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CIRCULAR INNOVATIONS IN SUPPLY CHAINS AS A DRIVER OF ENTERPRISE STRATEGIC DEVELOPMENT

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ЦИРКУЛЯРНІ ІННОВАЦІЇ В ЛАНЦЮГАХ ПОСТАЧАНЬ ЯК ДРАЙВЕР СТРАТЕГІЧНОГО РОЗВИТКУ ПІДПРИЄМСТВА

In the context of intensifying competition and expanding environmental challenges, enterprises are rethinking supply chain management models. This study aims to examine the role of circular innovations in supply chains as a driver of enterprise strategic development, as well as to identify the key factors for their effective implementation in modern economic conditions. The study finds that circular innovations represent a complex set of technological, organizational, managerial, and business solutions aimed at implementing circular economy principles within supply chains. Unlike traditional innovations, they are not focused on linear production growth but on the formation of closed-loop material and energy flows, which ensures resource reuse, waste reduction, and improved resource efficiency. Results show that within supply chain management systems, circular innovations serve as a key instrument for the structural transformation of supply chain models into integrated systems of forward and reverse flows. This transformation ensures effective coordination of forward and reverse material, information, and financial flows, as well as the integration of collection, sorting, recycling, and reintroduction of resources into the production cycle. It becomes evident that circular innovations in supply chains acquire the status of a driver of enterprise strategic development only when they are integrated into the business model and the strategic management system. They ensure reduced dependence on primary raw materials, cost reduction, effective functioning of new business models, as well as increased competitiveness and resilience of the enterprise. The practical value of the results lies in their applicability for enterprises in developing efficient circular supply chains and implementing reverse logistics and remanufacturing systems. Further research should focus on developing quantitative models for assessing the effectiveness of circular innovations in supply chains.

В умовах посилення конкуренції та розширення екологічних викликів, підприємства переосмислюють моделі управління ланцюгами постачань. Метою даної наукової статті є дослідження ролі циркулярних інновацій у ланцюгах постачань як драйвера стратегічного розвитку підприємства, а також визначення ключових факторів їх ефективного впровадження в сучасних умовах господарювання. У результаті проведеного дослідження встановлено, що циркулярні інновації є комплексною сукупністю технологічних, організаційних, управлінських та бізнес-рішень, спрямованих на реалізацію принципів циркулярної економіки у межах ланцюгів постачань. На відміну від традиційних інновацій, вони орієнтовані не на лінійне

зростання виробництва, а й на формування замкнених матеріальних і енергетичних потоків, що забезпечують повторне використання ресурсів, зменшення відходів і підвищення ресурсної ефективності. Доведено, що саме в системі управління ланцюгами постачань циркулярні інновації є ключовим інструментом трансформації ланцюгів постачань в інтегровані системи прямих та зворотних потоків. Ця трансформація забезпечує якісну координацію прямих і зворотних матеріальних, інформаційних та фінансових потоків, а також інтеграцію процесів збирання, сортування, переробки та повторного введення ресурсів у виробничий цикл. Встановлено, що циркулярні інновації в ланцюгах постачань набувають статусу драйвера стратегічного розвитку підприємства лише за умови їх інтеграції у бізнес-модель і систему стратегічного управління. Вони забезпечують зниження залежності від первинної сировини, скорочення витрат, ефективне функціонування нових бізнес-моделей, підвищення конкурентоспроможності та стійкості підприємства. Практична цінність результатів полягає у можливості їх використання для: формування ефективних циркулярних ланцюгів постачань та впровадження систем зворотної логістики та реманufактурингу. Подальші дослідження доцільно спрямувати на розробку кількісних моделей оцінювання ефективності циркулярних інновацій у ланцюгах постачань.

Key words: production cycle; instrument of structural transformation; supply chains; systems of forward and reverse flows; linear production growth.

Ключові слова: виробничий цикл; інструмент структурної трансформації; ланцюги постачань; системи прямих та зворотних потоків; лінійне зростання виробництва.

PROBLEM STATEMENT

In the context of intensifying competition and expanding environmental challenges, enterprises are rethinking supply chain management models. In particular, the linear economic model, based on the principle of "extract-produce-consume-dispose," is increasingly demonstrating limited effectiveness due to resource depletion, rising resource costs, and growing regulatory pressure regarding sustainable development. In this context, the development of the circular economy is gaining special priority as an innovative paradigm aimed at maximizing resource efficiency, minimizing waste, and extending product life cycles. Circular innovations in supply chains are increasingly regarded by management as a key tool for transforming business processes, ensuring the integration of reuse, recycling, recovery, and shared consumption principles at all stages of value creation.

Moreover, the study of the impact of circular innovations in supply chains on the strategic development of modern enterprises is of particular importance, since in contemporary practice-such as at "Obolon," "Myronivsky Hliboproduct (MHP)," "Interpipe," and "Epicentr K"-they not only contribute to improving operational efficiency but also create long-term competitive advantages, in particular by strengthening overall business resilience to external shocks and expanding new market opportunities. However, the implementation of such innovations is accompanied by a number of challenges related to the need for technological modernization, restructuring of partnership relations within supply chains, and changes in organizational culture.

ACTUAL SCIENTIFIC RESEARCHES AND ISSUES ANALYSIS

Issues of circular economy and supply chain innovations have been systematically examined in the works of Horbali N. I., Plish I. V. [1], Vasylieva O. O., Domashenko S. V., Hil L. A. [2], and Kukurudz N.R. [3]. These scholars have explored the theoretical and methodological foundations of circular transformation of business models, as well as key tools for the practical implementation of circular economy principles at the enterprise level. Concurrently, the specific properties of forming circular innovations in supply chains and the conditions under which they become a driver of enterprise strategic development have not been sufficiently addressed in the academic literature.

Hence, the mechanisms by which supply chains are transformed under circular innovations, as well as the resulting structural changes, remain insufficiently understood.

There are also general concepts of the circular economy; however, their integration into the operational and managerial mechanisms of SCM (Supply Chain Management) remains insufficiently explored.

RESEARCH AIM

This study aims to examine the role of circular innovations in supply chains as a driver of enterprise strategic development, as well as to identify the key factors for their effective implementation in modern economic conditions.

MAIN FINDINGS OF THE RESEARCH

Modern approaches to the general concept of circular innovations allow them to be defined as:

— a range of new technological, organizational, managerial, and business solutions aimed at implementing the principles of the circular economy [1; 4];

— a set of new technological, organizational, managerial, and business solutions for the transition to sustainable development and a "green" economy [7].

Simultaneously, Vasylieva O. O., Domashenko S. V., and Hil L. A. [2] demonstrate in their research that such innovations are effective only under the conditions of minimizing the use of primary resources, reducing waste

generation, reusing materials, repairing, restoring, recycling products, and extending their life cycle. Consequently, it is evident that, unlike traditional innovations (which are often oriented toward linear growth in production and consumption [7]), circular innovations focus on creating closed-loop material, energy, and other flows.

Considering the above specificity, it is within the context of supply chain management that circular innovations play a key role in transforming supply chain structure-namely, the transition from a linear model to an integrated system of forward and reverse logistics flows. In this case, supply chain management goes beyond the traditional coordination of forward flows and involves comprehensive management of both forward and reverse material, information, and financial flows.

Such an approach entails the inclusion of the following processes within the management system [5; 7]:

— collection of used products, their sorting, and recycling (forward processes);

— processes of reintegrating resources into the production cycle (reverse processes).

This is implemented through the organization of reverse logistics systems, the introduction of component remanufacturing, the reuse of packaging materials, as well as the recycling of production waste into secondary raw materials [7]. The managerial aspect of these changes is reflected in improved coordination and interaction among all participants in both forward and reverse supply chains, the development of partnership relationships, the integration of information systems, and the optimization of resource flows at all stages of their life cycle [3; 7]. In this context, the supply chain acquires the characteristics of a closed, self-regulating system, where the waste of one participant becomes a resource for another.

A crucial point is that the role of circular innovations in supply chains cannot be overestimated. When interpreted as a driver of enterprise strategic development, they ensure the formation of manageable, long-term competitive advantages and enhance business resilience. Namely, such innovations include:

1. contribute to reducing raw material and disposal costs through more efficient resource utilization;

2. stimulate the development of innovative business models, such as Product-as-a-Service, remanufacturing, and shared consumption;

3. enhance enterprises' environmental and social responsibility, thereby strengthening their reputation and investment attractiveness.

We endorse the view of Podra O. P. and Horoshko Yu. V. [3] that circular approaches integrated into supply chains enable enterprises to develop adaptability to resource constraints and regulatory changes. These approaches secure sustainable strategic development in the long-term perspective (see Table 1).

Such development is defined as a process of sustainable, purposeful, and continuous enterprise growth that ensures its competitiveness, adaptability, and efficiency in the future (over a horizon of 3 years or more) [1]. In practice, this implies enterprise development within the following algorithm:

$$S_1 \rightarrow S_2 \rightarrow S_3 \rightarrow S_4 \rightarrow S_5 \quad (1);$$

where: S_1 — resilience to changes; S_2 — formation of competitive advantages; S_3 — long-term economic efficiency; S_4 — innovative development; S_5 — compliance with sustainable development principles.

To ensure sustainable, purposeful, and continuous enterprise growth, circular innovations in supply chains must go beyond isolated initiatives. They should become an integrated part of the business model-specifically, the component that ensures the creation, movement, and delivery of a product or service from the supplier to the end consumer.

In general, the main conditions that transform circular innovations in supply chains into a strategic driver of development include: (1) integration into the business model; (2) effective supply chain management; (3) cost reduction and improved resource efficiency; (4) formation of competitive advantages; (5) compliance with regulatory requirements and ESG strategies.

From a broader perspective, it becomes evident that circular approaches (remanufacturing, reverse logistics, recycling) should be embedded in the core logic of value creation and adjustment, as well as in the management of interactions among supply chain participants (including personnel activities [6]). For example, when a company shifts from selling products to a "product-as-a-service" model [7].

Table 1. Examples of circular approaches in supply chains and their characteristics

Circular approach	Content (brief description)	Implementation features	Strategic effect for the enterprise
Reverse logistics (movement of goods, materials, or products from the end consumer back to the manufacturer or other supply chain participants)	Organization of product returns from consumers to the manufacturer	Requires a developed system for collection, transportation, and sorting	Reduction of raw material costs, increased control over the product life cycle
Remanufacturing (restoration of used or worn products to a condition close to new)	Restoration of used products to a near-new condition	Requires technological modernization and quality control	Reduction of production costs, creation of added value
Material recycling (collection, processing, and transformation of waste into secondary raw materials)	Use of waste as secondary raw materials	Requires recycling infrastructure and partnership networks	Reduced dependence on primary resources
Reuse (a process in which products, their components, or materials are used again)	Reuse of products or components without significant processing	Requires standardization and condition monitoring	Extension of product life cycle, cost reduction
Product-as-a-Service (PaaS)	Providing access to a product instead of selling it	Requires a change in business model and financial logic	Stable long-term revenues, strengthened customer relationships

Source: created by the author based on [1; 3—5].

Moreover, for the outlined circular innovations to contribute to enterprise development, they should:

— form closed-loop supply chains, meaning that waste and used products are returned into the production cycle as secondary resources;

— enable the enterprise to differentiate itself in the market through environmental responsibility, innovation, and accountability, thereby strengthening brand value and customer loyalty;

— improve the enterprise's ability to adapt to environmental standards and international sustainability requirements, reducing risks and increasing access to investment;

— foster new business models such as resale, leasing, product refurbishment, and secondary raw material sales.

Through circular innovations in supply chains, enterprises should achieve a real reduction in dependence on primary raw materials. This, in turn, decreases procurement and disposal costs, thereby improving overall efficiency.

Thus, the conditions identified above for transforming circular innovations in supply chains into a driver of enterprise strategic development are more systematically characterized in Table 2.

Thus, the mere implementation of individual circular innovations in supply chains does not, in itself, guarantee the strategic development of an enterprise. For instance, the use of recycled raw materials or the introduction of isolated resource reuse practices may fail to deliver the expected economic effect due to their localized nature or the lack of proper coordination among supply chain participants, insufficient digital support for tracking processes, and weak alignment with the enterprise's strategic priorities.

In contrast, when implemented systematically and at a broad scale, circular innovations in supply chains can become a genuine driver of strategic development by delivering tangible efficiency gains. For example, the implementation of such innovations across the entire supply chain, which connects all company processes, ensures a reduction in raw material costs through the use of secondary materials, lower waste disposal costs (via reverse logistics [3]), as well as the creation of additional revenue streams from remanufacturing.

Circular innovations are effective provided that innovative solutions are implemented across the entire supply chain (rather than in its separate segments).

This enables the closure of resource flows, improves resource efficiency, and creates higher added value for the enterprise.

In a broader sense, circular innovations in supply chains are effective if they [5; 7]:

— genuinely reduce the use of primary resources and the volume of waste at all stages of the supply chain;

— ensure economic benefits (through cost reduction or increased revenues for supply chain participants);

— contribute to enhancing the competitiveness of both the enterprise and the supply chain as a whole;

— are integrated into strategic supply chain management and are not treated as one-off initiatives.

The experience of modern enterprises that support development based on circular innovations (in particular in Ukraine-"Obolon," "Myronivsky Hliboproduct (MHP)," "Interpipe," "Epicentr K," as well as a number of enterprises in the processing and agricultural sectors) makes it possible to identify the following key factors of effective implementation in supply chains:

1. The availability (or implementation) of modern technologies that enable circular processes (i.e., a set of interrelated activities within the enterprise and supply chain aimed at closing resource flows). These are technologies that ensure the transition from the "take-make-dispose" model to the "use-return-recover-reuse" model [7].

2. The establishment of reverse logistics and partnership networks with suppliers and recycling companies to create closed-loop systems (i.e., an organization of material and product flows in which, after use, they do not leave the system as waste but are returned into the production process for reuse, recovery, or recycling). This represents a shift from the traditional linear model-raw materials → production → consumption → waste-to a closed-loop model-raw materials → production →

Table 2. Prerequisites for circular innovation transformation in supply chains into a driver of enterprise strategic development

Conditions for transformation	Essence of transformations of circular innovations in supply chains	Examples of transformations in supply chains	Strategic outcome for the enterprise
Integration into value creation	Shift from occasional environmental initiatives to the core business logic	Transition to a “product-as-a-service” model (leasing equipment instead of selling it)	Stable long-term revenues, strengthened control over the product life cycle
Formation of closed-loop supply chains	Returning products and waste back into the production cycle	Reverse logistics, product take-back systems, reuse of materials	Waste reduction, lower raw material costs, improved resource efficiency
Reduction of dependence on primary raw materials	Use of secondary resources instead of virgin materials	Plastic and metal recycling, remanufacturing of components	Lower procurement costs, increased resilience to resource risks
Formation of competitive advantages	Strengthening market position through sustainability and innovation	“Green” branding, eco-labeling of products	Increased customer loyalty, stronger brand equity
Compliance with regulatory requirements	Adaptation to environmental standards and ESG requirements	Implementation of ISO 14001, participation in sustainability programs	Reduced regulatory risks, improved access to investment and international markets
Business model diversification	Creation of new revenue streams	Product leasing, resale, secondary raw material sales	Increased profitability and business resilience

Source: created by the author based on [1; 2; 7].

consumption → collection → recovery/recycling → reuse [1—2].

3. The financial feasibility of circular solutions. This refers to the economic justification of implementing circular practices, taking into account effects such as reduced raw material and waste disposal costs, improved resource efficiency, and value creation through reuse, recycling, or product recovery. In other words, these are circular solutions that enable a transition from the model of high resource costs → waste generation → additional disposal costs to a model of efficient resource use → reuse/recycling → cost reduction + value creation [7].

CONCLUSIONS

As a result of the research conducted, it has been established that circular innovations constitute a complex set of technological, organizational, managerial, and business solutions for implementing the principles of the circular economy within supply chains. Unlike traditional innovations, they are not focused on linear production growth but on the formation of closed-loop material and energy flows, which ensures resource reuse, waste reduction, and improved resource efficiency.

Research has demonstrated that, in supply chain management systems, circular innovations serve as a key instrument for the structural transformation of supply chain models into integrated systems of forward and reverse flows. This transformation ensures effective coordination of forward and reverse material, information, and financial flows, as well as the integration of processes of collection, sorting, recycling, and reintegration of resources into the production cycle.

Studies have shown that circular innovations in supply chains acquire the status of a driver of enterprise strategic development only when integrated into the business model and strategic management system. They enable reduced dependence on primary raw materials, cost reduction, and the formation of new business models (in particular "product-as-a-service," remanufacturing, and resale), as well as increased competitiveness and resilience of enterprises.

Findings have demonstrated that the effectiveness of circular innovations is determined by their ability to simultaneously deliver environmental, economic, and social impacts, as well as by their integration into strategic supply chain management. In the absence of coordination among supply chain participants and adequate managerial and technological support, circular innovations do not generate a systemic strategic effect.

The practical value of the results lies in their applicability to enterprises in developing efficient circular supply chains and implementing reverse logistics and remanufacturing systems. Further research should focus on developing quantitative models for assessing the effectiveness of circular innovations in supply chains.

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