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Research Article

# The Synchronicity of Business Processes is the Basis of Organizing the Effective Recovery of Modern Enterprises

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**Abstract**

Effective strategic development of modern enterprises is possible through the rapid formation, introduction and implementation of measures for resource conservation and waste minimization without reducing overall efficiency. The paper proves that achieving this goal is possible through the formation of a rationalized set of business processes at the enterprise, connected by a mutual resource base, which do not necessarily have to be profitable in the current year. To determine the level of rational implementation of business processes of the enterprise, it is proposed to use the coefficient of synchronization. It is substantiated that the use of the coefficient of synchronicity of business processes will facilitate the selection of the most useful business processes for the strategic development of the enterprise and the rejection of those that are not sufficiently attractive in terms of certain characteristics. The proposed recommendations were tested on a sample of machine-building enterprises. According to the results obtained, it was determined that for the effective development of the studied enterprises it is necessary: for some - to combine their efforts with the capabilities of other enterprises; for others - to rationalize the composition and structure of existing business processes and/or create conditions for the effective implementation of new business processes that will contribute to the production of products necessary to ensure an effective full cycle of production of the enterprise. The obtained results made it possible to form certain clusters of enterprises in accordance with the general scenario of their development, determined by the value of the synchrony coefficient. The author substantiates the choice of a certain direction of movement for each of these clusters. In addition, practical recommendations for the effective strategic development of enterprises of these clusters within the chosen direction through the optimal increase of the necessary capabilities are presented. Drawing on a national development strategy, government officials should enhance and use the indicated clusters for meeting needs of a particular region or a country in general.

***Keywords:*** Business process; Resource efficiency; Effectiveness; Integrational adaptiveness; Synchronicity

## 1. Introduction

During the post-war period, the burning issue will be concerned with recovery of all facilities and the necessity for ensuring the appropriate functioning of certain cities. To provide the efficient operation of existing enterprises and to optimally increase capacities of new (destroyed) ones, it is necessary to balance and synchronize their business processes through maximally possible mutual resource provision. These measures are aimed at facilitating the specialization of certain enterprises for ensuring maximal effectiveness of their business processes in the long run (at the expense of the usage of corresponding managerial innovations). The next step is to eliminate insufficiently attractive business processes, which may be strategically attractive and effective for competitive development of other enterprises. Business process may be insufficiently attractive whether a part of their results, which is not useful for the effective execution of other interrelated business processes of a certain enterprise, incurs expenses exceeding an amount of benefits provided by a useful part of obtained results of business process realization.

## 2. Literature Review

In scientific literature, there are broad descriptions of processes, criteria, indicators, and measures for optimizing business processes underlying rationalization of the structure of these processes.

Mikhieienko (2012) substantiated the influence of optimization of business processes on capitalization of enterprises in the long run.

Having originally defined a conception of the business process improvement, Harrington et al. (2002) suggested practical recommendations regarding substituting business process reengineering for procedures and methods of the change.

Considering peculiarities of innovative development, authors of the article (The Website of Rise Manager Articles, 2018) assert that optimization has to encompass

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not only processes but also inter-functional relationships between them.

Shemaieva and Bezgin (2011) proposed an idea, which consists in implementing innovative technologies for achieving maximal quality of business processes and, in the process of their optimization, focusing on methods, which enable establishing equilibrium between satisfaction of consumers and rivals, on the one part, and indicators of business process effectiveness, on the other part.

Nikolayev (2001) suggests considering a notion of business process optimization in the context of enhancing and improving an enterprise's activity for attaining results that are more efficient. Meanwhile, A. Nikolayev observes ensuring the reduction of costs and a business process cycle by 90% and the simultaneous increase of its quality by more than 60%. In this case, business process optimization performs as one of aspects of organizational development. Under such development, an owner of a process undertakes a number of actions for revealing, analysing, and enhancing existing business processes at an enterprise in accordance with established objectives and goals such as the growth of profit, productivity, the expense reduction, as well as changes of existing business processes. This allows achieving product or service quality in order to meet needs of customers and consumers (Romanenkov & Zeiniiev, 2015).

Vantrappen (1992) considered an opportunity for optimization of three types of business processes enterprises apply to interact with their customers (the product creation, order processing, and rendering services grounded in creating values for customers), proving that exactly these processes provide a competitive advantage for enterprises.

Fehrer et al. (2022) present conceptualization of supplementary business process reengineering (aBPR). The aBPR conception directs users towards business process improvement based on reengineering templates. Depending on existing data, the aBPR conception classifies four types of recommendations, which differ in the automatization level.

Scientific papers consider: ways for business process optimization in the public administration sector (Battilani et al., 2022); an opportunity for business process improvement based on an approach, involving evidences, which maximally use existing information and knowledge (Delias & Nguyen, 2021); an approach of mathematical programming for business process optimization within digital supply chains (Perez et al., 2021); a theoretical approach to managing discrete events for enforcing declarative certifications of business processes and opportunities for expanding these measures used to solve a problem of reconfiguration (Nahabedian et al., 2022); a new complex approach to decomposition of manufacturing business processes in the cloud environment (Zhang et al., 2020); an opportunity for applying a queueing model in the process of executing optimization scenarios in order to quickly and accurately prognosticate periods of business process models (Peters et al., 2022).

Recommendation analytics regarding business processes have been also proposed for various industries, e.g. for capacity planning optimization (Eckert et al., 2008), resource distribution optimization (Xie et al., 2016), business process optimization in order to recover from the financial crisis, business process optimization in sales and personnel management (Hordieiev; Hurova & Sadekova, 2016; Popova; Tiahnenko, 2013), etc.

The above-mentioned scientific papers give significant attention to business process optimization through the maximally possible decrease of particular types of resources. Nevertheless, scientists do not take into account the prospective ability or the potential opportunity for developing adjacent and contiguous business processes. Implementing such processes supplemented by certain surplus of resources will currently conduce to obtaining considerable additional effects in the long run. This problem is particularly acute for domestic enterprises. This fact is confirmed by inefficiency of business processes executed at examined enterprises: as an amount of product types increases, the number of business processes rises; nevertheless, their irrational structure, regardless of market attractiveness of enterprises' products, ensures low profit rates.

For instance, the Kharkiv Tractor Plant was founded in 1930. The first tractor rolled of the line on 1 October 1931. Over the years, the plant have produced more than 3 million tractors and other specialized heavy machinery distinguished by reliability, functionality, and high quality of work. Nowadays, the Kharkiv Tractor Plant produces dozens of models of modern tractors and special equipment (The Kharkiv Tractor Plant, 2008).

The Lozova Forging and Mechanical Plant Limited Liability Company (LFMP) was built in 1966 according to a project of the Giprotractoroselkhozmash Institution (The Lozova Forging and Mechanical Plant has Begun to Produce Skeletons and Axles for Armoured Vehicles, 2010) for providing the Kharkiv group of agricultural engineering enterprises with hot stamping workpieces. At the beginning of 1974, the first entirely mechanized line for crankshaft stamping was put into operation. In the same year, a maintenance shed was created. In September 2006, the LFMP received the status of an approved vendor of accessory parts for the Swedish SKF Group (the world's leading supplier of rolling bearings) (Tarasenko, 2006). At the end of December 2006, the plant put into operation an air plasma cutting machine with computer numerical control called the Kharkiv P (Hryshchenko, 2006). In 2008-2010, the LFMP implemented a complex system for automatization of design and technological preparation and computer maintenance of the engineering production. At the beginning of June 2008, the LFMP resumed capacities existed during the Soviet era and began to manufacture skeletons for armoured vehicles, becoming a single enterprise on the territory of Ukraine, which possesses technology for creating thin-walled

armoured sheets (Hryshchenko, 2007). In the spring of 2010, the LFMP established production of skeletons and axles for the BTR-4 armoured vehicle. In September 2013, the LFMP finished development and established the manufacturing of a new product – the Dukat-16 disk harrow (Hryshchenko, 2013). In October 2014, having received an order for producing transfer cases for the BTR-4E, the plant was again involved into performing defence orders for the Armed Forces of Ukraine. At the end of April 2015, the plant manufactured the first transfer case turned over for testing. During an interview with journalists, V. Chornomaz, the plant's chief executive manager, informed that the production of military equipment at the LFMP would be continued and increased (Hryshchenko, 2015). In September 2015, specialists of the LFMP design bureau drew up 'a gadget for vehicle skeleton edging, which turns 180°, for parts of the BTR-4 in establishing anti-mine protection' (Dukat-12 – the UPEC Golden Project Competition's Winner, 2016). In March 2016, the LFMP announced launching the production of skeletons for the BTR-3 (The LFMP Plans to Increase Products Selling by Three Times, 2016). In October 2017, the first Albion-26 trailer, the British-Ukrainian collaboration product, rolled off the line of the Lozova Forging and Mechanical Plant. This trailer constitutes a grain trailer with the capacity of more than 26 tonne, which ought to gather grain crops from fields. Within the debut participation of the LFMP in the 2018 Arms and Security International Exhibition, which took place from 9 to 12 October in Kyiv, the plant reached a preliminary agreement with the Ministry of Defence of Kazakhstan on supplying constituent and replacement parts for major maintenance of armoured personnel carriers being at the disposal of Kazakhstan (The Lozova Forging and Mechanical Plant Will Supply Replacement Parts for Maintenance of Kazakhstan's Armoured Vehicles, 2018).

Moreover, research of the correlation between ratios of the major effect and additional one for examined enterprises indicates the low capability (desire, need) for revealing opportunities and encouraging their accumulation for gaining the additional effect (absence of rational interrelations between business processes), which is the basis of long-term competitive advantages for effective strategic development of an enterprise under the neo-technological post-war recovery.

As a result, it is necessary to optimize an enterprise's structure, using strategically attractive business processes and to search for a balanced long-term interrelation. Competition between such processes will allow choosing those ensuring maximal achievement of the synergetic effect from this interaction in the form of current (the major effect) and prospective (the additional effect) results. Therefore, managers should optimize not only business processes involved into certain activity, which foster accomplishing established goals, but also strategic business processes interrelated with them.

Correspondingly, to optimize business processes, managers should primarily determine their rational and strategically expedient complexity. Such complexity, in applying respective measures of managerial innovations, will ensure an additional competitive advantage and a particular specialized strength of a certain enterprise, which, if necessary, may be shared with other enterprises expanding their production capacities. Such terms may be achieved in case of forming an enterprise's business process portfolio, taking into account a criterion of their rational complexity, which should be presented in the form of the business process synchronicity ratio because of their mutual resource provision.

## 3. Highlighting Previously Unresolved Parts of the Overall Problem

In the studied scientific works, their authors considered increasing the efficiency of the enterprise through the optimization of their business processes. However, in their works, optimization concerned a change in the individual characteristics of business processes (reduction of costs, time, resources, etc.) or technologies for their implementation (combination of individual processes, reduction of their duration, etc.). We propose to increase the efficiency of the enterprise and its long-term competitiveness by streamlining business processes by increasing, reducing or eliminating their individual components or certain business processes in general, taking into account the level of interdependence and the degree of interaction of specific elements of different business processes, which increase their strategic attractiveness, prospects and effectiveness. The synchronization of business processes will initially, through effective relationships with the most attractive partners, increase the efficiency of their own business processes and, consequently, ensure the gradual increase of the relevant types of effects, which will enable the independent implementation of the necessary business processes to ensure the cyclicality and independence of production aimed at increasing the efficiency and stability of enterprise development. This will allow to implement as effectively as possible the principles of the circular economy, increase the efficiency of the enterprise, its stability in the market, protect against liquidation in case of lack of access to certain types of resources or reduction of capacity or termination of activities of individual enterprises.

## 4. Research Aim

The research aim is to draw up theoretical and methodological provisions for parametrization of an enterprise's business process synchronicity ratio and to suggest practical recommendations regarding its usage for rationalization of an enterprise's business processes in making decisions on the choice of an effective direction of an enterprise's strategic development in the period of its post-war recovery.

## 5. Methodological Approach

In the process of research, the author has used the following methods: analysis – for determining opportunities of domestic enterprises to form the additional effect being necessary for ensuring their long-term competitive advantages; grouping and a graphical method – for presenting parameterization of the synchronicity ratio and the consequence of its usage in making decisions regarding the choice of an effective direction for enterprise's strategic development; modelling in describing possible variants (scenarios) of enterprise development depending on its business processes' synchronicity ratio; comparison and hierarchic clusterization – for forming clusters encompassing researched engineering enterprises depending on their business processes' synchronicity ratio; fractal analysis – for specifying the time series forecasting methods for the business process synchronicity ratio of researched engineering enterprises; ordinary least squares and a moving average – for prognosticating the value of the business process synchronicity ratio for a sampling of researched enterprises; correlation and regression analysis – for building a correlation and regression model of engineering enterprise development.

## 6. Conducting Research and Results

The synchronicity ratio shows the extent of compatibility between integrational adaptive business processes executed with maximum effectiveness and interrelated through mutual resource provision.

Integrative adaptiveness shows effectiveness of executing a certain business process depending on complexity of resource provision with results of another business process realization. This affirms durability of their interrelation, which influence business process effectiveness, as well as precision and a time limit for building strategic development forecasts of an enterprise in terms of the post-war recovery.

Business process effectiveness is a comprehensive result derived from business process implementation, which indicates a general effect gained by an enterprise owing to undertaking a certain business process.

The business process synchronicity ratio for enterprises is calculated according to the following formula:

$$R_s=(BxM_a)/C_t, \quad \textit{where} \qquad (1)$$

B – effects (benefits) derived from undertaking a certain business process; $M_a$ – market attractiveness of results obtained from undertaking a certain business process; $C_t$ – costs being necessary for undertaking a certain business process (including a desirable profitability rate).

Determining a mutual provision rate through their active resource susceptibility by indicated key parameters will allow to rationalize the consequence of resource provision of corresponding business processes and to efficiently synchronize their execution. This will enhance effectiveness of implementing certain business processes. Business process synchronization will enable optimization of their structure and enhancement of enterprise activity efficiency under the post-war recovery of production towards the cost-effective usage of resource and rational implementation of the circular economy framework.

If $R_s$=1, resources within business processes are balanced; if $R_s$<1, managers should search for other soruces of resource provision; if $R_s$>1, managers should consider an opportunity for providing the execution of other business processes with additional results obtained from implementation of a considered business process.

An algorithm for synchronicity ratio parametrization and its application in the process of making decisions concerning the choice of an effective direction is presented in Figure 1.

Drawing on the synchronicity ratio value for implemented business processes, a certain enterprise may choose one of possible standard development scenarios: pessimistic; optimistic; realistic (Figure 1).

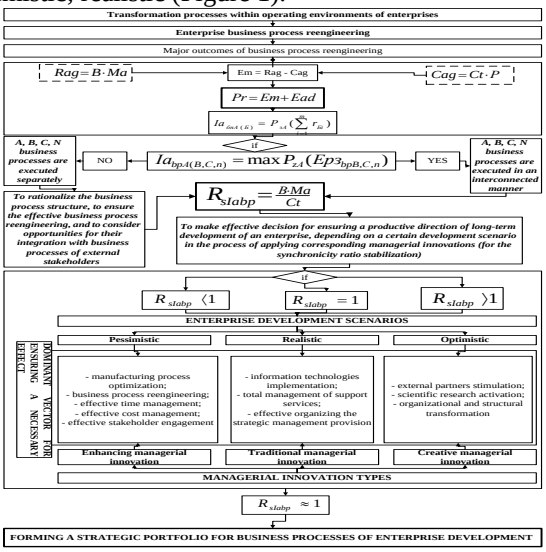


Fig. 1. An algorithm for the synchronicity ratio parametrization and its application in the process of making decisions concerning the choice of an effective direction for enterprise strategic development through determining its key parameters *Notice: developed by the author*

Figure legend: $E_{ad}$ – amount of the additional effect peripherally obtained in the process of implementing a certain business process; $E_m$ – amount of a major effect derived from implementing a certain business process; $R_{ag}$ – amount of an aggregated result derived from implementing a certain business process (according to planned parameters); $C_{ag}$ – aggregated costs being necessary for implementing a certain business process according to the main purpose; B – effect (benefit) derived from implementing a certain business process; $M_a$ – market attractiveness of results derived from implementing a certain business process; $C_t$ – costs needed for implementing a certain business process; P – desirable profitability rate; $Ia_{bpA(B)}$ – integrational adaptiveness of business processes A and B; $r_{Bi}$ – efficiency of complex provision of the business process A with an i-type of a resource, which is an outcome of implementing the business process B; m – amount of

resource varieties; RsIabp – synchronicity ratio for integrational adaptive business processes; A, B, C – types of an enterprise's business processes; n – the number of an enterprise's business processes.

To transfer from an existing development scenario to a desirable one, it is expedient to apply particular types of managerial innovations enabling to amend the content, structure, and types of an enterprise's business processes in order to correct their synchronicity ratio for ensuring the cost-effective usage of resources through specialization of certain enterprises or their strategic directions of activity. Figure 1 shows the main aspects of managerial innovations to be expanded and specified in order to effectively implement a chosen development direction in compliance with determined and desirable scenarios.

If the synchronicity ratio equals 1, an enterprise chooses a realistic development scenario characterized by the stable increase of particular types of an enterprise's potential.

For enterprises with the business process synchronicity ratio being significantly lower or significantly higher than 1, it is expedient to consider an opportunity for business process rationalization through liquidation of some of them or through enterprise activity reorientation in general. If the obtained synchronicity ratio exceeds 1, this means that, at some point, an enterprise possesses surplus opportunities, which, in applying corresponding managerial decisions, may ensure the additional effect. The proper usage of this effect will enable to amend transformational processes in environments, where other enterprises function, in order to support cyclicality of neo-technological reproduction aimed at recovery of enterprises in the post-war period, and to enhance success of a region and a country under such operating conditions. Thus, enterprises with the business process synchronicity ratio being significantly higher than 1 are able to offer certain results of the business processes execution for implementation at other enterprises or to launch production of a corresponding innovative, technically improved, technologically modified, or creatively changed product

Hence, whether enterprise's business processes are not synchronized to the full extent (the synchronicity ratio is not equal to 1), it is expedient to consider an opportunity for replacing particular business processes or supplementing their structure by processes of other enterprises, which will ensure higher effectiveness of implementation of interrelated business processes and foster enhancement of their synchronicity.

For instance, the increase of the synchronicity ratio for particular business processes at a certain enterprise should be considered through their possible integration with attractive stakeholders. In such case, we may observe the following direction for long-term enterprise development:

- firstly, attaching attention to business processes and their mutually stipulated interrelations, which ensure maximum effectiveness of business process execution and prospects of effects created in this interaction. Such complex business process interaction will provide corresponding specialization of an enterprise, which, in turn, will create significant long-term competitive advantages;

- secondly, establishing effective long-term integrational relationships between particular specialized complexes of synchronized business processes of various enterprises within corresponding components and elements of certain business processes oriented towards the maximum cost-effective usage of resources.

By considering opportunities for integration, an enterprise should give careful consideration to the choice of a partner. This solution will be concerned with expediency of involving those business processes to be used for ensuring the inappropriate or higher level of synchronicity between existing business processes in the long run (even if effectiveness of implementing a certain complex of interrelated business processes in the current period is not the highest of the possible options for development, a strategically possible effect will ensure considerable competitiveness). Internal companions – other business units of an enterprise, for which synchronicity of business processes is higher than one – may play the role of an attractive stakeholder. Such interaction will enable to enhance business processes effectiveness and to balance activities of an enterprise's business units, providing long-term efficiency and the search for an opportunity to form an additional effect through selecting directions (variants) for the maximal usage or optimization of existing surplus of results derived from implementing certain business processes at the expense of the maximum increase of a synergetic effect. Such synergetic effect is necessary for effective development of enterprises under the circular economy and the stable increase of essential (insufficient, desirable) capacities.

Under the pessimistic development scenario, to successfully function in the post-war period, enterprises should focus on technological components of manufacturing. That is to say, they should maximally try to keep synchronicity of business processes at the expense of their rationalization through the integration with business processes of other business units or other enterprises (attractive stakeholders).

Under the realistic and optimistic development scenarios, there is a need to rely on a particular innovative component of manufacturing (in case of applying the optimistic development scenario, a creative (intellectual) aspect of innovative components will be maximally important), which will enable forming the additional effect being necessary for cyclicality of transformational processes in operating environments of contemporary enterprises and stable strategic development of an enterprise under such environment.

Consequently, even the optimistic scenario requires an enterprise to carry out particular measures regarding reducing or increasing certain business processes of an enterprise being necessary in a corresponding period (through particular short-term collaboration with certain stakeholders). In other words, each of possible

development scenarios for ensuring the effective functioning of an enterprise and its components under conditions of the post-war environment require applying a corresponding management system based on business process reengineering and managerial innovations.

To specify the most possible measures for accumulating effective opportunities for enterprise development in the post-war period, we may determine the degree of strategic specialization being inherent to some of them, using the synchronicity ratio of their business processes. The object of this research implies engineering enterprises being strategically important for the post-war development of Ukraine.

Values of the business process synchronicity ratios of researched engineering enterprises for 2009-2018 are presented in Table 1. These calculations have been done in compliance with recommendations shown in Figure 1.

Table 1

Values of the business process synchronicity ratios of researched engineering enterprises for 2009-2018

| No. | Titles of enterprises | Values of business process synchronicity ratios by year, in the coefficient form | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| 1. | JSC Kharkiv Tractor Plant | 0.2 | 0.6 | 0.7 | 1.12 | 0.87 | 1.34 | 0.7 | 0.4 | 3.9 | 3.92 |
| 2. | LLC Lozova Forging and Mechanical Plant | 0.31 | 0.44 | 1.22 | 1.09 | 0.71 | 0.55 | 1.02 | 0.94 | 1.39 | 1.29 |
| 3. | PJSC Turboatom | 2.3 | 2.2 | 1.9 | 1.58 | 2.4 | 1.6 | 3.2 | 1.56 | 2.4 | 2.1 |
| 4. | JSC Novokramatorsk Machine-Building Plant | 1.2 | 1.26 | 1.34 | 1.15 | 1.64 | 1.37 | 1.6 | 1.53 | 2.2 | 2 |
| 5. | PJSC Drohobych Machine-Building Plant | 1.18 | 1.15 | 1.55 | 2.6 | 0.83 | 1.44 | 0.5 | 2.8 | 1.6 | 1.4 |
| 6. | PJSC Druzhkivka Machine-Building Plant | 0.89 | 0.9 | 1.28 | 0.98 | 0.44 | 0.132 | 0.035 | 0.2 | 0.24 | 0.3 |
| 7. | PJSC Borex | 0.32 | 0.64 | 0.97 | 0.48 | 0.59 | 0.36 | 1.29 | 1.91 | 0.48 | 0.6 |
| 8. | JSC Odesa Machine-Building Plant | 0.43 | 0.3 | 1.45 | 0.86 | 0.64 | 1.06 | 1.18 | 2.3 | 0.92 | 0.78 |
| 9. | PJSC Krasyliv Machine-Building Plant | 0.69 | 0.7 | 1.12 | 1.21 | 0.33 | 1.77 | 3.5 | 1 | 1.23 | 0.98 |
| 10. | PJSC Progress Berdychiv Machine-Building Plant | 0.78 | 1.2 | 1.59 | 1.15 | 1.71 | 1.38 | 1.39 | 2.25 | 1.98 | 1.7 |
| 11. | JSC Konveier | 0.37 | 0.2 | 0.99 | 1.13 | 0.93 | 1.24 | 1.26 | 1.63 | 1.6 | 1.23 |
| 12. | PJSC Elvorti | 0.44 | 0.7 | 1.01 | 1.24 | 1.27 | 1.63 | 2.2 | 2.06 | 1.63 | 1.01 |
| 13. | LLC Karpaty Experimental Mechanical Plant | 0.73 | 0.8 | 0.44 | 0.5 | 0.8 | 0.7 | 0.9 | 1.1 | 0.8 | 0.74 |
| 14. | JSC Verkhniodniprovsk Machine-Building Plant | 1.4 | 1 | 1.03 | 1.29 | 0.88 | 0.51 | 1.43 | 1.16 | 7.34 | 5.3 |
| 15. | PJSC AC Bohdan Motors | 0.15 | 0.4 | 0.7 | 1.11 | 0.32 | 2 | 2.04 | 1.48 | 7.7 | 8 |
| 16. | PJSC Nasosenerhomash Sumy Plant | 2.19 | 1.8 | 1.29 | 1.21 | 1.5 | 1.45 | 1.56 | 1.41 | 1.3 | 1.2 |
| 17. | JSC Bilopillia Machine-Building Plant | 0.21 | 0.4 | 0.3 | 0.6 | 0.7 | 0.4 | 0.37 | 0.7 | 0.9 | 0.84 |
| 18. | JSC Bar Machine-Building Plant | 0.8 | 0.94 | 1 | 1.13 | 0.99 | 1.61 | 1.49 | 1.27 | 1.28 | 1.3 |
| 19. | JSC Mohyliv-Podilskyi Machine Engineering Plant | 0.97 | 1.2 | 1.24 | 1.3 | 1.74 | 0.65 | 1.1 | 2.9 | 1.7 | 2 |

Notice: calculated by the author

Changes in the obtained values of the business process synchronicity ratio for a sampling of the researched engineering enterprises in different periods presented in Table 1 indicate structural instability of their business processes and the ordinary execution of similar business processes with various levels of effectiveness by the enterprises. This complicates processes of planning and stabilization of an enterprise's position in the market. The value of the synchronicity ratio being lower than one, as well as its considerable excess indicates absence of equilibrium between business processes of the researched enterprises. For example, the values of the business process synchronicity ratio for the researched JSC AC Bogdan Motors have been changing over the years: from 0.15 (in 2009) to 1.11 (in 2012). Then, we may again observe its decrease in 2013 and the significant increase of this ratio up to eight in 2018. Obviously, existence of some or other business processes over certain periods of enterprise's activity is justified by demand for a certain product type. Nevertheless, their non-synchronicity refrain an enterprise from receiving a stable position in the market and, therefore, appropriate activity results.

To clarify measures for stabilization of the values of the business process synchronicity ratio for the researched engineering enterprises, there is a need to group them by certain features. Tendencies for the change in the values of the business process synchronicity ratio for the researched engineering enterprises in various periods are not similar. In many cases, they are even opposite (the increase is replaced by the decrease). Hence, the author has suggested taking into account a prognosticated tendency of the changes in the values of their business process synchronicity ratio to reveal certain groups of enterprises.

The prognosticated values of the business process synchronicity ratio for the sampling of the researched enterprises calculated according to methods of ordinary least squares and a moving average are presented in Table 2. The

choice of these methods is specified by a result of fractal analysis of the business process synchronicity ratios for the researched enterprises grounded in the Hurst exponent equalling 0.51. This result indicates persistence in time series being inherent to the chosen methods for time series forecasting.

Table 2
Prognosticated values of the business process synchronicity ratio for the engineering enterprises calculated according to methods of ordinary least squares and a moving average

| No. | Titles of enterprises | Prognosticated values of the synchronicity ratio | | | | | |
|---|---|---|---|---|---|---|---|
| | | $y_t$ (ordinary least squares method for simple regression) | | | | | $y_{t+1}$ (moving average method), 2019 |
| | | 2019 | 2020 | 2021 | 2022 | 2023 | |
| 1. | JSC Kharkiv Tractor Plant | 3.19 | 3.52 | 3.85 | 4.18 | 4.50 | 2.75 |
| 2. | LLC Lozova Forging and Mechanical Plant | 1.34 | 1.43 | 1.51 | 1.59 | 1.68 | 1.17 |
| 3. | PJSC Turboatom | 2.19 | 2.204 | 2.22 | 2.228 | 2.24 | 1.92 |
| 4. | JSC Novokramatorsk Machine-Building Plant | 2.06 | 2.15 | 2.25 | 2.35 | 2.44 | 1.84 |
| 5. | PJSC Drohobych Machine-Building Plant | 1.69 | 1.73 | 1.76 | 1.79 | 1.83 | 1.9 |
| 6. | PJSC Druzhkivka Machine-Building Plant | 0.28 | 0.39 | 0.41 | 0.42 | 0.53 | 0.27 |
| 7. | PJSC Borex | 1.04 | 1.09 | 1.14 | 1.19 | 1.24 | 1.036 |
| 8. | JSC Odesa Machine-Building Plant | 1.43 | 1.51 | 1.59 | 1.67 | 1.73 | 1.29 |
| 9. | PJSC Krasyliv Machine-Building Plant | 1.72 | 1.8 | 1.89 | 1.98 | 2.06 | 0.99 |
| 10. | PJSC Progress Berdychiv Machine-Building Plant | 2.09 | 2.2 | 2.31 | 2.41 | 2.52 | 1.88 |
| 11. | JSC Konveier | 1.77 | 1.9 | 2.03 | 2.16 | 2.29 | 1.36 |
| 12. | PJSC Elvorti | 1.99 | 2.11 | 2.23 | 2.35 | 2.48 | 1.36 |
| 13. | LLC Karpaty Experimental Mechanical Plant | 0.93 | 0.96 | 0.99 | 1.02 | 1.05 | 0.86 |
| 14. | JSC Verkhniodniprovsk Machine-Building Plant | 4.85 | 5.34 | 5.83 | 6.32 | 6.81 | 3.92 |
| 15. | PJSC AC Bohdan Motors | 6.74 | 7.53 | 8.32 | 9.11 | 9.9 | 5.82 |
| 16. | PJSC Nasosenerhomash Sumy Plant | 1.13 | 1.07 | 1.01 | 0.94 | 0.87 | 1.27 |
| 17. | JSC Bilopillia Machine-Building Plant | 0.88 | 0.95 | 1.01 | 1.07 | 1.13 | 0.79 |
| 18. | JSC Bar Machine-Building Plant | 1.51 | 1.57 | 1.63 | 1.69 | 1.72 | 1.29 |
| 19. | JSC Mohyliv-Podilskyi Machine Engineering Plant | 2.07 | 2.18 | 2.29 | 2.4 | 2.51 | 2.3 |

Notice: formed by the author

The prognosticated values for the synchronicity ratio obtained according to the ordinary least squares method have fostered the division of the researched enterprises' sampling into certain clusters. Since a deviation of the calculated values has accounted for 13%, higher precision of the obtained data stipulate this opportunity. Usually, a tree diagram, which shows hierarchic dependence between clusters, is the main outcome of hierarchic clustarization (Figure 2). Hence, this diagram has been chosen to show the formed clusters.

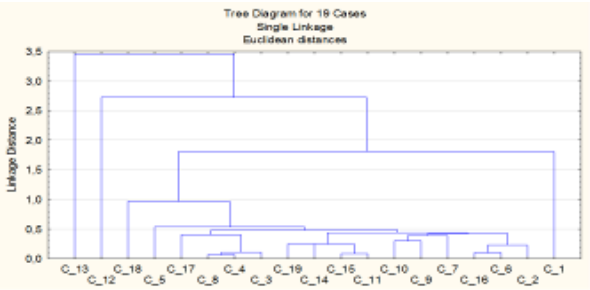


Fig. 2. Hierarchic tree diagram for the engineering enterprises based on the prognosticated values of the synchronicity ratio for business processes of their development

*Notice: built by the author*

Titles of the engineering enterprises belonging to different clusters according to cyphers, presented in the tree diagram, are shown in Figure 3.

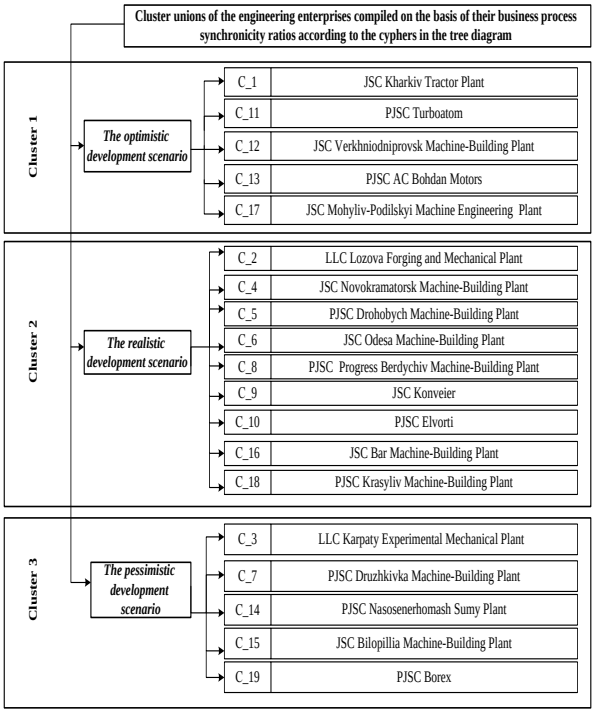


Fig. 3. Cluster unions of the engineering enterprises by their business process synchronicity ratio
*Notice: built by the author*

Taking into account the specified content of a managerial innovation (Prokhorova & Zalutska, 2020) and major accents to be focused on in forming managerial innovations (Prokhorova et al., 2021) for various enterprise development scenarios (Figure 1), the author has formed a set of managerial innovations separately for each of the indicated clusters of the engineering enterprises. They are presented in the form of regression equation.

Table 3 contains outcomes of building a correlation and regression model for the engineering enterprises.

The done research shows that development of enterprises from the cluster 1 should be modelled in compliance with the optimistic scenario. Under this scenario, the value of the business process synchronicity ratio is higher than 1. This fact indicates existence of excessive results or side effects of implementing certain business processes. Activity of such enterprises is characterized by the high level of development. Their efficiency in the long run depends on maximally beneficial implementation of results related to undertaking all the business processes of an enterprise. Such opportunity appears in creating corresponding innovative products, effective conditions of their diffusion, and involvement of attractive stakeholders into collaboration through the effective exchange of outcomes of activities.

Table 3
Outcomes of building a correlation and regression model for the engineering enterprises *(the author's design)*

| Regression equation | Multiple correlation coefficient R | Coefficient of determination $R^2$ | Adjusted $R^2$ | Fisher's criterion F | Approximation error |
|---|---|---|---|---|---|
| ***Cluster 1: JSC Kharkiv Tractor Plant; PJSC Turboatom; JSC Verkhniodniprovsk Machine-Building Plant; PJSC AC Bohdan Motors; JSC Mohyliv-Podilskyi Machine Engineering Plant*** | | | | | |
| $\mathbf{y=0.185+0.165\cdot X_1+0.16\cdot X_2-0.155\cdot X_3+0.151\cdot X_4+ 0.139\cdot X_5+0.11\cdot X_6+0.12\cdot X_7}$ | 0.89 | 0.85 | 0.832 | 30 | 0.0026 |
| ***Cluster 2: LLC Lozova Forging and Mechanical Plant; JSC Novokramatorsk Machine-Building Plant; PJSC Drohobych Machine-Building Plant; JSC Odesa Machine-Building Plant; PJSC Progress Berdychiv Machine-Building Plant; JSC Konveier; PJSC Elvorti; JSC Bar Machine-Building Plant; PJSC Krasyliv Machine-Building Plant*** | | | | | |
| $\mathbf{y=0.46-0.22\cdot X_8+0.204\cdot X_9+0.19\cdot X_{10}+0.13\cdot X_{11}+ 0.10\cdot X_{12}+0.094\cdot X_{13}}$ | 0.87 | 0.75 | 0.71 | 15.44 | 0.011 |
| ***Cluster 3: LLC Karpaty Experimental Mechanical Plant; PJSC Druzhkivka Machine-Building Plant; PJSC Nasosenerhomash Sumy Plant; JSC Bilopillia Machine-Building Plant; PJSC Borex*** | | | | | |
| $\mathbf{y=0.32+0.24\cdot X_{14}+0.226\cdot X_{15}+0.185\cdot X_{16}+0.15\cdot X_{17}- 0.159\cdot X_{18}+0.136\cdot X_{19}+0.129\cdot X_{20}+0.1062\cdot X_{21}}$ | 0.907 | 0.886 | 0.869 | 54 | 0.0015 |

Notice: formed by the author; $X_1$ – organizational and structural transformation; $X_2$ – brand management; $X_3$ – developing procedures for the capital investment budgeting; $X_4$ –creating autonomous innovative groups; $X_5$ – scientific research intensification; $X_6$ – equitable accumulation of intangible assets; $X_7$ – supporting facilities at an acceptable level; $X_8$ – the kaizen concept implementation; $X_9$ – quality management; $X_{10}$ – cost management; $X_{11}$ – the usage of mental capacities of low-level employees; $X_{12}$ – controlling; $X_{13}$ – effective ways for organizing the strategic management provision; $X_{14}$ – drastic improvement of processes; $X_{15}$ – staff selection and resocialization; $X_{16}$ – defect reduction; $X_{17}$ – cost-effective management; $X_{18}$ – effective time management; $X_{19}$ – stimulation of stakeholders; $X_{20}$ – total management of support services; $X_{21}$ – implementation of neural network technologies.

These activities will ensure creating the additional effect being necessary for competitive strategic development under the post-war recovery. However, in the process of maximal accumulation of an effect from improving

additional outcomes derived from implementing certain business processes, it is important to avoid losses in executing the main types of activities. Thus, in case of the optimistic development scenario for the engineering enterprises of the cluster 1, important managerial measures encompass: organizational and structural transformation ($X_1$); brand management ($X_2$); developing procedures for the capital investment budgeting ($X_3$); creating autonomous innovative groups ($X_4$); scientific research intensification ($X_5$); equitable accumulation of intangible assets ($X_6$); supporting facilities at an acceptable level ($X_7$). These measures enable to balance gaining the major and additional effects being necessary for long-term competitive development under the post-war recovery.

Development of enterprises falling into the cluster 2 is modelled according to the realistic scenario characterized by optimal synchronization of business processes implementation. The choice of this scenario is stipulated by the value of the synchronicity ratio being within 1. Nevertheless, the functioning of the engineering enterprises from the second cluster also requires executing certain managerial measures being necessary for maintaining the existing position or enhancing efficiency of activity. To keep development of an enterprise at a level being acceptable for obtaining a corresponding effect of long-term competitive development under the post-war recovery, it is essential to implement a system for improving processes (e.g., the kaizen concept). Simultaneously, there is a need to undertake measures restraining permanent processes of improvement in such a way as to ensure an appropriate level of quality for outcomes of business process implementation and an appropriate level of costs within acceptable margins and in compliance with established goals.

Implementation of the suggested measures is possible at the expense of the usage of corresponding technologies for explaining peculiarities of undertaking certain processes and their influence on efficiency of other related processes to direct perpetrators. This will conduce to perception of importance, possible contributions, and a rate of reward by employees of all the levels. Efficiency of implemented measures increases at the expense of the usage of the suggested strategic management recommendations (Zalutska et al., 2021) through effective implementation of stages for the strategy formation and realization. Such measures will ensure an interrelation between all the components of a managerial innovation for the enterprises of this cluster, control over their implementation, and direct elimination of strategic problems immediately after their appearance through applying a corresponding model for making effective managerial decisions.

The engineering enterprises falling into the third cluster develop in accordance with the pessimistic scenario, which, to enhance current activity and to ensure the strategic competitive functioning, requires applying managerial measures concerned with drastic reconfiguration of the structure and the number of business processes. It is possible to receive highly qualified and competent specialists owing to reviewing the composition of staff and enhancing their capacities through the selection and resocialization of staff. They will ensure the manufacturing of quality commodities through reducing defects of finished goods and carrying out business processes ($X_3$), which will stipulate the cost-effective usage of resources and the necessity for rigorous control over such cost-effective usage and carrying out business processes in order to avoid obtaining low-quality results. In addition, it is significantly important to balance effectiveness of implementing an enterprise's business processes with market entry of outcomes. In some cases, this process causes a need for borrowing particular resources from other enterprises to timely produce and to introduce a product, which has been created on the basis of such resources, to a market. This is because the independent manufacturing of required resources may extend a production process of finished goods and their introduction to a market. This will result in losing a part of consumers and profit. To optimize time for delivery of corresponding resources and distribution of certain products, it is expedient to form a database of suppliers and consumers.Appropriate motivational measures provide effective collaboration with suppliers and consumers. Simultaneously, managers should encourage own structural units for providing the prompt manufacturing of needed constituent parts or raw materials and implement corresponding technologies for transferring and processing information. Such information which will enable to gain a balance between own and a counterpart's resource provision or to determine more effective variants for involving resources at the moment of their implementation, as well as during a period of the manufacturing of competitive finished goods created on the basis of such resources.

The usage of the suggested complex of managerial innovations for each cluster will enable them to achieve an appropriate level of long-term development according to the corresponding scenario and to receive an opportunity to transfer to another cluster, where conditions of operation foster the strategic competitive functioning for effective accumulation of necessary capacities for independent successful strategic development under the post-war recovery.

Consequently, applying the business process synchronicity ratio will allow enterprises to create different specialized centres depending on the cluster they belong to. This will conduce to forming a particular set of enterprises with corresponding strategic opportunities (surplus or lack of opportunities) aimed at selecting certain strategic partners for competitive long-term development of an enterprise. Indication of

corresponding specialized centres will allow state leaders to outline specificity and a strategic opportunity of certain regions. This will enable to provide better balancing of their development and to form strategic strengths in certain areas of state development.

To carry out the suggested managerial innovations, which are oriented towards ensuring effectiveness of engineering enterprises in the post-war period, productively and maximally precisely, it is necessary to use a corresponding mechanism for enterprise development management being adequate to existing conditions.

## 7. Conclusion

The formation and development of enterprises in the post-war period depends on their ability to operatively increase opportunities of competitive long-term development. In such case, enterprises should put more emphasis on undertaking those types of activities they do best. This will foster enhancement of their effectiveness and an opportunity to intensify corresponding types of effects for strategic development.

Hence, a matter of operative and maximally precise determination of a list of prospective directions for activities managers can effectively perform owing to effective implementation of a rationally balanced complex of business processes is of great importance. Taking into account peculiarities of the global economy, namely the necessity for consideration of circular economy principles, managers should determine such complex of interrelated business processes through maximization of opportunities for resource efficiency contemplating the synchronicity ratio.

The synchronicity ratio value enables certain enterprises to form basic sets of effective business processes and to establish effective interrelations with prospective partners for ensuring successful strategic development of an enterprise.

**T**he usage of the business process synchronicity ratio as a basis for business process management system at the researched engineering enterprises confirms the increase of their effectiveness owing to the modelling of optimal variants of their interaction through applying effective methods of sequencing the implementation of certain business processes at the expense of efficient resource mutual provision. This enables to create a product, which maximally meets needs or additional neo-products emerged in a market. Such neo-products can better meet needs emerged in a market or cause new needs, which may satisfy a corresponding enterprise and help to obtain new additional effects. Further reproduction of created neo-products fosters adjustment and reorganization of particular business processes of an enterprise. This process amends an enterprise's structure and a direction of its development. In this case, it is considerably important to use particular managerial innovations, which enable to enhance, besides an effective interrelation between particular business processes being necessary for their productive implementation, corresponding effects, which ensure significant competitive advantages in a market for an enterprise. In turn, penetration of created effects into various spheres of activities of a particular enterprise, as well as into a society's vital activity will cause the emergence of new needs and methods of resource efficiency for meeting these needs through creative recovery of the manufacturing of corresponding products. Such products will be necessary for enterprise development under the post-war conditions.

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