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THE ROLE OF INDUSTRIAL STRATEGIES IN CHEMICAL PRODUCTION AND SERVICE SUPPLY LOGISTICS PROCESSES

JÁNOS JUHÁSZ[1]

Abstract: *The research topic focuses on applying industrial strategies, especially in chemical industry logistics processes. The research aims to examine the future of the chemical industry in Hungary and worldwide. The question is what is the role of logistics in the chemical supply chain and the difficulties faced in this area? The main difficulty that can be encountered is achieving effective automation and digitalization while maintaining appropriate safety, which is an essential aspect of the chemical industry. The research presents an existing AGV transport solution that significantly facilitates on-site logistics processes within a chemical company. In the research, the potential development areas are found which could be interesting to explore in logistics processes are also discussed.*

Keywords: *chemical industry, supply chain, process development, logistics*

1. INTRODUCTION

From the perspective of logistics supply chains, Industry 5.0 enables faster responses to customer demands and economical and efficient mass production and service processes tailored to individual needs. It supports the adaptation of new business models and the rapid introduction of new manufacturing processes and other innovations within logistics processes. The successful implementation can help achieve flexibility in the supply chain and contribute to flexible systems [1].

Industrial strategies play a critical role in enhancing the efficiency and effectiveness of logistics processes in both production and service supply chains. These strategies involve the implementation of advanced technologies, such as automation, digitalization, and data-driven decision-making, to streamline operations and reduce costs. In production logistics, industrial strategies focus on optimizing the flow of materials, improving inventory management, and integrating smart manufacturing techniques to meet the demands of modern industries.

Automated machines, decision-making systems, and software are increasingly taking over production and logistics tasks from human resources, allowing companies to reduce costs, improve competitiveness, and optimize their manufacturing and logistics operations. Such developments enhance the overall efficiency of the supply chain and enable flexible responses to the changing needs of the market.

In service supply logistics, the emphasis is on ensuring timely and reliable service delivery, optimizing distribution networks, and enhancing customer satisfaction through strategic planning and technological innovation. Key challenges include adapting to rapid technological changes, maintaining high safety standards, and managing the complexities of global supply chains. The application of industrial strategies helps companies overcome these challenges by improving process efficiency, increasing responsiveness to market demands, and ultimately contributing to a competitive advantage in the global market.

Fig. 1. represents the key industrial strategies in production and service supply logistics processes, highlighting the key components and their connections in production and service supply chains.

[1]Senior Lecturer, University of Miskolc, Institute of Logistics, Miskolc, Hungary
janos.juhasz1@uni-miskolc.hu

Figure 1. *The role of industrial strategies in production and service supply logistics processes [Own edit]*

Another approach is to manage the emerging I5.0 approaches and related technologies and to enable manufacturing companies to improve and maintain their competitiveness in a future I5.0 environment [2].

2. CHALLENGES TO THE DEVELOPMENT OF LOGISTICS SUPPLY PROCESSES IN THE HUNGARIAN CHEMICAL INDUSTRY

The chemical industry in Hungary has performed relatively prosperously over the past decade. The rubber and plastics industry has been particularly successful, while the pharmaceutical industry has shown less impressive growth rates. The overall growth of the chemical industry has been lower than the average for manufacturing [3].

Chemical logistics is organizing and managing the flow of chemicals and related materials from suppliers to manufacturers and consumers. The purpose of this process is to ensure that the right chemicals are delivered to the right place at the right time.

These logistics activities include transportation, inventory management, and safety requirements. To deliver safely, companies need to have comprehensive knowledge of the risks and proper handling procedures for chemicals. They must also have a secure transport network that allows chemicals to be transported safely and efficiently.

Inventory management is another challenge in the chemical industry. Chemical inventories change rapidly and can become obsolete, so companies need to develop an effective inventory management system. This includes tracking and efficient use of inventories [4].

Table 1 shows the main key solutions to the chemical logistics supply chain management difficulties. The specific characteristics and challenges of the chemical sector can often make

it difficult to design and manage innovative supply chains. Consider, for example, that the chemical industry often must handle large quantities of hazardous substances, which require strict safety standards and regulations. This regulated environment often limits flexibility and variability in supply chain design.

Table I.

The solutions to the chemical logistics supply chain difficulties [Own edit]

Difficulties	**Action**
Handling Hazard	Requires new up-to-date standards and regulations, limiting flexibility and variability in supply chain design methods.
Long-term R&D Cycles	Prolonged development periods can complicate supply chain planning and optimization required.
Large Quantity Deliveries	Shipping large volumes over long distances presents logistical challenges, particularly in international deliveries.
Environment	Regulatory constraints affect flexibility in logistics, impacting the ability to adapt quickly to changes.

In addition, chemical products often undergo long-term research and development processes before they are brought to market. This long-term development cycle can also pose challenges for supply chain planning and optimization, as market needs and conditions can change during development.

Chemical products are often shipped in large quantities and over long distances, which can pose additional logistical challenges.

3. IMPACTS OF THE ROLE OF INDUSTRIAL STRATEGIES IN CHEMICAL PRODUCTION AND SERVICE SUPPLY LOGISTICS PROCESSES

This section introduces the impacts of industrial strategies on production and service supply logistics, highlighting their transformative power in reshaping modern supply chains.

The role of industrial strategies in logistics is to support continuous improvement, drive innovation, and create sustainable, efficient supply chain operations that meet the evolving needs of both the production and service areas. As industries navigate an increasingly complex global landscape, the role of industrial strategies in logistics is crucial for achieving cost efficiency, enhancing service reliability, and ultimately, securing a competitive advantage.

As part of Industry 4.0, automated guided vehicles (AGVs) are used to transport containers at BASF's Ludwigshafen site. The new system includes an automated container terminal, patented tank containers, and autonomous vehicles that provide a faster and more cost-effective solution for supplying production facilities [5].

Modern chemistry has brought significant advances, but it also poses serious environmental challenges, particularly in sustainability. For the chemical industry, it is essential to find more sustainable and environmentally friendly solutions, which will require radical changes in current practices and technologies.

Digitalization and the introduction of innovations play a key role in transforming the industry, enabling more efficient data exchange and information flows. Industry needs to

coordinate its efforts along the whole value chain and develop new business models to facilitate the uptake of sustainable products [6].

Developing a culture of innovation readiness is key to the competitiveness and sustainability of companies [7]. In addition to the practical application and implementation of new ideas, technology, business processes, and data management must be aligned. To develop a successful innovative culture, companies need to integrate modern technologies and maintain a flexible corporate culture that is open to change. It is also important to involve both internal and external resources in the innovation process, including the active participation of employees and external partners.

Machine learning and other artificial intelligence techniques can be used to create databases that can help develop new products or optimize existing ones. AI-based algorithms can, for example, suggest ingredients for detergents or surface coatings, helping to create a new coating [8]. AI therefore plays an important role in context discovery and innovation processes.

Table II represents an overview of how industrial strategies influence both production and service supply logistics processes, highlighting their unique challenges, strategies, and overall impact on business operations.

Table II.

The impacts of the role of industrial strategies in chemical production and service supply logistics processes [Own edit]

Aspect of supply chain logistics	**Production**	**Service**
Role of the industrial	Optimizes material flow, manufacturing efficiency, and inventory management.	Enhances service delivery, distribution efficiency, and customer satisfaction.
Key Strategies	Automation and robotics, Smart manufacturing, Lean inventory management	Digitalization of service processes, Vehicle Route Planning, Customer relationship management
Challenges	High implementation costs, Integration of new technologies, Maintaining safety standards	Rapid technological change, Balancing cost with service quality, Managing complex distribution networks
Technological Focus	IoT and smart sensors, AI-driven production scheduling, Real-time tracking	Data analytics for demand forecasting, Automated service scheduling, Cloud-based logistics platforms
Benefits	Reduced production time, Lower operational costs, Improved quality control	Faster response times, Improved customer experience, Streamlined logistics operations
Examples	Automated guided vehicles (AGVs) in factories [5], Predictive maintenance	Last-mile delivery optimization, Automated customer service systems

4. MODELLING OF GENERAL CHEMICAL SUPPLY STRATEGIES

Mathematical models allow us to analyze and assess the performance of logistics systems, supporting manufacturing, purchasing, distribution, and reverse logistics, while also enhancing the efficiency of various service activities.

Given the above considerations, this study focuses exclusively on traditional, just-in-time, and just-in-sequence supply strategies.

With this in mind the following logistics supply chain cost components are defined in the production and service processes:

- material flow costs:
  - production logistics supply costs:
    - automation and robotics costs,
    - smart manufacturing costs,
    - lean inventory management costs.
  - service logistics supply costs:
    - digitalization of service processes costs,
    - vehicle route planning costs,
    - customer relationship management.
- natural usage costs.

The natural usage costs are defined as the natural resources used [9]:

$$C^{NAT} = C^{G} + C^{E} + C^{U}, \tag{1}$$

where:

- C^{G} is the specific cost of greenhouse emissions,
- C^{E} is the electricity cost of suppliers,
- C^{U} is the specific cost of unexpected natural resources for suppliers.

The costs of the material flow are defined as the chemical supply chain specific costs:

$$C^{MF} = C^{PAR} + C^{PSM} + C^{PLIM} + C^{SD} + C^{SVRP} + C^{SCRM}, \tag{2}$$

where:

- C^{PAR} is the specific costs of automation and robotics,
- C^{PSM} is the specific costs of smart manufacturing,
- C^{PLIM} is the specific costs of lean inventory management,
- C^{SD} is the specific costs of digitalization of service,
- C^{SVRP} is the specific costs of vehicle route planning,
- C^{SCRM} is the specific costs of customer relationship management,

The problem's objective function describes the minimization of supply chain operational costs:

$$C = \sum_{i=1}^{m} \sum_{j=1}^{n} C^{NAT}.x_{ij} + \sum_{i=1}^{m} \sum_{j=1}^{n} C^{MF}.x_{ij} \rightarrow min, \tag{3}$$

where:

- x_{ij} is an assignment matrix of participants, and associated sequences, where i=1...m and j=1...n, there is a direct connection between them.

5. NUMERICAL ANALYSIS

In this chapter, I examine the general model in chemical supply chain processes. This model has objective function elements, which are enabled to support the required just-in-sequence supply.

Table III shows the costs of *each* sequence in chemical supply chain tiers. Thus, it can be exactly measured and calculated of the material flow costs and natural costs of required sequences.

Table III.

Detail of sum of sequence costs [Own edit]

$SZUM\ t$	$C_{PAR}^{\square}$ [t€]	$C_{PSM}^{\square}$ [t€]	$C_{PLIM}^{\square}$ [t€]	$C_{SD}^{\square}$ [t€]	$C_{SVRP}^{\square}$ [t€]	$C_{SCRM}^{\square}$ t€]	$C_{NAT}^{\square}$	B [t€]
1 1 1	0,00	0,09	0,01	0,27	0,03	0,03	0,10	0,27
1 1 2	0,02	0,07	0,01	1,30	0,01	0,02	0,09	1,30
1 1 3	0,00	0,04	0,03	0,45	0,02	0,02	0,07	0,45
1 1 4	0,01	0,02	0,05	0,65	0,02	0,03	0,07	0,65
1 1 5	0,00	0,03	0,06	0,80	0,02	0,02	0,08	0,80
1 1 6	0,03	0,02	0,05	0,38	0,01	0,01	0,07	0,38
1 1 7	0,05	0,02	0,05	0,52	0,01	0,02	0,07	0,52
…	…	…	…	…	…	…	…	…
3 3 6	0,04	0,07	0,02	0,44	0,01	0,03	0,08	0,44
3 3 7	0,01	0,03	0,02	0,38	0,01	0,01	0,05	0,38
3 3 8	0,01	0,07	0,00	0,21	0,01	0,02	0,07	0,21
3 3 9	0,00	0,05	0,01	0,20	0,02	0,02	0,06	0,20
3 3 10	0,01	0,05	0,02	0,34	0,02	0,02	0,06	0,34

Fig. 2. shows the breakdown and the percentage of these cost components, where the sequence values were calculated to determine the whole supply chain cost of chemical supply chain processes.

The above calculations can be used to determine and evaluate the costs of just-in-sequence supply. Thus, the total cost of the ship-to-sequence supply system is 52,91 eEUR and the revenue from its activities is 53,59 eEUR.

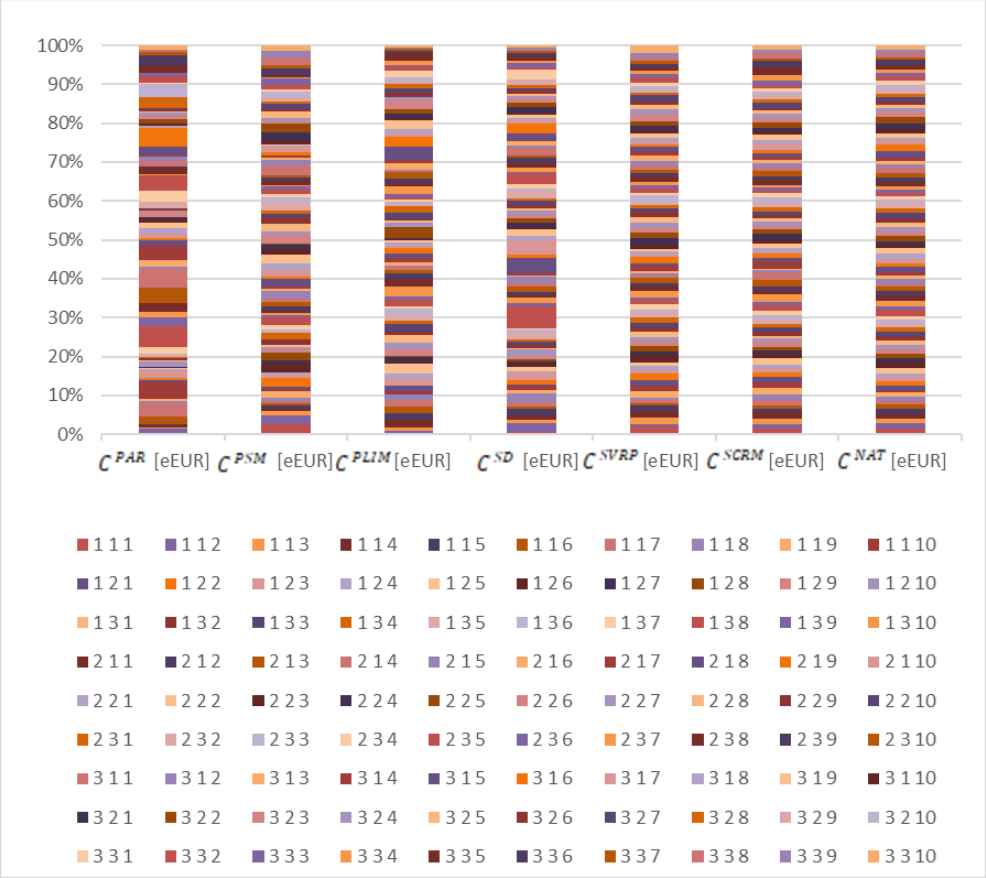

Figure 2. *Results of chemical supply costs calculations [Own edit]*

6. SUMMARY

In today's supply chains, all participants aim to minimize costs to stay competitive, taking advantage of every opportunity to reduce expenses.

The role of industrial strategies in logistics is to enhance continuous improvement and drive innovation within supply chain operations. These strategies are essential for developing sustainable and efficient logistics processes that adapt to both production and service needs.

In complex chemical logistics systems, industrial strategies play a crucial role in achieving cost efficiency and streamlining operations. They focus on optimizing logistics to reduce expenses and improve resource use.

Ultimately, effective industrial strategies in logistics contribute to securing a competitive advantage in the marketplace. Their comprehensive approach helps industries remain agile and effective in a rapidly evolving environment.

The impact of industrial strategies extends beyond operational improvements, especially in the chemical industry. It enables businesses to adapt to market changes, respond quickly to customer demands, and introduce new business models and production methods with agility.

REFERENCES

[1] Sarkar, B. D., Shardeo, V., Dwivedi, A. & Pamucar, D. (2024). Digital transition from industry 4.0 to industry 5.0 in smart manufacturing: A framework for sustainable future. *Technology in Society*, **78,** https://doi.org/10.1016/j.techsoc.2024.102649.

[2] van Erp, T., Carvalho, N. G. P., Gerolamo, M. C., Gonçalves, R., Rytter, N. G. M. & Gladysz, B. (2024). Industry 5.0: A new strategy framework for sustainability management and beyond. *Journal of Cleaner Production*, **461**(3), 142271, https://doi.org/10.1016/j.jclepro.2024.142271.

[3] Matheika, Z., Nagy, Á. & Palócz, É. *A magyar vegyipar helyzete*. Kopint-Tárki Konjunktúrakutató Intézet Zrt. Retrieved from https://kopint-tarki.hu/wp-content/uploads/2020/12/vegyipar_helyzete_2016.pdf, Accessed 01.09.2024.

[4] Allcargo Logistics. *Chemical logistics*. Retrieved from https://allcargologistics.com/chemical-logistics, Accessed 02.09.2024.

[5] Harald, S. & Thorsten, B.: *BASF Rail 4.0 New opportunities in intermodal transport*. BASF Class Tank Containers & autonomous driving. Retviered from https://www.era.europa.eu/system/files/2022-11/P3%20Impulse%20BASF%20MM%20Conference%20Schlegel.pdf, Accessed 02.09.2024.

[6] Fantke, P., Cinquemani, C., Yaseneva, P., De Mello, J., Schwabe, H., Ebeling, B. & Lapkin, A. A. (2019). Transition to sustainable chemistry through digitalization. *Chem*, **7**(11), 2866-2882, https://doi.org/10.1016/j.chempr.2021.09.012.

[7] Newman, D. & Mcclimans, F. (2017). Accelerating Digital Transformation in the chemicals industry, *Innovations*, **3**(7), 7.

[8] Ulbrich, M. & Aggarwal, V. (2019). The Digital Revolution is coming to chemical laboratories, *Journal of Business Chemistry*, **16**(2), https://doi.org/10.17879/76199421140.

[9] Juhász J. & Bányai T. (2024) Implementation of ship-to-sequence supply strategies, *Advanced Logistic Systems - Theory and Practice*, **18**(1), 99–106, https://doi.org/10.32971/als.2024.010.