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MODELING OF BUSINESS PROCESSES FOR MANAGING INTEGRATIVE DIGITAL DEVELOPMENT OF ENTERPRISES

It has been proven that the development of information and communication services enterprises is of strategic importance for the complementary growth of all sectors of the Ukrainian economy and serves as a platform for boosting and advancing proactive business segments overall.

The fundamental methods for modeling business process flows using mathematical and analytical tools, specifically a system of differential equations with defined initial conditions, have been substantiated, enabling the integral assessment of enterprise business process modeling. A capsulated approach to the digitalization of business processes and a comparative analysis of a broad range of financial and economic indicators for comprehensive diagnostics of integrative enterprise development effectiveness were applied, allowing for the determination of a probable development scenario for enterprises in the future.

The key flows of enterprise business processes have been identified: material, innovative-intellectual, information-marketing, and financial. The dependence of management efficiency and the achievement of positive outcomes on the synchronization of these flows has been revealed, taking into account possible temporary variations in the investment dynamics of each flow.

The mathematical model for calculating profitability was tested using data from the information and communication companies PJSC «Kyivstar», PJSC «Vodafone», and LLC «Lifecell». This approach enabled the identification of the most influential streams by year and

revealed patterns of leadership changes based on the impact of external environmental factors and internal organizational conditions.

The dependence of achieving positive results on the configuration of financial, material, innovative and intellectual, and information and marketing flows has been identified. This analysis allowed for the proposal of management vectors for managing the integrative development of information and communication services enterprises: passive, focused, sustainable and proactive integrative development.

Keywords: *enterprise, business processes, digitization, management, development*

JEL classification: *M11, C51, D61, L96*

Доведено, що розвиток підприємств інформаційно-комунікаційних послуг має стратегічне значення для комплементарного розвитку всіх сфер економіки України та є платформою форсування і піднесення проактивних сегментів бізнесу в цілому.

Обґрунтовано фундаментальні методи та інструменти моделювання потоків та бізнес-процесів із застосуванням математично-аналітичного апарату, а саме системи диференціальних рівнянь з визначеними початковими умовами, що дозволило розв'язати поставлену проблему інтегральної оцінки моделювання бізнес-процесів підприємства.

В результаті проведеного дослідження було доведено, що обрані теоретичні конструкції: процесний підхід управління якістю, загальна теорія систем, теорії конкурентних переваг та інновацій, а також аналіз технології "Process mining" дають змогу представляти цифрові бізнес-процеси як загальну складну систему, якою можна ефективно управляти, застосовуючи сучасні цифрові технології.

У зв'язку з цим в роботі було запропоновано застосування капсульованого підходу до цифровізації бізнес-процесів за потоками показників, які створюють платформу для аналізу поточних станів і дають змогу корегувати управління бізнес-процесами підприємства для досягнення максимальної ефективності.

Застосовано капсульований підхід до цифровізації бізнес-процесів, компаративний аналіз широкого спектру фінансово-економічних показників комплексної діагностики ефективності інтегративного розвитку підприємств, котрі дозволили визначити ймовірний сценарій розвитку підприємств у майбутньому періоді.

Виділено ключові потоки бізнес-процесів підприємств інформаційно-комунікаційної сфери: матеріального, інноваційно-інтелектуального, інформаційно-маркетингового та фінансового, виявлено залежність ефективності управління та досягнення позитивного результату від синхронізації потоків за можливого допущення тимчасового варіювання у динамічності інвестування того чи іншого потоку.

Математична модель розрахунку прибутковості апробована за даними підприємств інформаційно-комунікаційної сфери ПрАТ "Київстар", ПрАТ "Vodafone" та ТОВ "Lifecell", що дало змогу виділити найбільш впливові потоки за роками та виявити закономірність зміни лідирування залежно від впливу чинників зовнішнього середовища та внутрішніх умов організації роботи підприємства.

Виявлена залежність отримання позитивного результату від конфігурації конструктивів фінансового, матеріального, інноваційно-інтелектуального, інформаційно-маркетингового потоків, яка дала можливість запропонувати вектори управління інтегративним розвитком підприємств інформаційно-комунікаційних послуг: пасивний, сфокусований, сталий та проактивний інтегративний розвиток.

Ключові слова: *підприємство, бізнес-процеси, діджиталізація, управління, розвиток*

JEL classification: *M11, C51, D61, L 96*

Introduction. With the continuous increase in the volume of information related to identifying the effectiveness of business processes and enterprise flows, as well as the design, documentation, and control of their

components, economic management in this area is undergoing constant transformational changes. These changes are driven by the use of large data sets, which in turn affect key economic variables such as efficiency, cost, quality, and time.

Any business process functions as a network of multi-level hierarchical flow processes and links that are interconnected between members of various subsystems. Optimizing a specific business process, including those in information and communication enterprises, based on key criteria such as efficiency (effectiveness), cost, quality, and time, often has the opposite effect on other subsystems and processes. In other words, if the interdependence and mutual influence of business processes are not considered, improving one process according to a certain criterion may negatively affect another. Therefore, when deciding which business process to optimize, it is advisable to rely on business process modeling. This approach allows for consideration not only of the time impact on work processes but also the potential effects on cost and quality – both of which may vary depending on the specific content of the processes).

The relevance of studying business process modeling and the integral assessment of the integrative development of enterprises in the scientific context acquires special importance due to the following factors:

First, rapid changes in the modern business environment require enterprises to constantly adapt and improve their business processes. Through business process modeling, researchers and practitioners can analyze and understand current processes, identify problem areas, and implement effective changes to enhance the productivity and competitiveness of enterprises.

Secondly, the integrative development of enterprises involves the interaction and integration of various functional areas, such as production, marketing, finance, and human resource management. This creates the need to develop models that can describe and optimize the interactions between these areas, in order to achieve synergistic effects and fulfill the overall goals of the enterprise.

Thirdly, the relevance of this study extends beyond individual enterprises. Given the cumulative impact of business processes on social and economic development, business process modeling and the integral assessment of enterprise development

contribute to creating a sustainable economic environment. This, in turn, promotes sustainable development and fosters overall economic growth.

Therefore, research on business process modeling and the integral assessment of integrative enterprise development is relevant both for its practical significance to businesses and for its scientific contribution to the advancement of managerial theory and practice.

The purpose of the article. The purpose of this article is to substantiate a fundamental method for modeling a system of balanced criteria, essential for creating encapsulations within unified network protocols. These protocols are used to monitor every change in the business processes of enterprises or their modeling (simulation) and the polymorphism in business process management.

The article outlines methods and approaches that can be applied to model business processes for the integrative development of enterprises. In the context of information and communication enterprises (such as PJSC «Kyivstar,» PJSC «Vodafone,» LLC «Lifecell,» and JSC «Ukrtelecom»), business process modeling was conducted, and the relationships between various flows—material, financial, innovation and intellectual, information, and marketin – were determined.

To achieve the defined goal, the following tasks were set and addressed in the study: familiarization with scientific research on the chosen topic; identification of methods and approaches for modeling business processes; identification and substantiation of the most common problems that arise in enterprises during business process modeling; development of recommendations for solving the outlined problems; modeling the efficiency of integrative development in enterprises within the information and communication sector (PJSC «Kyivstar,» PrJSC «Vodafone,» LLC «Lifecell,» and JSC «Ukrtelecom»); providing recommendations on the identified vectors for managing the integrative development of enterprises in the information and communication sphere.

Literature review. Business processes modeling of integrative development is based on scientific, methodological and applied research. Integrative development is focused on the principles of society transformations and the economic environment as a result of the rapid spread and implementation of the digital economy. Integrative development involves the creation of unified digital platforms to ensure the progressive adaptive development of the changing external environment of enterprises. Enterprises in the information and communication services sector are among the most innovative and integrative, as their efficiency heavily depends on the quality of their services. In this environment, service quality is closely tied to the rapid implementation of innovative technological solutions. Consequently, modern and effective development requires a continuous revision and transformation of business models and individual business processes.

Effective and progressive management of enterprises and their business processes is grounded in a comprehensive study of various economic theories. The ability to apply the scientific insights from these theories in the practical activities of enterprises allows for a thorough analysis of the effectiveness of business model management in the context of the digital economy. The conceptual basis for further research includes the scientific and theoretical aspects of system dynamics, the process-based approach to enterprise development management, the theory of competitive advantages and innovations, the synthetic theory of management organization, and the analysis of “Process mining” technology.

F. Taylor, A. Fayol, and G. Emerson, who are the pioneers of the process-based approach to enterprise development management, laid the scientific and practical foundations for managing enterprises as a process [9; 21]. The study of their scientific contributions enabled the development of the author’s vision for the organizational and economic mechanism that structures individual functional operations, integrating them into a unified system of transformational

management. This system is based on encapsulation and systemic balance, particularly in the context of digitalization.

In his book *General and Industrial Management*, A. Fayol emphasizes that the effective management of an enterprise’s business processes relies on the execution of key management functions: forecasting, organization, planning, coordination, and control [19]. These functions promote systematicity, cyclical continuity, balance, flexibility, and stability in managing flows and business processes, ultimately maximizing profits and improving the enterprise’s efficiency. Additionally, effective management is achieved by optimizing information flows and incorporating innovative and digital technologies.

M. Porter’s theory of competitive advantages, which emerged in the early 1990s, identified key components of successful business and enterprise management, such as: the limitations of classic theories in outlining modern competitive advantages; the role of revolutionary technological changes in driving business success; the rise of new industrialized countries prompting a reevaluation of goods and services markets; and the expansion of international production accelerating globalization. In his work *International Competition*, M. Porter emphasizes that innovations and technologies serve as catalysts in the competitive business environment, driving enterprises toward global development strategies [17]. According to Porter, competitiveness is determined by an enterprise’s ability to successfully integrate innovations and technologies into its business processes. Achieving competitive advantages requires continuous, stable, and progressive development in a competitive environment.

The integrative development of enterprises is shaped by the general systems theory, founded by Ludwig von Bertalanffy [15]. According to this theory, development is based on modeling the structural interaction of the key components of an open socio-economic system, such as machine-human and machine-machine relationships.

Effective economic development of enterprises requires a comprehensive approach to management. This involves developing a set of methods and tools for optimizing business processes, including their monitoring, diagnostics, and planning, based on the implementation of specific innovative digital technologies. The modeling of an enterprise's integrative development and its individual business processes is grounded in the systemic management paradigm. In this study, the general theory of systems development allowed us to identify a set of criteria for modeling economic business processes and to create possible scenarios for future development.

The theory of innovation serves as the foundation for integrative development in the context of digitalization. Y.A. Schumpeter, the founder of the theory of innovation, viewed innovation as an economic category that, in conditions of cyclicity and dynamic technological competition, drives the primary impulse of enterprise development [19]. According to the theory of innovation, the implementation of innovations can occur through the following key approaches:

- introduction of either a new product unknown to consumers or a new type of product (consumer novelty);
- use of a new production method;
- opening of a new market where the industry has not been previously represented;
- discovery of a new source of raw materials;
- implementation of a new organizational structure in any industry [19].

Y.A. Schumpeter's theory of innovative development allows us to view an enterprise as an economic system capable of combining various factors and resources, as well as productive forces, to create a new product. In other words, innovative activity in the context of the digital economy is a key factor in generating excess profits and minimizing costs.

The modeling of business processes for the integrative development of enterprises is connected to the synthetic theory of management organization, pioneered by Lyndal Urwick and Luther Gulick. Their

concept of effective administration is based on a systemic approach, where each component plays a specific role in ensuring enterprise management through the implementation of interrelated management functions and principles. Thus, modeling business processes for managing the integrative development of enterprises becomes a systematic mechanism, comprising sequential operations and digital technologies for diagnosing enterprise development over a specific period [10; 22].

Process mining" technology is a practical implementation of the major advancements in information and communication technologies, enabling the analysis and modeling of business process development through the processing of large accumulated databases [7]. This technology allows for the visualization of possible scenarios for the development of enterprises and their business processes by studying individual flows within information systems.

Materials and methods. Thus, the methodological framework of our article can be divided into three blocks:

- analytical block establishes clear ratios of system components, forming the fundamental basis for analyzing the characteristics inherent in business processes. It also includes a comparative analysis of indicators from comprehensive diagnostics of the effectiveness of integrative enterprise development;
- expert-diagnostic block involves the application of mathematical modeling methods, including comparative analyses of short-term and medium-term financial and economic indicators of enterprises.
- forecast block – based on the results of the analytical and expert-diagnostic blocks, this block includes an integral assessment of the management of integrative development and enterprises, as well as the projection of likely scenarios for the future development of the enterprise.

Presenting main material research.

1. Methods and tools for modeling business processes of the enterprise

The analysis of modern approaches to business process management, with a focus on modeling criteria, reveals that this field

is gradually shifting from the fragmentation of modeling individual components of flow processes and their related actions (based on past changes) to the formalization of all key criteria in comprehensive network models with a unified representation language. These actions aim to formalize the main criteria within these complex models. However, a key challenge in managing business processes within the information and communication sector lies in the lack of information about these key criteria. A business process is not only defined by time, cost, results, and quality but also by its inherent fragmentation—a system of flows and individual processes [3].

Modern business process modeling in the context of integrative enterprise development is increasingly tied to the use of big data, with a focus on adapting this data

to automation technologies in management. The construction of management automation should be based on a balanced approach that allows for the modeling of potential changes during the interaction of all flow processes within a unified business system, ensuring the achievement of established program goals [24].

Business process modeling for the integrative development of enterprises involves the analysis, design, and optimization of business processes to enhance productivity, efficiency, and competitiveness. The primary goal is to integrate various functional areas of the enterprise and improve interaction between them. Various methods and tools can be utilized to model business processes for integrative development, as illustrated in Figure 1.

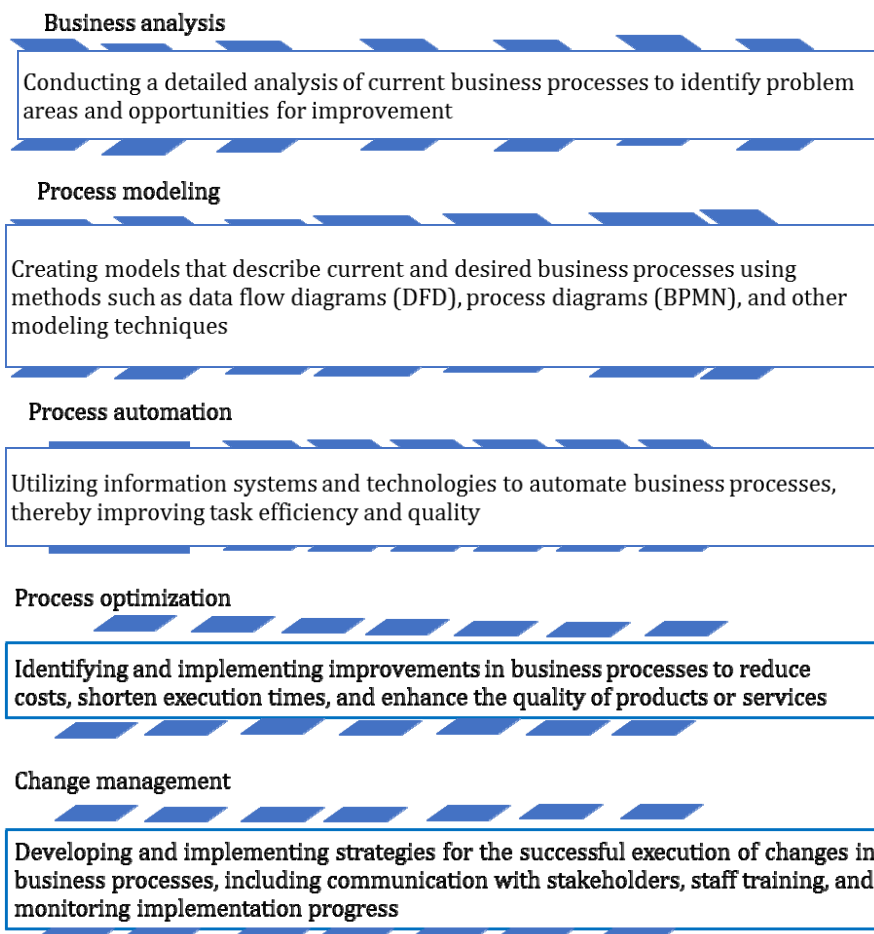


Fig.1. Methods and tools for modeling enterprise business processes.

Source: developed by the authors

Thus, considering the specific operational characteristics of the enterprise and its strategic goals, it is crucial to adapt business process modeling to its unique needs and context. Developing business process models for integrative development will enhance efficiency, improve production quality, and provide competitive advantages for the enterprise.

2. Justification of the business process model of the integrative development of enterprises

Modeling the business processes of integrative development in information and communication services enterprises should establish a set of operations for manipulating data networks within a system of criteria (such as efficiency, cost, quality, time, and fragmentation) for managing flow processes. This also includes forming routines to achieve a resource balance that leads to economic efficiency. The practical value of modeling integrative development lies in producing results that objectively reflect the actual state of each individual stream, as well as their interrelationships, based on the synthesis of programming technologies and economic performance indicators [24].

An economic problem arising from financial flows with different sources and functional significance can be approached by solving a differential equation or a system of differential equations with defined initial conditions [20]. In mathematical modeling, which leads to the formulation of these differential equations or systems, several challenges can arise:

1. The mathematical representation of a differential equation or a system of differential equations has a structure that may prevent obtaining an analytical representation of an integral curve as a solution [13; 14].

2. The initial conditions are not determined by the quantitative value of the financial flow at a given moment in time, but by a dependency over a time interval preceding the interval specified when obtaining the corresponding differential equation or system of equations in the modeling process [13; 14].

3. There may be an insufficient number of observations, or the time interval for the obtained data may not be long enough to construct a reliable differential equation or system [12; 18; 20].

Our study focuses on four types of flows that share the same monetary dimension (dimensionality): material flow (X1), financial flow (X2), innovation and intellectual flow (X3), and informational and marketing flow (X4). When each of these flows is considered separately as a function of time, there is insufficient quantitative data to determine the analytical dependence of each flow as a continuous function of time [11; 25]. Therefore, the challenge arises of replacing the differential equation with an analytical representation of the functional dependence of the financial flow over time, which serves as an approximate solution to the corresponding equation [8; 10; 11; 21].

It was established that such a dependence is a species dependence:

$$X_i = l_i + \left(\mu_i t \sum_{i=1}^i l_i + \zeta_i (t^2 - \tau^2) \right) \times p_i \quad (1)$$

X_i - is the corresponding flow during the observed time period.

l_i - the corresponding result of the performance, which was observed up to the current period of time.

μ_i - flow frequency – a parameter that determines the significance of the flow in relation to the profit growth rate.

ζ_i - flow acceleration – a value that is a function of the flow frequency.

p_i - the probability of the value of the flow volume in the considered time period.

τ - the time period under consideration. In our work, the meaning of this time is half a year.

t - the current moment of time within the half year.

The time dependence of a single flow does not provide complete information about the dynamics of profit and changes in its growth rate. It is important to determine the relationships between flows [4; 11]. Having such a relationship, it is possible to determine the flow that is dominant in the time period under consideration, to obtain

profit and determine the sustainability of its growth rate [8].

Thus, in order to obtain a qualitative portrait of the state of the flow distribution system to ensure the stability of the profit growth rate, it is necessary to have a phase portrait - a graphic relationship between the flows X_1 , X_2 , X_3 , X_4 . Since the maximum size of the phase space is 3, when studying the evolution of the system, it is necessary to get rid of the variable that has the smallest influence. Having a three-dimensional surface that is a function of three variables - flows that are significant in the time period under consideration, we determine the flow that is dominant in the given time period [2; 6; 15; 16].

In addition, by entering the function, the change in the rate of return at time t will be:

$$V(X_i^{(t)}) = \sum_{i=1}^4 X_i^{(t)} p_{X_i^{(t)}} - V(X_i^{(t-\tau)}) \quad (2)$$

On the basis of the given dependence of the change in the degree of profitability, we determine the influence of the flow, which is included in the consideration of the phase portrait, on the profitability [2; 6; 11; 14; 16]. This makes it possible to have information about the capital deficit, which does not allow to increase the rate of profit growth [11].

Having information that is determined by dependencies (1) and (2), it is possible to build a flow dynamics control function to determine profit growth strategies within a certain period of time [11; 25].

3. Construction of business process flow dependencies for information and communication services enterprises

In our work, we have developed models to establish flow dependencies related to profit for information and communication services enterprises. The information and communication services market in Ukraine is represented by companies such as Private Joint Stock Company «Kyivstar,» Private Joint Stock Company «VF Ukraine» («Vodafone»), Limited Liability Company «Lifecell,» Joint Stock Company «Ukrtelecom,» and other providers. These enterprises are part of international

companies that offer a range of services, including FMC (convergence of mobile and fixed communication), digital solutions like Big Data, industrial IoT, cloud services, mobile financial services, and the sale of equipment and accessories.

Modeling of the integrative development of the material flow (X_1), financial flow (X_2), innovation and intellectual flow (X_3) and information and marketing flow (X_4), their interrelationship and the impact of development on the rate of change in profitability was carried out in the Mathcad system (Figure 2)

The simulation results revealed the dependence of achieving positive outcomes, given the virtually homogeneous business environment, on the configuration of the constructs of financial (FF), material (MF), innovation and intellectual (IIF), and information and marketing flows (IMF). The results of modulating the efficiency of integrative flow development are summarized in Table 1..

Figure 3 presents a map of the results from modeling the integrative development of flows in information and communication services enterprises.

Therefore, at PJSC «Kyivstar,» the results of the modeling indicated that the financial flow was dominant during the studied period. In contrast, at PJSC «Vodafone» and LLC «Lifecell,» both the financial and innovation and intellectual flows were identified as dominant.

The conducted studies demonstrated that the integrative development of material, financial, innovation and intellectual, and information and marketing flows stimulates an increase in profits and overall efficiency for information and communication services enterprises. Conversely, a low level of flow integration leads to a slowdown in profit growth and, consequently, a reduction in enterprise efficiency.

4. Vectors of management of integrative development of enterprises of information and communication services

Based on the assessment of integrative development using the principles of the encapsulated approach, the modeling

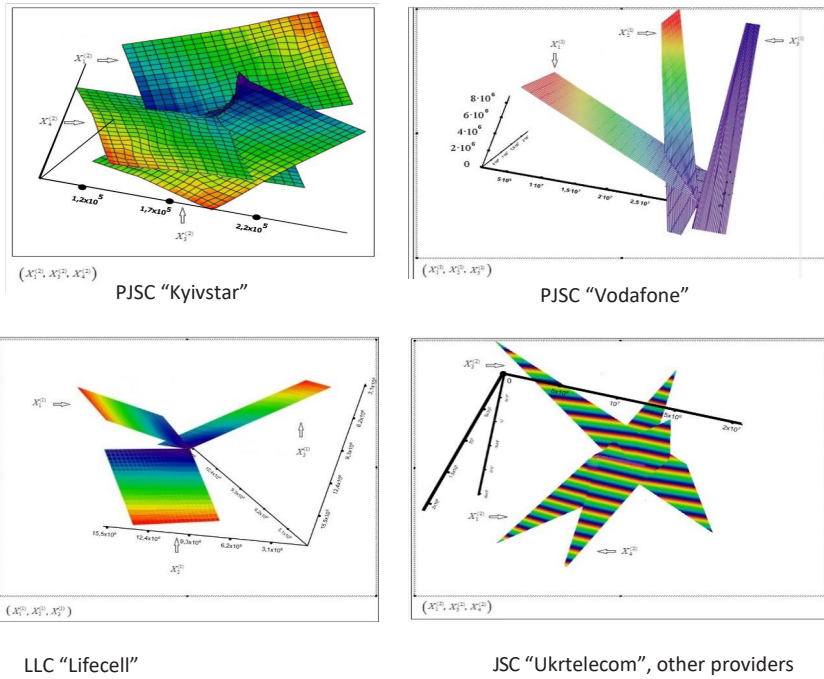


Fig. 2. Interrelation between the configuration of financial (FF), material (MF), innovation and intellectual (IIF), information and marketing (IMF) flows.
 Source: developed by the authors

Table 1

The effectiveness of the integrative development of flows in information and communication services enterprises

Period	Information and communication services enterprises			
	PJSC "Kyivstar"	PJSC "Vodafone"	LLC "Lifecell"	JSC "Ukrtelecom", other providers
1st semester 2019	Dominance IIF	Dominance FF	Dominance FF	Dominance IMF
Influx on efficiency (Influx of activity)	Development of IIF (directly proportional deposit)	Increase MF & FF & IIF Integrative development of MP & FP & IIP – Increase in profit	Increase in MF & FF & IIF Integrative development of MP & FP & IIP – Increased profit	Increased profit
2- d semester 2019	Dominance MF	Dominance IIF	Dominance IIF	Dominance FF
Influx on efficiency (Influx of activity)	Reduced IMF & IIF Reduced integration of flows - Increased Income	Increased MF & IIF & IMF Integrative development of MF & IIF & IMF – Increased Profit	Increase of MF & IMF Integrative development of MF & IMF - Increased Profit	Reduced profit
1st semester 2020	Dominance FF & IIF	Dominance FF & IIF	Dominance IIF	Stochastic dominance of flows
Influx on efficiency (Influx of activity)	Integrative development of FF & IIF - Increase of Profit Increase MF & FF & IIF Integrative development of MF & FF & IIF – Increase of Profit	Increase of IIF & FF Integrative development of IIF & FF – Increase in Profit	Increase MF & FF & IIF Integrative development of MF & FF & IIF – Increase of Profit	Reduced profit

End of the table 1

Period	Information and communication services enterprises			
	PJSC “Kyivstar”	PJSC “Vodafone”	LLC “Lifecell”	JSC “Ukrtelecom”, other providers
2-d semester 2020	Dominance FF	Dominance FF	Dominance FF	Stochastic dominance of flows
Influx on efficiency (Influx of activity)	Slowdown in the development (decrease) of IIF - decrease in Profit	Decrease in MF&FF&IMF - decrease in Profit	Increase MF&FF&IIF Low integration MF&FF&IIF slowing down of development and efficiency	Reduced profit
1st semester 2021	Dominance FP	Dominance MF	Dominance IIF	Stochastic dominance of flows
Influx on efficiency (Influx of activity)	Decrease in IIF - Decrease in profit Integrative development of MF & FF -Increase in Profit	Increase of MF-unstable efficiency	Increase MF& IMP &IIF Integration of MF& IMF &IIF Increase in Profit	Reduced profit

Source: developed by the authors

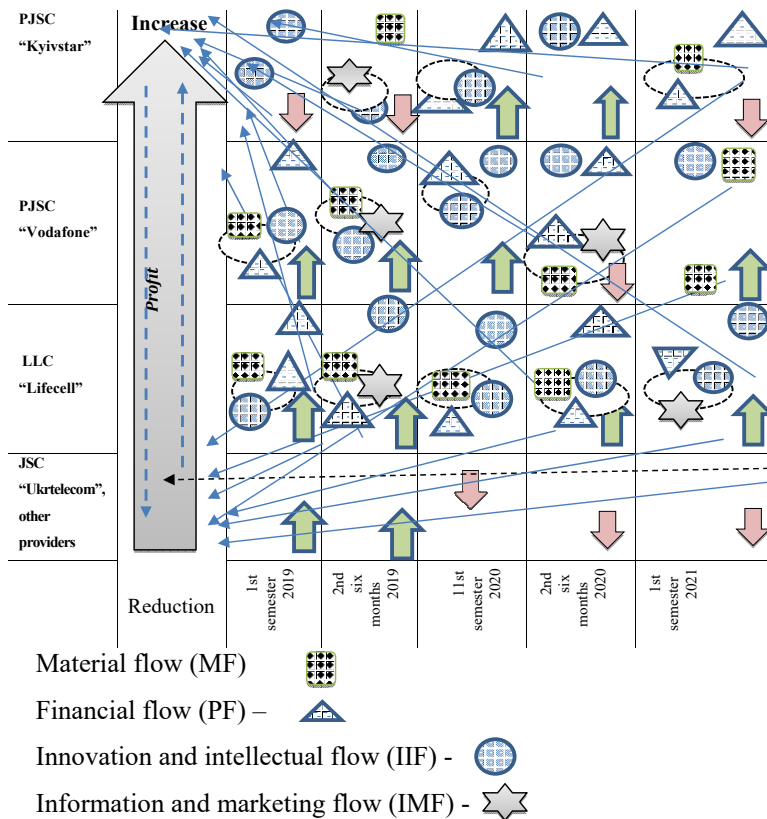


Fig. 3. Map of the results from modeling the integrative development of flows in information and communication services enterprises

Source: developed by the authors

of various integrations of financial, material, innovation and intellectual, and information and marketing flows, as well as the constructed map of integrative flow development at information and communication services enterprises, the influence of these flows on performance outcomes was determined. The integral values of the level of integrative development for these enterprises were calculated, and a summary of the results is presented in Table 2.

The integral assessment was based on assigning weights to each indicator across all analyzed flows – financial, material, innovation and intellectual, and information and marketing. For the studied enterprises, the degrees of importance for managing integrative development were established heuristically.

The integral indices for managing the integrative development of enterprises take into account the level of correspondence between the actual and reference (forecast) values of the indicators (S_{ij}). At the same time, the degrees of importance for achieving the planned result of each indicator for the investigated enterprise (d_{ij}) were also taken into account. The calculation of integral general indices for each flow: financial (MF), material (MF), innovation and intellectual (IIF), and innovation and marketing (IMF) was determined according to the following formula:

$$I_j = \frac{\sum_{i=1}^n (S_{ij} \times d_{ij})}{\sum_{i=1}^n d_{ij}} \quad (3)$$

Similarly, with the help of weighted average, the values of the general integral indices of the management of integrative development for each enterprise were determined.

In order to determine the quality of the obtained general integral indicator of the management of the integrative development of enterprises, a scale of its evaluation was developed. The determined step of the interval of values of the integral indicator was obtained by the formula:

$$Y = (I_{i \max} - I_{i \min}) / (1 + 3,32 \times \log(4)) \quad (4)$$

Where, $I_{i \max}, I_{i \min}$ – are the maximum and minimum value of integral indicators by components.

The developed scale for assessing the general integral indicator of managing the integrative development of enterprises serves as the foundation for determining the vectors of integrative development management. It also acts as a framework for creating digital strategic partnerships. Building on this concept, and based on heuristic research methods, we propose the introduction of a progressive scale for evaluating an enterprise's performance. This scale is dependent on the modeling of

Table 2

Integral indices of integrative development for information and communication services enterprises

Enterprises	Integral Index of Integrative Development	Level of Integrative development of the Enterprise	Integrative development management vector
PJSC “Kyivstar”	0,86	high	proactive
PJSC “Vodafone”	0,71	sufficient	constant
LLC “Lifecell”	0,42	moderate	focused
JSC “Ukrtelecom»	0,25	low	passive
ICT service providers Kolo. TB, Volya, MIT, Lanet, Vega, UTELS, Nashnet	0,12	low	passive

Source: developed by the authors

structural configurations, specifically their dominance, and the flows structured by the author. The goal is to provide the enterprise with favorable conditions for integrative development while maximizing profit:

1.00 - 0.80 – high level of integrative development;

0.79 - 0.60 – sufficient level of integrative development;

0.59 - 0.30 – a moderate level of integrative development;

0.29 - 0.10 - low level of integrative development.

A low level of development is focused only on separate processes or links of management of material or financial flows. Therefore, the management's focus on separate processes of one or two streams does not provide a balanced system result regarding the enterprise's activities and is unable to obtain the expected effect of functioning.

At a low level of integrative development (0.10 - 0.29), information and communication services enterprises are represented by individual scattered players on the information and communication market. Such enterprises include individual providers that provide information and communication services to enterprises and the population. Their activity is not aimed at the formation of progressive forms of integration, the basis of their functioning is to obtain profits and consolidate existing positions on the market.

A moderate level of development covers only part of the processes of innovation and intellectual or information and marketing flows and the emphasis is placed on partially material and financial flows. At a moderate level of integrative development (0.30 - 0.59), information and communication services enterprises have focused integration. These enterprises are focused on building digital strategic partnerships and are in the stage of finding partners to create effective integrations in order to expand their market niche and reach a new high-quality level of functioning, that is, they have a focused management of integrative development of activities.

Sufficient level of development of the enterprise involves some introduction of innovation and intellectual and information

and marketing flows, but more attention is paid to the financial flow.

At a sufficient level of integrative development (0.60 - 0.79), information and communication services enterprises implement a management strategy of sustainable integrative development. Such integrative development is implemented at enterprises that strive for a long-term strong competitive position in the market. Sustainable integration involves the formation of sustainable and effective digital strategic partnerships to expand the existing network and organize new areas of activity. Sustainable integrative development is a progressive system-process business organization aimed at the prospect of introducing innovative solutions and technologies into economic activity.

At a high level of enterprise development, a combination of innovation and intellectual and information and marketing flows is expected to lead to their dominance in the process of integrative development. At a high level of integrative development (0.80 - 1.00), information and communication services enterprises implement a proactive strategy of integrative development. This development of the enterprise is an innovative strategy of global integration into the international digital society. Proactive integration provides information and communication enterprises with a new high-quality level of functioning and contributes to consolidation of leading positions on the market.

It is worth noting that the ICT service providers studied in this paper – namely Kolo. TB, Volia, MIIT, Lanet, Vega, UTELS, and Nashnet – do not exhibit signs of integrative development, nor do they demonstrate partnerships aimed at creating unified digital platforms. In contrast, JSC “Ukrtelecom” shows signs of a low level of integrative development. As a result, these enterprises engage in passive management of integrative development.

A detailed diagnosis of the integrative development of the studied information and communication services enterprises, using the proposed encapsulated approach and modeling of their integrative development processes, has contributed to the selection of management vectors for the integrative development of these enterprises (Figure 4).

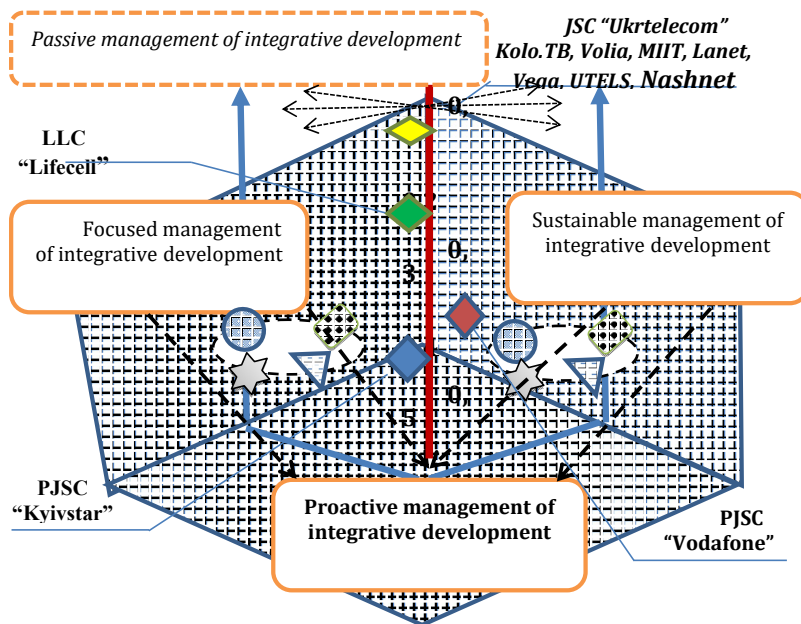


Fig.4. Management vectors for the integrative development of information and communication services enterprises

Source: developed by the authors

The graphic representation of the summarized results from the diagnostics of integrative development for the information and communication services enterprises—PJSC «Kyivstar», PJSC «Vodafone», and LLC «Lifecell» – reveals the following: PJSC «Kyivstar» exhibits proactive integrative development, PJSC «Vodafone» demonstrates stable integrative development, and LLC «Lifecell» is characterized by focused integrative development. In contrast, JSC «Ukrtelecom» and ICT service providers such as Kolo.TB, Volia, MIIT, Lanet, Vega, UTELS, and Nashnet show a low level of integrative development. These companies are unable to fully engage in integrative development due to passive management approaches.

Conclusions. In the context of globalization and digitalization, the information and communication sector is one of the most promising, as it provides the population with essential services, including communication and internet access. However, crisis conditions necessitate the transformation of the entire system of economic activity, particularly in

energy-dependent sectors. The key strategic direction for development is the creation of an adaptive, diversified, and integrative system of information and communication services.

The development of information and communication services enterprises in Ukraine holds strategic importance for the complementary growth of all sectors of the Ukrainian economy and serves as a platform to boost and elevate proactive business segments. An analysis of empirical data revealed that, although the rate of digitalization in Ukraine lags behind European and leading countries, domestic information and communication services enterprises show positive performance trends. This indicates a stable, positive trajectory in the development of Ukraine's information and communication sector.

The study demonstrates that the selected theoretical constructs—the process approach to quality management, the general systems theory, the theories of competitive advantages and innovations, and the analysis of «Process mining» technology—allow digital business processes to be represented

as a comprehensive system that can be effectively managed using modern digital technologies.

The ongoing process of global digitalization requires flexible management of business processes, adjustments to business models, and timely decision-making through the use of modern information technologies, such as «Process mining.» In this context, the study proposes the application of an encapsulated approach to the digitization of business processes, based on flow indicators. This approach provides a platform for analyzing current states and enables the adjustment of business process management to achieve maximum efficiency.

A detailed study of the selected key business process flows in information and communication enterprises—material, innovation and intellectual, information and marketing, and financial—revealed that management efficiency and the achievement of positive results depend on the synchronization of these flows, with potential temporary variations in the dynamics of investment in a particular flow. The mathematical model created for calculating profitability in the dynamics of

investment flows was tested using data from the information and communication services enterprises «Kyivstar,» «Vodafone,» and «Lifecell» for the period 2018-2021. This analysis allowed for the identification of the most influential flows by year and the detection of patterns in leadership shifts, depending on the influence of external factors and internal organizational conditions.

Mathematical modeling identified the dominant flows – financial and innovation and intellectual – highlighting the need for systematic, balanced management of the enterprise’s business processes in response to the changing external environment.

The results of modeling the integrative development processes of enterprises revealed that achieving positive outcomes, in a virtually homogeneous business environment, depends on the configuration of financial, material, innovation and intellectual, and information and marketing flows. This insight enabled the proposal of management vectors for the integrative development of information and communication services enterprises, which include passive, focused, sustainable, and proactive integrative development.

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MODELING OF BUSINESS PROCESSES FOR MANAGING INTEGRATIVE DIGITAL DEVELOPMENT OF ENTERPRISES

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It has been proven that the development of information and communication services enterprises is of strategic importance for the complementary growth of all sectors of the Ukrainian economy and serves as a platform for boosting and advancing proactive business segments overall.

The fundamental methods for modeling business process flows using mathematical and analytical tools, specifically a system of differential equations with defined initial conditions, have been substantiated, enabling the integral assessment of enterprise business process modeling. A capsulated approach to the digitalization of business processes and a comparative analysis of a broad range of financial and economic indicators for comprehensive diagnostics of integrative enterprise development effectiveness were applied, allowing for the determination of a probable development scenario for enterprises in the future.

The key flows of enterprise business processes have been identified: material, innovative-intellectual, information-marketing, and financial. The dependence of management efficiency and the achievement of positive outcomes on the synchronization of these flows has been revealed, taking into account possible temporary variations in the investment dynamics of each flow.

The mathematical model for calculating profitability was tested using data from the information and communication companies PJSC «Kyivstar», PJSC «Vodafone», and LLC «Lifecell». This

approach enabled the identification of the most influential streams by year and revealed patterns of leadership changes based on the impact of external environmental factors and internal organizational conditions.

The dependence of achieving positive results on the configuration of financial, material, innovative and intellectual, and information and marketing flows has been identified. This analysis allowed for the proposal of management vectors for managing the integrative development of information and communication services enterprises: passive, focused, sustainable and proactive integrative development.

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