Explaining the IT Value Through the Information Support of Decision-Making

Yuri Zelenkov

Abstract The issue of how IT impact the performance of an organization is still not fully explained. Many researchers believe that this effect is based on the automation of business processes and the replacement of unskilled routine labor. However, this does not explain the expected impact of digital transformation, since it offers completely new models. Relying on the achievements of organization theory, we suggest that the impact of IT on performance is realized through the quality of decision-making. We analyze the role of information processing in decision-making, identify the sources of inefficiency, which can be associated with incorrect assessment, lack or excess of information. Next, we revise the organization's design strategies and classify the information systems according to their information processing capabilities. The proposed approach can explain the way how IT impact is created and manifested both for traditional enterprise information systems and for new digital technologies.

Keywords IT value · Organization design · Decision-making · Information processing

1 Introduction

Many studies conducted since the 1980s consistently show that the impact of IT investment on labor productivity and economic growth is significant and positive at both the firm- and country-levels [1]. The explanation of IT value from economics point of view is the following. At the firm level, the performance of IT investments can be explained by complementary investments in organizational capital such as decentralized decision-making, quality management, personnel training, and business process redesign [2]. It leads to an increase in labor productivity, which stimulates the IT use sector, which, in turn, leads to a rise in demand and encourages the development of the IT industry. As a result, all this has a positive effect on economic growth [3].

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A lot of authors have empirically investigated the impact of IT investments on organizational performance. Some results confirm the presence of a positive relationship [4]; other authors do not detect such a dependence [5]. Although most researchers and practitioners are confident that there is a positive IT effect, the mechanism for creating this effect remains poorly understood [6, 7].

Many researchers believe that this effect is based on the automation of business processes and the replacement of unskilled routine labor [8, 9]. However, this does not explain the expected impact of digital transformation, since it does not come down to improving processes, but offers completely new business models.

In this paper, we consider the mechanism for creating and manifesting the value of IT through information support for decision-making [10]. The theory of organization has proved that the optimization of decision-making is the reason and meaning of the existence of an organization [11], determines its structure [12], and performance [13].

The work is structured as follows. After reviewing the literature in Sect. 3, we present a decision-making framework that extends the well-known models [12, 14, 15] by highlighting information processing. A glance through the prism of information support allows us to identify potential sources of ineffective decisions that are associated with incorrect assessment, lack or excess of information.

In Sect. 4, we look at organizational design strategies in terms of increasing its information effectiveness. These strategies are aimed at providing effective decisions and, therefore, obviously affect all other metrics of the organization's performance (finance, HR, etc.). To do this, we use the Galbraith model [16], which we revise following the latest achievements in management, organization theory, and information systems.

In Sect. 5, we analyze various types of information systems in terms of information processing. We consider two dimensions: the complexity of the work performed and the number of employees interacting in solving problems. This analysis allows you to determine the expected effect of each type of information system.

The contribution of our work has two components. Firstly, a theoretical model is proposed that explains the mechanism of the influence of IT as an information processing tool on organizational performance. The mediator of this influence is decision-making. Secondly, the proposed models can be of practical importance, since they allow you to identify the causes of ineffective decisions and enable choosing the best tools (both managerial and IT) to eliminate these problems.

2 Literature Review

2.1 IT Value

David [17] was the first who note that the impact of IT on an economy is best described through the concept of "general-purpose technology" (GPT). The main

contribution of GPT to improving efficiency is the creation of a foundation for new technologies, working methods, etc. [3]. Next, Milgrom and Roberts [18] showed that investments in IT should be complemented by simultaneous investments in other assets, such as changes in work processes and a portfolio of products and services, which is accompanied by a change in personnel qualification requirements [2].

Dedrick et al. [1], reviewing empirical research of the IT impact on productivity, highlighted that IT is not merely a tool for automating existing processes but is, more importantly, an enabler of organizational changes that can lead to additional productivity gains. Enterprise information systems substitute low- and middle-skilled workers while creating more demand for high-skilled workers.

Melville et al. [8] presented a model of IT business value based on the resource-based view of the firm and designed to combine various strands of research into a single framework. According to their model, IT impacts organizational performance via business processes. Other organizational resources such as workplace practices moderate or mediate IT in the attainment of organizational performance impacts. The external environment also plays a role in IT business value generation.

Summing up these and many other works, Kohli and Grover [6] noted that IT creates value only under certain conditions, it must be a part of a business value creating process when all organizational factors operating synergistically. Next, IT value could manifest itself in many ways: in the form of productivity similar to other types of capital, process improvements (cycle time), profitability (return on assets), or consumer surplus. Mediating factors that allow transforming IT resources in the value are complementary resources, organizational capabilities, and IT strategy alignment. However, the authors noted that, despite significant progress in IT value understanding, many issues remain unexplored, in particular topics on information and knowledge sharing and creating.

More recent empirical studies have provided additional evidence of the relationship between IT investment and business value. However, some researchers obtained contradictory results. In particular, Tambe and Hitt [4] found a significant difference between large and medium-sized firms. IT returns are substantially lower in medium-sized firms than in Fortune 500 companies, but they materialize faster in midsize firms. The second important finding of work [4] is that the measured marginal product of IT investment is higher from 2000 to 2006 than in any previous period. It can be explained by the fact that unlike the 1990s, when proprietary information systems prevailed, the 2000s are characterized by more standardized information systems with the rapid adoption of ERP and web technologies. However, contrary to early studies, the results of Chae et al. analysis [5] showed no significant link between IT capability and firm performance from 2001 to 2007. Analysis of 303 empirical studies [19] shows that primarily this contradiction is a consequence of methodological issues. There is no single widely adopted methodology, and the results of various authors depend on the model used (mainly it is regression), selected variables, and measurements. However, the scientific community and practitioners consider the impact of IT on firm performance as proven.

To conclude this part of the review, we refer to Mithas and Rust's remark [7] that there are three strategic paths from IT to firm performance. IT can be used to

(1) reduce costs by improving productivity and efficiency; (2) increase revenues; or (3) reduce costs and increase revenues simultaneously. However, despite significant progress in the literature, little is known about how these strategies jointly moderate the relationship between IT investments and firm performance.

From our point of view, the critical issue in ensuring overall performance is effective decision-making, which is based on the ability to provide the right information to the right people at the right time. So, information processing capability is vital to effective management, and it should be viewed as the primary function of an enterprise information system founding its value.

2.2 Information Management Capability

According to the definition of Mithas et al. [20]: *Information management capability is an ability to provide data and information to users with the appropriate level of accuracy, timeliness, reliability, security, confidentiality, connectivity, and access and the ability to tailor these in response to changing business needs and directions.*

As noted in the previous section, the research literature highlights the importance of information management aspects of IT capability. However, to the best of our knowledge, just a few studies examined the link between information management and firm performance before the 2010s. Nunamaker and Briggs [21] discussing Information Systems (IS) as an academic discipline argue that the crucial function of IS is informing the decision-makers. Thereby IS reduces the risk of decision and creates value for stakeholders affected by the decision.

Mithas et al. [20] confirmed these assumptions empirically. Authors found that information management capability plays an essential role in developing other firm capabilities, namely, for customer management, process management, and performance management. These capabilities enhance all aspects of the firm performance (customers, finance, human resources, etc.). Moreover, according to the authors, information management capability has a direct and most significant impact on the financial performance of the firm.

Few more recent works have empirically studied particular aspects of the impact of information management on performance. Liu et al. [22] found that IT capabilities affect firm performance through absorptive capacity and supply chain agility. Absorptive capacity refers to a firm's ability to value, assimilate, and apply new knowledge received from external sources. Information management has positive relationship with process management, which in turn has a positive effect on operational performance [9]. Besides, the effect of information management capabilities on firm performance was confirmed not only for the US but also for other countries, for example, Spain [23], India [24], and Brazil [25].

In the 2010s, new IT (such as big data, artificial intelligence, and blockchain) fundamentally reshaped business models, business processes, products, and services. Over previous decades, the prevailing notion of an IT strategy considered it as a functional level strategy, which should correspond to the firm's chosen business.

However, now it is necessary to view the IT strategy not as a subordinate of the business strategy, but as a digital transformation strategy [26]. Therefore, starting in 2010, many researchers pay attention to the impact of new IT on firm performance. For example, authors of [27] found that big data is associated with an average of three to seven percent improvement in the productivity of firms in information technology-intensive or highly competitive industries.

Data-Driven Decision-Making (DDD) became the new best practice since new opportunities to collect and leverage data have led many managers to change how they make decisions—relying less on intuition and more on data. Paper [28] reports that the use of DDD in US manufacturing nearly tripled (from 11 to 30% of plants) between 2005 and 2010.

Recent improvements in artificial intelligence (AI) can also help to reduce the cost of decision-making, as modern machine learning models make predictions that often exceed human capabilities, especially using large datasets. Thus, humans will delegate some decisions to algorithms [29]. According to [1], information systems replace low and medium-skilled workers; that is, routine mental tasks. According to the most radical point of view, AI aims to substitute, supplement, and amplify practically almost all the tasks currently performed by humans, and in fact, for the first time becomes a serious competitor for them [30]. Regardless of whether this assumption will turn out to be true, some of the decisions are already made by algorithms, i.e., for the first time, humanity is confronted with non-human actors.

To summarize this part of the review, we can note that according to the view presented in [21], the enterprise IS does not consist solely of IT artifacts (hardware and software). The information system is a balanced combination of people, data, procedures, policies, standards, equipment, software, etc. [31]. By extrapolating this approach, we can consider the entire organization as an information processing system facing uncertainty [32]. All aspects of the organization's activities require effective decision-making; very often, these decisions must be taken in uncertainty. Therefore, the effectiveness of the use of information to reduce uncertainty in decision-making underlies all other aspects of measuring effectiveness (processes, customers, finances, etc.). Empirical results show that the information system capabilities primarily positively affect the performance of decision-making [33]. Decision-making performance mediates the effect on business process performance and firm performance. Thus, considering digital technologies from this angle, we in particular can argue that their popularity is primarily due to the potential to improve decision-making.

2.3 Data, Information, Knowledge and Decision-Making

The objective of this part of the literature review is to provide a current understanding of the decision-making process and the role of data, information, and knowledge in it. The main results regarding the decision-making process were obtained back in the 1970s. The main results regarding the transformation of data to information and

knowledge were obtained back in 1990s. Here, we review the key concepts of both directions.

Davenport and Prusak [34] defined the data as objective facts about some events. In their view, data are simple sequences of signs and symbols that do not matter and simply exist. However, this definition was clarified later by Choo [35], who indicated that actual events that exist independently of the observer generate signals, i.e., sensory phenomena that are perceived by subject. An observer usually draws attention to a small number of signals that he senses as data. The selection and transformation of signals depend both on their physical nature and the observer's ability to adequately perceive them, and on the observer's previous experience (for example, on his expectations that this signal may indicate). An observer selects and recognizes signals following a specific structure that already exists in his mental model of the world, isomorphic, as he believes, to the current situation.

Data, therefore, is a more or less subjective set of facts and messages. In the context of an organization, data is usually stored as structured records of various transactions. Any transaction can be described using data, but they do not say anything, for example, about the reasons, goals, and quality of its implementation.

The subject interprets the data following his goals. In this process of giving data meaning, they are transformed into information, which, therefore, is even more subjective. Information is always processed in a specific context and influences the behavior of the subject [36]. We can say that the value of information depends on the degree of uncertainty reduction of the situation in which the subject makes the decision. In an organization, information is distributed through various networks, which can be both technical (for example, e-mail) and purely social (informal communication), and multiple combinations of them are also possible [37].

According to the definition of [34], knowledge is a mixture of accumulated experience, values, contextual information, and expert opinions that allow us to evaluate and absorb new skills and new information. Knowledge is entirely subjective since its carrier is an individual [36]. However, knowledge can also exist at the organization level, not only in the form of documents but also in the form of routines, norms, and procedures.

The knowledge allows us to transform data into information: evaluate its relevance taking into account a specific context, highlight critical components, remove apparent errors, and create a more compact representation. Knowledge allows us to make decisions, recognize and identify events, analyze the situation, and adapt to it, plan and control actions. Knowledge forms those mental structures that a person considers isomorphic to the current situation. Knowledge, unlike information, presupposes the presence of opinions and beliefs and implies action [36]. Besides, information, since it has contextual value, must effect a change in knowledge [32].

Managers frequently plan, solve problems, and make decisions based upon incomplete and sometimes inaccurate information. There are two general theories regarding management decision-making. One is the process theory, in which decision-making is viewed as a three-phase process [12, 14]. The first phase is an intelligence phase, in which a decision-maker understands the problem. The second is a conception phase, in which a decision-maker develops alternative solutions. The last is the choice

phase, in which a decision-maker chooses best alternative. Simon [12] also points out that decision-making process is not always rational and that decision-makers often possess incomplete and imperfect information.

The "garbage can" model is an alternative way of discovering order in decision-making that complements the process approach. The central idea of the garbage can model is the substitution of a temporal order by the dynamic, open process subjected to interferences, feedback loops, and dead-ends [15].

Information use is critical in both the process and garbage can models of decision-making. Saunders and Jones [10] proposed a general model relating information acquisition to the decision-making process. The model consists of three major components: decisional, information acquisition, and contextual. The decisional component reflects an integration of the Mintzberg et al. model [14] of unstructured decision processes with "garbage can" concepts. The information acquisition component focuses on the role of information sources (internal and external) and media (informal communications both scheduled and unscheduled, documents, computer systems, etc.) in channeling information to the decision-maker. The contextual component of the model focuses on factors that impinge directly upon the selection of source and medium. These factors include the perceived importance of the decision, a number of problems the decision-maker is working on simultaneously, time pressures, the organization's information environment, interaction patterns, etc.

Based on the above definition of information and knowledge, we can deduce two consequences of this model that are significant for the further presentation of our work. First, if the decision-maker has sufficient knowledge of a certain problem, his need for information is lower. It may even happen that his previous experience in solving such problems is exceptionally high; in this case, he does not need information at all. This way of decision-making is often interpreted as an intuitive style [38]. Patton [39] identified three sources of intuition used by decision-makers: (1) general experience, which coincides with the way described above; and two others: (2) innate response—the instinct that brings subconscious but adequate reactions; and (3) focused learning that originates from deliberate efforts to attain intuitive responses.

The second consequence is the fact that the information search process routinizes, as it is limited to the number of problems solved simultaneously, established interaction patterns, available sources and media, and other contextual factors. Thus, this issue is closely linked with information processing efficiency.

To summarize this part of the discussion, we should note that knowledge management is a critical element in decision-making. As IT radically changes the way of information access and processing, it facilitates the creation of knowledge in organizations and society [40]. Perhaps this is the most important aspect of the creation and manifestation of IT value today, superior to the effect of automation of routine processes.

3 Knowledge-Based Decision-Making Process

An underlying assumption in the theory of organization is that organizations are open social systems that must deal with external and internal sources of uncertainty. Since organizations must deal with uncertainty, a critical task of the organization is information processing. Information processing refers to the gathering, interpreting, and synthesis of information in the context of organizational decision-making [32].

Based on the results presented in the previous section, we propose a decision-making model that takes into account information processing (Fig. 1). For simplicity, it is represented using the Mintzberg et al. [14] process approach. Still, it implicitly suggests that, according to the "garbage can" model, there are feedback loops and recursive relationships between the phases and also dead-ends, interferences.

Simon [12] noted that "different representations of the problem will produce different proposals for solutions." Moreover, as certain solutions become familiar, they are more likely to shape the problem understanding itself [13]. Thus, according to the proposed model, at each stage, the decision-maker (DM) evaluates (explicitly or implicitly) the sufficiency of his knowledge. As a result of this assessment, he or she has two scenarios:

- If DM feels that his or her knowledge and experience are enough, he or she proceeds to the next stage. This way of action implements an intuitive decision-making style. However, the intuitive decisions are not necessarily optimal, since, as noted above, familiar solutions may distort the understanding of the problem. The decision-maker is too self-confident in this case.
- If a DM believes that his experience is not enough, he or she creates an information request to collect the data that can reduce uncertainty in a given context.

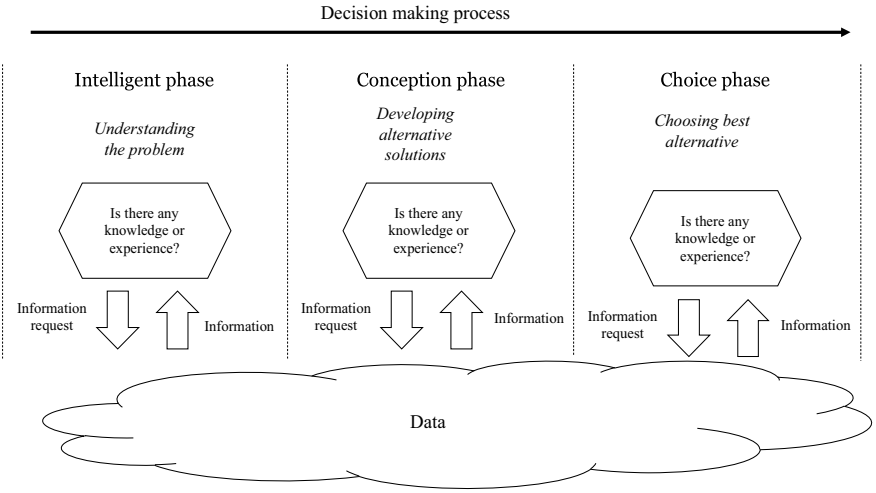

Fig. 1 Knowledge-based decision-making process

In this case, the search, processing, and provision of information (i.e., information processing) are of particular importance. These are functions that are usually considered as functions of an information system. However, these functions do not have to be implemented necessarily using IT; information processing can be performed using search in the paper archive or informal communication. A potential source of failure in this scenario is the routine procedures of information processing. As the context is continually changing, outdated procedures may return distorted, incomplete, and untimely data. It is the reason why many managers criticize their enterprise information systems [41, 42].

So, the performance of decision-making (i.e., quality of solutions or reasoning in general) depends on the quantity and quality of information that DM can receive. Note that the performance of DM correlates positively with the amount of information he or she receives—up to a certain point [43]. If further information is provided beyond this point, the performance will rapidly decline since extra information does not integrate into the decision-making process. Information overload will be the result in that case. Thus, we identified three potential sources for making wrong decisions:

- incorrect assessment of knowledge and competencies, in particular, by ignoring relevant information.
- inefficient information processing, i.e., distortion, incompleteness, or untimely presentation of information.
- information overload.

The central information processing problem is an optimal task allocation, i.e., organizational structure, given the costs of knowledge acquisition and communication [13]. This point of view is consistent with Milgrom and Roberts [11], who argue that two main functions of an organization are.

- coordination upon reaching an agreement between its participants, i.e., allocation of tasks, rights, and responsibilities.
- motivation to comply with the agreement reached.

To perform these functions, organization should know how its different components are functioning, about the quality of outputs, and conditions in external technological and market domains. However, information processing requires additional investments in systems, which increases costs, but is not directly related to the increase in the consumer value of products or services. Thus, the cost of information processing is a constraint that limited information capabilities of the organization. A trade-off between the amount of information necessary for the management and its cost is the main problem of organizational design.

4 Organizational Design from Information Processing View

Since the pioneering works of H. Simon in the 1940s, information processing was a central concept in organizational research related to knowledge acquisition and communication among decision-makers. According to Galbraith [16] and Tushman and Nadler [32], the role of the organizational structure is to increase the organization's information processing capacity to deal with internal complexity and environmental uncertainty.

In the review of research literature in organizational structures, information processing, and decision-making, Joseph and Gaba [13] conclude that existing research is divided into two directions: aggregation and constraint. The aggregation view reflects how different types of structures enable individuals to interact to make collective decisions. The constraint view reflects how the context established by the organizational structure enables or constrains individual decision-making.

In his seminal work, Galbraith [16] identified four organizational design strategies for information processing. Two of them aim at reducing the information necessary for management; the other two increase the organization's ability to process information. Here we propose a revision of the Galbraith model [16], taking into account the achievements in management over the 45 years that have passed since the publication of his work (Fig. 2).

Two strategies that allow reducing information that is processed are *Creation of Slack Resources* and *Creation of Self-Contained Tasks*. The next two strategies (*Investment in Information Systems* and *Creation of Knowledge Management System*) adapt the organization to process the growing amount of information from internal or external sources.

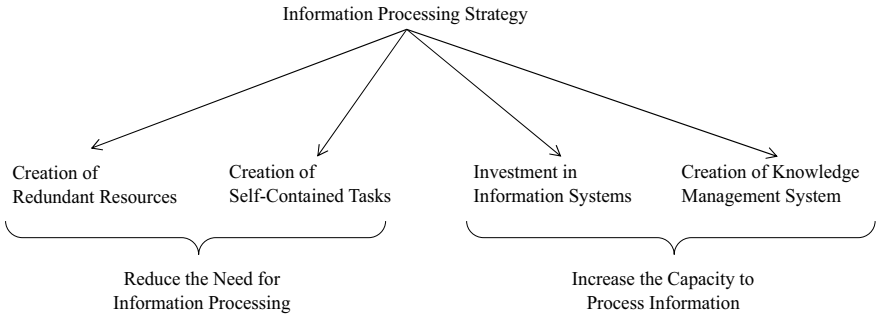

Fig. 2 Organizational information processing strategies, revised Galbraith [16] model

4.1 Creation of Redundant Resources

Galbraith [16] notes that Creation of a Slack Resources is a regular practice in solving job scheduling problems when completion dates can be extended until the number of exceptions that occur is within the existing information processing capabilities of the organization. However, from three popular managerial techniques, namely Theory of Constraints (TOC), Just in Time (JIT), and Lean Manufacturing (LM), these resources are losses.

For example, the purchasing manager to create the purchasing plan for the next period should know the manufacturing plan for this period. If the probability of changes in the manufacturing schedule is very high, he or she extends the list and quantity of purchased items to compensate for these variations. Obviously that a significant part of purchased items will not be claimed that leads to unnecessary stocks, freeze money, etc. It is an example of how uncertainty in one subdivision of the organization impacts the decision in another subdivision. In fact, the purchasing manager reduces the uncertainty by extra stocks.

Galbraith [16] notes that the strategy of using slack resources has its costs and whether slack resources are used to reduce information or not depends on the relative cost of the other alternatives. But we should add that this strategy appears spontaneously when available information does not allow reducing uncertainty, see example in [44]. All managerial approaches listed above (TOC, JIT, and LM) aim to reduce uncertainty and, therefore, to reduce the extra resources. In the Theory of Constraints, such excess resources are considered as buffers. TOC justifies that a buffer is needed only before the least productive node of the production chain since it determines the throughput of the entire line. So, we rename this strategy as *Creation of Redundant Resources*, bearing in mind that this strategy *contraries to the desire of management, arises from a lack of information, and leads to inefficiency of organizations in general*.

4.2 Creation of Self-Contained Tasks

The second strategy to reduce the amount of information processed is the *Creation of Self-Contained Tasks*. It is the decomposition of the system into loosely coupled modules grouped around similar products or services. Such a module should have all the necessary resources to ensure the entire value chain, and after that, it can be considered as a "black box" that hides internal information flows. Galbraith [16] notes that this approach shifts the basis of the authority structure from one based on input, resource, skill, or occupational categories to one based on output or geographical categories. We can add that it is today the main direction in the design of the organization not only at the enterprise level as Galbraith noted but also at the level of small teams (e.g., flexible manufacturing cells, agile project teams, etc.). This approach effectively solves the coupling problem described above, but it is not always easy

to implement. For example, it is impractical to split the IT team responsible for corporate data centers according to the business lines. The second problem is that organizations can lose economies of scale. Third, small autonomous teams can solve only small problems. If it becomes necessary to combine several teams for a more complex task, the processing of information may require more effort than in the case of non-autonomous groups, e.g., see discussion of scaling agile methods on the enterprise level in [45].

4.3 Investment in Information Systems

Galbraith [16] argues that the organization can invest in a mechanism that allows it to process information acquired during task performance without overloading the hierarchical communication channels. He calls such a tool as a *Vertical Information System*. The author notes that the effect of such systems is achieved by the formalization of a decision-making language that simplifies information processing in the authority hierarchy. The accounting system is an example of such a language.

However, providing more information, more often, may simply overload the decision-makers. It should be noted that modern information systems (based on IT) can solve the problem of information overload. First, "classical" enterprise resource management systems offer an optimized model of processes, which reduces the complexity of choosing an operating model at a strategic level. Secondly, these systems prescribe to workers certain actions that are rigidly integrated into the software and thereby reduce the uncertainty at the operational level. Thirdly, such systems provide a wide range of reports consolidating and transmitting information on the levels of management; this reduces uncertainty at the middle and higher levels. All this shapes the value of IT, which was considered by most researchers, e.g. [1, 4, 6–8, 19, 46].

New IT, often referred to as technology enabling digital transformation, opens up new ways to reduce information overload. First of all, it is the analysis of large volumes of data and the transfer of decision-making to algorithms [28].

So, this strategy that we renamed as an *Investment in Information Systems* potentially can provide improvement of information capabilities without information overload.

4.4 Creation of Knowledge Management Systems

The last strategy that Galbraith [16] identifies as a *Creation of Lateral Relationships* was most strongly redeveloped in the years since the publication of his work. According to the author, this strategy moves the decision-making down in the level to where the information exists but does so without reorganizing into self-contained groups. It is achieved through lateral relationships. However, since these informal

processes do not always arise spontaneously out of the needs of the task, they should be designed. In the 1970s researchers identified a few types of lateral relationships, e.g., direct contacts, liaison and integration roles, task forces, etc. [16, 32]. According to modern understanding, all these issues are related to the field of Knowledge Management (KM).

Paper [47] identifies four generations in the development of KM as a research discipline. In the first stage (1960–1980), concept of knowledge as a tool that impacts the performance of the organization has emerged. In the second stage (1990s), knowledge was viewed as a process. The third generation of research (2000s) had linked knowledge management to the success of organizations in general. In the current period (2010s), KM role is identified more as a social process than a management system that should be designed.

Thus, the modern knowledge management system in the broad sense is the technology and managerial methods that support the development of social capital, i.e., corporate culture motivating and stimulating the information exchange. Technologically, the knowledge management system can be based both on traditional communication systems [37] and on social networks. Note that the paradigm of social networks exactly corresponds to the model of social capital [48], which is defined through structural (horizontal relationships on the work level), cognitive (shared codes and language), and relational components (trust, norms, and obligations). In other words, we can say that the purpose of the knowledge management system is not to provide all the necessary knowledge to a specific employee but to quickly find in the organization or even outside it someone who has the competencies required. *Not to know everything, but to know who knows.*

Therefore, following the presented concepts, this information design strategy can be defined as the *Creation of a Knowledge Management System.* We can assume that it can be the most attractive strategy of organization design in the near future. However, it requires significant changes in a corporate culture that can become an insurmountable barrier for many organizations.

Table 1 presents all of the organization's design strategies in terms of information processing, their benefits, and limitations. As we can see, the first strategy—Creation of Redundant Resources—is viewed as the worst choice in any circumstances; and last—Creation of Knowledge Management System—as potentially the best one. However, in reality, any organization combines all four strategies that can exist at different levels of the hierarchy or in different vertical sub-systems.

5 Information Processing Capabilities of Information Systems

We have established above that effective information support for decision-making is the key to the performance of an organization in all other senses. Organizational design strategies that enhance an organization's ability to process information must

Table 1 Organizational information processing strategies

Strategy	Benefits	Limitations
Creation of redundant resources	In general, this strategy does not produce any benefits. According to TOC, the creation of redundant resources (buffers) is justified only in front of the least productive nodes of the job chain to guarantee their stable load	This strategy arises from a lack of information and leads to the inefficiency of organizations in general
Creation of self-contained tasks	The moving of the decision-making down in the level to where the tasks processed, and the information exists. The organization consists of a set of "black boxes" that hide internal complexity. There is no information exchange between "black boxes" and, therefore, no need for coordination and synchronization	It is complicated to implement such a system in practice fully. Small autonomous teams can solve only small problems. If it becomes necessary to combine several teams for a more complex task, the processing of information may require more effort than in the case of non-autonomous groups
Investment in information systems	The simplifying information processing in the authority hierarchy by the formalization of a decision-making language. It can be realized without IT	May lead to information overload. However, IT-based applications can reduce this overload due to (1) process and rules standardization and (2) implementation of algorithms that make a decision
Creation of knowledge management System	The moving of the decision-making down in the level to where the tasks processed and the information exists. Establishing a context that supports information and knowledge exchange between workers and groups	It requires significant changes in a corporate culture that can become an insurmountable barrier for many organizations

rely on Information Systems (IS). Currently, there are a significant number of classes of IS that ensure the satisfaction of the various needs of individuals, organizations, and humanity as a whole. Therefore, it is essential to assess information processing capabilities for each class of IS. This should help to align IT and business in choosing the best organizational design.

The results of an empirical study [49] show that IT-related practices have a significant impact on the information processing and knowledge management (KM), financial results, and competitiveness of the company, mainly if they are supported by appropriate actions in the field of HR.

A comparison of KM processes and core IT was conducted in [37]. Authors noted the role of technologies such as data mining (knowledge creation), databases

(knowledge storage), forums (knowledge transfer), and expert and workflow systems (knowledge use). In [50], the list of KM processes and associated IT systems has been significantly expanded to take into account recent technologies.

Hayes [51] noted that key IT that is associated with information processing and knowledge management could be classified into three main groups: integration systems that provide storage and retrieval (document management, data mining, directories, expert systems, workflow systems, etc.); interactive systems that support the interaction of people, the distribution, creation, and use of knowledge (e-mail, forums, social networks, blogs, and other Web 2.0 systems); and platforms (groupware, intranet, and enterprise 2.0) that offer general principles for building infrastructure.

Davenport [52] proposed a classification of organizational technologies that support the activities of various classes of employees. He considered two dimensions—the complexity of the work performed (from performing routine procedures to expert activity) and the level of independence from other employees (from an individual activity to large group interaction). Wiig [53] proposed a more detailed classification of work complexity—from routines to actions in a completely unpredictable situation. Based on the integration of the approaches of these researchers, it is possible to construct a classification of information systems that are used to support various types of activities related to information processing (Fig. 3).

The transactional class includes ERP systems that automate the performance of routine procedures and require the employee to know only their duties. The general process, the purpose of data, and their further use may not be known to him or her.

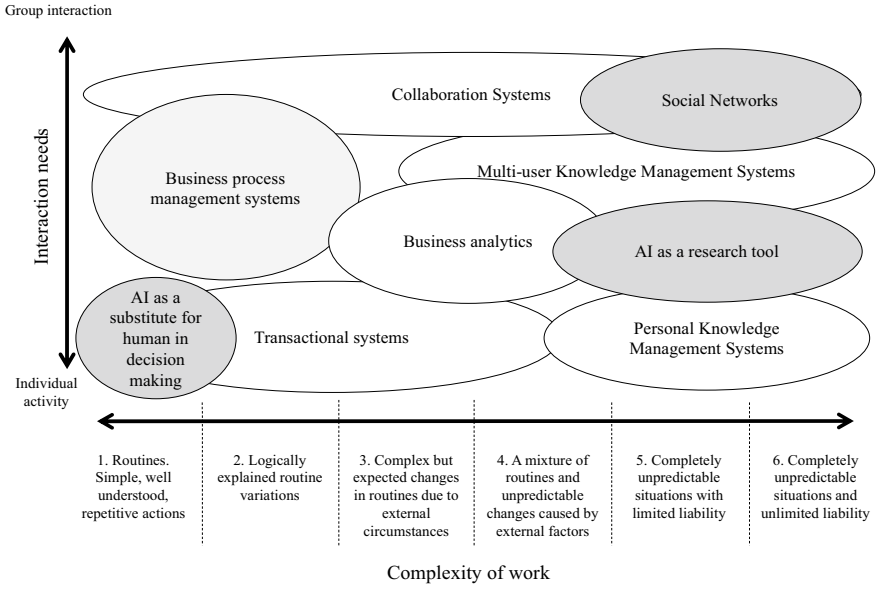

Fig. 3 Classification of information systems

Business process management systems (BPMS) support small and medium group collaboration within rigidly defined models; changing a process requires, at a minimum, modifying its description in the system.

Collaboration systems (e-mail, messengers, forums, and social networks) do not impose any restrictions on the processes. It can also be noted that the degree of data formalization decreases as one moves up the axis "Interaction needs."

Personal knowledge management systems include any tools that allow an employee to save his existing digital objects and the connections between them—from merely storing documents in a file system, to mind maps, etc. Search for objects in such systems, as a rule, is carried out using classifiers created by the user (for example, by the structure of the file system folders). Effectiveness of personal information management is determined, firstly, by the motivation of the employee, and secondly, by his ability to manage information [54].

Multi-user knowledge management systems should provide tools for working with metadata (data about data); advanced search tools; the ability to analyze the relationships that arise between elements of the system (users, documents, etc.). Traditionally, such systems were built as centralized repositories, often assuming the existence of a certain structure for saving and searching for knowledge. However, the modern view implies that knowledge cannot be controlled in this way, it is only necessary to provide the user with flexible tools for organizing their personalized networks of communication and knowledge, similar to how it is done in social networks such as Facebook. Therefore, the use of enterprise social networks (ESN) is today the main trend in the technological support of knowledge management [55].

The first studies of enterprise social networks [56] showed that the introduction of this class of systems has a positive effect on the individual productivity of employees, while the quality of processes is enhanced, and innovation activity is stimulated. Also, Leonardi [57] noted another essential role of ESN; they contribute to the spread of not only knowledge itself, but also meta-knowledge (knowledge about knowledge: "who knows what" and "who knows whom").

Business intelligence systems in their traditional form (i.e., On-Line Analytical Processing/OLAP) are designed to execute predefined queries that return generalized data sets. Recently, their functions are expanding through the use of AI systems. The use of artificial intelligence/data mining systems, especially those based on big data, is more like a scientific activity—hypotheses formulation and testing them against existing data. But we can also identify another class of AI-based systems that automate decision-making (for example, whether a given message is spam or whether this borrower is a scam) based on patterns and pre-trained models. Such models are implemented as routine functions and replace humans.

Note that outside the scope of our analysis, such approaches as the Internet of things (IoT), blockchain, etc. IoT is a metasystem that is a combination of smart devices that self-learn in the production process and interact with people in making decisions. From this point of view, IoT integrates the functions of both automation of routine processes (AI as a substitute for man) and AI as a tool of accumulating and analyzing data. Blockchain is a new technology for trusting data management that opens up new opportunities for communities, but its influence on decision-making

is much less pronounced. We can compare it with database technologies, which are technical components of information systems.

To summarize the above, each type of information system has its own niche both in terms of the complexity of the supported processes and in terms of the employees involved in them. Obviously, one information system cannot satisfy all the needs of an organization. Therefore, the set of systems must comply with the organization's information design strategy.

6 Conclusion

In the presented work, we examined the mechanism for creating and manifesting the impact of IT on the performance of an organization. Many researchers note that this effect is mainly due to the automation of processes and the implementation of best practices. Still, we believe that this is not true, especially with the advent of new technologies that enable digital transformation.

In our opinion, which is based on organization theory, the effect of IT is created through effective information support for decision-making. This approach allows us to identify the consequences of a lack and excess of information that equally lead to ineffective solutions.

Since information processing is the essential function of the organization, we revised the design strategies identified by Galbraith [16], taking into account the achievements in theory and practice since the publication of his work. As a result, we identified a lack of information as the cause of redundant resources.

We also presented an analysis of information processing capabilities for different types of information systems, which should help in aligning IT and business in choosing the optimal organization design strategy.

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