Systemy Logistyczne Wojsk
Zeszyt 56 (2022)
ISSN 1508-5430, s. 147-160
DOI: 10.37055/slw/155072

Instytut Logistyki
Wydział Bezpieczeństwa, Logistyki i Zarządzania
Wojskowa Akademia Techniczna
w Warszawie

Military Logistics Systems
Volume 56 (2022)
ISSN 1508-5430, pp. 147-160
DOI: 10.37055/slw/155072

Institute of Logistics
Faculty of Security, Logistics and Management
Military University of Technology
in Warsaw

Information in the decision-making process

Informacja w procesie decyzyjnym

Zbigniew Ścibiorek
zbscibi@wp.pl; ORCID: 0000-0002-7408-4302
The International University of Logistics and Transport, Faculty of Logistics and Transport, Poland

Anna Borucka
anna.borucka@wat.edu.pl; ORCID: 0000-0002-7892-9640
Military University of Technology, Faculty of Security, Logistics and Management, Poland

Abstract. The thesis that the variability of conditions in which organizations operate has an impact on the decisions made about their functioning is the starting point for achieving the research objective and presenting the research findings. The objective of the research was to demonstrate the importance of the information system in the organization and to visualize the impact of information on the decision--making process, also in terms of shaping the future. The analysis of a number of theoretical studies has led to conclusions that unequivocally prove that every decision should be based on reliable information. This is strongly emphasized in the article. The main methods used were literature analysis, synthesis, mathematical modeling and desk research.
In addition, the paper presents tools for describing the uncertainty associated with the occurrence of random phenomenon, i.e., for assessing the amount of information conveyed by the observation of random phenomenon and for comparing two variables with different information potential. The analyses conducted clearly indicate that decision making and information must be closely linked. The results of the research inquiries in the publication also indicate the role to be played by the information system in the organization. It contains the state-ment that no decision can be made without information. The approach adopted in the article allowed for presentation of essential research findings, while providing a basis for further, extended research on this ex-tremely important and topical issue, especially in the context of the internationalization of a number of phe-nomena and processes.
Keywords: entropy, information theory, Kullback-Leibler divergence, decision making, organization, globalization

Abstrakt. Teza, że zmienność warunków funkcjonowania organizacji nie pozostaje bez wpływu na dokonywane rozstrzygnięcia związane z ich funkcjonowaniem, jest punktem wyjścia do osiągnięcia założonego celu i prezentacji wyników badań. Celem podjętych badań było wykazanie znaczenia systemu informacyjnego w organizacji i unaocznienie wpływu informacji na proces decyzyjny, także pod kątem kształtowania przyszłości. W wyniku analizy wielu opracowań teoretycznych, także zawierających wyniki przeprowadzonych badań, wysnuto liczne wnioski. One to jednoznacznie dowodzą, że podstawą każdego rozstrzygnięcia powinna być wiarygodna informacja. Jest to mocno podkreślone w artykule. Ukazano również potrzebę podejmowania działań ukierunkowanych na zdobycie, w miarę szybko, nieodzownych informacji, aby stworzyć podstawy do korzystnych rozstrzygnięć dla firm, które funkcjonują w zmieniających się warunkach. Nieodzowne są także wysokie kompetencje informacyjne menedżerów. Przeprowadzone analizy jednoznacznie wskazują, że decydowanie i informacja muszą być ze sobą ściśle pozwiązane. Wyniki dociekań naukowych zawarte w publikacji wskazują również na rolę, jaką ma spełniać system informacyjny w organizacji, który choć składa się z trzech etapów, to są one logicznie powiązane, fazy te charakteryzuje pragmatyzm naukowy. Zawarto twierdzenie, że bez informacji nie ma decyzji. W artykule przyjęte podejście umożliwiło uzyskanie przekrojowego charakteru prezentacji wyników badań, dając jednocześnie podstawy do dalszych, poszerzonych badań tego niezwykle istotnego oraz aktualnego problemu, zwłaszcza w kontekście umiędzynarodowiania wielu zjawisk i procesów.
Słowa kluczowe: globalizacja, organizacja, informacja, decydowanie, otoczenie organizacji

Introduction

Society today is living in rather complex conditions affecting individuals, economic entities and even the environment [25], [16]. This is influenced by a number of factors, widely discussed in the literature [3], [30]. Globalization and the accompanying process of internationalization of all activities is not without influence on what takes place in relation to the functioning of organizations [40], [4]. The growing impact of the pandemic situation is also of considerable importance [10], [19], [1]. The increasingly turbulent environment directly enforces the need to modify one's behavior and rationally respond to the volatility of the environment. Decisions constantly need to be made, and information is integral to the decision-making process.

The growing interest in information has prompted an analysis of the perception of information in decision making without regard to the specifics of the organization, or its industry and location. In the specialized literature, one can find the opinion that information is used by humans mainly for decision-making, for economic activities [11], [8]. It is also indispensable in logistics processes [13], [31], [38]. Such an approach confines a person to professional activity, reduces him/her as a personality to an individual engaged only in business. Meanwhile, a person is an individuality that must be considered in various dimensions, e.g., professional, social, psychological, cultural, or historical. And in any such dimension, information is always needed by an individual and plays a variety of roles.

Findings from past research on decision-making issues support the conclusion that decisions are often based on insufficient information, leading to poorer choices. On the other hand, we find that a smaller information resource makes it

much easier to choose between two options, thereby reducing the cost invested in exploration [6], [15].

Interdisciplinary knowledge is necessary for effective decision-making. Experience is also important, but it cannot be the primary consideration in evaluating events and information to be taken into account when making a decision. This corresponds with the statement that the intellectual capacity of an organization's personnel becomes the source of its wealth [12].

Operating in an increasingly dynamic environment generates newer and newer types of risks that should be analyzed continuously and systematically. This requires having reliable information, acquired in a relatively quick time frame. Therefore, the purpose of the research presented in the article was to demonstrate the importance of the information system in the organization and to visualize the impact of information on the decision-making process, also in terms of shaping the future. In addition, tools for describing the uncertainty associated with the occurrence of random phenomenon, i.e., allowing the assessment of the amount of information conveyed by the observation of random phenomenon and also comparing two variables with different information potential, were presented. The need for actions aimed at gaining key information to lay the groundwork for decisions benefiting companies that operate in a changing environment was also demonstrated. At the same time, the importance of information literacy of managers, central to the decision-making processes, was emphasized. The scientific inquiries conducted by the authors also clarify the role to be played by the information system in the organization. Therefore, it can be concluded that the presented study is not only a comprehensive presentation of the concepts related to information, information system and decision-making process but also provides a basis for further, extended research on this important and topical issue, especially in the context of internationalization of a number of phenomena and processes.

Information features

Being information literate allows one to identify one's own information needs, locate the source of the information one needs, evaluate it, and use it effectively [27].

The analyses conducted clearly indicate that decision making and information must be closely linked. With considerable generalization, it can be concluded that decision making is a series of steps involving the reception, processing, and dissemination of information. Managers receiving information must decide what to do with it. Some can be kept for possible further use, while other pieces of information are grouped to form new information. Some pieces of information are used immediately, some are passed on to others, and some are discarded altogether.

Useful information is [36]:

- Accurate - if information is to have real value to the manager, it must be reliable. Such information is an authentic image reflecting reality.
- Up-to-date - up-to-date information must be available when it can be the basis for appropriate managerial action; this does not necessarily mean that it should be delivered quickly. Up-to-dateness is a function of the situation the manager is in.
- Complete - complete information provides the manager with all the facts and details he or she needs. The picture of the situation must be complete if the information is to be useful; if the information is incomplete, the manager may develop an inaccurate or distorted picture of reality.
- Appropriate - appropriate information is information that is useful to the manager, depending on his or her specific needs and conditions.

Verification of the above gave rise to the following question: Is the breakdown presented above accepted by everyone? Interpretation of a number of theoretical studies has led to the conclusion that the answer is not indeterminate, mainly because it is not uncommon to find records where, for example, the term useful or appropriate information is used instead of relevant.

The role of information in an organization

In an organization, information serves multiple functions. It depends on the objectives it serves, the level of management, the foresight of management in shaping the future of the enterprise, the degree of its activity, the complexity of operating conditions, etc. From the point of view of the needs of the company's management, the following types of information are distinguished:

- serving to assist in making various decisions,
- ensuring adequate communication between employees and their groups,
- satisfying other needs of its users (company members).

On the other hand, taking into account the needs of employees, it can be divided into orienting information, i.e., information about the whole enterprise, information about the conditions and results of employees' own work and position in the enterprise (information designing and correcting behavior) [28].

Information should be relevant to the needs of each level of management. In general, it can be assumed that the lower the level of management, the more detailed information the decision maker should have. Conversely, the higher the level of management, the more general the scope of information should be [45].

The list of information needs can be developed in two variants: in terms of the sender or in terms of the receiver. In the first case, the set of information needs is drawn up according to the organizational units or jobs where the sources of information are located and from where they are sent to the appropriate addressees. In the second

solution, lists of information needs are developed for jobs where specific decisions are to be made. Information is anything that can be used to more efficiently select a course of action to achieve a specific goal, ensuring the greatest possible impact.

An empirical assessment of owned information resources

Information in organization and management theory

As shown above, the foundation of any organization is the possession of certain information. It forms special resources of any business that play a very important role in its smooth operation.

Knowledge in this area is provided by organizational and management theory, which contains a set of empirically verified assertions available to management practitioners and lists of issues that should be resolved before action is taken and examined in the course of controlling the action taken. For example, these are the guidelines for efficient operation from organization and management theory. Their usefulness to practice is seen in the fact that it facilitates decision making by exploring and designing options for action according to different circumstances. Thus, theory serves to increase the accuracy of decisions, it also allows the practitioner to see certain phenomena that would remain unnoticed without its knowledge.

Having the right information is therefore the basis for success and an indispensable activity is constant observation and registration of changes occurring in the environment. This is the basis for making reasonably optimal decisions [7].

Information is collected (extracted), processed, stored, analyzed and transmitted for specific purposes. In the broadest terms, the information needed in the decision-making process can be obtained from two sources [24]:

- internal, when the organizational units and positions within the entity carry out the process of acquisition, collection, storage and processing of information;
- external, when using publicly available information sources or outsourcing this task to information preparation professionals; some of the information obtained from entities may come from business intelligence, which is emerging as an independent function of the business entity in modern management concepts.

It is worth emphasizing that even the best information is not in itself a guarantee of effective action, because the basis for decision-making must be knowledge. Knowledge is information selected, interpreted and used in such a way that, taken together, it forms a coherent picture of reality, useful for understanding what is currently happening in that reality (for example, the situation with respect to customers' preferences, signals coming from neighboring companies, the effects that a particular change in the law will have, the possible impact of the weather changes, etc.) [43].

Entropy as a measure of the amount of information

Today, an information system is needed to collect and gather information to respond quickly to opportunities and emerging threats.

It is important not only to obtain the right information, but also to process and use it correctly. What matters here are new ideas, innovative action, and the ability to generate new knowledge [5]. It is also extremely important to evaluate the information acquired, and this is where measures of information quantity come in handy. In the case of a data stream generated by a source, the concept of entropy is used to determine the amount of information.

Entropy — the expected amount of information — is particularly important for information processes. If we assume that set is a set of disjoint events exhausting the space of elementary events such that is 1 — is a certain event, then the entropy of the set , is called the number defined by the formula [32]:

$$H(Z) = -\sum_{i=1}^{n} P(A_i) \log_2 P(A_i) \tag{1}$$

The components of the above sum are a measure of the randomness of random events. Entropy reaches its maximum if events have equal probability. Then the maximum entropy

A measure used in information theory to determine the divergence (comparison of the amount of information) between two probability distributions is the Kullback-Leibler divergence (also called relative entropy) [18], [2], which, for discrete distributions (like the one analyzed in this paper), is expressed by the formula:

$$d_{KL}(p, q) = \sum_i p(i) \log_2 \frac{p(i)}{q(i)} \tag{2}$$

Where and denote the probability distributions being compared, respectively.

Probability values in the distribution of random variable X were estimated using the classical definition of probability as the relative frequency of occurrence of specific events. We assume that the space of elementary events has a finite number of elementary events and each event is equally likely, then the probability of any event is expressed by the formula:

For any $A \subset \Omega$: $P(A) = \frac{|A|}{|\Omega|}$

Where: is the probability of occurrence of event ,
is the event count,
is the size of the space of elementary events (i.e., the number of all elementary events in a random experiment)

Information criteria are also used for comparison, including the most popular Akaike Information Criterion (AIC) and the Bayes Information Criterion (BIC).

We determine the size of index from the formula:

$$\mathrm{AIC} = -2\ln \mathrm{L} + 2\mathrm{k} \tag{3}$$

while the value of according to the formula:

$$\mathrm{BIC} = -2\ln \mathrm{L} + \mathrm{k}\ln(\mathrm{n}) \tag{4}$$

where: — number of parameters in the model, — credibility function — sample size. The smaller the value of information indices, the better the model fit.

Measures of the amount of information — a case study

The presented measures of information were used in the analysis of sales effectiveness of selected agents, expressed by the number of sold products in relation to the number of customers visiting the analyzed outlets on a given day. The goal was to see what the measure of uncertainty is for the occurrence of a given event (in this case sales) in a set of events. Statistical entropies were determined first, according to equation (1). The results for selected 4 outlets are presented in Table 1.

Table 1. Values of statistical entropies determined for 4 selected outlets

Outlet no.	**Outlet no. 1**	**Outlet no. 2**	**Outlet no. 3**	**Outlet no. 4**
Entropy	24.16	30.07	19.56	27.06

Source: Own study

Figure 1 presents the obtained results in graphical form. It can be clearly seen that the smallest entropy value was obtained for outlet 3, which implies the smallest measure of uncertainty and the most concentrated distribution of the variable.

Then, using the Kullback-Leibler divergence, a comparison was made between all four outlets (each to each). The results for the analyzed outlets are presented in Table 2.

Table 2. Values of Kullback-Leibler divergence determined for selected outlets

	46.05
	56.72
	47.53
	60.4
	45.12
	4.49

Source: Own study

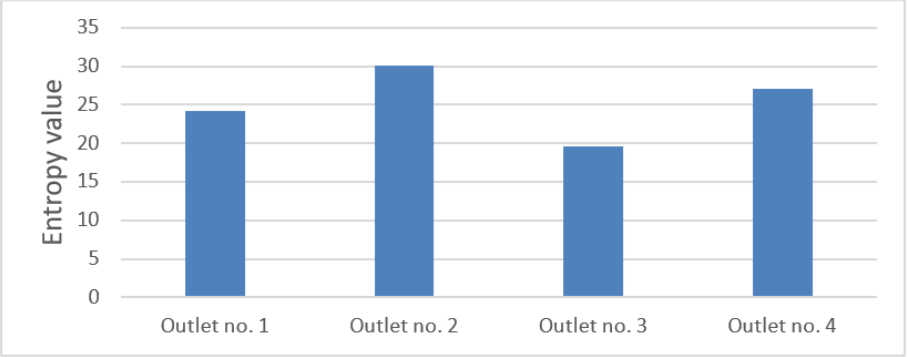

Fig. 1. Graph of calculated statistical entropy values
Source: Own study

Relative entropy always takes non-negative values, with zero if and only if the distributions being compared are identical [14], [26]. This did not occur in the case studied. The differences between most distributions are large. Only the value obtained for outlets 3 and 4 represents a small difference in information between the two distributions. For the company under study, this means seeking other sources of information on sales effectiveness. The value of the entropy obtained as well as the Kullback-Leibler divergence show that the uncertainty measure is large and the individual outlets cannot be compared with each other.

Information system

In the course of the research conducted, it was found that there is no unanimity regarding the organization's information system [20]. It is most often defined according to management theory as a set of material, financial resources, algorithms and people to ensure the efficient management of an enterprise [44], [20]. An enterprise information system is also understood as "a set of information senders and receivers (organizational units and positions), defined in material, spatial and temporal terms, interconnected by information channels and streams" [39].

The main purpose of an information system is to collect, process, and store useful information that previously existed in a fragmented form, and is available at various locations within and around the organization.

The elements of an information system are: people, hardware, software, databases, telecommunications, and organization.

An information system is a structured and orderly network of information links between elements such as humans, data, methods, and data collection, transmission, and processing devices designed to meet the information needs of the

links involved. A modern feature of such a system is usually the use of computers to collect and process data.

The information system should be characterized by a constant supply of information that must be [29]:

- true and accurate,
- available and current when needed,
- relevant to the situation under analysis,
- complete,
- with a specific frequency of acquisition,
- with a foreseeable projected time horizon,
- presented in a transparent form and suitable for a specific type of managerial decision.

The information system in an organization fulfills a number of tasks [22]. First and foremost, these include [23]:

- ensuring the efficient transmission of information,
- information storage,
- processing information for management purposes.

In any situation, the information system provides knowledge about the situation that has occurred as well as a forecast of how it will develop [17]. It is no less important that the information system ensures the efficient use of the information it contains through the speed and frequency of its circulation; this means that the information should be up-to-date, complete, and properly sorted. The modern information system is characterized by three basic phases (stages) of functioning [9], [46].

1. Information Acquisition. The information collected relates to all aspects of the organization's near and distant environment (e.g., legal and political, economic, social, technological, demographic, and cultural conditions), as well as its broadly defined interior. Hence, it is very important to be able to value, filter and properly interpret the acquired data [34].
2. Information Processing. Data processing enables data to be relativized and valued to extract the information needed to make a variety of decisions.
3. Sharing, using and storing information for its effective use. Hence, its basic feature should be its usefulness, which consists primarily of the reliability, timeliness and accuracy of information, as well as its form and possibility of making it available.

The information system plays a very important role in all management functions and brings numerous important benefits to the organization. These are mainly:

- up-to-date information and reports, which in a rapidly changing environment and complexity of decision-making problems means better efficiency of actions taken;

- flexible and selective data acquisition, making it possible for a manager to get the information he or she needs at a specific time according to the situation;
- the immediate perception of threats, opportunities and trends, which enables the discovery of changes taking place;
- using multiple sources of information at the same time;
- testing alternative strategies and plans, using simulation models;
- preventing information suppression in the organization to facilitate intermediate and difficult decisions.

The considerations so far lead to the conclusion that an information system is a set of interdependent subsystems that transform data from different sources into information that provides specific value for decisions and actions. Thus, this system bridges the gap between data sources and information users. It should also be emphasized that the quality of management in an organization depends primarily on the availability and possession of accurate, reliable and up-to-date information [42].

Evaluation of the obtained results and final conclusions

Management issues are of continuing interest to theorists and practitioners. Especially the latter are constantly striving to increase the efficiency of management, mainly decisions, which usually concern specific problems embedded in specific conditions [35]. This reality, perceived at the micro and macro scale, has an impact on the decisions made in organizations. They are increasingly embedded in the international dimension of their operations.

Management of an organization is closely related to the quality of decisions made by management. Managerial decisions in any company have a colossal impact not only on business results, but also on the organizational culture, work atmosphere, motivation and attitudes of employees, and how employees feel about their employer and superiors. As with other issues relating to the functioning of an organization, it is essential that decisions are viewed in systemic and process-oriented terms.

The decision-making process involves a logically related group of mental operations, ordered in the correct sequence, to evaluate a decision situation and select the most advantageous option. In this procedure information plays an important role, it is the basis for the decisions made.

It must be reliable and be delivered to the right place (person) at the right time, before becoming outdated.

The analysis of decision-making processes in an organization eventually leads to the grouping of decisions according to the same sets of information. This designates the decision-making areas. Separating them reduces the amount of information required and at the same time, makes them more understandable to decision makers.

This corresponds to the thesis that in order for the information in the company to fulfill its proper role, it should be developed according to certain requirements. In other words, it should create a system that ensures, above all, the selection and completeness of information and its speed to be used in the decision-making process [41].

Recognizing the dynamism of socio-economic processes, especially the speed and rapidity of the occurring phenomena, as well as their impact on decision-making processes, it is reasonable to divide the information according to the time which the information concerns. It is then possible to distinguish information about [37]:

- the past (retrospective),
- the future (prospective).

The problem under consideration deals with decisions made in modern organizations. Therefore, the criterion of the importance of information in the decision cycle is of great importance. In such a case, we distinguish [37]:

Relevant information (objective and subjective) influencing decision-making. Objective information is information that results in increased rationality of actions. Subjective information is used on an ongoing basis, except that its relevance (importance) may vary from person to person. The higher the level of action rationality, the smaller the difference between objective and subjective information.

- Irrelevant information that does not form the basis of the decision-making process and does not affect the final decision.

Since the criteria for the division of information due to the considered context of the decision cycle have been signaled, one more criterion cannot be omitted. From the point of view of the influence of information on decision-making in an organization, we distinguish information:

- concerning activities not covered by the program;
- initiating and establishing programs, not excluding their coordination;
- providing data for a particular strategy of action, thus answering the question: which course of action is better;
- calling the program and answering the question: what problems should be considered;
- communicating the results of an action (control).

Taking into account the way the user uses the information, we can define its nature as:

- direct - directly contributing to decision making;
- indirect - supplementing knowledge already possessed on a given topic, can be used in the future;
- neutral - having no influence on the decision, not arising interest in the recipient.

Information that has a direct impact on a decision can be:

- pre-decisional - necessary to make a decision, causing recognition of the decision problem, its analysis, selection of the option most satisfactory to the decision maker;

- decision-making - a condition of the decision-making process, i.e., the transformation of initial and already possessed information into a decision;
- resultant - reflecting the level of the implemented decision, task. It is most often the basis for subsequent decisions.

Information is the lifeblood of the management body — it is the basis for sound decisions. If the right information cannot be obtained, then decisions must be based on assumptions, feelings, and guesswork. Information is both the raw material and, when properly processed, the finished product (result) of the work. Information is the material from which a decision is formed, which informs later decisions and the implementers of the decision. Thus, a decision is a kind of information, carrying, in addition to the knowledge of reality, the factor of shaping the future.

Summary

The growing interest in the determinants of the decision-making process is an offshoot of the changing situations that occur in the environment and within organizations. They cause disruptions in its functioning, having an impact not only at the time when the specific event occurs, but also projecting into their future. Problem situations arise, the solution of which requires a well-thought-out decision. It is commonly believed that any range of action, even the narrowest one, consists of a sequence of decisions made by an acting entity, a continuous process of choosing options, goals, and courses of action. It is also emphasized that information is the basis for decision-making.

Due to the important interest of the operation of an organization, it is necessary to establish an information-based management system and an information management system. It is necessary to create conditions so that the functioning solutions are conducive to making the right decisions. This is fostered by having credible, reliable information that reflects reality as best as possible. Helpful in its evaluation are measures used in statistics and information theory to describe them or to identify discrepancies between them. The selected ones are presented in this article.

Information systems play an increasingly important role in the management of knowledge and innovation in the enterprise, and their application allows to increase the competitiveness of enterprises wishing to adapt to the global trends of civilization development and recognizing knowledge as a strategic resource of the enterprise. The dependence of a number of phenomena and processes on information is a premise for the statement that, living in an information society, we are beginning to create an information civilization.

In conclusion, it should be stated that the aim of the research, which was to demonstrate the importance of the information system in the organization and to visualize the impact of information on the decision-making process, also in terms of shaping the future, has been achieved. Detailed analysis of available theoretical studies clearly proves that the basis of any decision-making process should be reliable information, and the presented tools can be used to assess it.

BIBLIOGRAPHY

[1] Amdal, C. D., Pe, M., Falk, R. S., Piccinin, C., Bottomley, A., Arraras, J. I. & Bjordal, K., (2021). Health-related quality of life issues, including symptoms, in patients with active COVID-19 or post COVID-19; a systematic literature review. Quality of Life Research, 30(12), 3367-3381.

[2] Belov, D. I., Armstrong, R. D., 2011. Distributions of the Kullback–Leibler divergence with applications. British Journal of Mathematical and Statistical Psychology, 64(2), 291-309.

[3] Berbekova, A., Uysal, M., & Assaf, A. G., 2022. Toward an assessment of quality of life indicators as measures of destination performance. Journal of Travel Research, 61(6), 1424-1436.

[4] Beumer, C., Figge, L., Elliott, J., 2018. The sustainability of globalisation: Including the 'social robustness criterion'. Journal of Cleaner Production, 179, 704-715.

[5] Borowiecki, R., Kwieciński M.(red.), 2003. Informacja w zarządzaniu przedsiębiorstwem. Ku przedsiębiorstwu przyszłości, Grupa Wolters Kluwer, Kraków.

[6] Bradley, R., 2017. Decision theory with a human face. Cambridge University Press.

[7] Czermiński, J., 2002. Systemy wspomagania decyzji w zarządzaniu przedsiębiorstwem, Towarzystwo Naukowe Organizacji i Kierownictwa Dom Organizatora, Toruń.

[8] Dhingra, M., Jain, M., Jadon, R. S., 2016. Role of artificial intelligence in enterprise information security: A review. In 2016 fourth international conference on parallel, distributed and grid computing (PDGC), 188-191.

[9] Ferens, H. (red.), 1991. Organizacja przetwarzania danych, PWE, Warszawa.

[10] Ferreira, L. N., Pereira, L. N., da Fé Brás, M., Ilchuk, K., 2021. Quality of life under the COVID-19 quarantine. Quality of Life Research, 30(5), 1389-1405.

[11] Gorkhali, A., Xu, L. D., 2019. Enterprise architecture, enterprise information systems and enterprise integration: a review based on systems theory perspective. Journal of Industrial Integration and Management, 4(02), 1950001.

[12] Grodziski, J., 2003. Rola kapitału ludzkiego w rozwoju gospodarki globalnej, Uniwersytet Gdański, Gdańsk.

[13] Gunasekaran, A., Subramanian, N., Papadopoulos, T., 2017. Information technology for competitive advantage within logistics and supply chains: A review. Transportation Research Part E: Logistics and Transportation Review, 99, 14-33.

[14] Hobson, A., Cheng, B. K., 1973. A comparison of the Shannon and Kullback information measures. Journal of Statistical Physics, 7(4), 301-310.

[15] Huq, A. Z., 2020. A right to a human decision. Va. L. Rev., 106, 611.

[16] Iancu, A., Popescu, L., Popescu, V., 2021. Factors influencing social entrepreneurship intentions in Romania. Economic Research-Ekonomska Istraživanja, 34(1), 1190-1201.

[17] Jabnoun N., Sahraoui S., 2004. Enabling a TQM structure through information technology, Competitiveness Review, American Society for Competitiveness, Pittsburg.

[18] Joyce, J. M., 2011. Kullback-leibler divergence. In International encyclopedia of statistical science , 720-722. Springer, Berlin, Heidelberg.

[19] Kasar, K. S., Karaman, E., 2021. Life in lockdown: Social isolation, loneliness and quality of life in the elderly during the COVİD-19 pandemic: A scoping review. Geriatric Nursing, 42(5), 1222-1229.

[20] Kisielnicki, J., Sroka H., 2005. Systemy informacyjne biznesu. Informatyka dla zarządzania, Placet, Warszawa.

[21] Kisielnicki, J., 1998. Systemy informacyjne biznesu, Placet, Warszawa.

[22] Klonowski, Z. J., 2004. Systemy informatyczne zarządzania przedsiębiorstwem: modele rozwoju i właściwości funkcjonalne, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław.

[23] Korzeniowski, L., 2005. Wywiad gospodarczy. Historia i współczesność, European Association for Security, Kraków.

[24] Kwieciński, M., 1999. Wywiad gospodarczy w zarządzaniu przedsiębiorstwem, Wydawnictwo Naukowe PWN, Warszawa–Kraków.

[25] Losos, J. B., Lenski, R. E., 2016. How evolution shapes our lives: essays on BIOLOGY and society. Princeton University Press.

[26] MacKay, D. J., Mac Kay, D. J., 2003. Information theory, inference and learning algorithms. Cambridge university press.

[27] Modrzejewski, Z., 2020. Militarne obszary komunikacji strategicznej, Akademia Sztuki Wojennej, Warszawa.

[28] Oleński J., 1998. Ekonomika informacji, Fundacja Promocji Rozwoju im. Edmunda Lipskiego, Warszawa.

[29] Penc-Pietrzak I., 1998. Strategie biznesu i marketingu, Wydawnictwo Profesjonalnej Szkoły Biznesu, Kraków.

[30] Rabe, N. S., Osman, M. M., Bachok, S., Rosli, N. F., Abdullah, M. F., 2018. Perceptual study on conventional quality of life indicators. Planning Malaysia, 16.

[31] Sałek, R., 2021. The importance of telematic information and logistics indicators for the management of the quality of transport services. Production Engineering Archives, 27(3), 176-183.

[32] Shannon, C. E., 1948. A mathematical theory of communication. The Bell system technical journal, 27(3), 379-423.

[33] Szmit, M., 2003. Informatyka w zarządzaniu, Difin, Warszawa.

[34] Szybiński, L., 1979. Projektowanie organizacji przedsiębiorstw, PWE, Warszawa.

[35] Ścibiorek, Z., 2021. Decydowanie podstawową funkcją zarządzania, Toruń

[36] Ścibiorek, Z., 2018. Informacja podstawą decydowania [w:] Uwarunkowania procesu decyzyjnego w niemilitarnych zdarzeniach nadzwyczajnych, PWN, Warszawa.

[37] Ścibiorek, Z., 2003. Podejmowanie decyzji, Agencja Wydawnicza Ulmak, Warszawa.

[38] Tang, X., 2020. Research on smart logistics model based on Internet of Things technology. IEEE Access, 8, 151150-151159.

[39] Urbanowska-Sojkin, E., Banaszyk P., Witczak H., 2007. Zarządzanie strategiczne przedsiębiorstwem, PWE, Warszawa.

[40] Walsham, G., 2017. IT, globalisation and cultural diversity. In Information technology in context, 291-303. Routledge.

[41] Wierzbicki, K., 1999. Zarządzanie firmą u progu XXI wieku, Kwantum, Warszawa.

[42] Wrycza, S., 2010. Informatyka ekonomiczna. Podręcznik akademicki, PWE, Warszawa.

[43] Zając, A., Tadeusiewicz R., Grabowski M., Soja P., Trąbka J., 2012. Systemy informacyjne zarzadzania, Uniwersytet Ekonomiczny w Krakowie, Kraków.

[44] Zaskórski, P., 2008. Integracja zasobów i usług informacyjnych w organizacji biznesowej [w:] Zeszyty Naukowe Warszawskiej Wyższej Szkoły Informatyki, Warszawa, 203-217

[45] Zieliński, J. (red.), 1999. Inteligentne systemy zarządzania. Teoria i praktyka, Wydawnictwo Naukowe PWN, Warszawa.

[46] Zygała, R., 2000. Podstawy zarządzania informacją w przedsiębiorstwie, Wydawnictwo Akademii Ekonomicznej, Wrocław.