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THE ROLE OF INFORMATION MANAGEMENT SYSTEMS IN THE IMPLEMENTATION OF THE DIGITAL ECONOMY DEVELOPMENT STRATEGY

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ABSTRACT

Purpose: The aim of this study is to demonstrate the role that management information systems can play in developing the digital economy.

Theoretical framework. The theory of optimal discrete-continuous control, the principles of Pontryagin, Bellman and Markov and the theory of the development of digital interactions were used.

Design/methodology/approach: The systematic literature review was built from the content analysis of papers from the Web of Science and Scopus database. The papers were analyzed from descriptive, bibliographic, methodological, results and citation characteristics.

Findings: From the results, it was noted that Russia is the absolute position in studies related to digital economies and the role that management information systems can play in developing and achieving strategic development, growth and efficiency.

Research, Practical & Social implications: Many more publications could not be included for generalisation reasons because the study included data from two databases. Additionally, our research shows that there aren't many journals that have written about cause-related digital economy.

Originality/value. A model of digital control and development of digital interactions has been proposed and investigated, which takes into account the influence of the "white noise" effect in the system.

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O PAPEL DOS SISTEMAS DE GESTÃO DA INFORMAÇÃO NA IMPLEMENTAÇÃO DA ESTRATÉGIA DE DESENVOLVIMENTO DA ECONOMIA DIGITAL

RESUMEN

Objetivo: O objetivo deste estudo é demonstrar o papel que os sistemas de informação de gestão podem desempenhar no desenvolvimento da economia digital.

Base teórica: Foram utilizados a teoria do controle ótimo discreto-contínuo, os princípios de Pontryagin, Bellman e Markov e a teoria do desenvolvimento de interações digitais.

Desenho/metodologia/abordagem: A revisão sistemática da literatura foi construída a partir da análise de conteúdo de artigos da base de dados Web of Science e Scopus. Os artigos foram analisados a partir de características descritivas, bibliográficas, metodológicas, resultados e citações.

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Resultados: A partir dos resultados, observou-se que a Rússia é a posição absoluta nos estudos relacionados às economias digitais e ao papel que os sistemas de informação gerencial podem desempenhar no desenvolvimento e na obtenção de desenvolvimento estratégico, crescimento e eficiência.
Originalidade/valor: Foi proposto e investigado um modelo de controle digital e desenvolvimento de interações digitais, que leva em consideração a influência do efeito "ruído branco" no Sistema.

Palavras-chave: Sistemas de Informação, Gestão, Estratégia, Economia Digital, Processos de Negócio.

EL PAPEL DE LOS SISTEMAS DE GESTIÓN DE LA INFORMACIÓN EN LA IMPLEMENTACIÓN DE LA ESTRATEGIA DE DESARROLLO DE LA ECONOMÍA DIGITAL

RESUMEN
Propósito: El propósito de este estudio es demostrar el papel que pueden desempeñar los sistemas de información gerencial en el desarrollo de la economía digital.
Base teórica: Se utilizó la teoría del control óptimo discreto-continuo, los principios de Pontryagin, Bellman y Markov y la teoría del desarrollo de las interacciones digitales.
Diseño/metodología/aproximación: La revisión sistemática de la literatura se construyó a partir del análisis de contenido de artículos de la base de datos Web of Science y Scopus. Los artículos fueron analizados en base a características descriptivas, bibliográficas, metodológicas, resultados y citas.
Resultados: A partir de los resultados, se observó que Rusia ocupa la posición absoluta en los estudios relacionados con las economías digitales y el papel que pueden desempeñar los sistemas de información de gestión en el desarrollo y logro del desarrollo estratégico, el crecimiento y la eficiencia.
Originalidad/valor: Se propuso e investigó un modelo de control digital y desarrollo de interacciones digitales, que tiene en cuenta la influencia del efecto “ruido blanco” en el Sistema.

Palabras clave: Sistemas de Información, Gestión, Estrategia, Economía Digital, Procesos de Negocio.

INTRODUCTION

A strategically developing economy needs adequate support for management information systems. Control systems have gone from autonomous subsystems to an IT environment. Such ecosystems are based on innovative and intelligent potential, use the principle of space-time independence and scalability of processes and communications.

Digital transformations are aimed primarily at the formation and expansion of markets, promising and adaptive economic business models. They determine the competitive rating of enterprises and companies and the vector of market evolution.

The article conducted a systematic analysis of the purpose, role and objectives of information (innovative and intelligent) systems in the implementation of strategic management in the digital economy.

Mathematical and infological models of control are proposed and investigated.

LITERATURE REVIEW

The role of information and intelligent control systems of the digital economy, especially the B2B, B2C class, is growing.

"Manageability" is an ambiguous category. In the article, we understand it as a process that ensures the required accuracy, efficiency of the system response in response to control actions from a given control space with a minimum time (cost) of selecting a control action.

Relevant for the management and implementation of the digital economic development strategy are, in particular, the following tasks:

1) Creation and use of digital profiles and "digital counterparts" (business processes, customers, stakeholders, etc.);

2) Improving the digital environment, digital services, creating an evolutionary infrastructure for providing services in real time;

3) Intelligent and digital support of the control system in conditions of uncertainty and multifactoriness;

4) Development of a centralized platform for monitoring and analytics, monetization and improving the level of business culture.

Innovation and digital ecosystems create innovative competencies, intellectual and human potentials of society's economic structures. They allow you to effectively apply cash resources and promising tasks.

In the context of intense digital transformations, strategic goals, key elements, processes and subsystems aimed at generating and diffusing innovations can be distinguished in the Russian economy.

Digital transformation in the economy requires the development of an adaptive strategy to support the competitiveness of the national economy. This is a triune problem that unites the tasks of developing digital ecosystems, setting and solving new digital problems and educating new "digital" consumers.

In Russia, there are appropriate plans and programs, state, public-private, corporate and public measures to support transformations are applied. Especially in small business, to support startups. Including, using:

1) Tax relief for the business entity;

2) Procurement of finished digital products and solutions in the public sector ("e-government", etc.);

3) Providing broadband access, 5G networks;

4) Changes in regulatory regulation;

5) Creation of infrastructure and industry digital platforms, pilot projects, in particular, such as "smart, lean production";

6) Stimulating investment and innovation activity;

7) Big Data, Data Analytics, Machine Learning, Artificial Intelligence, Data Mining, etc.

Digital transformation promotes digital reengineering of the economy's infrastructure.

Researchers define the digital economy in different ways, for example, as a virtual environment (augmented reality) (Ivanov and Malinetsky, 2017), a socio-economic phenomenon (Pozovikhina, 2018) or the use of digital technologies in the real economy and business (Gromov, 2018), including both crowd models (Kaziev and Kazieva, 2019) and the systemic innovation potential of the region (Naumenko and Nesterenko, 2019).

The potential of digital transformations is formed by the massive application of digital transformations (technologies) (Panshin, 2019) to optimize and support processes (especially management), resources. But, most importantly, support for the tasks being solved in the economy, society and the growth of the competencies of the manufacturer and consumer, i.e. the entire ecosystem hierarchy. Not excluding participation in the socio-political life of the country (Al-Hasan and Khalil, 2021), (Eubank and Grossman, 2021).

MATERIAL AND METHODOLOGY

The Digital Methodology (Paradigm) of the Modern Economic System is Defined and Stimulated Follow Processes:

1) The pace of implementation of new digital capabilities and adaptability to the environment by the system;

2) Simplifying, accelerating and reducing the cost of monitoring and updating big data;

3) Personalization of requests, needs and proposals;

4) Growth of target audience and diversity of digital channels;

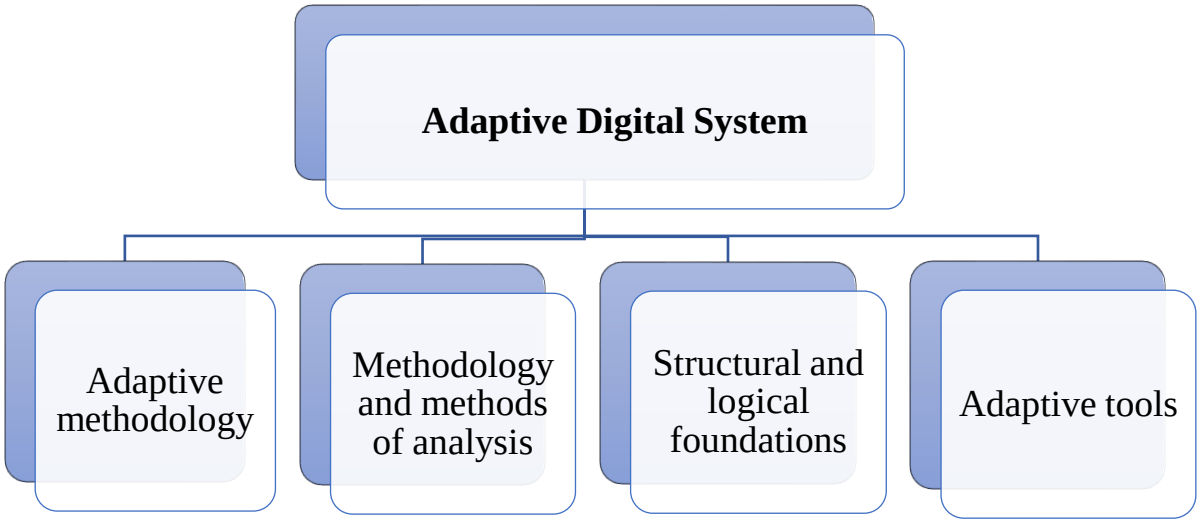
5) Efficiency of socio-economic communications and digital platforms;

6) Crowding out extra links and creating new mechanisms for market cooperation through digital organizational procedures.

Figure (1) shows the methodological diagram of the adaptive digital economic system.

An adaptive system is inherent in self-organization with its attribute - controllability (self-regulation). Self-developing adaptive systems are inherent in invariance, which allows you to reduce the measure of system complexity.

Figure 1. Methodological scheme of adaptive digital transformations



Source: Prepared by the authors (2023).

The work uses system analysis-synthesis, as well as mathematical and info logical modeling, statistical analysis, multidimensional classification, etc.

RESULTS AND DISCUSSION

1. Digital activity of managers and its system goals, tasks and functions

In the digital economy, activity is stimulated by digital relations of production, trade and communications, the formation of hybrid forms, for example, production (Eriashvili, Ivanova and Radchenko, 2021).

The manager's participation in network interactions takes place at various sites, services (digital participating platforms). Digital management is distinguished by cooperation with institutional structures. Interactions are aimed at improving manageability, the role of management, digital resources.

The degree of economic activity is determined by the model of economic relations used and the possibilities of their activation. Activity is "digitalized", personified, becomes effective. Digital promotions and online participation stimulate activity outside the network (Menteş, 2019).

The competencies of the manager to solve innovative tasks include:

1) Openness to new;

2) The ability to look for alternative solutions;

3) System analysis of the problem;

4) The ability to respond promptly to a changing environment;

5) Creative management unity to solve the problem, etc.

The competencies of the manager, the intellectual capital of the system contribute to the formalization, intellectualization of the entire digital ecosystem.

2. Digital Production and the Role of Lean-Agile Personnel in the Implementation of the Digital Economy Development Strategy

Digital manufacturing is a business concept focused on maximizing the consideration of digital opportunity and consumer value when creating a product. At all stages of its life cycle, with the constant involvement of personnel in digital transformations. The principle is as follows: "from motivation, support for effective (effective) performers from above" to "stimulating the initiative and support for effective solutions from below".

We need workers – team leaders, generators of ideas, capable of cognitive and creative methods to control their behavior.

Lean uses leader-manager training to support ideas and solutions:

1) Quality management;

2) Standardization and certification;

3) Increasing the value of the product, solution, company;

4) Development and analysis of the "target tree";

5) Organizational strategies and communications;

6) Digital innovation;

7) Career planning, etc.

To assess the manager's potential, use transition matrices (risks, changes, training, response, recovery, etc.).

Personnel management is the primary task of management, the most important resource of the company (Sannikova, 2017). Especially during periods of crisis, "remote work", reengineering and restructuring of communications. The HR department should be relevant in assessing the creative contribution and abilities of each employee in creating values, an innovative product, and making decisions "on the spot".

Assessing the effectiveness of personnel requires effective tools that are consistent with the levels of work and professionalism of employees, as well as with their evolutionary potential and digital goals relevant to this potential. The goals are different, for example, the correspondence of the position, increasing the contribution to the value and efficiency of work, increasing motivation, improving feedback, reducing the subjectivity of assessments, etc. The

estimates themselves are extracted from accounting data, statistical reporting, primary and design documentation, monitoring and audit, etc.

Lean-Agile leadership is a new formation of manufacturing relationships and lean manufacturing based on HR management. The key task of the company's management was to manage the leadership qualities of personnel, to create a whole system focused on improving quality and reducing losses. (Shakatreh, Mansour and Alatyat, 2022)

Lean manufacturing is a complex of principles-methods of efficient production, focused on continuous improvement of quality and economy. Agile is a collaborative approach of development leaders (e.g. software). It builds the value of development with self-organizing teams. Agile paradigm is used in many different areas.

We will formulate HR-qualities of Lean management leadership:

1) Organizational capacity;

2) influence on the consumer, personnel;

3) Controlled and teamwork;

4) Rationality, accuracy, mobility and efficiency of control;

5) Management of consciousness and responsibility;

6) Social orientation and simplicity of positions;

7) Emotional and psychological community of personnel;

8) Education of a culture of constant improvement, etc.

In the digital environment, each employee will be able to perform leadership functions (planning, standardization, motivation, control, etc.), participate in various teams (projects), both as an executor and leader, an expert.

We will indicate the main qualities of the leaders-managers of the digital economy:

1) Intellectuality and consistency;

2) Initiative, responsibility and self-improvement;

3) Taking into account the needs of the team and the uncertainties of the environment;

4) Efficient and creative, cognitive project management;

5) Ecological approach, etc.

Motivation and an innovative approach are the main factors of the employee's labor orientation, especially the manager. These and other factors are stimulated not only by material (according to labor achievements in the team), but also by intangible (in fairness) approaches. (Mark, 2021)

3. Monitoring and Discrete Optimum Control of Digital Business Processes

The problem of optimum control of an economic system and the business processes happening in her is unsolvable if there are no data of monitoring of a system (process). As a rule, with a priori the set tool accuracy and "power". Similar problems are solved with using of optimum control, for example, across methods of Lyapunov, Pontryagin or Bellman.

For example, stability is determined by complexity concerning a set of admissible decisions and deviations of $E = \{\varepsilon: \varepsilon \to \varepsilon_0\}$. It's so-called ε-stability, option with stability assessment:

$$\rho(y_1, y_2) = \sup_{0 \le t \le T} |y_1(t) - y_2(t)|.$$

We will consider a problem of optimum control in relation to optimizing digital interactions, for example, of management and monitoring.

Except stochastic influences of factors, an environment and "white noise", the complexity of a task is defined also by degree of coherence, self-organization of a system.

Defined control of a condition of digital infrastructure (cluster of elements) is made in knots of monitoring. Then it's possible to consider a vector

$$x_k = (x_{k1}, x_{k2}, \dots, x_{kn});$$
$$k = 1,2, \dots, m,$$

Which determines the maximum allowed errors in node k by set of the considered parameters i.

Our hypothesis of modeling: during a step of a response observation, errors dynamically increase (don't decrease).

Within the accepted hypothesis dynamics of changes of a possible maximum error can be described differential ratios:

$$x_{jk}(t+1) = x_{jk}(t) + |\Delta a_{jk}(t)| + \theta\left(v_{jk}(t)\right)(\delta(v_{jk}(t) - |\Delta a_{jk}(t)| - x_{jk}(t),$$
$$k = 1,2, \dots, n;$$
$$j = 1,2, \dots, m;$$
$$t = 0,1, \dots, T-1,$$

Where $\Delta a_{jk}(t)$ is increment of j of parameter in k knot for a step from t to $t+1$, v_{jk} is option of monitoring, measurement of parameter j in node k in time-point of t, $\delta(v_{jk}(t))$ is an error for v_{jk}:

$$\theta\left(v_{jk}(t)\right) = \begin{cases} 0, v_{jk}(t) = 0; \\ 1, v_{jk}(t) \neq 0. \end{cases}$$

If the cost (costs of measurement) of option $v_{jk}(t)$ is equal to $s(v_{jk}(t))$, then on implementation of all monitoring procedure of expense will make:

$$S = \sum_{k=1}^{n} \sum_{j=1}^{m} \sum_{t=0}^{T-1} s(v_{jk}(t)).$$

The optimizing task of management of things in a digital economic system can be formulated so:

$$S \Rightarrow min,$$
$$0 \leq v_{jk}(t) \leq n_j;$$
$$0 \leq x_{jk}(t+1) \leq \varepsilon_j;$$
$$k = 1,2, \dots, n;$$
$$j = 1,2, \dots, m;$$
$$i = 0,1, \dots, T-1,$$

Where n_j; quantity of various (used) measurement is options, and ε_j is the set measurement accuracy threshold for parameter j.

In such general statement a task difficult solvable. Because of multidimensionality, jumps gaps, complexity of monitoring and uncertainty of determinants indicators of innovative development (Falko and Somina, 2022). Not so representative statistics (Budnikova and Kiryukhina, 2021) also.

We will specify a modeling hypothesis:

1) Measurements in various knots are independent, for example, they are made in the real mode, at the same time;

2) Measurements of parameters of a state are also independent.

Then the task becomes simpler, and the optimizing task is approximated by consistently solvable problems of a look:

$$\sum_{t=0}^{T-1} s(v(t)) \Rightarrow min,$$

$$0 \le v(t) \le V;$$

$$0 \le x(t+1) \le \varepsilon,$$

$$i = 0,1,\dots,T-1,$$

$$x(t+1) = x(t) + |\Delta a(t)| + g\big(t; b, v(t)\big)\big(\delta\big(v(t)\big) - x(t) - |\Delta a(t)|\big).$$

Function g is approximated by a polynomial with any set accuracy (Shilov, 1961) functions $g(t; b, v) \in C^{\infty}(0; T)$ look:

$$g(t; b, v) = 1 - \begin{cases} \exp(bv^2(t)/(v^2(t) - 1)), & v(t) < 1; \\ 0, & v(t) \ge 1. \end{cases}$$

If to present by means of final and differential discrete-time operator L of increment:

$$\Delta a_{jk}(t) = L_{jk} = a_{jk}(t+1) - a_{jk}(t),$$

$$i = 0,1,\dots,T-1,$$

That it's possible to consider a linear form

$$y(t) = \sum_{j=1}^{l} \alpha_j(t) x_j(t),$$

yt

Exit of *y (t)* for entrances

$$x(t) = \big(x_1(t), x_2(t), \dots, x_l(t)\big)$$

With the coefficients of influence of each of them equal $\alpha_j(t),\ j = 1,2, \dots l.$

These coefficients are set heuristically or identified, for example, by method of maximum likelihood. In the determined case – from a condition of a minimum of functionality of a method of the least squares method.

As a discussion of the results, consider the role of Lean-Agile staff and their career advancement within the paradigm of digital economy and digital lean manufacturing processes.

The success of the manager is determined by his abilities and performance, for example, the abilities to urgently intervene in the management process, accelerating the solution of the problem. Innovative ("digital") management principles are used – "from results to processes", "from team management to its training, support", "and sustainable development is an evolution in the approaches and actions of personnel".

By modeling situational behavior, management can develop the corporate culture needed for Lean-Agile approaches, models and experiences.

As an example, we will point out SAFe (Scaled Agile Framework) – a framework for flexible software development that allows you to use Agile methodologies in large teams (10-50 people). The main emphasis is made on the consistency, quality, transparency and feasibility of the program.

Leader behavior is decisive in communications, accents of these values (cases).

Consistency is the basis of the strategy of the SAFe portfolio (a set of programs provided by the company's budget) and the concept of decision-making or planning. Quality is based on refusal to accept/supply a low-quality product, commitment to quality and coherence of work. Transparency – responsibility for inconsistencies, creating an environment with transparent facts, processes. Feasibility – planning and accounting for business values, balance of volumes and resources.

SAFe relies on systems analysis, Lean-Agile and DevOps, but at the same time guarantees a steady increase in business flexibility with the full activity of managers, leaders who form rational (optimal) ways to implement ideas and processes.

The team in SAFe is cross-functional, with all the competencies that are required for software development, from specifications to implementation. SAFe is provided by a single portfolio management office as part of a single development, investment and budgeting strategy.

CONCLUSIONS

With the help of digital ecosystems, the consumer is organized, activated, contributes to efficient and distributed traffic, processing of data flows. It's important to use the most efficient business model. For example, using a C2C class model forms and strengthens feedbacks.

From a theoretical standpoint, in the study of digital processes, in particular, monitoring and control, Markov circuits, transient probability matrices can be used. But practically assessing these probabilities is difficult: monitoring is not only complex, but also expensive, with possible loss of information and uncertainty at each transition.

The mathematical model proposed and studied by us will allow us to evaluate the control efficiency at the interval, during the observation (measurement) of the response, when the errors dynamically increase (don't decrease).

Neural networks and expert procedures for responding to digital risks and deviations from specifications are developing. Every vulnerability in the digital ecosystem will require analysis and accounting. The functionality of the monitoring system depends on the purpose, tasks and related technologies. The application of personnel monitoring can be included in personnel contracts as an addition.

Management is primarily interested in the dynamics of efficiency and approaches to improving the manageability of business processes. This increases the efficiency, coherence and security of business processes. In conditions where there are no clear prescriptions, there is a growing need for analytics ("shield" of business), as well as monitoring and situational modeling.

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