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APPLICATION OF DIGITAL PRODUCTION MODELS IN PRACTICE

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ABSTRACT

Today, digitization is an integral part of the modern world. It is becoming increasingly clear that all manufacturing and service sectors in developed countries will not be able to remain competitive and deliver products and services that must be ready on time and on schedule without modern technology. For this reason, this article aims to develop a conceptual system that implements the effectiveness of digital tools for the introduction of a circular economy in railway and construction enterprises.

Keywords: circular economy, digital technologies, 4.0 industrial tools, social participation.

INTRODUCTION

The concept of a circular economy is the organization of efficient use of resources in general production areas under the conditions of resource limitations, and this creates the possibility of identifying errors and shortcomings with the help of digital technologies, and eliminating them at the right time and place. Although the concept of circular economy (CE) has been applied to various sectors of the economy, it has not been successfully applied to the construction industry.[1] Therefore, digitization as a part of the 4.0 industry concept is accelerating the introduction of the circular economy concept in the construction sector by facilitating the relationship between products, processes and people in the life cycle through physical technologies.[2]

[1] Chauhan, C.; Parida, V.; Dhir, A. Linking circular economy and digitalisation technologies: A systematic literature review of past achievements and future promises. Technol. Forecast. Soc. Chang. **2022**, 177, 121508.
[2] Muscio, A.; Ciffolilli, A. What drives the capacity to integrate Industry 4.0 technologies? Evidence from European R&D projects. Econ. Innov. New Technol. **2020**, 29, 169–183.
Mrugalska, B.;Wyrwicka, M.K. Towards Lean Production in Industry 4.0. Proc. Eng. **2017**, 182, 466–473.
Antikainen, M.; Uusitalo, T.; Kivikytö-Reponen, P. Digitalisation as an Enabler of Circular Economy. Procedia CIRP **2018**, 73, 45–49.

LITERATURE REVIEW:

Those based on the circular economy:

The concept of circular economy began to develop in the late 1970s and continues to be widely used in various sectors to this day.[3] Çetin, DeWolf[4] explains that "closing the loop" is the reuse of recyclable materials and components or materials at the end consumer; "slowing down the loop" reduces usage and consumption by increasing the life cycle of materials and extending the life cycle of products; "loop reduction" means reducing the efficiency of product production and the output of resources in production.

Those based on digitalization: The development of the fourth industrial revolution has led to the introduction of advanced digital tools in the cross-section of industries. As the population increases in urban areas, the manufacturing industry faces challenges such as cost, time and quality.[5] Digital transformations in the management of production processes are seen as a solution to overcome such difficulties.[6] Digitization of systems also offers new opportunities such as new collaboration models, advanced implementation and enhanced project outcomes.[7] This research explores the gaps and barriers in how different digitalization tools can support the implementation of different CE strategies in the manufacturing sector.

METHODOLOGY

As for the methodological approach, the work was divided into 3 parts: theoretical conceptual structure, optimization and confirmation of the conceptual structure.

Theoretical Conceptual Framework:

This phase aims to develop a roadmap for building specific AI strategies and building digital tools. This research consists of dual combinations: Circular Economy, Sustainability, Strategies, Digital Technologies, Valuation Models.

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[3] MacArthur, E. Towards the circular economy. J. Ind. Ecol. **2013**, 2, 23–44.
[4] Çetin, S.; de Wolf, C.; Bocken, N. Circular digital built environment: An emerging framework. Sustainability **2021**, 13, 6348.
[5] Durdyev, S. Review of construction journals on causes of project cost overruns. Eng. Constr. Arch. Manag. **2020**, 28, 1241–1260. Durdyev, S. Review of construction journals on causes of project cost overruns. Eng. Constr. Arch. Manag. **2020**, 28, 1241–1260.
[6] Jahanger, Q.K.; Louis, J.; Pestana, C.; Trejo, D. Potential positive impacts of digitalization of construction-phase information management for project owners. J. Inf. Technol. Constr. **2021**, 26, 1–22.
Durdyev, S.; Mbachu, J.; Thurnell, D.; Zhao, L.; Hosseini, M. BIM Adoption in the Cambodian Construction Industry: Key Drivers and Barriers. ISPRS Int. J. Geo-Inf. **2021**, 10, 215.
[7] Stoyanova, M. Good practices and recommendations for success in construction digitalization. TEM J. **2020**, 9, 42–47.

In practice in today's manufacturing sector, it includes processes such as: design, planning/scheduling, production operations/supply operations, and last but not least the life cycle. The manufacturing life cycle steps are mapped in the following strategies:

1. Material flow;
2. Resource use;
3. Consists of circular movement.

In addition to this process, technologies including BIM, BIG DATA, INTERNET OF THINGS, CLOUD COMPUTING, etc. are used to evaluate the development of advanced digital technologies in the manufacturing industry and follow up on the theoretical working program.

Optimizing the conceptual framework:

After the initial conceptual framework has been created, optimization can be carried out through consultation with industry experts. This goal begins with a three-step consultation:

1. Development of awareness and practice on the principles of circular economy in the manufacturing industry;
2. To study the use of various digital tools in the production value chain;
3. How well the initial conceptual system reflects the current market conditions in the model manufacturing sector.

Validation of the conceptual framework:

This process is the last stage of the key study. The main goal of this process is to confirm the optimized system in the enterprise and apply it to the enterprise from the development side of circular motion. This system has been implemented in more than 80 projects in different regions and approved according to the results. This system also has a practical application in the way of reducing gaps and inconsistencies in circular movement and digitization in those enterprises.

RESULTS AND DISCUSSIONS:

The developed concept was presented to various enterprises, and the BIM digital technology model shows significant results in resource management and planning, and it helps users to control the necessary proportion and appropriate dimensions of materials. In addition, it has sustainable advantages for enterprises that tend to increase the organization of production in efficient ways and the minimum use of resources.

In the table below, by creating a web platform of production processes with digital technologies, activities in production are digitized from managers, specialists to management, digital information is stored in the enterprise database, and reports are formed based on the information requested by entering commands for use.

Preparation of the enterprise for circular economy

Circular economy strategy	Digital technologies used
Resource management	During the construction planning phase, the company uses Opera Built software, which connects the project team with services such as planning and routing of all materials and resources. The material or resources may be monitored, changed and updated for an undisclosed period. This digital tool allows efficient scheduling of resource routing and allows the user to plan the use of long-term storage material in a long-term cycle.
Establishment management	The enterprise uses Building Information Modeling (BIM) technologies for project design. This tool connects to a planned system where all production (construction) value chain steps can be modeled in software. Material evaluation (passports, technical characteristics and properties) is presented in BIM under each specific resource. This tool helps assess current production (construction) needs during the design phase by correlating the project with other dimensions.
Social involvement	Currently, digital technologies are not significantly used in the business engagement stage for enterprise and government shares. Not only are traffic regulations and behaviors not digitized, but some proposals will spur further development in this area.
Digitization	In conclusion, the enterprise actively uses digital tools during its operational activities in the following stages: (1) project design (both structural and architectural), (2) materials management, (3) project planning, (4) internal relations, (5) standards-based enterprise database, (6) construction operations, and (7) customer services.

Existing weaknesses and strengths of the enterprise

Disadvantage	**Lack of general understanding of circular economy principles and strategy implementation;** **Very low and unmeasurable support from executive team.**
Strong point	Strong and unique organizational culture; High technological development compared to current competitors; Specific strategic long-term goals, including technological development.

CONCLUSION

Products processed in the production sector serve to eliminate negative consequences for the environment and human health, as well as to ensure the competitiveness of the enterprise in the market. The concept of a circular economy introduces long-term and sustainability by how much resources can be recycled in the circular loop of production. When the production sites serve different purposes, the use and potential re-use of the materials for another purpose or for another project is selected during the long-term viability period.

This case study develops a conceptual framework that facilitates the needs for AI transfer. During development, several interviews with academic and industry experts were conducted to formulate and validate the conceptual framework. This research reveals many potential opportunities for deployable Industry 4.0 tools that support circular practices.

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