TECHNOLOGICAL THEORIES IN ECONOMICS AND MANAGEMENT: EVOLUTION AND APPLIED ASPECTS

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Abstract: The contemporary stage of social development is characterized by the widespread adoption of technologies that contribute to the effective advancement of business and the economy as a whole. The successful application of these technologies in economic and managerial practices necessitates an exploration of past ideas and experiences, which are subsequently to be theoretically conceptualized and enhanced. In this context, the objective of the current article is to trace the evolution of technological theories, pinpoint some unresolved issues, and emphasize the need for further investigation within the realm of managerial technologies. To achieve this objective, a retrospective examination of technological theories has been undertaken, analyzing fundamental theoretical and practical aspects of management technologies. As a result of this investigation, a shift has been identified from specialized towards comprehensive managerial technologies, the more significant characteristics have been systematized, and main elements and trends in modern managerial technologies have been analyzed.

Key words: technological theories, evolution, resource, management technologies

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1. Introduction

The historical evolution of technological theories in economics and management impacted the way societies and organizations approach the utilization of technology in their processes. A comprehensive grasp of the historical roots and evolutionary trajectory of technology theories holds vital significance in effectively maneuvering through contemporary business and economics. Modern society cannot be imagined without technologies that permeate all spheres of activity. The objects of technologization can encompass both instrumental and technical means and social, production and financial relations, and processes. Through the lens of technologization, the entire set of means for effective functioning utilized by society can be examined. Technologization becomes a means of risk reduction through predictability, standardization, and control over all social processes.

Scientific and practical interest in management technologies is driven by the increasing complexity and scale of management tools and the need for coherence among different management elements. Additionally, management technologies serve as an important reserve for enhancing the efficiency and quality of organizational management. Contemporary experts view management technologies as effective tools that enable the alignment of departments and employees towards achieving common goals. Management technologization can become not only the primary source of organizational competitive advantages but also a catalyst for the transition of management to a new level of development.

2. Methodology

The research is based on the historical evolution of technological theories in economics and management. The research scheme includes a chronological analysis of these theories. It is important to note that while the separate stages provide a research framework, the evolution of technological theories in economics and management is a complex and continuous process, with overlapping influences and ongoing developments in response to new technological advancements and societal changes.

In order to ensure a meticulous and all-encompassing analysis, a case study of Bain & Company (Bain & Company, 2015) was integrated. This consulting firm conducted a survey of over 13,000 companies spanning 70 countries across the globe, including North America, Europe, Asia, Africa, the

Middle East, and Latin America, to compile a thorough list of management technologies. Furthermore, Ukrainian researcher Veronika Verba presents the results of a survey conducted on executives and top-level managers from over 300 enterprises in her work (Verba, 2014).

Regarding the latest investigations, the study is based on the Gartner's analysis that identifies the revolutionized trends for 2023 (Gartner, 2023). According to it, we can observe how organizations can leverage contemporary technological theories within the digitalized prism of modernity.

3. Historical evolution

3.1. Early research

The historical evolution of technological theories in economics and management has been the subject of early research spanning several centuries. The necessity of management has been a concern since the dawn of civilization when agriculture and animal husbandry began to develop. With the emergence of the first states, the challenges of managing them became even more complex. Scholars and thinkers throughout history have grappled with understanding the principles and applications of technology in economic and managerial contexts. The great philosophers of Ancient Greece, such as Plato (428-377 BCE) and Aristotle (384-322 BCE), started to develop theories of managing the state. The earliest hints of management theory can be traced back to the ancient philosopher Diogenes (circa 400-325 BCE), who was the first-known professional in the field of management (Small, 1993).

During the Medieval and Renaissance Period (500 - 1500 CE), scholars focused on theories of labour, trade and commerce. Prominent works include Thomas Aquinas' "Summa Theologica," which addressed economic ethics, and the writings of Italian merchant Francesco Datini, who documented business practices of the time (Britannica), (Byrne & Congdon, 1999).

In the Early Modern Period (1500 - 1800 CE), the rise of mercantilism as an economic theory in the 16^{th} – 17^{th} century shaped early discussions on technology and trade (Gomes, 1987). Scholars like Jean-Baptiste Colbert (1619-1683) in France and Adam Smith (1723-1790) in Scotland explored concepts of wealth, trade, and productivity. Adam Smith's "The Wealth of Nations" is considered a seminal work in classical economics and addressed the role of technology in economic growth. The theory of state management

was also developed by Niccolò Machiavelli (1469-1527), Thomas Hobbes (1588-1679) and other philosophers and thinkers.

In the period of Industrial Revolution and Beyond (18th – 20th century), a significant shift in technological theories in economics and management was marked. Scholars like Karl Marx, Friedrich Engels and Max Weber examined the impact of industrialization, capitalism and technological advancements on the economy and society.

Scientific management principles introduced by F. W. Taylor and the emergence of neoclassical economics further contributed to the understanding of technology's role in production and management (Taylor, 2004), (Giannantonio & Hurley-Hanson, 2011).

The first explicit inquiry into the scientific approach to managing complex systems was initiated in the 1830s by André-Marie Ampère (Ampère, 1834). In constructing a classification of all possible sciences, including those that did not yet exist at that time, he established a specific discipline dedicated to managing the state and named it cybernetics. In doing so, he not only identified the appropriate place for cybernetics among other sciences but also emphasized its fundamental systemic characteristics. Later, another scholar, Polish philosopher B. Trentowski, aimed to establish the scientific foundations for the practical activities of a leader (a "cybernetic") (Vallée, 2009).

However, the society of the mid-19th century was not prepared to embrace cybernetic ideas. Initially, the science of management was not recognized as a separate field, but rather considered an art, a view that still persists to some extent. The era of precise methods in management theory came much later. The advent of precise methods in the field of control theory can be attributed to renowned scientists such as J.C. Maxwell (1831-1879), E. Routh (1831-1907), A. Hurwitz (1859-1919), A. Stodola (1859-1942), and others. These scholars ushered in an era of exact methods when there arose a need for providing accurate quantitative descriptions of processes occurring in automatic control systems – namely, technical systems that operate without human intervention.

Subsequently, control theory came to be regarded as an integral component of cybernetics.

As the field progressed, automatic control and regulation evolved into scientific disciplines and became a part of the curriculum at higher education institutions, primarily based on frequency-domain methods.

3.2. Late and current research

In the 20th century, economists and management theorists expanded upon earlier theories and introduced new perspectives on technology's impact on economic growth, innovation, and competitive advantage. Different evolutionary trajectories can be outlined here.

Technological Innovation and Economic Growth

In the neoclassical theory, technological progress is considered an exogenous factor that drives economic growth. This idea is embedded in the model proposed by R. Solow (Solow, 1956), but empirical tests refute it. In the quest to explain the discrepancy between the theoretical model and real-life circumstances, the endogenous growth theory emerges. For its development, significant importance lies in the contributions of P. Romer (Romer, 1986) and R. Lucas (Lucas, 1988), who argue that the growth of total production is primarily a function of internally economic and institutional factors. This theory asserts research and development, human capital, and knowledge diffusion as key drivers of long-term economic growth, supported by state economic policy.

Technological Change and Organizational Performance

One of the contingency theories suggests that the relationship between technology and organizational performance depends on the fit between the technological characteristics and the organizational structure and processes. This theory acknowledges that different technologies require different organizational approaches and that the effectiveness of technology adoption is contingent on organizational factors such as size, structure, and culture (Lenz, 1981).

Another example is the resource-based view of the firm (Wernerfelt, 1984), which emphasizes the role of technological capabilities and resources in achieving competitive advantage. This theory posits that firms with superior technological capabilities, such as advanced manufacturing processes or innovative product development, are more likely to outperform their competitors.

Since the late 20th century theories such as the dynamic capabilities perspective have emerged, focusing on the ability of organizations to adapt and harness technological change as a source of competitive advantage (Knudsen & Madsen, 2002). These theories recognize the importance of organizational learning, agility, and the ability to absorb and exploit new technologies for sustained performance.

More recently, the Resource-Based View (RBV) theory (Madhani, 2010) suggests that organizations can gain a competitive advantage by

leveraging their unique technological resources and capabilities. Over time, this theory has evolved to incorporate concepts such as dynamic capabilities and absorptive capacity, emphasizing the importance of an organization's ability to adapt and integrate new technologies to enhance performance.

Technological Disruption and Industry Dynamics

This trajectory of technological theories is in understanding the phenomenon of technological disruption and its effects on industry dynamics. It examines how theories have evolved to explain the emergence and impact of disruptive technologies on traditional industries. One notable example is Clayton Christensen's theory of disruptive innovation, which suggests that disruptive technologies can fundamentally alter industry landscapes, leading to the displacement of established companies by disruptive newcomers (Christensen et al., 2006). This theory has been further developed and refined to account for various industry contexts and dynamics, providing insights into how firms can respond and adapt to disruptive technologies.

Technology Adoption and Diffusion

Here we trace the development of these theories from early models such as Everett Rogers' Diffusion of Innovations theory to more recent frameworks that consider the role of social networks and contextual factors in shaping technology adoption. Thus, the Technology-Organization-Environment (TOE) framework incorporates technological, organizational, and environmental factors to explain the adoption and diffusion of innovations (Baker, 2012) (Awa, Ukoha, & Igwe, 2017). This framework has been widely applied to examine technology adoption in various industries, providing helpful data into the factors that influence the adoption and diffusion processes.

These evolutionary trajectories demonstrate how technological theories have developed and refined, improving our understanding of the complex interactions between technology, organizations, and economic outcomes.

The late 20th century witnessed a growing interest in the role of technology in economic and managerial contexts. Scholars such as Michael Porter and his work on competitive advantage (Porter, 2011), as well as Peter Drucker and his emphasis on innovation and knowledge management (Drucker, 2012), greatly influenced the understanding of technology's impact on organizational performance (Parwita et al., 2021). The issue of diffusion and the absorption and adoption of innovation has long been the subject of interest for many scientists, which is dictated by the great importance of the course of these processes for the broadly understood innovation of economies and enterprises themselves in an era of global crises (Niewczas-Dobrowolska, et al., 2024).

Nowadays, we can observe the emergence of digital technologies and the internet. The rapid advancement of digital technologies and the widespread adoption of the internet have greatly influenced both economics and management (Azimov & Petrova, 2022; Popova et al., 2022; Petrova et al., 2022; Jarmusevica et al, 2019). Research during this period focused on understanding the effects of these technologies on industries, business models, and consumer behavior (Malerba, 2007; Petrova & Tairov, 2022; Matyushenko et al, 2021; Górka-Chowaniec, 2017). Understanding the pace of change in thinking and consequently in contemporary consumer behavior can enable to cope with the volatile reality and properly recognize consumer preferences by adapting the architecture of the goods or services being sold to them (Górka-Chowaniec & Sikora, 2022). Topics such as e-commerce, digital marketing, and data analytics gained prominence (Khan, 2023).

The integration of artificial intelligence (AI) and machine learning (ML) has revolutionized the technological theories in economics and management. Researchers have explored the applications of AI and ML in areas such as predictive analytics, decision-making, and automation (Chalmers et al., 2021). This has led to the emergence of fields like business intelligence and data science.

With increasing concerns about environmental sustainability, researchers have focused on the integration of sustainable technologies and the principles of the circular economy (Stupnytskyi, 2023). Ul-Durar et al. highlighted the role of technology in achieving sustainable development goals and managing resources efficiently (Ul-Durar, Awan, Varma, Memon, & Mention, 2023) .

In the shape of future trends, current research is exploring cutting-edge technologies such as blockchain, Internet of Things (IoT), and quantum computing and their potential impact on economic and managerial theories (Younan et al., 2022). Additionally, according to Ross (Ross, 2023) interdisciplinary approaches, incorporating concepts from the fields of behavioral economics, psychology and sociology, are gaining traction to provide a more comprehensive understanding of technological theories in economics and management.

An analysis of civilizational changes demonstrates that technology has become a fundamental, multi-faceted component of human activity, emerging as an independent resource of the post-industrial economy and forming the basis of the economic system. Unlike previous stages of development, technology does not treat any traditional factor of production as capital, but rather combines them.

At present, the fundamental principles, rules, and requirements for economic management within organizations have been established. However, the actual technologies employed in management remain predominantly descriptive or fragmented in nature. There is a need to address the following unresolved components of the overarching problem in the field of management technology: (1) the development of a comprehensive framework that encompasses the evolution of management technologies in financial-economic processes, (2) the delineation of key characteristics and distinguishing features of specialized and integrated management technologies, and (3) the identification and analysis of essential elements of contemporary management technologies. These efforts are essential for effectively incorporating management technologies into the operational practices of economic agents.

4. Applied aspects and trends

Technologization permeates not only the overall economic system but also the sphere of management at the level of specific organizations. Furthermore, Drucker (Drucker, 2006) notes that "there is no such thing as a technology belonging exclusively to a particular industry and, conversely, all technologies can, at least theoretically, have significant importance for any industry and influence any industry." From this standpoint, it is legitimate to utilize scientific developments in the field of technologies in general, as well as in the sphere of economic and financial management, provided they are adapted to the specific functioning of a particular object.

The origins of management technologies in the field of enterprise economics have taken shape in the form of principles for managing economic processes, which were explored in philosophy from an economic perspective.

The concept of technology in the organizational environment emerged in the 1960s. Technology was viewed as information and the means of storing it, as the activity and knowledge of cause-and-effect relationships, and as the variability of resources and search processes. Later on, the term "management know-how" emerged, which encompassed various managerial practices, principles and techniques used by managers in the United States and Western Europe to perform management functions (Negandhi & Estafen, 1965). The works of Drucker parallel to the development of post-industrial society laid the foundation for the formation of technological economic school.

At the end of the 20th century, the increasing pace of external and internal changes within organizations necessitated the regular review of management practices, as actual processes began to significantly deviate from the planned ones. This stage witnessed the breakdown of stereotypes in management thinking and the transition from the "rational management" school to the behavioral approach.

The organization's economy is seen as an open system operating in an environment characterized by technological variability and uncertainty, and managing entities managers must be aware that due to the current conditions managed by them companies will face new and new challenges not only in the area of changing consumer preferences and consequently changing market demand but also in terms of disturbances in the supply changing a high level of security of services provided andining consumer confidence (Górka-Chowaniec, et al., 2023).

Consequently, the current focus of economic technological theory lies in identifying the regularities of organizational functioning and developing the most efficient and cost-effective methods and processes. The stages of evolution of technological theories in organizations are presented in Table 1. (See Table 1).

Technological advancements have revolutionized the field of management, undergoing its own evolution. Initially, management technology was closely associated with production processes, neglecting the unique aspects of managerial activities.

Subsequently, a scheme for structuring management tasks was proposed, dividing the management process into functions composed of a set of management procedures. This led to the emergence of goal-oriented and process-oriented management technologies, team-building technologies, and employee involvement in the management process. Over time, management technology evolved into a dynamic structure of components, with cognitive aspects being the predominant focus.

Nowadays, there is a shift towards comprehensive (systemic) management technologies, as well as the generation and self-reproduction of new management technologies. The emphasis is on achieving profitability while ensuring the financial stability of economic entities. This has led to the prominence of financial management as a foundational management technology that offers a holistic perspective through a financial lens.

The functions of financial planning, financial analysis and control are subsequently realized through budgeting technologies, managerial accounting, and financial controlling. Financial controlling, in particular, serves as a comprehensive management technology aimed at coordinating the interaction of various financial management subsystems and monitoring their effectiveness.

Table 1.
Evolution of technological theories in organizations (compiled by the authors)

The main types of economic management technological processes	There was limited use of advanced technologies or sophis-ticated ma-nagement techniques during this period, with economic activities pri-marily dri-ven by the resources and avail-ability of la-bour within the agrarian economy	Production organization techno-logies Techno-logies of labour or-ganization Production techno-logies	Special management technologies (personnel, sales, logistics) Linear control technologies	Technolo-gies of management by results, by deviations Budgeting Serial-parallel control technologies	Computerized management systems Decision Support Systems (DSS) Communi-cation and networking technologies Electronic Data Interchange (EDI) Quantitative analysis and modelling	Benchmarking Strategic planning CRM Outsourcing A balanced system of indicators Controlling Change management Key competencies Reengineering of business processes Consumer segmentation Quality management Loyalty management
Nature of technology	Labour-intensive	Capital-intensive				Science-intensive
Basic resource	Physical work (personal factor)	Capital (material factor): machines, equipment				Technology (integrated factor): information and communication technologies, biotechnologies, nanotechnologies, etc.
General characteristics of the stage	The dominance of agrarian and feudal economies	Introducing the term "technology" into scient-ific use	Extension of the non-classical model of factors of production due to the technological resource	Emergence of the concept of management technology	The emergence of the concept of stagflation	Development of infor-mation, processing, cognitive technologies / Development of complex technologies, generation of new techno-logies
Pre-industrial stage (before 1770)		**Late 18th century**	**1956**	**1960s**	**1970s**	**1990s** / **2000s**
		Industrial stage (1770 – 1980)				**Post-industrial stage (1980 –present)**

Process-oriented management is also gaining significant traction, becoming one of the most utilized and effective approaches. Process technologies do not oppose financially-oriented ones; rather, they complement them with non-financial components such as customer relationships, business processes, and personnel. An example of such

technologies is the balanced scorecard, which enables the measurement of strategic goal achievement through key performance indicators.

The modern arsenal of management technologies encompasses a significant variety of types, depending on the degree of centralization, order of operations and procedures, division of labour, object-oriented, subject-oriented, and function-oriented focus, as well as the level of automation and management structure.

In a generalized form, the composition of technologies used in economic management includes strategic management, business planning, marketing management, financial management, human resource management, corporate governance, quality management, information technologies, operations management, production management, logistics technologies, internal accounting and control technologies, and business process structuring and organization technologies (Nunn, 2009).

A slightly different list of management technologies has been identified by the consulting company Bain & Company (Bain & Company, 2015), which conducted its fifteenth survey of over 13,000 companies from 70 countries in North America, Europe, Asia, Africa, the Middle East, and Latin America (Figure 1).

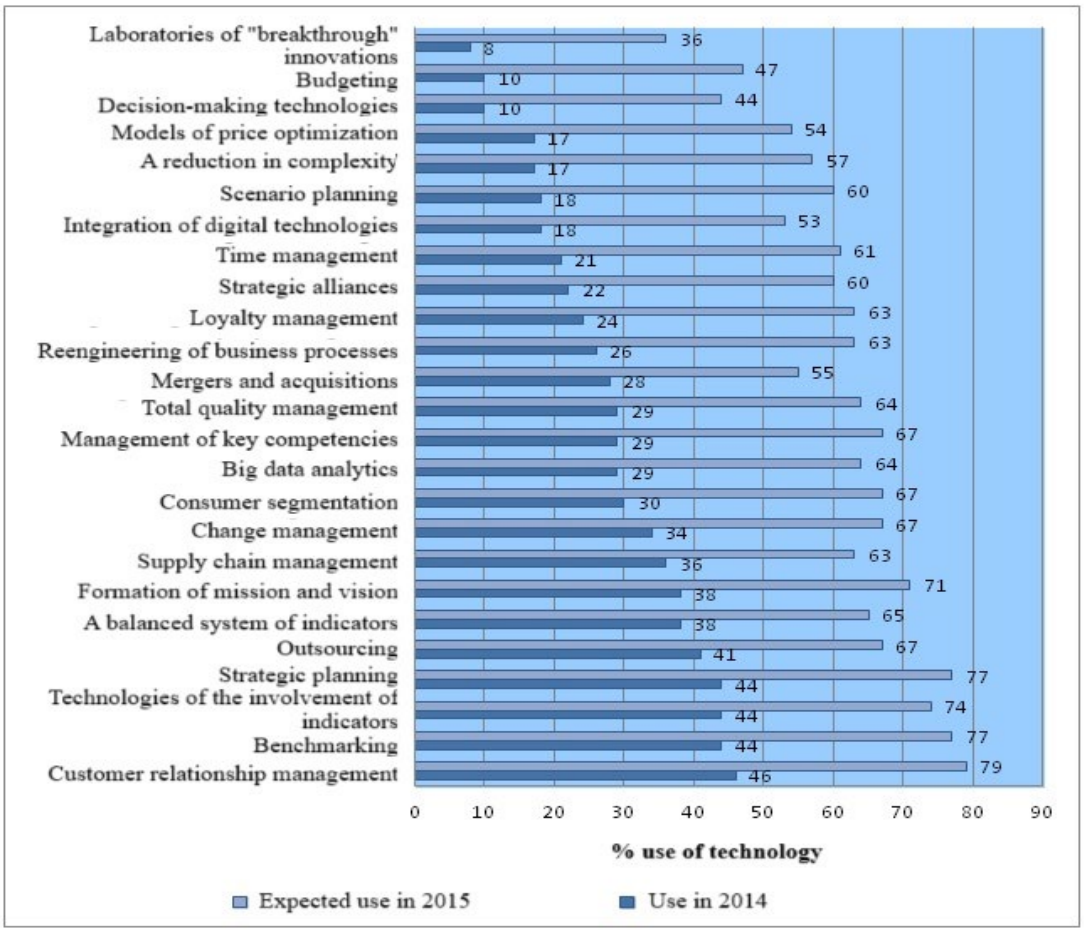

Figure 1. Use of management technologies in the world (Chmutova, 2014))

According to the survey results, the most commonly used management technologies in the world are customer relationship management, benchmarking, employee engagement surveys, strategic planning, outsourcing, balanced scorecard, mission and vision formation. It was expected that there would be a significant increase in the percentage of their usage in 2015.

A survey conducted on over 300 executives and top managers from various enterprises between 1999 and 2013, the results of which are presented in a study (Verba, 2014), revealed that companies were increasingly adopting strategic management tools (Table 2).

Table 2.
The dynamics of changes in the popularity level of management technologies between 1999 and 2013

Popularity rank	**1999**	**2006**	**2009**	**2013**
1	Strategic planning	Strategic planning	Benchmarking	Customer Relationship Management (CRM)
2	Formation of mission and vision	CRM	Strategic planning	Strategic planning
3	Benchmarking	Segmentation of pollinators	Formation of mission and vision	Benchmarking
4	Evaluation of the level of customer satisfaction	Benchmarking	CRM	Formation of mission and vision
5	Outsourcing	Formation of mission and vision	Outsourcing	Key competencies
6	Performance management	Key competencies	A balanced system of indicators	Change management
7	Growth strategies	Outsourcing	Change management	Consumer segmentation
8	Customer segmentation	Reengineering of business processes	Key competencies	Loyalty management
9	Key competencies	Scenario planning	Strategic alliances	Quality management system
10	Quality management system	Knowledge management	Consumer segmentation	Supply chain management

The high level of utilization is seen in customer relationship management tools (66.7% of respondents) and budgeting technologies (70.6%), indicating the proactive search by domestic management for methods of adapting enterprises, identifying new sources of competitive advantage, and directions for the development of Ukrainian businesses. However, there is insufficient application of management technologies in

innovative management. Specifically, only 39% of respondents acknowledge the presence of innovation management in their enterprises, 31% benchmarking, 32% knowledge management, 22.5% change management, and 21% scenario planning. Given the turbulent changes in the external and internal environment, the development and implementation of management technologies become essential, requiring continuous benchmarking, scenario planning, and systematic change management.

Thus, the analysis of management technology application in economics and finance indicates a shift in priorities towards transitioning from specialized management technologies to comprehensive self-replicating ones.

The essence and impact of comprehensive management technologies in financial and economic processes are reflected in their characteristics, which are synthesized based on the study (Table 3).

Table 3.
The most significant characteristics of modern management technologies

1	Dynamism	Management technology in financial and economic processes encompasses the execution of various dynamic processes, movements, and actions.
2	Goal-directedness	The procedures and operations of management technology in financial and economic processes are subordinate to a common objective.
3	Result-orientation	Management technology in financial and economic processes clearly defines the desired outcome of activities.
4	Temporal and spatial organization	The procedures and operations that constitute management technology in financial and economic processes are structured in a chronological and spatially coordinated manner.
5	Divisibility	Any management technology in financial and economic processes can be broken down into interconnected stages, phases, procedures, and operations.
6	Unambiguity and regulation	The execution of procedures and operations within management technology in financial and economic processes is characterized by clarity and adherence to regulations, which are crucial for achieving the desired results.
7	Coordination and synchronization	Management technology in financial and economic processes ensures coordination and synchronization of stages, phases, and procedures within its framework.
8	Focus on achieving high-quality management	Management technology in financial and economic processes emphasizes the pursuit of excellence in management practices.
9	Rationality	Management technology in financial and economic processes facilitates the rational allocation and utilization of financial resources.
10	Uniqueness	It reflects the dependence of the technology of managing financial and economic processes on the values, goals, and qualifications of the management subjects. The property of uniqueness is manifested in the fact that identical technologies in each specific organization can be filled with their own procedures, tools, and management methods.

11	Intellectual nature	The technology of managing financial and economic processes is characterized by its intellectual nature, implying the utilization of cognitive capabilities, analytical thinking, and decision-making skills
12		Interchangeability of influence tools and parallelism of their application regarding a single object.
13		Dependence on the competence of personnel utilizing the technology: the effectiveness of the technology of managing financial and economic processes relies on the competence and expertise of the workforce implementing it.
14	Variability and flexibility	The technology of managing financial and economic processes is a movable structure of components that can be changed depending on the achieved results and evolving circumstances.
15	Synergistic effect	Complex and systematic approaches to executing procedures and operations lead to the attainment of a synergistic effect, where the whole is greater than the sum of its parts.
16	Massiveness	The technology of managing financial and economic processes makes the goal achievable on a large scale.
17	Balanced nature	It is based on categories such as compatibility, coherence, equilibrium, coordination, and rational proportionality of interconnected elements. The balanced nature of the technology of managing financial and economic processes entails both coordinated dynamics of its components, which are subordinated to the development of the organization as a holistic system, and the fulfillment of the balance between goals, financial resources, interests of stakeholders, and objectives at all levels of management.
18	Adaptability	The technology of managing financial and economic processes ensures the prompt response to changes in the external and internal environment, timely identification of problems, and their prevention.
19	Innovative orientation	The technology of managing financial and economic processes facilitates the development and adoption of innovative decisions concerning the organization's development.

Identifying the aforementioned characteristics allows for their consideration in the process of forming a system of technologies for managing financial and economic processes specific to an organization. This enables the development of corresponding procedures and the selection of suitable tools for their implementation.

In the contemporary stage of the evolution, several key trends have emerged that warrant analysis. Gartner's research (Gartner, 2023) highlights these trends, driven by the recognition of the pivotal role played by leaders in showcasing the value of analytics for the entire organization. To determine the optimal approach to implementing Data and Analytics (D&A), managers of different levels must engage with stakeholders across the company, ranging from top executives to frontline staff (Choubey, 2023). This collaborative effort fosters more productive interactions in end-to-end processes, taking into account the psychology of individuals and their values.

Table 4.
The primary technological trends in data processing and analysis that will shape the immediate future

No	Trends-2023	Concepts
1	Augmented analytics	Leveraging advanced technologies like machine learning and AI, augmented analytics empowers businesses to extract valuable insights from vast datasets. It enhances decision-making by providing automated data preparation, analysis, and natural language processing capabilities.
2	Measuring the value of data utilization and analysis	Executives often struggle to define the organizational benefits of data analytics. To effectively measure the value derived from the integration of data, analytics, and artificial intelligence (AI), leaders need to acquire a diverse set of skills. These skills encompass the ability to convey and elucidate the benefits to diverse audiences, prioritize investments, and align them with final business results to ascertain the achievement of predetermined objectives. Leaders who focus on optimizing data analytics must establish value chains that demonstrate the impact of data and analytics practices on the attainment of crucial organizational priorities.
3	Responsible AI	With the growing prominence of AI in various sectors, ensuring ethical and responsible AI practices has become imperative. Organizations are increasingly embracing transparency, fairness, and accountability in AI algorithms and processes to address potential biases and mitigate risks.
4	Risk management	Organizations are exploring novel frontiers in utilizing AI technologies, but this expansion introduces inherent risks that must be addressed. A notable risk is the prevalence of fraudulent activities, characterized by the deliberate injection of false information, commonly known as "data poisoning." To effectively manage the risks associated with AI, regulatory compliance alone is insufficient. Establishing trust among stakeholders and accelerating AI implementation in companies require the development of effective governance structures and responsible utilization of intelligent tools.
5	Explainable AI	As AI systems become more complex, the need for interpretability and transparency in AI decision-making grows. Explainable AI techniques aim to provide understandable explanations for AI-generated outputs, building trust and facilitating human-AI collaboration.
6	Observability of data management systems	Observability is a vital attribute that facilitates enhanced monitoring and understanding of data management systems. With heightened observability, organizations can promptly detect and address operational issues, optimize system performance, and make informed decisions based on reliable data. D&A managers play a critical role in assessing the efficacy of data management tools in meeting user needs and ensuring seamless integration within the broader IT infrastructure.
7	Data democratization	Breaking down data silos and promoting data accessibility across the organization is a crucial trend. By enabling employees at all levels to access and understand relevant data, organizations foster a data-driven culture and empower individuals to make informed decisions.
8	Data exchange	In the modern business landscape, data has become a valuable asset that can be harnessed for competitive advantage. As companies embrace the concept of data as a product, they recognize the importance of establishing efficient data exchange mechanisms with various stakeholders. This not only facilitates improved decision-making processes but also fosters innovation and drives collaboration within the business ecosystem. By embracing data exchange, organizations can unlock the full potential of their data assets and create new opportunities for growth and value creation.

9	The contribution of Data and Analytics (D&A) in ensuring sustainable development	Through data-driven insights, organizations can facilitate the enhancement of environmental, social, and managerial corporate initiatives. D&A managers are compelled to explore avenues for process optimization to foster sustainable business practices. Companies adopting D&A and AI strategies are more cognizant of their environmental footprint, leading them to prioritize energy consumption reduction measures. For instance, cloud data centres can deploy more energy-efficient equipment, thereby minimizing their environmental impact.
10	Edge Analytics	The proliferation of IoT devices and edge computing has led to the emergence of edge analytics, where data is processed and analyzed at the edge of the network. This trend enables real-time insights, reduces latency, and enhances operational efficiency.
11	The data fabric serves as a centralized framework	The concept of a *data fabric* represents a contemporary and efficient approach to information management, encompassing the accumulation of diverse metadata types to inform practical decision-making. By gathering and enriching the semantics of underlying databases and continuously analyzing supplementary information, IT systems can generate proactive alerts and recommendations. Subsequently, these insights can be acted upon by other software products or human users. This facilitates confident data utilization by business users and provides ample opportunities for integration and model creation without the need for extensive development efforts.
12	Emergent Artificial Intelligence (AI)	The evolution of emergent AI represents a paradigm shift in how organizations approach the challenges of scalability, universal applicability, and adaptiveness. This progressive advancement will redefine the value proposition of AI and drive the widespread adoption of intelligent systems in domains that previously faced constraints.
13	Universal Data and Analytics (D&A) ecosystems	Creating universal D&A ecosystems holds great promise for ensuring seamless integration of all business processes within an organization. This objective is achieved through complete integration, unified governance policies, and technological compatibility of various automation tools. The potential for flexible composition of ecosystem elements should be considered at all stages of application and service development: during design, assembly, and deployment. A well-designed ecosystem architecture enables the creation of more modular D&A systems that can easily adapt to specific requirements. The ability to scale allows businesses to effectively address rapidly changing needs and adapt to external transformations.
14	Content consumers are becoming content creators	Users are spending less time in pre-set interfaces. A dynamic conversational interface will replace them, providing a qualitatively new experience to content consumers and meeting their specific needs at the moment of interaction with automated services. Organizations that can leverage accumulated analytics will be able to offer consumers understandable, automated, and easily adaptable dialog tools.
15	Human decision-making remains vital	By integrating automation, AI, robotics, and other technologies, intelligent systems are being developed today that can operate without human involvement. However, not all decisions can currently be made automatically. Technologies should provide additional capabilities in the data analysis process. The primary role in decision-making should still be held by humans. If a company is solely managed automatically based on data, it will inevitably lead to distortion of the original goals and loss of meaningfulness.

In the current stage it has become imperative for companies to engage in continuous analysis of accumulated data. This analytical approach

empowers businesses to make proactive forecasts of key performance indicators, streamline operational expenditures, and enhance the overall customer journey. The strategic trajectory of Data and Analytics (D&A) elucidates an intensifying requirement for proficient data governance tools, while concurrently broadening the horizons of technological possibilities. Nonetheless, it is crucial to acknowledge that the intricacies of data interpretation and decision-making processes continue to necessitate human involvement and expertise.

Conclusions

The tracing of the evolution of technological theories holds profound significance. On one hand, it synthesizes existing knowledge and experiences in this field, while on the other, it assists contemporary managers in their decision-making by revealing various methodological principles and ideas for interpreting facts, contingent upon historical epochs and specific situations. The dynamics of management technologies result from societal development and the increasing complexities of economic processes. The burgeoning size and intricacy of interconnections among diverse organizations, as well as within individual structures, individuals, and systems within an organization, necessitate flexible management approaches and innovative solutions. In this regard, studies and analyses of managerial technologies gain ever-greater importance. They synthesize scientific and cognitive, including historical, foundations for addressing issues within the considered field. Based on these foundations, the development and implementation of comprehensive, strategically oriented, and proactive management technologies will ensure continuity of connections, coordination, and effectiveness in managerial actions.

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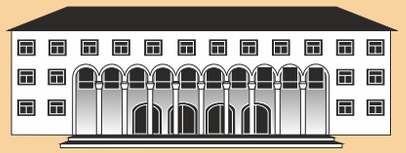

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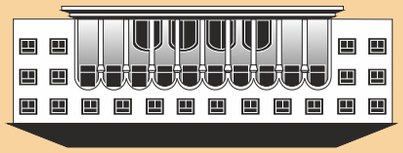

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