

EFFECTIVENESS OF JUST-IN-TIME PRINCIPLE IN TODAY'S CIRCULAR ECONOMY AND ITS NEGATIVE EFFECT

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Abstract

In the context of circular economy, manufacturers aim to improve the quality of the environment and human life. With regard to the nature of their production, business entities within circular economy adopt the philosophy of the Just-In-Time method. This paper analyses the impact of this method on the current supplier-customer relations in the Czech Republic as well as the quality of fulfilment of its obligations. Moreover, it is evaluated whether the concept of Just-In-Time method is suitable for efficient functioning of this economy. Based on the data obtained, a comparison analysis of the research problem is performed. The level of meeting deadlines for supplies in the manufacturing process of a domestic business entity is examined. The analysis performed did not confirm the idea of combining speed with the adaptive response to change. In the Czech Republic, the Just-In-Time method is currently influenced by a number of negative factors, which significantly affect the current supplier-customer relations and the quality of fulfilment of their obligations. The key factors affecting the effectiveness of the Just-In-Time principle include the extension of the stock replenishment period and inaccurate logistics cooperation in the area of production planning.

Key words:

Circular economy, Just-In-Time, stock, effectiveness of manufacturing process, production, automotive, production theory, minimization of costs

JEL classification: L620, L210

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Introduction

Circular economy is a concept adopted by individual countries' governments as an attitude to increasing uncertainty related to natural resources, environmental degradation, and climate changes. The historical background of this issue date back to the 1960s, when mass consumption was predominantly enhanced in post-war policies, and the economic, cultural, and social context of consumption was neglected. Disinterest in this issue lead society to the brink of the global environmental crisis (Crocker, 2018).

At that time, many business models are created and innovated, which respond to resource depletion, waste of resources, and emissions. Circular economy thus gains popularity both in the academic community and in industry and policy making (Geissdoerfer et al., 2020).

The society is already diversified these days. Companies supporting circular economy transform the infrastructure of its business economy into a closed continuous cycle, which

is seen as a basic principle of circular economy. Manufacturers now strive for reducing waste and use of non-renewable resources, recycling raw materials, composting, reprocessing goods and reusing them, or sorting waste. By increasing the efficiency of production, they aim at improving the quality of the environment and human life. With regard to the nature of production and own philosophical conception of closed circuit, companies introduce a method that increases the productivity of their processes. Under ideal conditions, this method represents a principle of effective production process management, which combines the required speed with the adaptive response to a change. In simple terms, these are steps performed in a precisely defined quantity, time, and according to the customer's requirements. This method is referred to as Just-In-Time (JIT).

Early studies of this method focus on improving operational efficiency and minimizing waste. The experience from the last decades combines the Just-In-Time principles with efficient logistics, mainly with the timely distribution of raw materials in the production

process and subsequently finished products to customers (Memari et al., 2018).

Based on understanding the concept of the process functioning in an optimal market economy, the objective of this paper is to identify the negative impact of this method on the circular economy of the Czech Republic in 2022, at a time of impending economic crisis and a time strongly affected by the effects of the COVID-19 crisis, or to analyse the impact of this method on the efficiency of the production process and society.

For the purposes of meeting the objective set, two research questions are formulated:

1. How is JIT method currently influenced in the Czech Republic by the supplier-customer relationships and the quality of fulfilling their obligations?
2. Is the concept of JIT still suitable for the efficient functioning of this type of economy?

1. Literature research

The philosophy of the JIT is the manufacturing excellence, which reduces waste and improves productivity. Production based on customer requirements, i.e. the maximally flexible and effective, it aims to significantly reduce the manufacturing costs related to storing materials and semi-finished products, and maximization of productivity. Assuming that the elements of the supply chain, such as supply, production, and distribution are flawlessly secured, the most commonly used logistic concept of JIT is justified and can be considered the key element in the competitiveness of companies. The links in the supply chain are influenced by the current circular economy.

The process of efficient supply is influenced by a number of factors. The key ones include the availability of the necessary material and raw material in the market, proper planning and purchasing stock, optimal use of input, production and sales warehouses, operational and strategic management and optimization of stock. In the event of a failure of some link, the production cannot be quickly adapted and customer requirements satisfied (Suleiman et al., 2021). The flexibility of production process is directly subordinate to the JIT supplier method.

Aghazadeh and Seyed (2008) analysed factors influencing labour productivity. The authors examined the effects of stable production supporting work in progress, employee management, and investing in employees on the process efficiency. Memari et al. (2018) also examined this extensive logistic problem of JIT. They pointed to the new factor, a source of uncertainty. They propose to consider this factor when dealing with the limited supplier capacity and increased customer demand, which encourages production.

In production, for the application of JIT, it is necessary to ensure reliability of processes. In linear regression analysis of the impact of lean principles on the operational performance of manufacturing companies all over the world, Belekoukias, Garza-reyes and Kumar (2014) focused on improving the operational performance when using the method of machinery maintenance, TPM (Total Productive Management), the process of efficient use of equipment OEE (Overall equipment effectiveness), the process of efficient use of machinery TSM (Total Service Management), the process of ensuring quality TQM (Total Quality Management), the process of ensuring efficiency in administration and the concept of continuous improvement within elimination of waste. Although the supply in such a divided production with subsequent processes corresponds to the principles of JIT, it is very energy-intensive. Zhou and He (2021) focused on the analysis of energy costs management in the process of car manufacturing. Furthermore, they evaluated the impact of stock minimization on the production efficiency. The diversification of production and small-batch distribution of material in production can be in conflict with the required energy savings, which is one of the goals of circular economy. Ahmad et al. (2003) deal with the managerial interest in the infrastructure and the effects of the infrastructure on the internal environment of the manufacturing entity. They analysed the effective processes in the manufacturing entity when using normative, universal configurational, and unpredictable management models. Another negative impact of the Just-in-time method was addressed by Tortorella et al. (2018). From the perspective of organization and supply chain, the principle of Just-in-time is seen as a strictly defined process.

The implementation of Just-in-time in the production process requires a cognitive load, which is in contrast with the capacity to process the workload of individual employees. The implementation of Just-In-Time puts emotional pressure on employees. Tortorella et al. (2018) analysed the impact of Just-in-time on employees' operational performance and health, as they are exposed to constant stress. They evaluated that the implementation of Just-in-time principles requires employees to be actively involved and deal with large degree of changes, certain level of self-organization of tasks and cognitive skills. Such demands may not be always good for employee health and satisfaction.

The difficulty of distributing goods lies in the proper determination of the optimal distribution and decision on won or external logistics. Efficient logistics leads to a reduction of operating costs related to storage and overall operational optimization. Chakrabarty, Roy and Chaudhuri (2018) compared two warehouse models. They analysed unit costs of storage in rented and owned warehouses. The function of total costs is performed under the effect of JIT setup costs. If order exceeded the capacity of own storage premises, excessive goods were stored in a rented warehouse, but there were higher unit costs of storage.

Manufacturing industry is a backbone of economy, which converts the input material into strategic products. Production diversification, or small-batch distribution of material puts emphasis on logistic accuracy. As part of the agreed supplier-customer relationships, storage facilities are moved to trucks on roads. The environmental behaviour of entities will change, as the global transport industry faces a negative impact of the COVID-19 pandemic. Timely supply is significantly influenced by lack of workforce, non-fulfilment of production deadlines of subcontractors, closure of their operations and non-systematic search for substitute suppliers, extension of delivery time when using international maritime transport, technical problems in shipping and road transport. Circular economy strives for reaching industrial symbiosis. The European standard classification of economic activities (NACE) used in the European Union since 1970 includes the statistical data on the industries of

manufacturing sector ranging from steel, cement or minerals to chemicals. In terms of emissions and intensive use of energy and resources, the existence of manufacturing industry has a great impact on the environment (Mendez et al., 2021). Within specific production operations, sustainability requirement is directed at managers, who need to find and manage such process and methods that would increase the efficiency of resources and overall sustainability. Kurdve and Bellgran (2021) conducted research where they analysed the impact of managers' and production operators' involvement on the final improvement of the overall environmental behaviour. The improvement was achieved by setting priorities and environmental improvements identified as crucial by production micro teams. The authors analysed the theory of green lean manufacturing and its integration with circular economy in the context of production. They found that efficient production is focused on performance and time lost, while green manufacturing enhances minimization of resource waste and the amount of waste.

The principle of circular economy also consists in reusing end-of-life products or material recycling. Parajuly, Keshav and Wenzel (2017) analyse potential sales revenues and revenues from material recovery. Similar issue is addressed by Wiebe et al. (2019). They extended the idea by considering the limited world resources. They assumed 10 billion of people in 2050, with the same material requirements as today's high-income countries. They analysed whether circular economy ensures sustainable growth and evaluated the decrease in global mining, which is positive and with small impact on employment. They considered the transition from resource extraction sector to the services sector, where there are more job opportunities for qualified ad female workers.

2. Methodology

2.1 Research problem

As mentioned above, the level of output of a business entity and continuity of its production process Just-in-time is significantly influenced by a number of factors. The key ones include reliability, timely delivery, quality, and flexibility.

Automotive is one of the drivers of Czech economy. The year-on-year increase in GDP showed significant drops compared to the period before the COVID-19 which is most likely a cause of the global economic crisis. Due to the lack of employees, manufacturers do not have the capacity to meet their export deadlines and thus put their customers in a situation that disrupts the continuity of their production or even leads to suspension or cessation of production. In the application part of this work, the degree of their flexibility in these complex conditions is evaluated, as well as their reliability, or supplier level.

2.2 Procedure and methods

To achieve the goal of the paper, it is necessary to evaluate the negative impact of failing supply on the circular economy of the Czech Republic in 2022. The most transparent factor for a comparative analysis appears to be the factor of meeting the delivery date, or the

continuity of the supply process. Due to the inefficiency of JIT, the point evaluation of approved suppliers deteriorates across the whole transparent sample of them. For the purposes of the paper, an analysis will be performed, which will also evaluate the level of continuity of the supply process. If the level of supply declines, conclusions can be made.

In order to collect data, a business entity Kostečka Group s.r.o. was selected. The company has an internal tool of evaluation criteria (see Table 1). This tool includes comparison criteria by significance in ascending order. For individual delivery of goods in the monitored period, the tool evaluates the accuracy of the delivered quantity, its quality, and reliability concerning meeting the delivery date. Other values represent the degree of fulfilment of each criterion. Fulfilment of evaluation criteria is based on a point scale from 1 to 5, where 5 represents the highest score, 1 is the lowest one.

Table 1. Evaluation criteria tool

CRITERION	SCORE of approved suppliers				
	5 – very good	4 - good	3 - neutral	2 - acceptable	1 - poor
Delivered quantity	Corresponds to the order	Quantity exceeds the ordered quantity by less than 5 %	Quantity exceeds the ordered quantity by more than 5 %	Delivered quantity is not met by more than 5 %	Criterion not met by more than 10 %
Quality	Higher than stipulated in the contractual conditions	Partially higher than stipulated in the contractual conditions	Corresponds to the contractual conditions	Minor deficiencies	Significant effects of some products, complaints necessary
Delivery date	Met precisely	Delivered less than one week before the deadline	Delay by more than 1 day, delivered more than 1 week before the deadline	Delayed by more than 1 week delay	Delayed by more than 2 weeks, delivered after urgency

Source: Kostečka Group s.r.o. (2022), authors.

2.3 Data

Subsequent analysis evaluated the data of a selected business entity obtained from its corporate information system. The monitored period includes the years 2018-2021.

The primary data for all deliveries executed in the relevant period were stated in writing on delivery notes. Based on the acceptance of goods, a responsible employee stamped and signed the delivery note and evaluated the individual criteria in writing. In the case of the selected company, the responsible persons are the warehouse manager, and the head of the quality department. These employees are fully responsible for the accuracy of the primary data. The warehouse manager is responsible for the criterion of the delivery date and quantity delivered, while the head of the quality department is responsible for quality. The evaluation of supplier level can be performed already at the stage of acceptance of goods, since the selected company and the approved suppliers have agreed such delivery conditions that also prescribe the form of the delivery note. Delivery note must contain information about goods, its specification, quantity, agreed delivery date, etc. The necessary information for evaluating the supplier level is thus made available.

At the moment of the receipt of the tax document for such a delivery, or the relevant delivery note, the business case is submitted to the accounting department. Here, it is posted, paid, and the relevant data of the evaluation criteria are entered into the company software. The selected company uses the information system ESO9.

In the annual balance, each approved supplier is informed about the results of this evaluation. The results are further used as a basis for assessing the approved suppliers and new contracts.

3. Results

The analysis of the supplier level of approved suppliers of Czech business entity, company Kostečka Group s.r.o., focuses its three key suppliers of goods in the monitored period 2018-2021.

These are two foreign and one Czech company. The Spanish company Eurofred S.A., Carrer del Marquès de Sentmenat, 97, 08029 Barcelona is an approved supplier of heat pumps and air conditioners. The Chinese company Midea Group, Beijiao, Shunde/Foshan is also an approved supplier of heat pumps and air conditioners, the Czech company HOTJET CZ s.r.o., Průmyslová 966, 747 23 Bolatice is an approved supplier of heat pumps.

For each delivery of goods executed in the monitored period, these selected approved suppliers were awarded a corresponding rating for fulfilling a given criterion. Fulfilment of evaluation criteria was based on the aforementioned point scale (see Table 1). For the calculation of the mean level, simple arithmetic mean was selected. The secondary data were obtained from the corporate information system of the selected company.

The values obtained based on the rating were summarized (see Figure 2). On the basis of this sample, data were evaluated using the method of the mean value and a graph of relevant supplier level was compiled (Graph 1).

Fig. 1. Evaluation of supplier level of selected suppliers of company Kostečka Group s.r.o.

Supplier	Eur ofred S.A.																										
	15.01.2018	03.04.2018	07.07.2018	08.09.2018	11.12.2018	average	17.01.2019	05.03.2019	09.06.2019	10.08.2019	13.11.2019	17.12.2019	average	12.01.2020	01.03.2020	04.06.2020	05.08.2020	08.11.2020	12.12.2020	average	15.01.2021	03.04.2021	07.07.2021	08.09.2021	11.12.2021	average	
Quantity delivered	5	5	5	5	5	5	5	5	4	5	5	5	5	5	5	4	5	5	5	5	5	5	5	5	5	5	5
Quality	3	2	3	3	2	3	4	3	3	2	3	4	3	4	4	3	2	2	3	3	3	2	3	3	3	2	3
Deadline	5	4	5	5	3	4	5	4	5	5	3	3	4	5	3	2	1	1	1	2	1	1	1	1	1	1	1
Evaluation						12						12						10						9			

Supplier	Midea Group																					
Criterion	03.02.2018	05.07.2018	20.10.2018		average	10.01.2019	25.02.2019	29.05.2019	20.06.2019		average	07.03.2020	15.08.2020	09.12.2020		average	05.02.2021	23.05.2021	27.08.2021	18.10.2021	average	
Quantity delivered	5	5	5		5	5	5	5	5		5	5	5	4		5	5	5	5	5	5	5
Quality	3	2	3		3	4	3	3	3		3	4	3	3		3	3	2	3	3	3	3
Deadline	5	5	5		5	5	4	5	4		5	2	1	1		1	1	1	1	1	1	1
Evaluation	13					13					9					9						

Supplier	HOTJET CZ s.r.o.																					
Criterion	20.02.2018	17.05.2018	20.11.2018	10.12.2018	average	17.02.2019	05.05.2019	09.08.2019	10.10.2019	13.12.2019	average	17.02.2020	30.04.2020	23.08.2020	17.11.2020	average	25.01.2021	23.04.2021	17.07.2021	28.09.2021	30.12.2021	average
Quantity delivered	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Quality	3	2	3	2	3	4	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	2
Deadline	5	5	5	5	5	5	4	5	4	4	4	1	1	1	1	1	1	1	1	1	1	1
Evaluation	13					13					9					9						

Source: Kostečka Group s.r.o. (2022), authors.

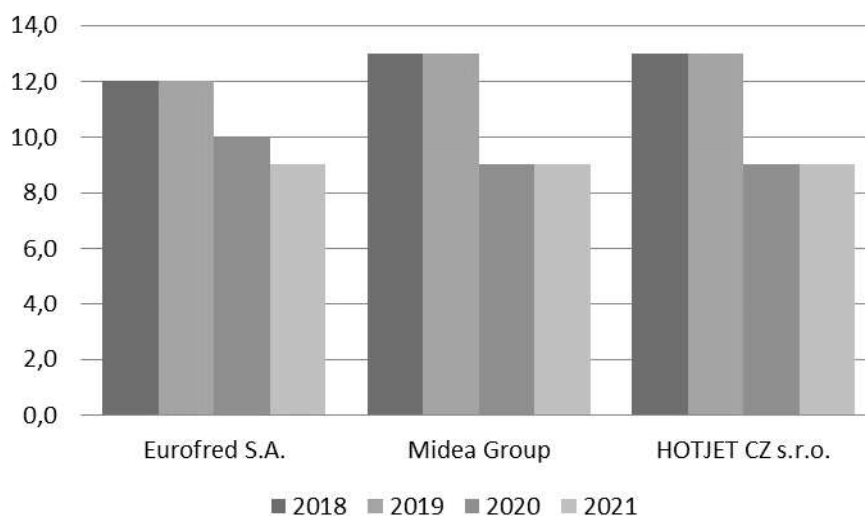
4. Discussion of results

In order to achieve the set goal of the paper submitted, two research questions were formulated:

1. How is JIT method currently influenced in the Czech Republic by the supplier-customer relationships and the quality of fulfilling their obligations?
2. Is the concept of JIT still suitable for the efficient functioning of this type of economy?

The analysis of the supplier level of approved suppliers of a given Czech business entity in the years 2018-2021 showed a downward trend. Despite the fact that the company Kostečka Group s.r.o. ensured more approved suppliers for its key products in the supply portfolio, the efficiency of the supply process was significantly disrupted. From the year 2020, there is a clear downward trend. The level decreased by up to 4 evaluation points, i.e. 31 %.

Graph 1. Evaluation of supplier level in the years 2018-2021



Source: Kostečka Group s.r.o. (2022), authors.

The level of the criterion “quantity delivered” is stable. The criterion “quality” shows a deteriorating trend. The worst results were recorded in the case of the criterion “delivery date”.

By deduction, the author concludes that this is caused by several factors. First of all, it is a lack of qualified and trained production staff of the supplier. It can be assumed that the supplier compensates for the drop in production capacity with new employees whose quality of work shows imperfection. Other problems the suppliers have to face are related to the lack of material, goods, or problems in logistic routes.

It can thus be concluded that there was a decrease in the level of supply. Inefficient functioning of the JIT methods significantly affects the production and the original concept of the methods appears to be insufficient for the efficient functioning of the economy.

Conclusion

When achieving the set objective of this paper, the philosophy of the JIT method was examined. Previous research on this issue shows that it is a specific approach to production shaped by the characteristics of a specific business entity. When following a set of defined rules and procedures, under optimal conditions,

it is possible to produce goods in a specified quantity, time, and in accordance with the customer requirements, with increased productivity of work and efficiency of machinery, minimizing costs, and in maximum quality. Excess stock is reduced, and so are the costs of inventory and storage space. The efficiency of production and sales and thus the return on investment is ensured.

For the purpose of achieving the set objective of this paper, an analysis was performed with the aim to find answers to the formulated research questions. Specifically, it was an analysis of the level of supplier-customer relationships that directly influence the supply of a business entity in the Czech Republic.

The performed analysis did not confirm the idea of combining speed and adaptive response to change. In the Czech Republic, the JIT method is currently affected by a number of negative factors, which significantly influence the current supplier-customer relationships and the quality of fulfilment of their obligations. The most important factors include the extension of stock replenishment time and inappropriate cooperation of logistics in the area of production planning. The concept of JIT is thus not suitable for ensuring efficient functioning the current

circular economy in the Czech Republic in 2022. The objective of the paper was thus achieved.

Research limitation is the small volume of the source data when analysing the supplier-customer relationships. Further follow-up research can thus be focused on addressing more business entities.

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