm performance. There is a positive effect of lean production on performance proxied by innovation performance. This is substantiated by the path coefficient (0.25) of lean production on performance. Finally, participative design/engineering was revealed to have a positive effect on performance proxied by innovation performance. This is substantiated by the path coefficient (0.23) of participative design/engineering on performance.

Originality/Value/Practical implications. This paper demonstrates that a higher degree of acceptance, application, and enhancement in SCM methods would directly increase the performance of manufacturing firms, especially in third world countries.

Keywords: supply chain management; manufacturing firms; performance; SEM.

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Introduction

The sustainability of any business depends on its ability to continuously improve its performance metrics and stay profitable and competitive. A supply chain is a network of functions or organizations connected through the products and services that they offer in order to deliver them to the end consumer. Crandall, Crandall, & Chen (2015) highlights that a simple supply chain consists of participants in a certain order from upstream to downstream. The practices and activities of managing supply chains are known as supply chain management (SCM). They are the set of events and activities that happen in an organization to ensure the effective management of the value chain (Truong et al., 2017). The Association of Supply Chain Management (2019) defines SCM as "the design, planning, execution, control, and monitoring of supply chain activities with the objective of creating net value, building a competitive infrastructure, leveraging worldwide logistics, synchronizing supply with demand, and measuring performance globally". The practice of SCM refers to all sets of activities that are done in organizations to improve efficiency in the internal supply chain. This will help the organization to achieve sustained good performance and excellent customer service (Omoruyi & Mafini, 2016).

Manufacturing firms are faced with competition and other tough external factors that shape their operating environment and impacts performance. Local manufacturing firms have to compete with globally sourced goods. Moreover, government policies regulate the operations of firms and can impact manufacturing costs and general performance. This means that firms must improve their performance by developing and implementing agile and responsive practices in supply chain management. Hence, the study adopts the RBV theory, which states that an organization can focus on the potential of its internal resources to deliver some competitive edge. The concept of supply chain management has gained the attention of professionals and scholars alike (Chaghooshi et al., 2015) as manufacturing firms all over the world are faced with lots of challenges that impact their performance; challenges like market instability, high cost of raw material and energy abound in the sector. However, few studies have been conducted to unravel the impact of SCM practices on organizational performance in a volatile business environment. The study of Sharma and Modgil (2020) used total quality management as the independent variable and SCM to mediate its influence on the operational performance of the pharmaceutical industry in India. A similar kaleidoscopic business environment like Nigeria is the focus of this study where the contribution of the manufacturing sector has been on a downward trend despite the strategic importance of this sector to the economy; there is an urgent research attention. Hence, a study of how their activities under SCM influence their performance is required and will help those organizations to focus and repurpose their resources to ensure optimal performance. This paper set out to evaluate supply chain management practices in manufacturing firms from the perspectives of professionals with the aid of structural equation modelling (SEM).

Literature Review

Supply chain management is a set of methods used for the efficient integration of supply chain partners- suppliers, manufacturers, warehouses, and retailers so that a correct number of goods can be manufactured and distributed at the best place and time at an optimal cost. (Shafiei & Tarmost, 2014). To be effective, supply chain management (SCM) integrates the internal cross-function within a firm with the exterior operations of external partners in a close and effective manner. SCM's goal is to share market information, develop new products, improve the number of suppliers for manufacturers, and activate and release management resources to build long-term relationships based on the members' initial trust needs (Nilipour--Tabatabaei et al., 2012). According to Phan et al. (2019), in 2010, many manufacturing companies in Vietnam became more focused on supply chain management (SCM) practices to find the way to respond rapidly, correctly, and profitably to market demands which any focused manufacturing firms must ensure. Thus, Managers must pay more attention to building long-term partnerships with suppliers, selecting the suppliers based on quality issues rather than cost, sharing information with suppliers and customers, involving customers and suppliers in problem-solving and quality

improvement activities (Zeng, Phan, & Matsui, 2013) which are essential practices in supply chain management.

For a partnership to be strategic, it focuses on smooth, lasting association and boosts common planning and solution proffering efforts (Zhao & Lee, 2009). This makes working together mutually beneficial among the parties and brings about continuous involvement in core areas such as technology, portfolio, and markets. An effective partnership with a supplier can be a critical component of a leading-edge supply chain (Kroes & Ghosh, 2010). Moreover, a strategic supplier relationship is an important criterion in achieving a long-term association for both the buyer and the supplier of any organization (Theodorakioglou et al., 2006). As information is important for maintaining supplier relationships in the long term, various tools and techniques are used (Teller et al., 2017).

H_{01}: Strategic supplier partnership has no impact on customer satisfaction of manufacturing firms in Nigeria.

The practice of attending to consumers to manage their complaints, establish long-term relationships with customers, and improve customer satisfaction is known as customer relationship management (Li et al., 2006). This encompasses all procedures aimed at resolving market grievances, establishing lasting partnerships, and increasing customer happiness. According to Jharkharia & Shankar (2006), a vital part of SCM practices is the managing of relationships with customers. Relevant to the successful implementation of SCM programs is the partnership with customers (Jie et al., 2013). Closing the gaps with customers makes it easy for an organization to deliver differentiated services. This will make customers loyal and significantly improve value offerings.

H_{02}: Customer relationship management has no impact on customer satisfaction of manufacturing firms in Nigeria.

The level of information sharing is the extent of the availability of critical and proprietary information among supply chain partners (Li et al., 2005). Part of this timely information, accurate information, as well as the authenticity of information disseminated to SCM partners. Both quantity and reliability of information sharing are vital to SCM and are usually regarded as separate constructs in previous research (Chau, 1997). The level is measured by the extent to which relevant and occupational information is available for partners to use. (Tan, 2002). Exchanged information is either strategic or tactical in nature. It also varies from information about logistics activities to general market and customer information (Slater & Narver, 2000). By readily making data available for other parties within the supply chain, information can be used as a source of competitive advantage (Liere et al., 2010).

H_{03}: Information sharing has no impact on the manufacturing excellence of manufacturing firms in Nigeria.

Lean practice is the process that is used to eliminate waste in a manufacturing cycle. It is a philosophy, a work environment, a method, an administrative idea. It is considered valuable, methodic, and ethical. Today, lean has metamorphosed, and it can improve aspects of an organization. (Mark, Wilson & Ram, 2009). Lean practices have numerous benefits, including helping to eliminate waste in all procurement cycles, prevent shortfalls, reduce inventory cost, reduce procurement lead time and cost, increase inventory turnover, and ensure customer satisfaction. (Lewis, 2000). With regards to Lean practices and Supply Chain Performance, Zaman and Ahsan (2014) state that Lean practices can be applied in many supply chains,

particularly those seeking to boost performance by eliminating waste. If a supply chain is cost-competitive, utilization of lean to remove waste and reduce costs will be required. The lean tools and techniques can help to achieve the linkage between supply chain practices and performance.

H_{04}: Material flow management has no impact on the manufacturing excellence of manufacturing firms

in Nigeria.

Banjoko (2000) explained the basic aim of materials management, and that is to make certain that material is procured and delivered at an optimal time, cost, location with the best price in mind. Barker (1989) identified five key functional areas that materials management cuts across, which include purchasing, production and inventory control, quality control, storage and warehousing and physical distribution. Materials are the backbone of any production system and even service system; no organization can operate without them. Coordination and scheduling of production activity require that materials must be and delivered at an optimal time, cost, location with the best price. Chase, Jacobs, Aquilano and Agarwal (2009) discussed the elements of materials management and mentioned the comprehensive systems framework for understanding the full flow of information, materials, and services from business suppliers to the market through the internal processes of the company.

H_{05}: Lean production has no impact on the innovation performance of manufacturing firms in Nigeria.

There are numerous methods for evaluating a company's performance; nonetheless, many firms' ultimate purpose is to achieve financial and accounting results (Macinati, 2008). In research involving just about any aspect of management, the ultimate desire has always been to understand overall organizational performance. This construct is critical for researchers and managers to compare and analyze the operations of companies throughout time (Richard, Devinney, Yip & Johnson, 2009). Organizational performance is a metric that assesses how well a company achieves its objectives (Ho, 2008). There is no universal agreement on what constitutes organizational performance or its means of measurement. Several previous studies used several dimensions to assess organizational success. Financial indicators, on the other hand, have long been used as a tool for comparing firms and evaluating their performance (Karimi & Rafiee, 2014). Several studies have identified various elements of assessing organizational success, with a bulk of them relying on indicators that have financial leaning as primary indicators, for example, market volume, ROI, growth parameters, the profit margin on sales, and the position of the firm within the industry. Review of organizational performance is separated into two aspects based on the results of performed research: performance in terms of operations and profitability (Radu-Ioan, 2014).

H_{06}: Participative design/engineering has no impact on the innovation performance of manufacturing firms in Nigeria

Methodology

The research design adopted for the study is the survey research design, where the cross-sectional research design, which involves a one-time sampling of respondent's opinions relevant to answer the research questions and to allow data to be collected from a large sample at the same time period was employed. The target population in the study was composed of SCM professionals within selected manufacturing companies in Lagos State, Nigeria. A proportionate

sampling method was used due to the stratified nature of the population. Based on the nature of the observed variables and the objectives to be achieved in this study, primary data was employed, and a self-administered questionnaire was designed to assess the study population with respect to the described dimensions and generate the data for the study. A pilot study was carried out, and first-order confirmatory factor analysis (CFA) was conducted to assess the validity and reliability of the measurement model in structural equation modelling (SEM). SEM path analysis was deployed for the test of the hypothesis with the aid of Analysis of Moments Structures (AMOS) Graphics to ascertain the strength of the relationship between the latent constructs of SCM and the performance's constructs in the study.

The target population in the study composes of SCM professionals within five selected manufacturing companies in Lagos State, Nigeria. The target population was obtained to be five hundred and twenty-three (523) professionals across the five companies, as seen in Table 1.

Table 1. Study Population

Functions	Crown Flour Mill Ltd	BUA Sugar Refinery	Dangote Flour Mill	Kimberly Clark	Perfetti Van Melle	Total
Procurement/Purchasing	12	6	11	5	9	43
Stores/Inventory/Material Handling	33	14	22	12	14	95
Operations/Production	44	46	56	24	33	203
Logistics/Fleet/Evacuation	24	36	38	13	12	123
Warehousing/Distribution	6	8	7	18	20	59
						0
	119	110	134	72	88	523

A proportionate sampling method was used due to the stratified nature of the population. To be included in the sample study, individuals had to meet some criteria; the individual had to be currently occupying a position in which they perform supply chain management functions in a manufacturing firm. These functions are sourcing, material management, production planning, distribution, and sales planning. It is also required to have accrued a minimum of one year of experience performing these functions to be included. The sample selection of targeted firms was based on the years of their existence in the business, market presence of products, location, and the prompt retrieval of relevant data.

The sample size was determined from a population of 523 professionals using the formula from Yamane (1967), $n=N/(1+Ne^2)$ where n is the sample size, N is population size 523, e is margin of error at 5%, using this, the sample size came out as 227, considering the proportion of the various functions in the population the required breakdown of sample is as Table 2.

Table 2. Sample size proportion

Functions	Crown Flour Mill Ltd	BUA Sugar Refinery	Dangote Flour Mill	Kimberly Clark	Perfetti Van Melle	Total	sample size
Procurement/Purchasing	12	6	11	5	9	43	19
Stores/Inventory/Material Handling	33	14	22	12	14	95	41
Operations/Production	44	46	56	24	33	203	88
Logistics/Fleet/Evacuation	24	36	38	13	12	123	53
Warehousing/Distribution	6	8	7	18	20	59	26
						523	227

The data used for the study were generated through questionnaires' responses taken from the respondents. The questionnaire was structured into two sections. Section A addresses the social-demographic characteristics of the respondents such as gender, age, marital status, qualification, years of experience in supply chain businesses, while Section B to G comprise some questions related to SCM practices. Section H includes all questions related to performance measures.

The data extracted from the questionnaire administered were analyzed using descriptive statistics on SPSS to determine the mean and frequency distribution of the data. Analysis of Moments Structures (AMOS) for the structural equation model was used to test the hypothesis. A structural equation model combines a structural model and measurement model and is useful for the analysis of latent variables, which are the types of variables used to represent SCM practices.

The regression model for the study is hereby specified as follows:

$$DY = f(CRM, SSP, LOI, LP, MM, PE) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (i)$$

Written in mathematical form,

$$DY = \beta 0 + \beta 1 CRM + \beta 2 SSP + \beta 3 LOI + \beta 4 LP + \beta 5 MM + \beta 6 PE + \epsilon \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (ii)$$

Where:

DY = Dependent Variable (organizational performance)

CRM = Customer Relationship Management

SSP = Strategic Supplier Partnership

LOI = Level of Information Sharing

LP = Lean Production

MM = Material Management

PE = Participative Design/Engineering

E = Error terms

B0, β1, β2…. = parameters

Results

Demographic Data

The study established the relationship between supply chain management practices and manufacturing firms' performance. Two hundred and twenty-seven (227) respondents were selected as the sample size, and the same copies of the questionnaire were distributed out, of which two hundred and three (203) were duly filled, returned, and were found fit for data analysis. This gives an approximate response rate of 89.4%. The data collected revealed that 71.4% of the total respondents were male; 28.6% of the respondents were female. It shows that most of the respondents were male. Notwithstanding, the study is not gender-bias; it cuts across all gender. 28.1% of the respondents fall within the age bracket of 18-24years; 39.4% were between 25-30years; 24.6% were within 31-49yrs; while 7.9% fall within the age bracket of 50years and above. On educational qualification, 15.8% of the respondents were ND/Equivalent holders; 62.1% were HND/BSc holders, and 22.2% were MSc degree holders. It revealed that most of the respondents were learned and quite educated to know the relevance and implication of the study. In terms of work experience, 27.6% of the respondents had 1-3years experience, 52.2% had 4-9years experience, and 20.2% had ten years and above. It indicates that the

majority of the respondents are well-experienced in their respective fields and can provide data relevant to the context of this study.

From the data collected, the overall mean score (4.07) revealed that the firm had adopted strategic supplier relationships to a larger extent. From the data collected, the overall mean score (3.92) revealed that the firm had adopted customer relationship management to a greater extent. From the data collected, the overall mean score (3.94) revealed that there is a high level of information sharing in the studied firms. From the data collected, the overall mean score (3.88) revealed that material flow management is highly practiced in the studied firms. From the data collected, the overall mean score (3.88) revealed that lean production is highly practiced in the studied firms. Furthermore, the overall mean score (3.85) revealed that there is high participative design/engineering in the studied firms.

Analysis of Research Objectives

This sub-section deals with the analysis of the study's objectives, which were analyzed using structural equation modelling (path analysis) with the aid of Analysis of Moments Structures (AMOS) Graphics. Figure 1 below displays the path diagram resulting from the structural modelling analysis using AMOS Graphics. The model's explanatory power is determined by two values: squared multiple correlations (R^2) and path coefficient. The path coefficients demonstrate the strength of links between constructs, whereas R^2 reveals the proportion of variance an endogenous represents in the model. Endogenous R^2 is defined as strong = 0.26, moderate = 0.13, and weak = 0.02 (Chin, 1998). The structural model's R^2 score in this study is 0.41, indicating that it has a great deal of power in describing the influence of all factors on firm performance. The results also demonstrate that all of the measurements have substantial loadings on the constructs they correspond to.

Table 3 presents the fitness of the structural model. The indices adopted for achieving the fitness of the structural model show satisfactory fit with their corresponding values greater than the recommended values. Therefore, the structural model can be considered a good representation of the data.

Table 3. The fitness of the Structural Model

Goodness of fit Statistic	Structural Model Values	Recommended* values for good fit
$\chi 2$ /df	2.752	< 3.00
NFI	0.901	> 0.9
TLI	0.911	> 0.9
CFI	0.921	> 0.90
RMSEA	0.071	< 0.08

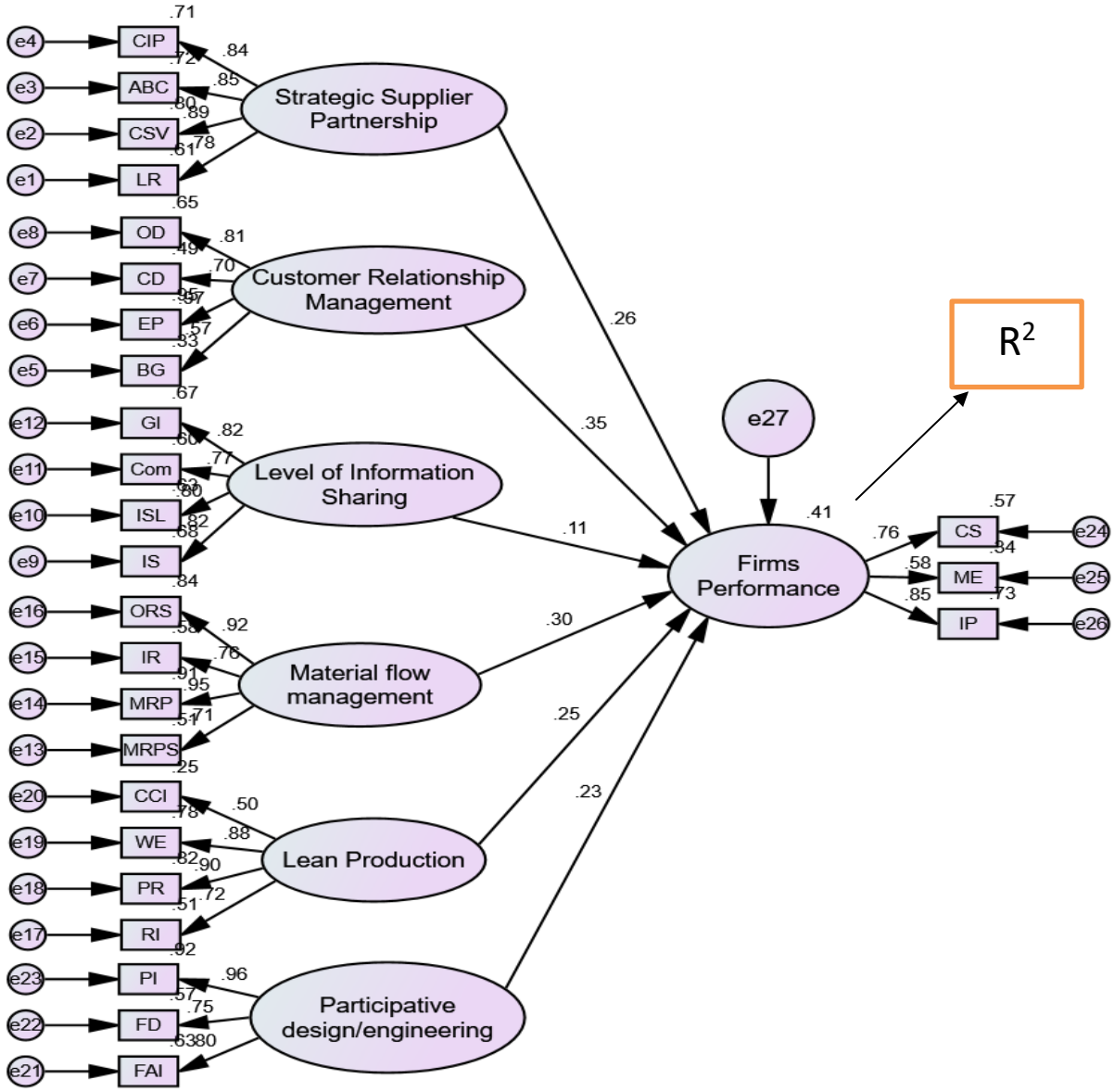

Fig.1. Structural Model for Supply Chain Management Practices and Manufacturing Firms' Performance

Table 4 shows the summary of path coefficients of the latent independent constructs (strategic supply partnership, customer relationship management, level of information sharing, material flow management, lean production, and participative design/engineering) to latent dependent construct (firm performance) extracted from the structural model in Figure 1. The finding revealed that Hypotheses 1, 2, 4, 5, and 6 were accepted, which indicated that strategic supply partnership (SSP), customer relationship management (CRM), material flow management (MFM), lean production (LP), and participative design/engineering have a significant and positive effect on firm performance. However, Hypothesis 3 was rejected, which indicated that the level of information sharing (LIS) has no insignificant effect on firm performance.

Table 4. Construct Structural Model (SCM Practices and Performance)

Link in the model	Hypothesis	Path Coefficient	Critical Ratio (CA)	p-value	Result
P <-- SSP	H1	0.26	2.169	0.050	Alternate hypothesis Accepted
P <-- CRM	H2	0.35	2.614	0.009	Alternate hypothesis Accepted
P <-- LIS	H3	0.11	0.921	0.357	Alternate hypothesis Rejected
P <-- MFM	H4	0.30	2.428	0.015	Alternate hypothesis Accepted
P <-- LP	H5	0.25	2.034	0.042	Alternate hypothesis Accepted
P <-- PD/G	H6	0.23	1.986	0.049	Alternate hypothesis Accepted

Test of Hypotheses

The result of the path analysis in Figure 1 reveals a positive effect of strategic supplier partnership on firm performance proxied by customer satisfaction. This is substantiated by the path coefficient (0. 26) of strategic supplier partnership on performance. This implies that a 1% increase in strategic supplier partnership accounted for a 26% increase in customer satisfaction. Furthermore, the effect of strategic supplier partnership on firm performance was found significant at $p < 0.05$ and $CR > 1.96$. This, therefore, led the study to reject the null hypothesis and concluded that strategic supplier partnership has a significant positive effect on firm performance.

Customer relationship management was revealed to have a positive effect on firm performance from the path analysis. This is substantiated by the path coefficient (0.35) of customer relationship management on performance proxied by customer satisfaction. This implied that a 1% increase in customer relationship management accounted for a 35% increase in customer satisfaction. Furthermore, the effect of customer relationship management on firm performance was found significant at $p < 0.05$ and $CR > 1.96$. This, therefore, led the study to reject the null hypothesis and concluded that customer relationship management had a significant positive effect on firm performance.

As revealed in the path analysis, information sharing has a weak positive effect on performance proxied by manufacturing efficiency. This is substantiated by the path coefficient (0.11) of Information sharing on performance. This implies that a 1% increase in information sharing accounted for an 11% increase in performance. However, the effect of information sharing on firm performance was found to be insignificant as $p > 0.05$ and $CR < 1.96$. This, therefore, led the study to accept the null hypothesis and concluded that information sharing has no significant effect on firm performance.

It was further revealed that material flow management has a positive effect on performance proxied by manufacturing efficiency. This is substantiated by the path coefficient (0.30) of material flow management on firm performance. This implied that a 1% increase in material flow management accounted for a 30% increase in firm performance. Furthermore, the effect of quality focus on firm performance was found to be significant at $p < 0.05$ and $CR > 1.96$. This, therefore, led the study to reject the null hypothesis and concluded that material flow management has a significant positive effect on firm performance.

The path analysis revealed a positive effect of lean production on performance proxied by innovation performance. This is substantiated by the path coefficient (0.25) of lean production on performance. This implied that a 1% increase in lean production accounted for a 25%

increase in firm performance. Furthermore, the effect of lean production on performance was found significant at $p < 0.05$ and $CR > 1.96$. This, therefore, led the study to reject the null hypothesis and concluded that lean production has a significant positive effect on firm performance

Finally, participative design/engineering was revealed to have a positive effect on performance proxied by innovation performance. This is substantiated by the path coefficient (0.23) of participative design/engineering on performance. This implied that a 1% increase in lean production accounted for a 23% increase in firm performance. Furthermore, the effect of participative design/engineering on performance was found significant at $p<0.05$ and $CR>1.96$. This, therefore, led the study to reject the null hypothesis and concluded that participative design/engineering has a significant positive effect on firm performance.

Discussion

The study established the relationship between supply chain management practices and manufacturing firms' performance. The study deployed structural equation modelling (Path Analysis) for data analysis and test of hypotheses in a bid to achieve the objectives of the study. The findings were in line with most previous studies.

In hypothesis one, we conclude that there is a significant causal effect of strategic supply partnership on firm performance proxied by customer satisfaction. This result is consistent with the work of Mohammad et al. (2019), which found that supplier relationships had a beneficial impact on long-term performance. It also supports the findings of Richard et al. (2020). According to them, strategic supplier alliances are positively connected with operational success and are a crucial component of supply chain management in enhancing firm success.

In hypothesis two, the findings revealed that customer relationship management has a significant causal effect on firm performance proxied by customer satisfaction. This result backs up the findings of Sofi, Bashir, Parry, and Dar (2020) study, which demonstrated a high and positive link between CRM and customer satisfaction. Rodriguez & Boyer (2020) also suggested that when collaboration is utilized to mediate the conversation, CRM has an impact on customer relationship performance.

In hypothesis three, information sharing was found to have a weak positive effect and insignificant effect on firm performance. Information system integrated across functions in the studied firms does not impact manufacturing efficiency as revealed in the study. This finding is incompatible with the study of Makena and Mike (2014) on the impact of supply chain management practices on organizational performance and reported that information sharing had a stronger effect on firm performance. Furthermore, this result from this study is consistent through the study of Phan, Nguyen, Trieu, Nguyen and Matsui, (2019) that demonstrate the significant linkage between supply chain quality management practices and operational performance empirical evidence from manufacturing companies in Vietnam.

Considering hypothesis four, material flow management has a positive effect on performance proxied by manufacturing efficiency. It is evident that the studied firms have a robust material requirement planning system in place to facilitate manufacturing efficiency. Achieving production efficiency in a manufacturing outfit requires proper management and control of inventory by ensuring the accuracy of inventory records, which invariably impact the overall performance of firms.

The stated hypothesis, H_{05}, was rejected as the findings further show that lean production has a positive effect on performance proxied by innovation performance. The components of lean products were extensively practiced by the studied firms. There is a culture of continuous improvement in the studied firms, and firms' production rate is synchronized with customer demand to sustain their competitiveness. Firms need to employ lean manufacturing strategies to be efficient and successful. In order to sustain such behaviors, it is necessary to employ a variety of approaches as well as appropriate strategies to help mitigate their effects and therefore improve organizational performance. Prior research has shown that using such strategies may

result in significant cost reductions, including reduced manufacturing costs, lower supervision costs, shorter cycle times, enhanced customer responsiveness, increased investment, increased sales, and larger profitability. This finding is in line with the findings of Lokpriya and Vivek (2020) and Mohamad (2020), that state that lean production has a significant effect on performance. Consequently, it has been suggested that we examine the allocation of resources that really should be undertaken over time since prolonging this phase may impede more work on the previous phase from being completed.

Finally, H_{06} was rejected as findings revealed an existing positive effect of participative design and engineering on innovation performance. It is evident that all the functional areas in the studied firms are involved in product design. By adopting modern technology in the production, new product development and product design can be facilitated at a minimum cost and at the same time maximizing customer satisfaction thus, enhancing firms' profitability (Omoruyi & Mafini, 2016).

Conclusions

The study established the relationship between supply chain management practices and manufacturing firms' performance. The study establishes the need for supply chain managers to align suppliers with the organization's values and strategies, as well as maintain bi-directional communication with them. Manufacturing firms that want to improve their customer satisfaction must ensure clear goals have been defined that relate to customer development and retention coupled with the inclusion of customer satisfaction in the employee performance measurement. The findings show that a higher degree of acceptance, application, and enhancement in SCM methods would directly increase the performance of manufacturing companies. Hence, the study recommends that manufacturing firms endeavor to maintain long term relationships with suppliers by way of maintaining open and bi-directional communications with the suppliers to ensure quick delivery of quality materials or components par for production, which enhances production flow and quick delivery of finished products to the consumers. Future studies can appraise the performance of manufacturing firms with other quantitative techniques such as regression and correlation analysis or a combination of both the quantitative approach and the qualitative approach. Future studies may consider other predictors other than strategic supply partnership, customer relationship management, level of information sharing, material flow management, lean production, and participative design/engineering in the design of SCM parameters.

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EVALUATION OF KEY FACTOR OF DIGITAL ECONOMY IN EUROPEAN UNION

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Abstract

Research purpose. This article presents insights on the concept and key factors of the digital economy based on a literature review. The article focuses on the identification of the factors of the digital economy and evaluation of their importance in terms of the European Union countries. The aim of the article is to determine the factors of the digital economy and evaluate their importance.

Design / Methodology / Approach. Panel regression analysis was used to evaluate which indicator of selected digital economy indicators is the most important. Panel regression was chosen to have an overall view of all European Union as one unit.

Findings. Digital technologies are radically changing the way society, business or the whole economy operates. The survey of this article reveals that the high-quality infrastructure of the internet plays an essential role in the digital economy. In order to create value and improve the ICT sector performance in the whole economy, high-quality infrastructure in terms of the internet is needed. Only fast and high-stability connection ensures needed infrastructure and development in the digital economy. Business and government should invest in high-quality internet infrastructure to ensure the steady growth of the digital economy. To take full advantage of digital infrastructure and the digital economy, individuals should use it daily. Daily usage of the internet has a positive effect on the percentage for the ICT sector in GDP regardless of activities on the internet.

Originality / Value / Practical implications. Definition of the digital economy was suggested: the digital economy is considered to be all economic activities that include using or creating digital technologies to generate value-added of digital enablers and development of digital infrastructure, which is the key factor of the digital economy. High quality and available for everyone internet access is crucial for steady growth and the best performance of the digital economy. This study has several practical contributions. This survey may serve as a guide for understanding the concept and the factors of the digital economy for other researchers. We also propose a potential explanation why countries should invest in high technology infrastructure, and these results can help to create a new strategy for ICT sector expansion in different countries.

Keywords: digital economy; digital economy development; digital infrastructure; DESI, European Union.

JEL codes: M15, M21.

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Introduction

The digital economy, being one of the six priorities announced by the European Commission for 2019-2024, confirms that society is living in the digital age and increasingly relies on digital technologies in daily activities (European Commission, 2019). The development of the digital economy has become one of the priorities in most countries, confirming that the advantages and

opportunities of the digital economy are undoubted (Lyapuntsova et al., 2018). Expansion of digital-enabling infrastructure creates new areas of scientific research and innovations, services, economic growth, and improvement in the quality of life of the society.

Even though the digital economy is emerging as a catalyst for globalisation, it is also a key driver of growth and development, boosting competitiveness across all sectors (Mukhtorovna, 2021). The digital economy ensures better communication, information exchange, efficiency and enables collaboration which is needed in order to cover all growing needs of society (Mahmudov Baxriddin Jurayevich and Mullabayev Baxtiyarjon Bulturbayevich, 2020). A better understanding of the digital economy can help businesses improve their production capacity; however, the most important feature of the digital economy is an expansion to the new and biggest market: the internet. In order to succeed in the global market, principles should be examined (Danilin, 2019).

Based on that, it is essential to understand the concept of the digital economy and its main factors. The concept, development, and perspectives of the digital economy have been examined since 1996 (Tapscott, 1996); however, a unified concept and factors of the digital economy have not been developed yet. That encourages to look for new perspectives and aligns with the aim of this article: to identify the factors of the digital economy and evaluate their importance in terms of the European Union countries. In order to reach the aim of the paper, the concept of the digital economy was highlighted, and the factors of digital economy development were examined. A suitable methodology for assessing the factors of the digital economy in the EU was chosen, and an evaluation of the factors of the digital economy in the EU was performed.

Like every study, the present one has several limitations. The data of digital infrastructure and usage was used in this article as factors of the digital economy, but due to missing data, several countries were excluded from the research. They are as follows: Cyprus, Denmark, Ireland, Luxembourg, Netherlands, Portugal, Spain, Sweden. Data used for the year 2015-2019 (2019 data of the percentage of the ICT sector in GDP were not published and were predicted using moving average. There might be some deviations from the actual data of this indicator in 2019).

This paper is organised as follows: the theoretical background section gives a comprehensive literature review; the methodology part describes the methods used in the research and selected indicators. Empirical findings illustrate the empirical data used in the research and numerical expressions, the results of the survey and possible causes, while the conclusion gives some concluding remarks.

Theoretical Background

According to World Economic Forum (2016), the digital economy affects all aspects of society, including the economic landscape, the way of collaboration and communication between people, the abilities needed to get a decent job, and even how political decisions are made. Although the digital economy is a part of our daily life, the concept is not clear yet. It is a lack of a globally agreed definition of the digital economy and unified evaluation system. The goal of this section is to describe the concept and development of the digital economy and identify the factors that reveal the development of the digital economy.

The term digital economy was first described by Tapscott in 1996 as a tool of using technologies and networking of human beings to create wealth and enhance social development through a combination of creativity, intelligence, and knowledge for breakthroughs (Tapscott, 1996). Since there is no internationally agreed definition of the digital economy, it is crucial to compare definitions from different sources to get a better understanding of what the digital economy is.

According to Chen (2020), narrowly, the digital economy can be defined as economic activities in the information and communication technologies (ICT) sector, including the internet, IT services, telecommunication, etc. The broad definition covers the combined value of information and communication technologies (ICT) production and digital inputs to the rest of the economy. Most importantly, if we would consider that the digital economy covers all

economic activities that use or are facilitated by digitised data, we could say that the digital economy is a great part of nowadays economy.

The digital economy, as reported by Skilton (2015), is a part of the digital ecosystem which is an interaction of information technologies and business to create new consumers, determine better business results, etc. The digital economy is considered as virtual resources and digital services to create added value for both individuals and businesses or countries. According to the World Bank Group (2016), the digital economy is doing business and using digital technologies across all sectors, including education, manufacturing, healthcare, transportation, agriculture, entertainment, etc., and cannot be limited by e-commerce or e-business. One of the main advantages of the digital-based business is the low marginal cost to enter the business; however, that also leads to higher competition (Chohan, 2020). The digital economy is an accelerator of global economic development that increases the productivity of existing industries and opens opportunities for new markets and industries, providing sustainable growth. At the same time, the digital economy connects different communities, industries, ideas, or products and allows different parts to collaborate and raise the value chain.

The digital economy is a result of the widespread implementation of ICT into the economy and is considered through the creation, processing, and use of information and knowledge presented in digital form. Digitalisation covers most spheres of the economy nowadays and brings digital technologies and knowledge as a base for new digital skills, opportunities, and value for business or society (Puzina et al., 2021).

Kim et al. (2014) stated that the digital economy is a step toward a knowledge-based society. The digital economy grows faster and faster and overtakes the traditional industrial economy. The key factor of the digital economy is the development of information and communication technologies (ICT) and innovations creating new economic growth structures in all aspects of life. Besides the digitalisation of core economic activities as production, distribution, and consumption of goods and services, one of the essential properties of the digital economy is its inclusion of knowledge and information in main production factors. Digitalisation is a part of almost all economic activities, and it is constantly expanding (Szeles & Simionescu, 2020). Recent transformation to digitalisation in every part of the economy created new opportunities and showed that it is possible to exchange data as a new good in the market. As stated by Shi et al. (2021), the digital economy is an essential driving force of global economic and social development. Digital technology as an enabler of the digital economy ensures productivity improvement, which is reflected in the progress of use-value, efficiency, quality, and cost.

Based on all definitions, the digital economy is considered as all economic activities that include using or creating digital technologies to generate value-added of digital enablers and development of digital infrastructure.

Barefoot et al. (2018) state that the digital economy starts with the digital-enabling infrastructure, which is crucial for a computer network to exist and operate. The digital economy includes all digital transactions made using that infrastructure, and the result is all the content that digital economy users create and access.

As stated by Tian and Liu (2021), the digital economy covers all economic activities in which the key factors are digital knowledge and information, modern networks, ICT. All these factors improve efficiency and structural optimisation. The digital economy as a priority of countries' development strategies becomes the main driving force of the future economy.

According to the European Commission (2014), the digital economy cannot be described as a separate part of the mainstream economy. European Commission declares that the main factors of the digital economy are mobility, network effects, and the use of data. It is stated that the digital economy sometimes can be called the internet economy. As reported by OECD (2018), the digital economy relies on or is enhanced by the use of digital inputs that includes digital technologies, infrastructure, services and data. It covers all producers and consumers, including the government. Izmaylov et al. (2018) also stated that the digital economy could be described by three main parts: infrastructure, including development and support of both hardware and software, telecommunication systems and networks, electronic business, including automation

of business processes and use of technologies; e-commerce business. The main factors and driving forces of a fully effective digital economy are human resources and intellectual capital.

To sum up, all of the mentioned factors of the digital economy have some touchpoints. The most important factor of the digital economy is infrastructure. The use of that infrastructure creates digital goods and services that can be provided or used by private individuals, businesses, or the public sector. As stated by Bukht and Heeks (2018), the internet was the foundation of the digital economy, and it is still one of the main factors of success in the digital economy. The development of the internet made massive progress in the digital economy introducing new technologies such as the internet of things or 5G, but the internet itself remains the main factor of the digital economy. Since the internet plays a crucial role in the digital economy, two different indicators were included in our evaluation system that covers overall internet infrastructure (accessibility for the households) and accessibility of more advanced internet connection that is needed to take full advantage of the digital economy. High technology internet infrastructure allows all households, businesses, or governments to benefit from an enhanced and more efficient broadband internet connection. Companies are enabled to increase their capacities; households can enjoy a better online experience and use multiple devices or services simultaneously (Hasbi, 2017).

Another common factor of the digital economy mentioned in most of the definitions was that the digital economy cannot be limited by e-commerce and covers lots of different services online. Only the digital infrastructure is not enough for the successful performance of the digital economy. It is essential that society has at least basic digital skills and is able to use digital services such as internet banking, e-government, social networks, e-health and others. Taking advantage of digital infrastructure equals using different digital services as often as possible. This also has advantages as time-saving, operational coast optimisation tools and acts as the key to inclusive economic and social development in the digital economy (The Monetary Authority of Singapore, 2021). Since the definition of the digital economy varies, it can be complicated to select one indicator that covers the overall performance of the digital economy. However, often as mentioned before, the digital economy is based on the ICT sector (Chen, 2020; Puzina et al., 2021; Tian & Liu, 2021), and its added value on GDP can be considered as the overall performance of the digital economy in the whole economy (Herbert & Loudon, 2020)

From a methodological view, there are several different studies focused on the evaluation of the digital economy, including the Digital Economy and Society Index (DESI) proposed by the European Commission. The structure of the DESI index is shown in Table 1.

Table 1. Dimensions of Digital Economy and Society Index (Source: Bánhidi et al., 2020; Česnauskė, 2019; European Commission, 2021; Kontolaimou & Skintzi, 2018)

Connectivity	Measures the deployment of broadband infrastructure and its quality
Human capital	Measures the basic and advanced digital skills needed to participate and take advantage of the digital economy
Use of internet	Measures variety of online activities performed by citizens
Integration of digital technologies	Measures the digitisation of businesses. E-commerce and other digital solutions for business.
Digital public services	Measures the digitisation of public services, increasing efficiency of public administration. Accessibility of digital public services focusing on eGovernment or eHealth

In overall DESI calculation, each dimension has its weight: connectivity - 25%, human capital – 25%, use of the internet – 15%, integration of digital technologies – 20%, digital public services – 15%. Based on this distribution, digital infrastructure, and its quality, as well as basic and advanced digital skills needed for the digital economy, are considered as the most relevant dimensions.

In the technology-oriented world, individuals are more connected than ever before. The considerable expansion in connectivity across the entire society proves that infrastructure and the development of broadband connection are crucial for the digital economy. It is likely that we will go even further with the growth of digital tools and communication (Stoica & Bogoslov, 2017).

According to Folea (2018), the EU should consider improving its strategy for digital skills and align regulations to improve. It is urgent to significantly increase the number of people with basic and advanced digital skills to take advantage of the digital economy. Kontolaimou & Skintzi (2018) agree that human capital plays a critical role in the digital economy and affects its performance. The digital divide is a critical issue, whether it concerns inequalities between countries but also within different social groups. The digital gap should be minimised to achieve inclusive growth of the digital economy.

The DESI index describes the progress of EU countries in the development of the digital economy and society and allows the justification of areas where such changes should be the priority (Stavytskyy et al., 2019). According to Stoica & Bogoslov (2017) DESI index is connected to the policy of the digital economy in European Union and shows the overall view of the digital economy in the whole Europe. European Commission's goal to create the single digital market in Europe confirms that changes should be implemented in the whole union, and the gap between leading and following countries in terms of the digital economy should be minimised. As stated by Bánhidi et al. (2020), the main advantage of the DESI index is that it is measured all across Europe and enables comparison between countries and provides a picture of the digital ecosystem and overall performance of the digital economy in the EU.

Methodology

First, in order to have a further study of the development of the digital economy in Europe, the digital economy indicator evaluation system was constructed by selecting relevant digital economy indicators. To evaluate digital economy development in Europe panel regression model was used.

The Hausman test was performed to evaluate which model (fixed effect or random effect) applies to the data. The null hypothesis is that the preferred model is random effects, and the alternate hypothesis is that the model is fixed effects. In the current case, the p-value of the Hausman test was 0,9903, which means that the alternative hypothesis should be rejected, and the model is considered as a random effect.

Moreover, the data was checked for cointegration using the Kao cointegration test. According to the Kao Augmented Dickey-Fuller test, the p-value is equal to 0.0049, which means that all the panels are cointegrated.

Regression analysis was performed using panel data. The p-value provides information about the probability that the data would be inconsistent. It is generally assumed that a p-value ≤ 0.05 implies that results are significant (Bermudez-Edo et al., 2018). The coefficient of determination (or r squared) gives information about the proportion of variation in the dependent variable, which might be considered as being associated with the variation in the independent variable (Bolboaca & Jäntschi, 2006).

Panel data contain information on temporal and spatial dimensions. The temporal dimension is when repeated measurements are made, such as month or year. The spatial dimension is the unit of observations such as firms or countries. One of the advantages of using panel data is to increase the number of observations for the analysis and minimise the standard errors probability (Xu et al., 2007).

The general multiple regression model of panel data in this article can be expressed as follows:

$$y = \beta_{it} \times I1 + \beta_{it} \times I2 + \beta_{it} \times U1 + \beta_{it} \times U2 + \beta_{it} \times A1 + \beta_{it} \times A2 + \beta_{it} \times A3 + \beta_{it} \times A4 + u_{it} \quad (1)$$

where

y is the dependent variable percentage of the ICT sector on GDP
β_{it} is the coefficient of each explanatory variable
u_{it} is intercept
I1 Households - level of internet access
I2 Households - type of connection to the internet
U1 Individuals - internet use
U2 Individuals - frequency of internet use
A1 Individuals - internet activities: Internet banking
A2 Internet purchases by individuals
A3 E-government activities of individuals via websites: submitting completed
A4 E-government activities of individuals via websites: interaction with public authorities

The data required to perform the study are collected from Eurostat. All the data are public and available on the Eurostat website. Due to the lack of statistical data, some values were calculated using moving average as a widely known technical indicator used to predict the future data in time series analysis.

A set of 9 variables was extracted that measure the digital infrastructure and usage of that infrastructure for different digital services or online activities. Among them, two variables are related to digital infrastructure; two indicators reveal overall usage of the internet, other four are related to individuals and usage of different activities using the internet, including e-commerce and digital public services.

Two indicators that are related to digital infrastructure (I1 and I2) for the year 2015-2019 are the following:

- I1 Households - level of internet access – indicator is given as a percentage of households that has an internet connection.
- I2 Households – type of connection to the internet – indicator represents the percentage of households that has a broadband internet connection.

Two indicators that are related to the overall usage of the internet (U1 and U2) for the year 2015-2019 are the following:

- U1 Individuals - internet use – a percentage of all the individuals that have accessed the internet in the last 12 months.
- U2 Individuals - frequency of internet use – indicator represents the percentage of individuals that use the internet daily.

Four indicators that are related to the usage of different online services (A1 and A4) for the year 2015-2019 are the following:

- A1 Individuals - internet activities: Internet banking – the percentage of all individuals that have used the internet for internet banking.
- A2 Internet purchases by individuals – the percentage of all individuals that have made an online purchase in the last three months.
- A3 E-government activities of individuals via websites: submitting completed forms – the percentage of individuals that have submitted completed forms for government institutions in the last 12 months.
- A4 E-government activities of individuals via websites: interaction with public authorities – the percentage of individuals that have been interacting with public authorities online in the last 12 months.

The final indicator is related to the overall performance of the ICT sector as the key sector of the digital economy in the overall economy. The indicator for the year 2015-2018 is the following:

- Percentage of the ICT sector on GDP – value added at factor cost in the ICT sector as a percentage of total value added at factor cost. The indicator includes both ICT manufacturing and ICT services. Value-added at factor cost is defined as Gross value added (at basic prices) minus other taxes, minus other subsidies on production. For the year 2019, since the data is not published yet moving average method was applied, and missing values were generated.

Results

In this section, the results of panel regression analysis are presented. Multiple panel regression analysis was performed, and results are given in Table 2.

Table 2. Percentage of the ICT sector in GDP, Households – level of internet access and Individuals – internet use; frequency of internet use; internet activities: internet banking multiple panel regression results (Source: made by the author)

		Coefficients	Coefficient of determination	p-value
Households - level of internet access	I1	0,0540	0,30486	0,000029
Individuals - internet use	U1	-0,0526		
Individuals - frequency of internet use	U2	0,0374		
Individuals - internet activities: Internet banking	A1	-0,0256		

As shown in Table 2, the results are statistically significant based on the p-value. The coefficient of determination is 0,30486. Based on provided coefficients of variables, the panel regression equation of percentage of the ICT sector in GDP and four independent variables: Households – level of internet access, Individuals – internet use, Individuals – frequency of internet use and Individuals – internet activities: internet banking would be:

$$y = 0{,}0540 \times I1 - \ 0{,}0526 \ \times U1 + 0{,}0374 \times U2 - 0{,}0256 \times A1 \qquad (2)$$

The given value of the coefficient of determination shows that 30,486% of the data fit the regression model. The model is considered statistically significant. In order to predict values given regression equation can be used. The coefficient of I1 indicates that for every additional percentage of Households – level of internet access, we can expect the percentage of the ICT sector in GDP to increase by an average of 0,0540 while other variable does not change. The coefficient of U1 indicates that for every additional percentage of Individuals – internet use, we can expect the percentage of the ICT sector in GDP to decrease by an average of 0,0526 while other variable does not change. The coefficient of U2 indicates that for every additional percentage of Individuals - frequency of internet use, we can expect the percentage of the ICT

sector in GDP to increase by an average of 0,0374 while other variable does not change. The coefficient of A1 indicates that for every additional percentage of Individuals – internet activities: Internet banking, we can expect the percentage of the ICT sector in GDP to decrease by an average of 0,0526 while other variable does not change.

Variables' correlation coefficients given in Table 2 reveal some interesting findings. It demonstrates the fact that to create value and improve the ICT sector performance in the whole economy, high-quality infrastructure in terms of the internet is necessary. Only fast and high-stability connection ensures needed infrastructure and development in the digital economy. In order to achieve a better result in the ICT sector, countries or businesses should invest in modern new internet infrastructure technologies such as 5G or others. Another interesting finding is that to take full advantage of that infrastructure; individuals should use it daily. As shown in Table 2, the daily usage of the internet has a positive effect on the percentage of the ICT sector in GDP regardless of activities on the internet. Only increasing constant internet usage as a whole with all different services and activities can increase the percentage of the ICT sector in GDP. Also, individuals who use the internet daily likely use more services. Individuals should use as many digital services as possible to create additional value for the ICT sector.

It is important to mention that results are considered statistically significant based on p-value and determination coefficient. Given the value of the coefficient of determination shows that 30,486% of the data fit the multiple panel regression model. It is essential to understand that internet infrastructure and usage are one of the key indicators of ICT or digital economy, but it is not enough for a complete analysis to create an accurate model. In order to have more representative data, more variables should be included to increase the accuracy of the regression analysis. As shown in the panel regression equation, the expansion of internet access for households has a positive effect on the percentage of the ICT sector in GDP. As for the usage of the internet, it is important to mention that the internet should be used on a daily basis to improve the results of the digital economy since individuals that access the internet only once in 12 months cannot be considered as playing an active role in the digital economy and do not create an added value to the performance of the digital economy.

Conclusions

In this paper, a comprehensive literature review of different definitions of the digital economy was performed. The definition of the digital economy developed over time, starting with a considerable expansion of the internet, and can no longer be limited to e-commerce. By creating new markets, services and goods, the digital economy became the priority of most countries. In this paper, the digital economy is considered as all economic activities that include using or creating digital technologies to generate additional value and development of digital technologies. The key factor of the digital economy – infrastructure and use of digital services became an object for the empirical study of this paper. The most important variable, as the study showed, is Households - level of internet access. The level of internet access refers to the infrastructure needed for the digital economy to exist. In order to take advantage of the digital economy, high-quality infrastructure is needed for the steady growth of the digital economy. It also confirms the insights stated in the theoretical part of this article that infrastructure is the most important feature of the digital economy.

This study has several practical contributions. This survey may serve as a guide for understanding the concept and the factors of the digital economy for other researchers. We also propose a potential explanation why countries should invest in high technology infrastructure, and these results can help to create a new strategy for ICT sector expansion in different countries.

Limitations of this study present new opportunities for future research. For future research, the study can be expanded to more countries, also can be performed again after new data is published to have precious results. For future research, more indicators can be included based on available data to have a wider view of the overall performance of the digital economy.

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HOW MONETARY POLICY AFFECTS THE LENDING AND ECONOMIC ACTIVITY IN A BANKING SYSTEM WITH EXCESS LIQUIDITY

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Abstract

Research purpose. The purpose of this paper is to examine the efficiency of the transmission mechanism of the monetary policy in a banking system with excess liquidity. More specifically, it aims to examine how the interest rates of the central bank bills and inflation rate affect total lending and the overall economic activity in the country. For this purpose, the analysis is based on the case of the Republic of North Macedonia, whose banking system has exhibited excess liquidity in the past decade.

Design / Methodology / Approach. The paper is based on two different VECM models, analyzing the impact of the central bank bills interest rates and the inflation rate, on lending and real GDP in the Republic of North Macedonia, for the period 2000 – 2019. The analysis also encompasses unit root tests for the variables of interest in order to determine their order of integration and choose appropriate statistical methods. The short-run causality is assessed using the Granger causality test, whereas the existence of the potential long-run relationship is examined using the Johansen cointegration test. In addition, in order to determine the magnitude of the mutual relationship, variance decomposition is employed in both estimated models. Moreover, the stability of the models when exposed to external shocks is observed through their impulse response functions.

Findings. Conducted analysis shows the negative long-term impact of the central bank bills interest rates on lending and real GDP in North Macedonia. However, no statistically significant impact in this regard is found in the short run. Opposingly, the inflation rate negatively affects lending and real GDP in North Macedonia in the short run, whereas, in the long run, it does not have a statistically significant impact.

Originality / Value / Practical implications. Unlike many other studies in this area, this paper provides practical guidance for the monetary authorities in countries with excess liquidity in the banking system. Namely, its findings imply that central banks should reduce the interbank rate when faced with crises that cause liquidity disparities between banks. Failure to reduce interest rates during the crisis disrupts financial stability, which causes banks to withhold investing their liquid assets in the real economy.

Keywords: interest rates of the central bank bills, inflation, total lending, real GDP, monetary policy.

JEL codes: E43, E31, E51, E52.

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Introduction

When the monetary policy is focused on maintaining Denar exchange rate stability, interest rates and money supply are dependent categories determined by the achievement of the intermediary objective. The research on the movement of interest rates on the central bank bills in North Macedonia during the Great Economic Crisis of 2008 and the economic recovery shows high-interest rates on central bank bills. The monetary policy in the Republic of North

Macedonia (RNM) during and after the Great Economic Crisis was tight, with high-interest rates of central bank's bills (CB bills). In this regard, maybe we should consider harmonization of the monetary policy and reduction of external influences.

Interest rates of the CB bills are fundamental monetary policy indicators, in general as well as in North Macedonia specifically, especially in the post-crisis period. Namely, when the national economy was struggling to get out of the recession, high interest rates of CB bills, as passive interest rates, were tempting for investment by commercial banks in the country. Instead of pursuing an expansionary monetary policy, the National Bank of the Republic of North Macedonia (NBRNM) contributed to the withdrawal of excess liquidity of the commercial banks but did not direct it towards investing in the real economy. The National Bank, through its interest rate policy, sends monetary signals to commercial banks and thus, tends to influence their lending and deposit interest rates. Implementing such monetary strategy in conditions of a structural surplus of liquidity made be CB bills auction the main instrument of the monetary policy (an instrument used to withdraw instead to create liquidity in the banking system). Therefore, the interest rate achieved at the CB bills auctions is regarded as the key interest rate of the National Bank. According to Freixas, et al. (2011), central banks should reduce the interbank rate when faced with crises that cause liquidity disparities between banks. They also note that the failure to reduce interest rates during the crisis disrupts financial stability, which causes banks to withhold investing their liquid assets in the real economy.

The primary objective of the monetary policy in the RNM is to maintain price stability. NBRNM also supports the economic policy and the financial stability of the country, but without jeopardizing the accomplishment of its primary objective. For achieving its ultimate objective, NBRNM establishes an intermediary objective of the monetary policy. Since 1995 intermediary objective of the monetary policy has been the maintenance of the exchange rate stability (targeting the nominal exchange rate of the Denar against the Euro (prior 2002 against the Deutsche Mark)). Given that banks consider CB bills as an alternative instrument for placing their funds, the issue of the efficiency of the monetary policy transmission mechanism is particularly interesting for analysis.

The research subject measures the short-term and long-term effects of CB bills interest rates and inflation rate on total lending and real GDP in North Macedonia from 2000 to 2019. In this regard, it is assumed that CB bills interest rates, as well as the inflation rate, negatively affect total lending and real GDP, both in the short run and in the long run.

Literature review

According to the empirical analysis, there are different approaches to the analysis of financial activity and economic growth, i.e., the effects of CB bills interest rates and inflation on credit activity and economic growth. Schumpeter's (2017) development theory explains that bank loans play a crucial role in economic growth. They are defined as the aggregate equivalent of funds provided by commercial banks for the needs of individuals, business organizations, and governments' requirements. Credit, therefore, plays an essential role in the economic development of a country.

Levine (2004) reviewed theoretical and empirical work on the relationship between financial development and economic growth. He illuminates many of the channels through which the emergence of financial instruments, markets, and institutions affect - and are affected by - economic development. Central to the debates is whether an economic activity can explain the growth of the financial sector or the development of the financial sector drives economic growth (Chandrashekar, et al., 2018). According to Karimo et al. (2017), the causal relationship between financial development and economic growth depends on the stage of economic development. Namely, they argue that in the early stages, the development of financial services positively affects economic growth through the creation of new financial services and opportunities, both for savers and investors. In other words, the demand-leading view dominates, alongside financial and economic development, while the supply-leading view is becoming less important. In addition, Levine (2004), through various studies and analogies,

shows a strong positive relationship between the functioning of the financial system and long-term economic growth.

On the other hand, economic growth, as well as the overall macroeconomic stability, also affect the financial sector in the country and its development. With respect to the influence of price stability on financial development, Ehigiamusoe et al. (2019) provide evidence that inflation negatively affects financial development in countries with high and medium inflation. Furthermore, Shijaku et al. (2013), using the VECM model based on supply and demand indicators for the case of Albania in the period 2001 – 2011, show that economic growth positively affects lending. In any case, the discussion in this regard only emphasizes the importance of the relationship between economic growth and financial development and its relevance for the overall economic development of the country.

One of the most crucial topics in monetary policy research is whether to focus on nominal or real terms (Barnett & Su, 2019). The conclusion of classical economists is that nominal income is determined by the movement of money supply and relies on the assumption that the speed PY / M can be treated as reasonably constant (Bambujijumugisha, 2016). Irving Fisher developed the theory of the amount of money for transactions such as MV = PY, where M is the currency and other forms of money in circulation (M1, M2, M3), i.e. M is defined as the amount of money, V is the velocity of money, P represents the price level and Y is the actual output, where the velocity of money (V) is fixed in this model, and it is stated that the nominal GDP (PY) is affected by any change in the money supply (Sultana, 2018). On the other hand, while "Monetarists" believe that monetary policy affects prices, but not real GDP, Keynesians argue that changes in the money supply led to changes in the real output and prices (Chaitipa et al., 2015).

There is a number of courses of action in which monetary policy gets transmitted to the real economy. The monetary transmission mechanism describes how policy-induced changes in the nominal money stock or the short-term nominal interest rate impact real variables such as aggregate output (Ireland, 2006). The central bank may have a more significant set of goals than just its primary goal of stabilizing inflation and stabilizing output (Capie & Wood, 2016). Its primary function as a liquidity management instrument is to sell short-term securities by the central bank, whereby the interest rate is the basic interest rate that determines the monetary policy. According to Gonpot et al. (2010), higher interest rates make domestic assets more attractive than investments in other currencies and contribute to higher domestic currency demand.

On the other hand, lower domestic interest rates will cause cheaper domestic goods than foreign ones and an increase in net exports. However, lending is not only related to the CB bills interest rates but also to commercial banks' net worth, the risk level, level of the existing asset portfolio and regulatory constraints (Greenwald and Stiglitz, 2003). Nyawata (2013) discusses the challenging question of whether central banks should use central bank accounts to drain excess liquidity in the banking system. He notes that CB bills are the first best option because they have positive externalities in the financial sector and the rest of the economy. The three main pillars are operational independence of central banks, market development, and strengthening the transmission of impulses to monetary policy.

Monetary policy actions do not affect every country in the world equally. Willems's (2018), using VAR panel analysis for 162 countries for the period 1970-2017, shows that developing countries have greater price flexibility (monetary neutrality), while advanced economies show more significant price stickiness signs. According to his study, raising interest rates by 100 basis points in developed economies is associated with a reduction of real GDP by 0.5% against a 0.3% reduction in developing countries.

According to Olofinlade et al. (2020), monetary policy rate and inflation rate in Nigeria have insignificant influence on bank lending in the country. In addition, these two variables have a negative but also insignificant impact on the economic performance of the country, as well. Given the findings, the authors suggest facilitating regulatory and supervisory frameworks to secure a strong financial sector for efficient intermediation.

Similarly, Amidu (2006) also provide evidence that the central bank's prime rate and inflation rate have a negative but statistically insignificant impact on banks' lending for the case of Ghana for the period 1998-2004. He argues that economic activity in the country, as well as changes in the money supply, significantly affect banks' lending behavior. In another study for the case of Ghana, but for a more recent period (2002-2014), Akosah's (2015) examines the effectiveness of Ghana's monetary policy transmission, highlighting the prominent role of central bank bills in the Ghanaian interest rate transmission channel. The study concludes that short-term inflation has a more significant impact than the foreign exchange shock, while on the other hand, medium and long-term interest rate shocks mainly cause inflation.

The subject of the effectiveness of the monetary transition mechanism in countries with excess liquidity in the banking system (specifically North Macedonia) is also the main focus of interest for several North Macedonian researchers. Namely, Jovanovic et al. (2015) examine the real effects of several monetary policy instruments, whereby they primarily find that the interest rate channel does not have a strongly emphasized effect in North Macedonia. More specifically, they argue that economic activity in the country can be affected through the reserve requirement and offered amount of CB bills, which would have a diverse impact given the excess liquidity in the banking sector in North Macedonia. Similarly, Kabashi & Suleva (2016) provide evidence of fairly limited effects of the monetary policy in North Macedonia on lending activity. Namely, they argue that landing rates are affected more than the loan volumes, which might be a relevant finding for the overall economic activity in the country.

Regarding the interest rate pass-through, Gigineishvili's (2011) finds that excess liquidity in the banking sector has an adverse impact, while the inflation rate positively affects it. These findings are based on a cross-sectional analysis covering low income, emerging and developed countries from all regions.

In line with the theoretical and empirical literature, the purpose of this paper is to examine the efficiency of the transmission mechanism of the monetary policy in the RNM as an example of a country with excess liquidity in the banking system. More specifically, the focus is on the impact that CB bills interest rates and the inflation rate have on total lending and the overall economic activity in the country.

Methodology

This research used quarterly data from the databases of the World Bank (WB) and the National Bank of the Republic of North Macedonia (NBRNM) for the period from 2000 to 2019. Originally, real GDP (in North Macedonian Denars) and inflation rate (in percentages, calculated based on the consumer price index) were taken from the WB database on an annual basis. Afterwards, GDP was transformed quarterly by breaking down annual data into average quarterly data. Quarterly inflation data is obtained by converting the frequency in the statistical software EViews using the cubic method, as used in most scientific papers, due to its integration of the polynomial function. CB bills interest rates were taken from the NBRNM database on a monthly basis, whereby they were also quarterly transformed by averaging them for the corresponding quarter. Similarly, total lending was also taken from the NBRNM database and transformed quarterly, only here instead of average; it was summarized on a quarterly level since it is expressed in absolute amounts (North Macedonian Denar) rather than in percentages.

Regarding the variable selection, it is important to emphasize in this point that CB bills, as used in the analysis, is not the same as treasury bills. Namely, the treasury bills are an instrument of the fiscal policy of the country, namely the Ministry of Finance, whereas, on the other hand, CB bills are an instrument of the monetary policy in the RNM. Therefore, these two are different instruments, that in a way, serve the same goal. However, the focus in this paper is on the CB bills interest rates.

In line with the empirical literature in this area (Calza et al., 2001), the research was founded on two econometric models based on the vector error correction mechanism (VECM) model approach. In the first model (VECM_1), the natural logarithm of the total lending (LCREDIT) is taken as a dependent variable, whereby independent variables are CB bills interest rates

(INT_R) and inflation rate (INFL). In the second model (VECM_2), the dependent variable is the real GDP, also in the natural logarithm (LRGDP), whereas the independent variables are the same as in the previous model. For estimation of the model coefficients, as well as for the analysis in general, EViews 10 statistical software was used.

Given the obvious seasonality in the data, all the variables were seasonally adjusted using the Census X12 method (additive approach). Also, in order to determine the level of integration of the variables, the Augmented Dickey-Fuller unit root test was employed, whereby the lag length was determined automatically, based on the Schwartz information criterion. Obtained results (Table 1) indicate that all the variables were non-stationary at level or integrated of 1st order.

Table 1. Augmented Dickey-Fuller test (p-values) (Source: Authors' calculations)

Variable	Included in the test equation	level	1st diff.	Order of integration
LRGDP	Intercept	0.9715	0.0000	I(1)
	Trend and intercept	0.6834	0.0000	
	None	1.0000	0.0010	
LCREDIT	Intercept	0.6536	0.0389	I(1)
	Trend and intercept	0.8983	0.1079	
	None	0.9894	0.0382	
INT_R	Intercept	0.2891	0.0028	I(1)
	Trend and intercept	0.0230	0.0104	
	None	0.0035	0.0005	
INFL	Intercept	0.1655	0.0013	I(1)
	Trend and intercept	0.2461	0.0088	
	None	0.2368	0.0001	

As for the lag length in the estimated VECM models, based on the Akaike information criterion, the optimal lag length for the models (p) was 3. Given this optimal number of lags, the Johansen test indicated the presence of long term cointegration between the variables in both models, at 0.05 significance level, assuming intercept and no trend in the cointegration equation. Consequently, the theoretical VECM model was defined as follows:

$$\Delta Y_i = \beta_0 + \alpha_1(Y_i - \delta_1 INT\_R_{t-1} - \delta_2 INFL_{t-1} - \delta_0) + \beta_{1p}\sum_{p=1}^{3}\Delta Y_{i_{t-p}} + \beta_{2p}\sum_{p=1}^{3}\Delta INT\_R_{t-p} + \beta_{3p}\sum_{p=1}^{3}\Delta INFL_{t-p} + u_t \quad (1)$$

Where Y_i represents LCREDIT and LRGDP in VECM_1 and VECM_2 models respectively; $\alpha_1$is the cointegrating coefficient, which is assumed to be statistically significant and negative; $Y_i - \delta_1 INT\_R_{t-1} - \delta_2 INFL_{t-1} - \delta_0$ is the cointegrating equation or the long-term relationship between variables; $\beta_{1\mathrm{p}}$, $\beta_{2\mathrm{p}}$ и $\beta_{3\mathrm{p}}$ are the short-term causality coefficients; and u_t is the error term. Given that the above theoretical model is essentially a VECM model with three endogenous variables, it consists of 3 model equations, one for each of the endogenous variables. However, for simplicity matters, (Eq.1) only presents the equation for the variables of interest (LCREDIT and LRGDP).

Results

Keeping in mind the monetary policy strategy in the North Macedonia, CB bills interest rates are maintained on a relatively high level. Dynamically analyzed, a decreasing trend was registered in the pre-crisis period (before 2008), followed by a simultaneous moderate increase

in economic activity. On the other hand, the inflation rate is stable throughout the analyzed period, with small variations in the period immediately before the crisis. Thus, the inflation rate in the period 2000-2019 is 1.7% on average (in the pre-crisis period, it averaged around 3%, and in the post-crisis period, around 1%). At the same time, the GDP growth rate is 2.9% on average (3.5% in the pre-crisis period and 2.4% in the post-crisis period). Regarding total lending, two periods can be clearly distinguished. One is the period before the global economic crisis (2002-2008) when a trend of a significant increase in credit growth was registered. Namely, in 2008 credit growth reached 40% on an annual basis, which corresponds to the relatively higher GDP growth rates in spite of the still relatively high CB bills interest rates in this period. The second period is the period after the crisis (2010-2019) when a significant decrease in credit growth was registered. The average credit growth in this second period is 6%, which reflects the increased credit risk and the prudent approach of the banks in conditions of weaker economic activity. In addition, this also reflects the stricter regulatory requirements established by the NBRNM.

In line with the theoretical and empirical literature, CB bills interest rates and inflation rate in North Macedonia have a negative linear relationship with total lending and real GDP. However, based on the estimated correlation coefficients (Table 2), one can easily notice that CB bills interest rates have a far stronger negative linear relationship with the total lending and real GDP in North Macedonia than the inflation rate.

Table 2. Pearson's correlation coefficients between dependent and independent variables (Source: Authors' calculations)

	LCREDIT	**LRGDP**
INT_R	-0.86	-0.86
INFL	-0.26	-0.31

Regarding the estimated models, a summary of the obtained results for both VECM_1 and VECM_2 models is presented in Table 3. Although overall, both estimated models are statistically significant (probability for the F-statistics < 0.05), the VECM_1 model has a far better model fit than the VECM_2 model. Namely, the adjusted R-squared coefficient in the VECM_1 model is 0.68, which means that the model explains around 70% of the variations of the dependent variable (LCREDIT), as opposed to 0.13, or 13% of the variations of the dependent variable in VECM_2 model (LRGDP). According to Ferguson (2009), the minimum acceptable effect size is F=2 is, whereas F > 4 indicates a strong effect size. In addition, unlike the VECM_1 model, VECM_2 violates the assumption of no serial correlation in the residuals (LM = 19.96). On the other hand, heteroskedasticity is not a problem in both estimated models. Furthermore, both VECM models meet the stationarity requirements since there are two inverse roots in each of the models.

Table 3. Summary for the estimated VECM_1 and VECM_2 models (Source: Author's calculation)

Dependent variable	**VECM_1: D(LCREDIT)**	**VECM_2: D(LRGDP)**
R-squared	0.72	0.24
Adjusted R-squared	0.68	0.13
F-statistics	16.9	2.1
Prob. F-statistics	0.000	0.039
Breusch-Godfrey serial correlation LM test	0.057*	19.96
White test for heteroskedasticity	13.508*	10.19*

Note: The coefficients marked with * are statistically insignificant at 0.05 significance level

Regarding the mutual relationship between the endogenous variables, conducted Granger-Causality test shows that CB bills interest rates do not cause total lending, nor real GDP, in the short run. On the contrary, the inflation rate seems to have a statistically significant short-term impact on both of these variables. Table 4 presents the Chi-square test statistics of the Granger-

causality test for both models. As one can notice, the null hypothesis of no causal relationship cannot be rejected for the case of the CB bills interest rates, whereas for the inflation rate, it can be rejected at a 0.05 significance level.

Table 4. Granger-Causality test for VECM_1 and VECM_2 models (test statistics) (Source: Authors' calculation)

Variable	VECM_1: D(LCREDIT)	VECM_2: D(LRGDP)
D(INT_R)	4.1 *	2.3 *
D(INFL)	10.8	9.1

Note: The coefficients marked with * are statistically insignificant at 0.05 significance level

Regarding the long-run relationship, as one can notice from the results presented in Table 5, the estimated cointegration coefficients in both models are negative and statistically significant at a 0.05 significance level (Hendry, 2003). This means that the models tend to converge in some long-run equilibrium level, with the speed of adjustment of 0.02 and 0.03 respectively for VECM_1 and VECM_2 models. As opposed to the results for the short-run relationship, the inflation rate does not have a statistically significant long-term impact on total lending nor on the real GDP in North Macedonia. On the other hand, CB bills interest rates negatively affect both of these variables in the long run, whereby the impact is much stronger on the total lending (-0.24) compared to the real GDP (-0.06).

Table 5. Cointegration coefficients (long-run relationship) for both estimated models (Source: Authors' calculation)

Variable	VECM_1: D(LCREDIT)	VECM_2: D(LRGDP)
Cointegration coefficient	-0.02	-0.03
C	14.2	25.6
INT_R(-1)	-0.24	-0.06
INFL(-1)	0.06 *	-0.02 *

Note: The coefficients marked with * are statistically insignificant at 0.05 significance level

The above long-run relationship can be visualized through the accumulated impulse responses of the total lending and real GDP to a shock of one standard deviation in the CB bills interest rates and the inflation rate. As can be noticed from Figure 1, there seems to be a certain time lag in the long-run relationship, whereby the impulse responses in both cases show an obvious tendency to increase over time.

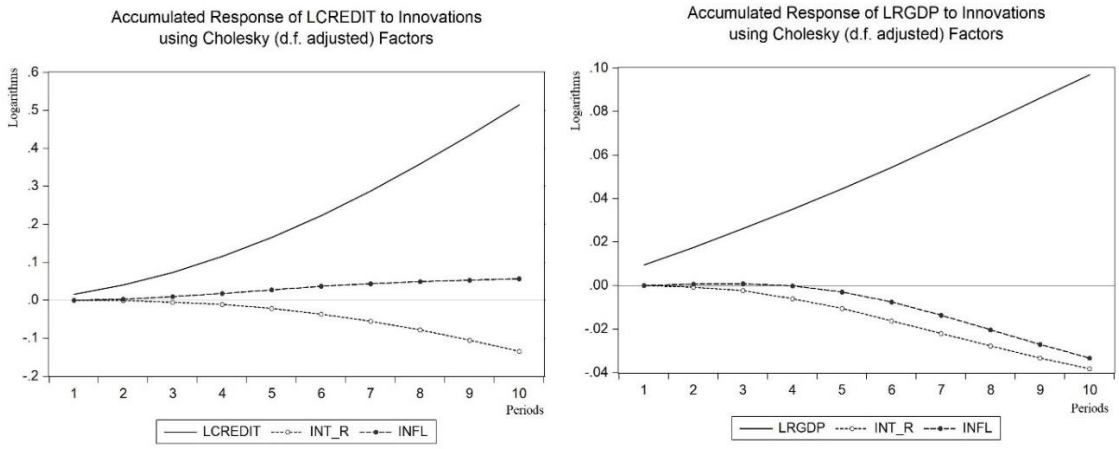

Figure 1. Accumulated impulse responses of total lending (left) and real GDP (right) (Source: Authors' illustration)

However, the CB bills interest rates explain as much as 8.4% of the variations of the total lending and 14.4% of the variations of the real GDP in North Macedonia (Figure 2). On the other hand, the inflation rate has a far smaller impact when it comes to the total lending (explains 1.2% of the total variations), whereas regarding the real GDP, it explains almost 15%, almost the same as the CB bills interest rates.

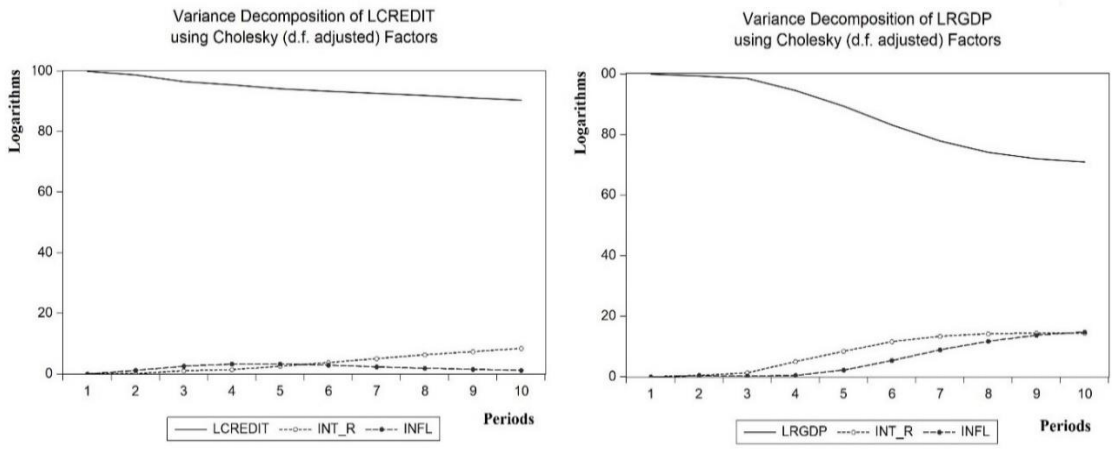

Figure 2. Variance decomposition of total lending (left) and real GDP (right) (Source: Authors' illustration)

Conducted analysis shows the negative long-term impact of the CB bills interest rates on lending and real GDP in RNM. The inflation rate, in the long run, does not have a statistically significant impact.

Conclusions

The role of the central banks and financial markets, through different channels of action, are particularly relevant for the countries' economic activity, especially in small and open economies characterized by banking systems with excess liquidity. The monetary policy strategy in conditions of structural excess liquidity in the country determines the main instrument of the auction of the central bank treasury bills. Therefore, the interest rates achieved at the treasury bills auctions are considered to be the basic interest rate of the National Bank. Banks, on the other hand, consider CB bills as an alternative instrument for placing their assets and receiving monetary signals that have an impact on interest rates on lending and deposits.

From the methodological point of view, the analysis is based on the estimation of two different VECM models, one for the total lending and one for the real GDP, whereby CB bills interest rates and inflation rate are taken as independent variables. The analysis also includes Granger causality and Johansen cointegration tests for the short-run and the long-run relationship, respectively, as well as estimation of the impulse response function and variance decomposition.

Based on the conducted empirical analysis for the case of the Republic of North Macedonia, one can conclude that interest rates on CB bills, as passive interest rates, do not have a statistically significant short-term impact on total lending as well as on the country's real GDP. On the other hand, results show a statistically significant, negative long-term impact of the CB bills interest rates on both total lending and real GDP in North Macedonia. This implies that central banks should reduce the interbank rate when faced with crises that cause liquidity disparities between banks, and the failure to reduce interest rates during the crisis disrupts financial stability, which increases the risk of banks operating. As for the impact of the inflation rate, the research provides opposite results. Namely, the inflation rate has a statistically significant, negative, short-term impact on total lending and real GDP in North Macedonia, but no long-term impact.

The results of the paper open the possibility for further research, given that Greenwald and Stiglitz (2003) confirm that lending is not only related to the CB bills interest rates, but also to their net worth, level of risk, level of the existing asset portfolio and regulatory constraints.

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DIGITAL TRANSFORMATION AS A COMPETITIVE FACTOR IN SUPPLY CHAIN MANAGEMENT: PROOF OF CONCEPT IN ONE OF THE LARGEST EDITORIAL GROUPS IN PORTUGAL

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Abstract

Research purpose. Through the adoption of the concept of the Proof of Concept, the main objective of this work is to highlight the approach that allows the framework and study of the viability of investments in the digital transformation of companies. The research focuses on the publishing sector and, mainly, on one of the largest publishing groups in Portugal and focuses on the strategic decision, due to the covid-19 pandemic situation, to adopt a Warehouse Management System to increase productivity, competitiveness, and sustainability of the company under study. Due to the need for confinement, publishers saw their sales drop drastically and the option of e-commerce implied the need for adjustments in the organizational dynamics associated with the distribution of products. The research/paper goal is to show the viability of investments in the digital transformation of companies in order to enlarge their efficiency and effectiveness.

Design / Methodology / Approach. As a methodology adopted in the first phase, the authors developed a framework of current challenges through the focus group technique. In the second phase, the authors conducted semi-structured interviews with the different managers of the group's various companies and their departments. These methodological options aim to obtain more specific information on facts, the degree of relevance, validity, and reliability that is analyzed from the perspective of collecting information. Both methods provide elasticity in the approach and depth of the intended analysis, favoring spontaneous responses and the creation of openness to the approach of more complex and delicate topics.

Findings. Information technology investments do not automatically bring competitive advantages. It is essential to carry out careful management of the project and carefully analyze the economic and financial viability of the investment. The disruptive changes do not allow errors in investment. So, adopting a methodology that integrates the strategic analysis of the challenges and technical analysis of the assets and respective viability seems critical for the success of digital transformation projects, namely in the publishing sector.

Originality / Value / Practical implications. The digital transformation of companies is a current reality. The pandemic has highlighted digital as a factor of sustainability. However, this finding requires the preparation of management and the adoption of appropriate models and instruments. The present work presents a model that organizations can adapt to in a changing context.

Keywords: digital transformation; warehouse management system; information systems; warehouse management; logistics.

JEL codes: M1; M15.

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Introduction

The digital transformation of companies is a current reality resulting from the pressures of technologies, markets, the economy, and society itself. Consumers' and citizens' adherence to information and communication technologies (ICT) puts pressure on economic organizations to adapt information systems (SI) and internal operations to the specific nature of the market and customers (Anunciação, 2008).

This fact is a reality across all economic sectors and is even a condition for economic sustainability (Anunciação, 2014). Therefore, it is natural that companies opt for a gradual and incremental transformation process as an evolutionary response to the challenges they face, seeking to minimize the risks inherent in a radical change. Within the supply chain, storage, as a critical area of economic support, has also been subject to technological restructuring. Andrade (2014) stated that the undeniable strategic relevance of the current technological reality and its impact on business conduct has resulted in the various organizational areas in which warehouses are included and have to adapt or even reinvent themselves.

Many companies, due to the pandemic, had to strengthen their presence in the market through Electronic Commerce. This change in commercial strategy direction, as a factor of sustainability, forced the reorganization and streamlining of several areas, such as logistics. An example of this is the book sector. Considering that the logistics mission is to deliver the right product, in the correct quantity, to the right customer, in the right place, and at the lowest possible cost (Moura, 2006), it is in this context that the warehouse plays a determining role for the perfect order.

The effectiveness of their management depends on the SI/ICT support. The warehouse is a buffer between production and the market. The implementation and operation of warehousing and distribution systems along the chain aim to reduce pressure on warehouses, seek the optimization of logistic performance, increase productivity, reduce logistical costs, and offer additional services and customer satisfaction (Hompel et *al.*, 2017). The warehouse constitutes a service unit, in a functional logic, with storage, conservation, and control objectives, but above all, making it possible to supply materials and products (Richards, 2011).

Pressure on distribution chains has led to a diversification of the function of warehouses (cross-docking, postponement, fulfilment, etc.), resulting from cost-effective requirements such as Just-in-Time or Efficient Consumer Response. The case of the cross-docking warehouse, for example, reflects the need to consolidate and as well reverse actions in loads with diversified destinations, allowing more considerable added value and a closer approach to the market. The logistics postponement warehouse looks for the best location to position the decoupling point, which can also be considered a buffer within the supply chain, as is the case of warehouses dedicated to co-packing operations.

Warehousing is becoming a critical activity in the supply chain to outperform competitors on customer service, lead times, and costs (Nynke, de Koster & Van de Velde, 2002). In this sense, the Warehouse Management System (WMS) is an opportunity to streamline operations management, allowing to simplify processes and monetize resources because of the company's competitiveness (Mulcahy & Sydow, 2008). The WMS is an IS management tool that controls the warehouse's physical and informative flows, involving both inbound and outbound processes (Shiau & Lee, 2010; Baruffaldi et al., 2019).

WMS facilitates shorter lead times, access to more diverse distribution channels, and improved responses to a more global market. As an integral part of the supply chain, the warehouses directly support the market trends, increase the product range, reduce delivery times, optimize the most critical variable of the market, the time-to-market, or the time-to-respond. In this way, warehouses must be designed and managed according to the specificity of the chain they belong to since their nature may vary enormously. Still, the objective is not to obtain the lowest possible cost and the highest possible level of service.

However, it is not enough to acquire software associated with storage management to expect the automatic acquisition of competitive benefits (Westerman, 2018). A strategy is before

technology (Schwertner, 2017) (Westerman, 2017), and the technology must match strategical plans. The decision relating to the computerization of warehouses must follow the economic principles of assessing investments and economic viability. Oliveira (2004) stated that the economic and social climate has been favorable. The power of suppliers has been powerfully motivating such acquisitions and consumptions, inducing new concepts, processes, and values in the field of modernity, competitiveness, prestige, and the result of ease. Moreover, this author adds that some believe that IS/ICT always gives good outcomes, and it is not necessary to study, a priori, the feasibility (technical and economic) of the acquisition or use.

However, as decisions about investments in IS/IT are increasingly complex, many managers, in an attempt to simplify them, reduce the evaluation to an investment costs approach. They ignore that IS/IT investments' success or failure depends on how they are defined, architected, measured, and implemented.

The digital transformation processes of enterprises and the specificity of IS/ICT should oblige top management to think about and envisage the acquisition and their use as «investment projects». Some of the critical steps in the analysis are as follows (Oliveira, 2004):

- General and global awareness of the problem manifested in management or business;
- Research and in-depth study of the issues raised and the naturally related adjacent issues;
- Critical analysis of the existing situation as part of the solutions provided by the systems and technologies in use;
- Presentation of proposals for solutions to the diagnosed problems because of the deficiencies presented by the systems in existing information technologies and, also, due to the new information needs identified by the business and management;
- Evaluation of proposals using weights and criteria according to management policy, the desired organizational model, business needs, and the level of competitiveness to be achieved through investment;
- Formal approval and decision by the top management body;
- Implementation of the preferred solution according to defined priorities and a schedule of activities to be developed;
- Control of the investment to achieve the chosen objectives for the assets and the calculation, analysis, and justification of possible deviations from the expected, with the attribution of the inherent responsibilities.

Bounfour (2016) refers to it as a challenge of digital transformation that no one can ignore, which requires appropriate management methods and tools.

Supply Chain Management and Warehousing

Supply chain management (SCM) seems critical in supporting economic activities (Tejero, 2011) (Vieira & Roux, 2011). SCM is part of a set of undertakings acting in an economic sequence, upstream, to make products or services available to customers. It presupposes a collaboration and integration of processes, information, and systems, which condition the strategic positioning, aiming high efficiency and operational effectiveness (Carvalho, 2020) and developing an urban perspective on the global organization (Anunciação & Zorrinho, 2006).

Supply chains are growing more complex and challenging (CSCMP, 2021), and this involves planning and managing all sourcing and procurement activities and converting all logistical activities. Thus, it is clear that there is a need for collaboration and coordination between partners, whether suppliers, intermediaries, logistics service providers, or customers (Novaes, 2007). This collaboration presupposes an organizational arrangement appropriate to each organization's functional areas, processes, and channels connected with suppliers, partners, and customers across organizational boundaries (Bowersox et al., 2013). To achieve it, the diversity

of systems' flows and operations have to be designed and developed, ensuring the coherence of upstream objectives downstream of the chain (Anunciação & Zorrinho, 2006).

Putting the right product at the right time in the right place at the lowest possible cost is a management challenge. Bowersox et al. (2016) stated that this management must have at least three perspectives of value: economic value, market value, and value. Economic value refers to the efficiency of the Economy of scale, leading to lower total cost and the creation of goods and services. The market value corresponds to product diversification at the right time and place to optimize costs. Finally, the value of relevance corresponds to the customization, diversity of segment, and positioning of goods and services.

In this regard, the central role of the information systems should consider four levels:

- Strategic planning, through the formulation of strategic alliances, customer service analysis, and the development and improvement of skills and opportunities;
- Decision analysis, through route programming, stock management, and vertical integration versus outsourcing;
- Administrative control, through financial monitoring of costs and assets, customer service mediation, and measurement of productivity and quality;
- Transactions through order management, order sorting and dispatch, customer information, billing, and stocks.

Information Systems include information and communication technologies in their genesis, and both form the link between economic and logistical activities. It is in this context that the term «intelligent logistics» is considered to be a result of a growing connection of machines, people, transport, among other «Things» through the IoT (Internet of Things). This digital interconnection of several «Things» provides, through the disposal of sensors, gains of some intelligence and communication capacity (Porter & Heppelmann, 2015). A warehouse that uses RFID tags, for example, to identify articles, does not need close contact with the optical reader to read the label, as, with its radio frequency technology, it communicates directly with the WMS. In this new reality, the supply chain is the network where the chain elements converge, in a programmed and organized way, constituting an ecosystem (Ross, 2011).

Warehouse Management System

The opportunity to adopt a WMS (Mulcahy, 2013) is associated with difficulties related to the differences between actual balances of inventory and physical stocks, partial satisfaction of customer requests due to stock shortages or inventory shortfalls, cancellation of customer orders due to lack of supply or increased customer complaints. A WMS is a warehouse management module. It is responsible for product control, identifying the best storage area, obeying restrictions imposed, controlling information such as expiration date, batch (traceability), and quick location of any stored item (CSCMP, 2020; Fleury, Wanke e Figueiredo, 2000; Hompel, 2007). It also facilitates planning, organization, management, and optimization activities in using resources in the movement and storage of materials, inside and outside the warehouse, and provides information necessary for the correct execution of activities. Through WMS, it is possible to visualize inventory levels in real-time and know the exact location of the products, making more efficient the daily operation of the put-away and the picking (Hill, 2003).

A WMS integrates the traditional functionalities of a warehouse, such as scheduling and order entry, planning and resource allocation, reception of materials and products, storage, transfers, product separation, shipment, inventories, checks on containers and reports (Banzato, 1998), however at a more demanding level of economic response. Richards (2011) points out the following benefits of a WMS: visibility and traceability of stock in real-time; improved productivity; reduction of wrong choices; automatic restock; reductions in reverse logistics; accurate reporting; improved responsiveness; remote data visibility; better customer service; and minimizing print processes.

Nevertheless, implementing a WMS solution requires prior preparation of the company. Laurent Cochet (2020) states that the answer will entail disruptive challenges for logistics agents by optimizing resources and logistics processes in the warehouse, requiring a preliminary analysis as a success factor for the project, starting with their respective attributes their framework in business strategy. According to Ruriani (2003), WMS must integrate with other systems, interface with internal and external networks, act as a technology integrator (Voice Picking, RFID, etc.), easy-to-use, among other things. However, in the field of management, prior verification of investment and operating costs is advisable. The solution should match its needs, avoiding unnecessary costs for features that one will not need. The ideal will be to opt for modular solutions adjustable to future needs, allowing a gradual development and evolution.

The system must comply with best practices recommended for storage management, that is, according to BASDA (2020), be able to optimize movements within the warehouse (task merge, automated receiving, targeted sequences, storage, optimized refueling tasks, document management, and warehouse mapping). Ideally, the system will monitor the speed of items within the warehouse and locate them (Slotting) or provide the data in a format that can be transferred to programs with slotting functionality.

Methodology

By adopting the "Proof of Concept" concept, the main objective is to highlight an approach that allows the framework and study of investments' viability in the digital transformation of companies. The Proof of Concept's adoption aimed to present a practical model that could be adopted and used in the present case to validate its usefulness and practical application (Kendig, 2016). The need for the digital transformation of companies, particularly in the book sector, is a must nowadays. The authors sought the possible strategic decision to adopt a WMS by the top management of this case study was to highlight the usefulness of the proposed methodology as a tool to ensure the coherence of future decisions to be taken in this field.

The study was based on a qualitative research approach to describe and interpret the actual situation under study (Fortin, 2009). This case study aimed to explicitly understand the presumed casual relationships that occur in the actual context. It is too complex to be explained by the research or experimental techniques, making it possible to explore situations where evaluated interventions have no clear consequences or outcomes (Yin, 2018; Stake, 2012; Thomas, 2011; Cavalcanti & Moreira, 2010; Fortin, 2009; Crewell, 2007; Yin, 2005; Yin, 1999).

The case study focuses on one of the largest editorial groups in Portugal, composed of three publishers working in two business areas: school editions and general editions. For each of the business areas, the company has a distributor. In each company, publisher, and distributor, there is a warehouse. The publishing sector is a clear case of the relevance of WMS in supporting the reverse distribution and logistics activity. This becomes even more evident due to the consequences of COVID-19, the consequent low-touch Economy, and the assumption that *e*-commerce has become a vital commercial channel for the survival of companies.

The study will include the phases indicated by Oliveira (2004), namely general and global awareness of the problem/opportunity; research and review of the issues raised:

- critical analysis – General and global awareness of the problem manifested within the scope of management or business, research and in-depth study of the questions raised and the adjacent naturally linked ones, and critical analysis of the existing situation, within the scope of the solutions provided by the systems and technologies in use;
- proposals for solutions to the problems identified – presentation of proposed solutions to the diagnosed problems, given the deficiencies presented by the systems in existing information technologies and, also, given the new information needs inculcated by the business and management;

- the evaluation of proposals – evaluation of proposals using weights and criteria depending on the management policy, the desired organizational model, the business needs, and the level of competitiveness to be achieved with the investment;
- final approval – formal approval and decision by the top management body;
- implementation – implantation/implementation of the preferred solution according to the defined priorities and a schedule of activities to be developed; and,
- control of investment – investment control, with a view to the level of compliance with the objectives chosen for the investment and the determination, analysis, and justification of any deviations from what was foreseen, with the attribution of the inherent responsibilities.

By the nature of this exploratory analysis, shall not be examined the last three phases (the formal approval and decision by the top management body, the implementation of the preferred solution according to the defined priorities, and the control of the investment) under the Proof of Concept.

As a methodology adopted in a first phase, the authors developed a framework of current challenges through the Focus group technique (Queirós & Lacerda, 2013) (Berg, 2001) (Morgan, 1996), and in a second phase, through semi-structured interviews with the various managers of the different companies of the group and their respective departments, more specific analyses associated with organizational impacts, namely related to automation of warehouse management (Ghiglione & Matalon, 1997). These methodological options aim to obtain more detailed information on facts, the degree of relevance, validity, and reliability in which is analyzed from the perspective of the objectives of collecting data (Boni & Quaresma, 2005; Ketele & Roegiers, 1998; Hanguette, 1997). Both methods present as an advantage the elasticity of the approach and depth of the intended analysis, favoring spontaneous responses and the creation of openness in the direction of more complex and delicate topics (Selltiz, 1987).

Results: analysis of the case study

Firstly, it is crucial to justify the choice of the study case—the justification for choosing a publisher's case study results from several reasons. The first is that there are many academic publications about WMS, around 5500 on the web of science, but they do not study with this economic sector. The second, because it is a confirmed case of one of the largest companies in the sector in Portugal. The third, due to the complexity of the bookstore activity that works with thousands of product references. Moreover, the last one, because this change was accelerated with the Covid-19 pandemic.

Following the steps proposed by Oliveira (2004), the evidence obtained was as follows:

- General and global awareness of the problem/opportunity

Trade is about information, not about goods. Goods sit in the warehouse until information moves them (Cherryh, 1992). Adopting technological tools that ensure more advantageous proximity to customers and more explicit support in decision-making is a source of competitive advantage. According to logistics challenges, the adequacy of warehouse layout, inventory management, product traceability, and the dematerialization of documents and processes are critical success factors. Technologies can improve the company’s productivity and consequently the competitive advantage if they increase productivity, increase customer satisfaction levels, reduce costs, and facilitate the logistic mission. There are several technologies with potential impact on organizational functioning, namely, ERP (Enterprise Resource Planning), EDI (Electronic Data Interchange), CRP (Continuous Replenishment Program), ECR (Efficient Consumer Response), WMS, DMS (Distribution Manager System), automatic identification systems for the identification, capture and sharing of data on products, goods, and persons, among others. Each of the technologies mentioned above brings benefits to the organization that must be identified and quantified.

- Investigation and study of the issues raised.

Inventory is one of the most valuable assets of companies. The stock represents an investment in articles for future use, expected to exist in the correct quantity, at the right time, at the right place with the lowest possible cost. Efficient inventory management gives the company a competitive advantage over its competitors. Its management provides a balance of costs (product financial costs and storage costs) and stock ownership (avoiding overstock levels and break situations). With the adoption of technologies to support storage management, the solution goes through an approximation to the production Just-in-Time, where the stock corresponds to the real needs and the storage, when it exists, even in cross-docking.

WMS also allows one to move forward with other strategic initiatives. The omnichannel experience, in which one will seek to satisfy customers as an increasingly demanding, facilitating its movement in different channels (physical store, virtual store, or APP), presupposes a technological integration of the order to the storage ending in the distribution. The Last Mile can even be considered the most demanding moment of the logistics operation, acting as a barometer of the whole process. If the customer is not satisfied may occur risks and high extra costs.

- Critical analysis of the existing situation

The focus of the improvements targeted by the company's management aims to optimize inventory management, seeking to avoid situations of overstock or article breakdowns and the implementation of a correct layout and simplification of processes. The explicit recognition of the need for technologies to speed up the processes of continuous improvement and re-balancing the business to meet the challenges given to the continually changing market, not only through customer purchasing habits but mainly for the omnichannel experience, is a must.

Also significant is adopting a WMS that ensures customer service excellence and greater agility and accuracy of storage operations. Improving the warehouse location of products, providing greater efficiency and effectiveness in the shipment process, and product traceability are essential on the external level to monitor the product's path along the chain to the final destination, significant in customer loyalty.

The option of investing in a WMS will be a relevant factor for business continuity where the online channel is increasingly preferred. There is a need to shorten the average time of the order cycle, sharing information along the chain and integration with the current ERP. The possibility of optimized flight routes constitutes a fundamental point for decreasing the order Cycle time and the Perfect order. The warehouse area that will be more beneficial is the picking, followed by the reception and conference of goods. This Logistics Center, which houses three publishers and two distributors with more than six thousand SKU's, makes kiting of school and promotional products, intra-group purchases, among others, so that a WMS solution would transversally benefit the entire activity.

- Proposals for solutions to the identified problems

for better warehouse productivity and internal communication with other departments, the technological focus involves adopting an integrated WMS with an ERP and is supported by automation technologies, RFID, or voice recognition. The company's strategy must be understood so that its current and future needs meet with the appropriate choice of a WMS solution.

It is expected with the acquisition and implementation in the Company of a WMS to achieve the following benefits: reduction of the average time of preparation of orders, simplification in the process of locating goods, optimization of storage space, permanent and real-time inventory, traceability of items from reception to the end of the Sumer, reduction of flight and dispatch errors, reduction of time in internal logistical flows, reduction of logistical costs, increased productivity, real-time decision-support information, adaptation to e-commerce needs, and omnichannel operations management.

- Evaluation of proposals using weights and criteria according to management policy

The expected gains comprise, in the view of the various managers, a predictable reduction of 50% in the time associated with the reception and checking and storage of merchandise, a predictable decrease of 50% in the time related to the delivery routes.

Also is predictable an increase of about 30% in shipping speed, a 30% reduction in shipping errors, and a 20% increase in the quantity of orders/day shipped.

Significant gains are also expected in the consumption of paper and other consumables associated with the daily activity of the warehouse using PDAs, not needing printing orders to get a projected reduction of about 35% in consumables and a considerable gain in sustainability.

The gains associated with merchandise receipt are related to the fact that there is a possibility of a location suggested by the WMS and the respective printing of labels with the SSCC barcode (the logistic unit serial code).

Therefore, this will profoundly change the current process of predominantly manual nature and using Excel.

Will be reduced sorting orders time because the system indicates the operator the optimal route of delivery, which will minimize the total distance traveled and increase the speed of dispatching orders. The percentage of Perfect Order and OTIF - On time in full will increase significantly, and there will be a decrease in OCT - Order cycle time.

The investment will be around 50.000,00 €, wishing a Payback less than three years. Table 1 summarizes the expected benefits of the investment.

Table 1. Expected Benefits

Earnings				
Item	Year 2020	Forecast	Valuation	% of estimated earnings
Staff reduction	6	4	31.244,00€	30%
OCT – Order Cycle time	1h	0,45h		25%
Nº daily expeditions (Jan-Nov)	37	46	17.021,73€	25%
Inventory counting / settlement time (# days)	8	4	1.792,00€	50%
Elimination of printed orders	8136	0	780,38€	

The main objectives to be achieved are the following: customer service excellence, increased delivery efficiency, storage space optimization, reduced shipping time, increased productivity, simplification of the process, and reduction of time in annual inventory counts. This decrease will have a massive impact since they require a stop in daily shipping activity.

The following table resumes the estimated costs associated with the investment.

Table 2. Expected Costs

Nature	Valuation
Investment	
Software	7.004,00 €
Implementation Project	6.368,00 €
Hardware	5.084,50 €
Annual Costs	
Annual License	3.151,80 €
Maintenance contract/year	2.500,00 €
Consumables / Year	500 €
Wi-Fi network in the Logistics Center / Year	3.750 €

As an essential factor associated with the management of change, resistance to change by logistics operators has been highlighted, as this solution will represent a disruptive change in processes and practices. The expected mitigation of the effects of the change will be supported by an appropriate training plan aiming for successful integration. However, as this plan is not defined, these costs were not considered.

Subsequently, with the specific participation of the SI/ICT Director, the most appropriate characteristics, and criteria for identifying and selecting the available Packages addressed to manufacturers, logistic operators, distributors, or retailers were identified across all of them and centralized in warehouse management. The main characteristics indicated and considered were as follows: multi-warehouse, independent database (vertical solution), real-time operating system, integration with ERP. The following general factors were highlighted: picking, inventory, graphical warehouse drawing, management of document types, physical definition and layout logic, products, traceability, customer and supplier management, order management, route management, radiofrequency terminals, operations management, and reverse logistics.

The criteria for evaluating the solutions identified by the focus group elements with responsibility for the storage, logistics, and information systems, were as follows: safety, functionalities, integration with ERP, ease of use, compatibility with other technologies used, or in the future necessary, maintenance. The analysis of existing solutions in the market identified Generix Group as a company specialized in Collaborative Supply chains. A Supply Chain Hub: a collaborative platform for manufacturers, distributors, 3PL/4PL retailers, where they present 150 processes, 19 applications on a single platform in SaaS.

Through the platform, it is possible to execute logistics flows, access solutions to digitize information flows, optimize process performance, visibility in real-time, and connect all players in the ecosystem. Mecalux is known as one of the leading companies in the world market for storage systems. The company sells Easy WMS, a powerful, robust, versatile, and flexible software capable of managing a manually operated warehouse (through paper or radiofrequency) with the same efficiency as an automatic warehouse. Eye Peak, which offers a WMS solution, promises centralized management of all processes and faster operations. This solution provides a service layer that ensures integration with automation and robotic systems, allowing one to obtain the outputs of these machines and integrate them automatically into the WMS. Moreover, finally, Tecnibite makes available the xlog, which is a WMS to respond to companies in the logistics sector and companies that need to manage their warehouses.

It allows warehouse management and supports the most modern identification and handling technologies, such as barcode, Datamatix, RFID, radiofrequency, and voice picking.

To select between the identified solutions, the scoring model's methodology was adopted. According to the focus group intervenient, it allows a weighting of the most relevant variables according to the client’s criteria. The overall score obtained allows forming the basis for a later decision. The solutions found in the market and the requirements identified by the logistics and informatics were classified according to Table 3. The Eye Peak solution got the highest score.

Table 3. Scores of the solutions available according to the selection criteria

Solution	Eye Peak	xLog	Easy WMS	Generix
Safety	4	2	2	3
Functionality	4	4	3	2
ERP integration	5	3	2	1
Easy intuitive use	4	4	3	3
Compatibility	4	4	3	4
Maintenance	4	4	3	4
Cost	4	2	1	2
Classification	29	23	17	19

This analysis considered the criteria technical adequacy, management capacity, quality, guarantees, and price. Weights were assigned according to the indications mentioned by the Informatics Director. The results are shown in the table below.

Table 4. Score of solutions available with weights

Criteria	Weight	**Eye Peak**	**xLog**
Technical suitability	0,35	5	5
Management skills	0,15	4	3
Quality	0,20	4	3
Guarantees	0,10	4	4
Price	0,20	3	4
Classification	**1,00**	**4,15**	**4,00**

The last phase and the previous data permitted the analysis of the viability of the investment in the WMS, as shown in Table 5.

Table 5. Score of solutions available with weights

	0	1	2	3	4
Estimated income		50.838,11€	50.838,11€	50.838,11	50.838,11
Expected costs		9.901,80€	9.901,80€	9.901,80€	9.901,80€
Cash flow		40.936,31€	40.936,31€	40.936,31€	40.936,31€
Update Factor (i = 5%)		0,952381	0,907029	0,863838	0,822702
Updated cash flow		38.986,96€	37.130,44€	35.363,32	33.687,40
Investment	18.456,50€				
Net present value	126.711,62€				

It is possible to verify that the net present value provides a high return on investment representing a significant lever for competitiveness while delivering considerable efficiency gains by the optics of cost reduction. Analyzing the results, although the management's desire has evidenced a recovery period of the investment in 3 years, as previously mentioned, the investment will be recovered in the first year.

These results represent an opportunity to develop a more detailed study. They have not been considered other benefits, which, because they are intangible, are challenging to quantify, such as increasing the level of service, customer loyalty, and employee satisfaction.

The last phases of the proposed model, namely the formal approval and decision by the top management body; the implementation of the preferred solution according to the defined priorities; and the control of the investment, were not considered due to the exploratory nature adopted and limited to proof of concept.

Conclusions

The digital transformation of companies is a current reality resulting from the pressures of technologies, markets, the Economy, and society itself. The pandemic situation forced many enterprises to increase the technical support process and change from traditional physical to virtual channels. Companies feel the need to adapt to the new digital reality to maintain their competitive advantage. That is the case of study of present research work, that, due to the Covid-19 pandemic situation, had to strengthen their presence in the market through Electronic Commerce. A new storage automation strategy could get significant efficiency and efficiency results.

In this case study, it was possible to verify that warehousing has become a critical activity in the supply chain to outperform competitors on customer service, lead times, and costs. However, as

stated by Westerman (2018), it is not enough to acquire software associated with storage management to expect the automatic acquisition of competitive benefits. The use of a WMS does not automatically bring competitive advantages. It is essential to carefully manage the project and carefully analyze the economic and financial viability of the investment. In addition to this, the change, in this case study, is disruptive and transversal to the whole company. The relevance of this strategic option became evident through the interviews carried out, an awareness of the impacts of this digital transformation with the possible implementation of a WMS. It was also clear the importance of knowledge with greater detail of the needs and requirements of the warehouse and its integration with the company's objectives.

This study may be a first step towards automating this company's warehouses. An attempt was made to find a strategic, economic, and financial justification for this decision, taking into account the solution chosen by the management. After a survey of existing market solutions and identifying the requirements of the ICT officer in the enterprise, a management decision on this type of investment is now safer by analyzing economic and financial viability. So, we concluded that the adoption of proof of concept was a relevant tool in the analysis and proposal of a methodology to support the management in the digital transformation process.

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CULTURE AS A DRIVER OF SUSTAINABLE DEVELOPMENT IN EUROPE

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Abstract

Research purpose. The link between culture and sustainable development has been frequently debated by European authorities and academicians. Culture is treated as a tool for the implementation of Sustainable Development Goals (SDGs) and considered as the fourth pillar of sustainable development. The research goal is to investigate the relationship between culture-related indices and a country's sustainable development based on European sample data.

Design / Methodology / Approach. To complete research, culture-related statistics indicators from Eurostat were collected and regressed against the SDG index, based on data covered 2016-2019.

Findings. The relationship between culture-related indices and SDG score was specified using European statistical data. The most significant impact on sustainable development measure was revealed regarding the factors “cultural employment” and “government expenditure on culture”.

Originality / Value / Practical implications. The current research differs from most studies that investigated cultural issues using the mathematical apparatus versus the commonly used practice of interviewing consumers or representatives of the cultural sector. The results of this research could be used by municipalities, the cultural private sector, and NGOs by arguing for funding and applying for EU grants. On the other hand, the results and approach of this research could be transposed to other regions to understand the common cultural impact on sustainable development in the non-EU part of the world.

Keywords: sustainable development; culture impact; culture economy; European countries.

JEL codes: Q01; E20; Z10.

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Introduction

The role of culture in sustainable development and the achievement of the Sustainable Development Goals (SDG) has been discussed and explained in various documents and reports. "Global report on culture for sustainable urban development" prepared by UNESCO (UNESCO, 2016) recognises the role of culture in urban renewal and innovation. The Secretary of State for International Cooperation and Ibero-America, Kingdom of Spain, in his preface to the report, stated that "it is no longer possible to imagine sustainable development without culture." The COST Action IS1007 "Investigating Cultural Sustainability" sees culture as "the necessary overall foundation and structure for achieving the aims of sustainable development". (Dessein et al., 2015). The Council of the European Union (2014) emphasises the role of cultural heritage "…in creating and enhancing social capital…" and recognises "…important economic impact, including as an integral part of the cultural and creative sectors…".

During the last decades, the interest in investigating the role of culture in sustainable development has been increasingly grown. For instance, doing a search in Web of Science Core Collection with the keywords "culture sustainable development", the number of results for 2017-2021 is larger than the number of identified sources published in 1990-2016.

The authors usually discuss policy issues (Dessein et al. 2015; Duxbury et al., 2017), the role of specific aspects of culture, such as “cultural heritage” (Nocca, 2017), “tourism” (Rinzin et al., 2007), “Creative industries” (Yang&Cerneviciute, 2017; Kaymas, 2020).

The authors of the given paper analysed the literature focusing on the methods used to investigate the role of culture in sustainable development. In general, the researchers discuss the documents and previous studies or interview experts (Wiktor-Mach, 2020; Bakri; 2018; Zheng et al., 2021; Bervar&Trnavcevic, 2019). The number of papers employing the quantitative methods is quite limited (Streimikiene et al., 2019; Lin et al., 2016; Sisto et al., 2020; Kostis, 2021). Besides, the content of each paper is rather specific, and the methods to measure the impact of culture on sustainable development differ widely.

The incentive for this research was the authors’ intention to show the role of culture in sustainable development based on statistical indicators. Thus, the goal of the research is to investigate the relationship between culture-related indices and a country's sustainable development based on European sample data.

To achieve the research goal, data from the *Europe Sustainable Development Reports* (SDSN & IEEP, 2016-2019) and data from *Eurostat* (Eurostat 2021a; 2021b; 2021c; 2021d) were collected. The general measure for assessing the level of a country's sustainable development is the Sustainable Development Index (SDGI). SDGI is "an indicator of strong sustainability that measures nations' ecological efficiency in delivering human development." (Hickel, 2020) SDI was regressed against culture-related statistical indices for 27 European Union countries and the UK. To ensure data consistency, information was collected about 2016-2019 because periods of data availability differed for each indicator. The logistic regression method was applied for data processing. Dependent variable SDGI had two possible values labelled with "0" (if SDGI for a country was below EU average) and with “1” (if SDGI for a country was above EU average).

Literature review

Culture and sustainable development

The Policy statement “Culture is the Fourth Pillar of Sustainable Development” approved in 2010 by the Executive Bureau of United Cities and Local Governments (UCLG) promoted culture to become a specific dimension of sustainable development because “culture ultimately shapes what we mean by development and determines how people act in the world.” However, the debates on the relationship between culture and sustainable development began in the 1990s. To follow the historical path of merging these two concepts, one can study the works of Dallaire&Colbert (2012), Al-Zo’by (2019), Parameswara (2020) and others. The authors of the given paper collected some definitions and extracts from the papers published in 2001-2021 to substantiate the fact that many voices advocate for a strong link between culture and sustainable development (Table 1).

Table 1. Link between culture and sustainable development (Source: authors’ compilation, based on analysis of previous studies)

Source	Research	Citation
Hawkes (2001, preface, summary)	The fourth pillar of sustainability: Culture’s essential role in public planning.	"Cultural vitality is as essential to a healthy and sustainable society as social equity, environmental responsibility and economic viability"
Throsby (2009, p.7)	Sustainability and Culture: Some Theoretical Issues	"... largely thanks to work within UNESCO...the importance of culture as a component of national life, and of cultural development as a matter of international concern, has been

		increasingly recognised. Yet, these two phenomena, sustainability, and culture, have sat somewhat awkwardly together. “
Duxbury& Jeannotte (2010)	Culture, sustainability, and communities: Exploring the myths	"Growing attention and thinking about culture and sustainable communities is evident in Australia, New Zealand, Canada, and Europe, in writings from Asia on sustainable urbanisation and culture; in European theorisation on arts and sustainability; in Brazilian writing on cultural economies and sustainable development; and in papers from Africa and the Caribbean on cultural essentials of sustainable development. “
UN System Task Team on the Post-2015 UN Development Agenda (2012, p.6)	Culture: a driver and an enabler of sustainable development	"Culture is a transversal and cross-cutting concern and, as such, affects all the dimensions of development."
Soini&Dossein (2016, p.3)	Culture-Sustainability Relation: Towards a Conceptual Framework	“…*culture in sustainability …* sees cultural sustainability as parallel to ecological, social, and economic sustainability." “*culture for sustainability* suggests that both material and immaterial culture are seen as an essential resource for local and regional economic development". “*culture as sustainability* encloses the other pillars of sustainability and becomes an overarching dimension of sustainability.”
Laine (2016, p.53)	Culture in Sustainability – Defining Cultural Sustainability in Education	“The “culture in sustainable development” approach views culture as having a separate, independent role as part of sustainable development, as a so-called fourth pillar in addition to ecological, economic and social sustainability.”
Vila et al. (2021, pp.85-86)	Cultural Sustainability and the SDGs: Strategies and Priorities in the European Union Countries	"...proposals of the EU's cultural policies are aligned with the sustainable development..."

Cultural aspects are essential for achieving the Sustainable Development Goals (SDGs). (Yildirim et al., 2019; British Council, 2020; Streimikiene et al. 2019). Zheng et al. (2021) analysed SDGs and concluded that culture has an impact on the achievement of 133 of 160 SDG targets. Vries (2020) analysed five out of 17 SDGs and eight of169 SDG targets to illustrate “the scope and potential of culture as a dimension of EU policy to implement the SDGs.”, for instance:

- “Target 4.7: By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including …. *appreciation of cultural diversity and of culture’s contribution to sustainable development*…
- Target 8.9: By 2030, devise and implement policies to promote sustainable tourism that creates jobs and *promotes local culture* and products.
- Target 11.4: Strengthen efforts to protect and safeguard the world’s *cultural and natural heritage…".*

Culture measures

Measuring the contribution of culture to sustainable development is a big challenge (UNESCO, 2021a). Attempts to analyse related issues and propose practical guidelines have been made by many researchers and organisations (Snowball, 2007; Vries, 2020; UNESCO; World Bank, 2021).

Analysing the literature on measuring culture impact, one of the most frequently mentioned notions is "Cultural Impact Assessment" (CIA) that has been discussed in detail by

Partal&Dunphy (2016). Members of the Mackenzie Valley Review Board listed some tools and methods to conduct CIA (Mackenzie Valley Review Board, 2009).

A comprehensive overview of progress in measuring the impact of culture was made by Liu (2018). “Historical background of measuring the economic contribution of cultural industries” was described in UNESCO Framework for Cultural Statistics Handbook (UNESCO Institute for Statistics, 2009). However, the authors of the given paper were primarily interested in concrete indices to apply the statistical methods. The results of the authors' search are summarised in Table 2.

Table 2. Culture-related indices (Source: authors’ compilation)

Source	Culture-related indices
European Commission (2006)	− Turnover − Value-added to EU GDP − Contribution to EU growth − Employment
UNESCO Institute for Statistics (2009)	− Gross value added (3 indices in this group, e.g., “share of cultural industries sub-sectors in total gross value added/GDP of cultural industries in absolute and relative terms". − Employment (4 indices in this group, e.g., “share of cultural industries employees in total employment (%)”) − Business activity (6 indices in this group, e.g., “number of new businesses in cultural industries per 10,000 persons".
Montalto et al. (2019)	Indices for cultural and creative cities (29 indices in total): − Cultural venues & facilities (5 indices in this group, e.g., “cinema seats“) − Cultural participation & attractiveness (4 indices in this group, e.g., “Museum visitors“) − Creative & knowledge-based jobs (3 indices in this group, e.g., “Jobs in arts, culture & entertainment“) − Intellectual property & innovation (2 indices in this group, e.g., “Community design applications“) − New jobs in creative sectors (3 indices in this group, e.g., “Jobs in new arts, culture & entertainment enterprises“) − Human capital & education (3 indices in this group, e.g., “Graduates in arts and humanities“) − Openness, tolerance & trust (5 indices in this group, e.g., “Foreign graduates“) − Local & international connections (2 indices in this group, e.g., “Passenger flights“) − Quality of governance
OECD (2021)	− Cultural and creative sectors as a share of employment − Cultural and creative sectors as a share of value-added − Employment in cultural and creative sectors − Share of expenditure on recreation and culture − Share of creative goods in total exports − Share of creative goods in total imports − Total government expenditure on recreation, culture, and religion

One of the UNESCO initiatives in response to the issue of measuring culture contribution to sustainable development is the development of "UNESCO Culture for Development Indicator Suite" (CDIS) – "…an advocacy and policy tool that assesses the multidimensional role of culture in development processes through facts and figures.” (UNESCO, 2021b) CDIS covers seven interrelated policy dimensions and includes 22 indicators. UNESCO document "Thematic Indicators for Culture in the 2030 Agenda" – "framework for measuring and collecting data on culture is foundational both for advocating for the role of culture in the SDGs, as well as for integrating culture into development plans and policies at the national and urban levels and within the United Nations Development Assistance Frameworks (UNDAF)" – includes not only indices but also a description of assessment methodology. (UNESCO, 2019)

Methodology

The positive relationship between cultural indicators and sustainable development was confirmed in previous studies (Mosaferi *et al.*, 2019; UNESCO; World Bank, 2021). The selection of culture-related indices for the current research was determined by data availability for European countries. To ensure data relevance, the statistics were collected for the period of 2016-2019.

The dependent and independent variables are presented in Table 3.

Table 3. Research variables and data sources (Source: summarised by authors)

Variables	Index	Unit of measure	Label	Data available	Source
Y	SDG score	Points for ranking	SDGI	2016-2021	SDSN & IEEP (2021)
X1	Cultural employment by sex	thousand persons	CultEmp_males	2011-2020	Eurostat (2021a)
X2			CultEmp_females		
X3	Number of enterprises in the cultural sectors	number	NoEnt	2010-2018	Eurostat (2021b)
X4	Intra-EU trade in cultural goods	thousand EUR	IntraEU_import	2010-2019	Eurostat (2021c)
X5			IntraEU_export		
X6	General government expenditure by function (cultural services)	million EUR	GovExp	2010-2019	Eurostat (2021d)

Based on the selected explanatory variables, four hypotheses have been formulated:

H1: There is a statistically significant relationship between cultural employment and the sustainable development of a country.

H2: There is a statistically significant relationship between the number of enterprises in the cultural sector and the sustainable development of a country.

H3: There is a statistically significant relationship between the trade volume of cultural goods and the sustainable development of a country.

H4: There is a statistically significant relationship between government expenditure on culture and the sustainable development of a country.

In order to find out the impact of the selected independent variables on the dependent one, the logistic regression for panel data is established. For that purpose, the SDGI data was restructured (Table 4). First, the average of SDGI was calculated and based on that; the countries were assigned with the SDGI level represented by 0 and 1. If the country's SDGI is above the average, the level of 1 was assigned; if the SDGI is below average, the country was given 0.

Table 4. SDGI of European Countries and average SDGI, 2016-2019 (Source: SDSN & IEEP (2021))

Country	2016	2017	2018	2019	Country	2016	2017	2018	2019
Austria	79.1	81.4	80	81.1	Italy	70.9	75.5	74.2	75.8
Belgium	77.4	80	79	78.9	Latvia	72.5	75.2	74.7	77.1
Bulgaria	71.8	72.5	73.1	74.5	Lithuania	72.1	73.6	72.9	75.1
Croatia	70.7	76.9	76.5	77.8	Luxembourg	76.7	75	76.1	74.8
Cyprus	66.5	70.6	70.4	70.1	Malta	72	77	74.2	76.1
Czech Republic	76.7	81.9	78.7	80.7	Netherlands	78.9	79.9	79.5	80.4
Denmark	83.9	84.2	84.6	85.2	Poland	69.8	75.8	73.7	75.9
Estonia	74.5	78.6	78.3	80.2	Portugal	71.5	75.6	74	76.4
Finland	81	84	83	82.8	Romania	67.5	74.1	71.2	72.7
France	77.9	80.3	81.2	81.5	Slovak Republic	72.7	76.9	75.6	76.2
Germany	80.5	81.7	82.3	81.1	Slovenia	76.6	80.5	80	79.4
Greece	69.9	72.9	70.6	71.4	Spain	72.2	76.8	75.4	77.8
Hungary	73.4	78	75	76.9	Sweden	84.5	85.6	85	85
Ireland	76.7	77.9	77.5	78.2	United Kingdom	78.1	78.3	78.7	79.4

The average SDGI value is 74.86, 77.88, 76.98 and 77.95 for 2016, 2017, 2018 and 2019, respectively.

The logistic regression model is presented below:

$$\ln\left(\frac{\mathbb{P}(Y=1)}{\mathbb{P}(Y=0)}\right) = \beta_0 + \sum_{i=1}^{n} \beta_i x_i,$$

where $Y = 1 -$ the countries with the level of SDGI above the EU average;

$Y = 0 -$ the countries with the level of SDGI below the EU average;

$\beta_0 -$ intercept;

$\beta_i (i = 1, 2, \dots, n) -$ coefficient associated with independent variables $x_1, x_2, \dots, x_n$.

Results

First of all, the data was tested for cointegration. According to the Kao Augmented Dickey-Fuller test (p-value = 0.000), all the panels are cointegrated, and further research could be conducted. Secondly, the logistic regression was performed. From the initial analysis, it became evident that the coefficients of X3 and X4 are statistically insignificant (p-values greater than 0.1); hence those two variables were removed from the research. It means that the second and third hypotheses H2 and H3 are rejected.

The results obtained after the recalculation are presented below.

$$\ln\left(\frac{\mathbb{P}(Y=1)}{\mathbb{P}(Y=0)}\right) = -1.597 - 0.036X_1 - 0.0002X_2 + 0.00000273X_5 + 0.007X_6$$

In the presented regression equation, according to which the calculations were performed, we see that when **y** is equal to **0,** SDGI is below the EU average, and when **y** is equal to **1,** SDGI is above the EU average. Thus, the calculations performed according to the given equation showed that the values of X1 and X2 are minus, i.e., X1 and X2 increase the probability that the SDGI

will be below the EU average, while values of X5 and X6 are positive, i.e. these factors increase the likelihood that a country's SDGI will be above the EU average.

Variables X1 and X2 are Cultural employment by sex, and the fact that these variables influence the acquisition of a dependent variable, which is below the EU average, is also shown by other research examining the impact of gender equality on sustainable development goals. Kerras, Sánchez-Navarro, López-Becerra, & de-Miguel Gomez (2020) states that gender equality contributes to sustainable development goals, but gender segregation to men and women does not have a significant impact on the sustainable development goals. Manandhar, Hawkes, Buse, Nosrati & Magar (2018) emphasise the need to change attitudes and not to divide the employment sector into male or female, but to create equal conditions for both sexes by working in different fields, thus contributing to the goals of sustainable development. Thus, for this reason, the obtained research results do not contradict the scientific literature and theory.

Variable X5 is Intra-EU trade in cultural goods export; this variable affects the probability that SDGI will take on a value of **1**, i.e., will be above the EU average. Proper export of cultural goods contributes to EU cultural cooperation, promotes equal and high-quality access to culture (Omri & Ben Mabrouk, 2020). Throsby (2012) emphasises that such exports of cultural goods increase social inclusion and thus contribute to the goals of sustainable development but also pose certain risks to the less developed EU countries. The poorer EU countries are failing to adequately protect their cultural goods, in which case the export of cultural goods from these countries becomes excess, so it needs to be appropriately regulated.

Variable X6 is General government expenditure by function (cultural services); this variable is estimated to have the most significant impact on affecting the probability of SDGI in EU countries being above the EU average. This impact is also supported by science research Omri & Mabrouk (2020), Bestvina Bukvic, Bjelic & Sain (2020) states that efficient financing of the cultural sector increases the number of employees in the cultural sector, improves the infrastructure of cultural objects, promotes innovations in the cultural sector. All this increases the country's cultural attractiveness, promotes cultural tourism, and contributes to the implementation of sustainable development goals. The results show that the fourth hypothesis H4 is confirmed.

Thus, summarising the study, it can be seen that all the variables mentioned have an impact on the EU SDGI average (and for its probability of gaining a value of **1** or **0**); however, the export of cultural goods and the financing of cultural services have the most significant impact, as they are directly related to cultural income, which is also supported by scientific sources. It means that the first hypothesis, H1, is confirmed.

Conclusions

The authors of the given paper made an attempt to confirm the fact that culture positively contributes to the sustainable development of a country, based on statistical data and applying a quantitative approach. The results of the testing of the stated hypotheses are as follows:

- H1 has been confirmed based on the research results that revealed that most all of the distinguished factors measuring cultural performance do impact SDGI.
- H2 has been rejected as, based on the performed calculations, it was found that the number of enterprises in the cultural sector is insignificant and, hence, we cannot claim that there is a relationship between the mentioned variable and sustainable development.
- H3 has been rejected for the same reasons as the H2, i.e., the coefficient of the variable is not significant; hence, the relationship cannot be proved.
- H4 has been confirmed since the analysed variable was found as the most significant and had the highest impact on the sustainable development of a country.

Limitations of the study are related to the availability of statistical data for culture-related indices. Most of the indices are available from 2010 through 2019. In turn, the SDG score was started to be calculated only in 2016. It discovers the potential for research extension when

researchers will have SDG score statistics for a more extended period. Besides, the statistical data warehouse is expected to be enlarged, considering the results of UNESCO contribution to the field with its comprehensive set of 22 culture-related indicators. The research can also be conducted within a particular country based on internal statistical data. However, the potential researcher should evaluate data appropriateness. For instance, the Latvian Statistical Bureau provides data on employment by sectors, but there is no information about the cultural sector only, but about "Arts, entertainment and recreation, activities of households as employers". However, on the other hand, it is possible to extract more indices – for instance, data about average monthly wages, etc.

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