
Methods Used in Researching the Information Infrastructure of a Military University Library

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Abstract:

Purpose: The aim of the paper was to present the research methods used in scientific research projects led by M. Popławski, PhD entitled "Modeling of socio-economic security in Polish regions" (Project No: 119/WZA/72/DzS financed in 2019 by the Ministry of National Defense), "Multifactorial model of socio-economic security" (Project No: 108/WZA/61/DzS financed in 2018 from the statutory funds the Gen. T. Kościuszko Military Academy of Land Forces and partly by the Ministry of Science and Higher Education) as well as "Multifactorial system for managing the economic security of Lower Silesia" (Project No: 69/WZA/45/DzS financed in 2016-2017 from statutory funds of the Gen. T. Kościuszko Military Academy of Land Forces) in the part concerning research on the information infrastructure of a military university library.

Design/Methodology/Approach: In the introduction to this paper, the justification for the need to undertake research in relation to the research problem posed was presented, and then the research methodology used in the above-mentioned projects was presented in the following order: goal, research hypotheses, scope and sources of work. The last part of the paper presents the research methods in detail together with the justification for their application. The paper ends with summary, where it is indicated how the selected research methods allowed to solve the research problem, and thus to achieve the aim of the work and verify the hypotheses.

Findings: The research problem was solved in the conducted scientific process, which referred to its material scope – the library of military universities, the subject – the management and management system, and space-time – data from domestic and foreign military university libraries from the past. The use of selected research methods allowed for the achievement of the research goal and confirmation of research hypotheses, which were verified through the obtained results of comparative and index analysis carried out in the analyzed libraries of selected military universities.

Practical Implications: The comparative analysis made it possible to indicate which specific elements of the information infrastructure have the most important impact on the functionality of a given library.

Originality/value: As a result of the research undertaken, using the methods presented in the paper, on the one hand – in the cognitive sense, contributed to the enrichment of knowledge in the discipline of management and quality sciences, on the other – in the normative sense, the issues of key information resources for the library of a military university were identified, and

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on the other hand, the third – in the axiological sense, a useful tool was created in the form of the resulting diagram, which can be used to improve the management of information infrastructure.

Keywords: *Research on information infrastructure, research problem, research methodology, purpose of work, research hypotheses, scope of work, sources of work, research methods*

JEL classification: *C000, O300, I230, O310, O320.*

Paper Type: *Research paper.*

1. Introduction

Attempts to improve solutions in the field of managing the information infrastructure of a university library have already been made, but to a limited extent and to a limited extent. The authors focused primarily on measuring the infrastructure of scientific libraries in general (e.g. research carried out since 2001 as part of the project Analysis of the Functioning of Scientific Libraries by the Team for Standards for Scientific Libraries with the participation of the Polish Librarians Association – AFBN (in Polish: Analiza Funkcjonowania Bibliotek Naukowych – Libraries Functioning Analysis – <https://afb.sbp.pl/afb>). However, its individual elements, e.g. information resources, were not distinguished, nor was any attempt to diagnose their condition.

Meanwhile, R. Tomaszewski and M. Polarczyk presented one of the solutions in this regard in the form of the concept of a learning library (referring to the concept of a learning organization – OUS). In their work, they tried to answer the question of whether the OUS will remain only a theoretical model or a practical solution to contemporary problems for libraries of higher education institutions (Tomaszewski and Polarczyk, 2017). On the other hand, R. Orzechowski emphasizes the important role that information technologies play in modern enterprises and other (non-business) organizations (Orzechowski, 2007). These considerations can be transferred to university libraries. Due to the abundance of information nowadays, modern university libraries could not function without the use of information technology (IT).

It is the dissemination of modern technologies that is crucial for this type of organization. M. Wójcik pointed out how important it is to use big data in information management processes in university libraries (Wójcik, 2016). As she noted, big data processing is a phenomenon that can significantly affect not only the way information is managed, but also the management of the entire information infrastructure of academic libraries. The literature also includes works on the knowledge society. It is obvious that modern university libraries should actively contribute to the knowledge society. E. Chmielecka and S. Cisek rightly noticed that access to information, and more precisely, the ability to open up access to it, builds a new social stratification (Chmielecka, 2004; Cisek, 2017). Due to the emergence of the knowledge society, the

importance of information services has increased, their scope and range have expanded, and new forms, methods and tools of work have emerged. Creating a knowledge society will certainly have a very positive impact on the information infrastructure of academic research libraries. It therefore becomes necessary to study it more carefully.

2. Research Carried out so far by the Authors of the Work on the Information Infrastructure of Libraries

A. Kuźnik, being a member of the research team led by M. Popławski, PhD and his PhD candidate (auxiliary promoter), has already undertaken research in the field of managing the information infrastructure of a military university library. As a result of the work undertaken, she delivered a number of papers at domestic and international scientific conferences and published a number of papers in specialist journals. First, on a selected group of university libraries, she initially assessed the impact of information infrastructure on key indicators of university libraries' activity (A. Kuźnik, M. Popławski, and S. Stanek, 2017), she also reviewed the methods used in research on the information infrastructure management process in scientific libraries (Kuźnik, 2019) to then publish the results of preliminary research on the information infrastructure of selected libraries of military universities (Kuźnik, 2019).

In the next two articles, she discussed the subject of information retrieval systems in scientific research projects (Kuźnik, 2016) and proposed a detailed methodology for researching the information infrastructure of modern libraries of military universities (Kuźnik, 2019). Subsequently, she reviewed new directions and trends in the management of information resources in libraries of military universities in Poland (Kuźnik, 2020) and presented detailed results of research on the implementation of management functions in selected libraries of military universities in the country (Kuźnik, 2020). Finally, she synthetically presented the results of her own research on the information infrastructure management process in selected libraries of military universities in Poland, as an element of the decision support system (DSS) (Kuźnik, 2020).

The results of the research undertaken constitute an original contribution to the discipline of management and quality, as they explain the complicated process of managing the information infrastructure of a military university library. Until now, no such research has been carried out in Poland. In the utilitarian dimension, the conducted research resulted in the preparation of a report on the state of the information infrastructure of libraries in selected military universities (The Library of the War Studies University, The Jarosław Dąbrowski Main Library of the Military University of Technology, The Lech Kaczyński Main Library of the Polish Naval Academy of the Heroes of Westerplatte and The Library of the Gen. Tadeusz Kościuszko Military University of Land Forces). The report may in the future be used by decision-makers to modernize and improve the process of managing information resources in libraries they manage.

3. Research Methodology, Research Problem and its Location

In view of the lack of research undertaken in this area, mentioned in the introduction, the main research problem in the implemented projects, in the part for which A. Kuźnik was responsible, was to explain the process of managing the information infrastructure of the military university library. In the cognitive sense, taking up the above problem meant enriching knowledge in the field of management and quality sciences and attempting to explain the process of library management at a military university, in the normative sense – an attempt to identify the issue of information resources, and in the axiological sense – the issue of the usefulness of the created management process scheme (Schroeder, 2016). The research problem was solved in the scientific process related to its material, subject and space-time scope. The material scope included the libraries of military universities, the subject scope – the entire management and management system, and the space-time scope - data from the past and future forecasts, as well as from domestic and foreign libraries of military universities.

Both the database on information resources of military universities' libraries was created and the scheme of the information infrastructure management process itself may constitute Decision Support System (DSS) undertaken by middle and senior management in the surveyed organizations. In the literature on the subject, the authors provide three basic components of the DSS architecture, i.e., database (or knowledge base), model (e.g. decision-making, user criteria) and user interface (Haettenschwiler, 1999; Power, 2002; Sprague and Carlson, 1982; Haag, Cummings, McCubbrey, Pinsonneault, and Donovan 2000; Marakas 1999). As a result of the undertaken works, the first two elements were created, a database on information resources of military university libraries and a diagram of the process of managing the information infrastructure of a military university library.

According to the classification of C.H. Holsapple and A.B. Whinston, the two above-mentioned elements could co-create a problem-oriented DSS and provide practical organizational support (Holsapple and Whinston 1996). After adding the user interface, understood here as the part of the software responsible for interaction with the user (Shneiderman and Plaisant 2009), the system could generate a diagnosis and forecast of the state of information resources along with the proposed remedial actions, which would undoubtedly help to improve the functioning of the entire organization - here: the library of a military university.

Effective implementation of the resulting DSS would require further, according to P. Gołoś (Gołoś, 2010), appropriate preparation and implementation of the entire process of related activities, i.e., selecting the appropriate implementation methodology – e.g., by commercializing the resulting system, estimating the budget, planning and designing individual activities of the implementation process – from its patenting, through testing, and ending with commercialization, establishing and defining the implementation schedule, allocating material and intangible resources necessary to

implement the implementation, and determining factors and constraints that may affect individual stages of the implementation process.

4. Purpose, Research Hypotheses, Scope and Sources of Work

The aim of the work was to explain the process of managing the information infrastructure of a military university library. The resulting flowchart of the process may contribute to the improvement of the information resources of military university libraries.

Two research hypotheses were formulated in the work: 1) With the use of selected methods, it is possible to identify solutions that improve the management of information resources of a military university library, and 2) There are interactions between management functions in a military university library. The research hypotheses were verified by the obtained results of comparative and index analysis carried out in selected libraries of military universities.

The scope of the work covered selected libraries of military universities in Poland: The Library of the War Studies University, The Jarosław Dąbrowski Main Library of the Military University of Technology, The Lech Kaczyński Main Library of the Polish Naval Academy of the Heroes of Westerplatte and The Library of the Gen. Tadeusz Kościuszko Military University of Land Forces. The work also refers to data and information obtained from libraries of other military universities in the world (e.g., Military Academy at West Point). The time range is modern times – the data comes from the last few years.

This work is based on the literature on the subject, legal acts, articles from professional press, electronic sources and source materials obtained from the analyzed organizations (qualitative and quantitative data). The functional indicators that were the subject of statistical analysis (grouping-type taxonomy method) were developed by the AFBN (effectiveness indicators and statistical data [on-line]: <https://afb.sbp.pl/afbn/materialy>). The project selected indicators that may have an impact on the information infrastructure. The data necessary to calculate the functionality indicators of the analyzed libraries of military universities were obtained from the directors of individual libraries, with the exception of the library of the Military University of Technology, which provided the indicators already calculated, because it participates directly in the AFBN project. Of the 109 functionality indicators developed by AFBN, 41 have been distinguished which strictly relate to the information infrastructure (Kuźnik 2019a; 2019b). The above functional indicators were calculated after obtaining raw data from individual libraries of military universities. The formula for calculating the indicators was included in the study of the AFBN project (Library Functional Analysis – [on-line]: https://afb.sbp.pl/afbn/wpcontent/uploads/2020/02/AFBN_wskazniki_2019_portal.pdf).

5. The Methods Used in this Work

J. Ledzianowski and A. Michaluk indicate that the scientific method should aim at establishing and explaining new facts, phenomena, processes, relationships and dependencies between them. According to the authors, it must therefore be clear – universally understandable, unambiguous and excluding freedom of interpretation; purposeful - that is, subordinated to a specific goal; effective – to achieve the goal at the lowest cost, use of resources, resources and time; reliable – allow you to achieve the intended results, goals, with a high degree of probability; repeatable – ensure repeated obtaining of identical results for the same test conditions. Scientific methods are developed according to the subject of research and the scientific discipline. The choice of methods should be characteristic and appropriate for a given scientific discipline (Ledzianowski and Michaluk 2012). On the other hand, K. Duraj-Nowakowa emphasizes the importance of the creative aspect of science, which - in her opinion - deserves special attention because creativity is defined as activities carried out without patterns - due to their objective lack – and aimed at obtaining original and socially valuable products and scientifically (Duraj-Nowakowa 2012).

The following research methods were used in the work, the first four of which belong to the group of pragmatic methods, and the last to the group of formal methods (according to the general classification) (Zdonek and Hysa, 2017; Sułkowski, 2011):

- 1) a method of in-depth studies of the subject literature and source data,
- 2) case study method,
- 3) methods of comparative and index analysis,
- 4) methods of direct and telephone interview and
- 5) statistical methods: taxonomy method in the grouping type (based on the study of the distance from the standard), the arithmetic mean method and the weighted average method.

Ref. 1): The method of studying the subject literature was the first to be used in the work because, as K. Duraj-Nowakowa argues, it is not indifferent to any field, discipline and specialization of science, how the state of knowledge on the selected problem of cognition will be developed as the goal of complementary works in the case of description of the full cognitive cycle, from theoretical premises, through the concept of own research and their implementation, to the preparation of the results (Duraj-Nowakowa, 2012). The authors, before undertaking the measurement of information infrastructure, had to precisely define its concept. That is why they started with theoretical considerations about information infrastructure, information resources, their management, and information culture. It was also necessary to synthesize the theoretical knowledge on the research methodology and research methods used in management sciences and library science in relation to the research area undertaken by the author.

Ref. 2): The application of the case study method found its justification in the need to perform a comparative analysis of information resources in four selected libraries of military universities. As J. Brzeziński points out, the implementation of various goals of scientific cognition, apart from explaining reality and/or predicting the occurrence of new states of affairs, is also to describe this reality (Brzeziński, 1997), which, as M. Matejun states in his research, is particularly applicable in the works of young scientists in the field of management sciences (Matejun, 2011). As a result of the application of this method, the authors indicated the key information resources for the functioning and development of selected libraries.

Ref. 3): Comparative and index analysis methods. The authors of the main concept of the factor analysis method are CH psychologists. Spearman (1904) and L.L. Thurstone (1913). Ch. Spearman introduced the concept of a single general factor to explain the results of intelligence tests, and L.L. Thurstone laid the foundations for the theoretical foundations of factor analysis. The purpose of factor analysis is to strive to isolate all factors that may actually be in the correlations of a given system of variables, while maintaining as much information as possible contained in the primary variables, and then reducing these factors (Czopek, 2013). 41 factors influencing the shape of the information infrastructure in university libraries were selected by the author from 109 developed by AFBN.

In a detailed analysis, they were defined as indicators of the functionality of the information infrastructure. It was their examination that made it possible to identify those factors that had a positive and negative impact on the functioning of the information infrastructure in the studied libraries and to indicate the directions of improvement activities.

The term "comparative analysis method" (multidimensional comparative analysis - WAP), successfully used in the capital market, refers to a group of statistical methods by which at least two variables describing each object or phenomenon are simultaneously analyzed (Dmitruk and Gawinecki, 2017). In the comparative analysis, the objects were statistical data and those of a qualitative nature from the studied libraries, and the variables were the information resources of the studied libraries. The requirement that the comparative analysis method should serve the study of directly immeasurable phenomena characterizing specific objects subject to analysis has been met here. According to another definition, derived from taxonomic methods, WAP consists in ordering a relatively homogeneous set of objects or features in order to make decisions about the selection of an object or feature according to a predetermined criterion (Grabiński, Wydymus, and Zeliaś, 1989).

The analysis carried out in the study also met the requirements of this definition, because from the set of functional indicators of AFBN scientific libraries, those related to the information infrastructure were selected. The results of the index and comparative analysis made it possible to explain the process of managing the information infrastructure of the military university library.

Ref. 4): The use of direct and telephone interview methods was necessary to provide an opinion (in the form of a self-assessment) of the functioning of the information infrastructure by the authorities of individual libraries surveyed. The self-assessments were confronted with the results of the index analysis, which allowed for a more complete view of the studied phenomenon. M. Szreder points out that direct interview involves obtaining information from the respondent through direct contact with the researcher. Direct contact may take the form of a personal contact – a face-to-face interview (personal), or contact by phone – a telephone interview (Szreder 2002). J. Czekaj points out that the interview is the second most frequently used method of collecting data, the main purpose of which is to examine the opinions and opinions of the interlocutor on a specific topic (Czekaj, 2012), and B. Stępień, that it is also the most flexible – both in terms of the number of received answers and the possibility of control (Stępień, 2004). The questions for the interview used in this paper have been constructed in relation to the indicators of the functionality of scientific libraries related to the information infrastructure. For this purpose, the authors used a self-assessment scale 1-5, then summarized the obtained responses and calculated the arithmetic mean, which indicated which library was rated the highest.

Ref. 5): Statistical methods taxonomy method in the grouping type (based on the study of the distance from the standard), the arithmetic mean method and the weighted average method. The term taxonomy was created by combining two Greek words taxis (system), order and nomos (law, principle). Thus, it can be generally stated that the taxonomy, the roots of which date back to the 18th century, is a science about the principles of classification, and even a synonym for the word classification (Pociecha 2008). Apart from this classic definition, other terms also function in the literature. To emphasize the fact that quantitative methods are used to classify objects in the multidimensional space of features, the term "numerical taxonomy" was introduced.

The famous professor Zdzisław Hellwig introduced and popularized the alternative term "taxonomy", analogous to the terms: econometrics, biometrics, sociometry, psychometrics (Hellwig, 1990). In turn, a branch of the taxonomy are methods of linear ordering of objects, consisting in projecting them from a multidimensional space of features onto a certain straight line, called methods of multidimensional comparative analysis. It is this method that the authors used in their work. It is worth emphasizing that the creator of the multidimensional comparative analysis is Professor Z. Hellwig (Hellwig, 1968).

The effectiveness of the applied taxonomic methods for the classification of socio-economic phenomena has been confirmed by studies, e.g. by B. Prus and K. Król (Prus and Król, 2017). Statistical methods (taxonomy, arithmetic mean and weighted average) as well as direct and telephone interviews were quantitative, while the method of in-depth studies of the subject literature and source data, and the method of comparative analysis - qualitative. The research techniques used in the work are statistical data processing using a spreadsheet and logical conclusions.

6. Summary and Concluding Comments

The management of the information infrastructure in the military university library is of key importance for the functioning of this type of organization as modern information centers. The challenge that was taken up in the research projects, the research methods of which are presented in this article, was to explain the process of managing the information infrastructure of a military university library. As a result, on the one hand – in the cognitive sense, it contributed to the enrichment of knowledge in the discipline of management and quality sciences, on the other – in the normative sense, the issues of key information resources for the military university library were identified, and on the third – in the axiological sense, useful a tool in the form of a resulting diagram that can be used to improve the management of information infrastructure. The research problem was solved in the conducted scientific process, which referred to its material scope – the library of military universities, the subject scope – the management and management system, and space-time – data from domestic and foreign military libraries from the past. And although a number of problems were found, it was possible to answer the questions asked to solve the research problem.

The use of selected research methods allowed for the achievement of the research goal and confirmation of research hypotheses, which were verified through the obtained results of comparative and index analysis carried out in the analyzed libraries of selected military universities.

A comparative analysis allowed to indicate which specific elements of the information infrastructure have the most significant impact on the functionality of a given library (Kuźnik 2020). As the research shows, these factors turned out to be, apart from electronic library systems, still printed books and periodicals (especially national). However, modern databases are gaining more and more importance, including the unique ones (such as in the Security and Defense Portal and the Scientific Information System SINUS of the Biblioteki Library of the War Studies University) and emerging special, specific organizational units, whose task is to care for the development of information resources (such as the Department of Automation of Library Processes in the Library of the Polish Naval Academy or the Technical and Information Section in the Library of the Military University of Technology).

As shown by the results of direct interviews, in the opinion of the authorities of the surveyed libraries of military universities, the best functioning areas of information infrastructure are those relating to library services, library budget management, collection development and increasing the possibility of using the collections.

The ratio analysis made it possible to indicate which specific factors had a positive and which had a negative impact on the functioning of the information infrastructure. Research has shown a particularly positive impact of the appropriate number of jobs, the dynamics of the growth of collections in various forms and computer-generated

printed books, increased expenditure on printed books and electronic resources, the increase in downloaded documents from licensed electronic journals and full-text databases, the increase in the number of training hours and didactic classes for users and vocational training for employees and lowering the cost of using the collections. On the other hand, in the light of the results of the ratio analysis, low general expenditure of libraries, in particular on library collections in various forms, and, on the other hand, high operating costs in relation to the interest in their services have a negative impact. In addition, the inadequate functioning of the information infrastructure is indicated by little interest in the services of a given library, as evidenced by the low number of registering users and students from the university where it is located, a small number of borrowings or downloaded documents from licensed electronic journals and full-text databases, as well as large number of library employees in relation to the number of its users. The research results indicate the long time it takes to prepare books as the reason for the above state of affairs. Moreover, the ratio analysis, and more specifically a synthetic list of functionality indicators related to the information infrastructure, made it possible to rank the libraries in this respect. The Library of the War Studies University ranked highest, followed by the Jarosław Dąbrowski Main Library of the Military University of Technology, the Library of the Gen. Tadeusz Kościuszko Military University of Land Forces was ranked third, and the Lech Kaczyński Main Library of the Polish Naval Academy of the Heroes of Westerplatte was ranked last.

The use of the methods discussed in the article allowed in the last part of the work to characterize the implementation of specific management functions in selected libraries of military universities and to suggest directions of activities in order to improve the entire process of managing the information infrastructure in the studied units. The resulting scheme of the management process allowed for the specification of the most important elements of each of the management functions, which are essential for the proper functioning of the library as a modern information center (Kuźnik 2020 Implementation of the organizing function, Kuźnik 2020 Implementation of the control function, Kuźnik 2019 Implementation of the motivating function, Kuźnik 2020 Implementation of the planning function). It has been pointed out that there are specific interactions between certain management functions that should be taken into account when trying to improve the overall management of the information infrastructure. It has been shown that in libraries of military universities, the planning and controlling functions are particularly interconnected, the visible link is also shown by the function of organizing with the functions of controlling, planning and motivating, and to some extent the functions of controlling and organizing are linked with motivation.

The explanation of the process of managing the information infrastructure of a military university library is a contribution to further research, which will be developed in the future in the research team, whose members are the authors of this article. The described process can also be practically used as an element of the decision support system in managing the resources of various modern information centers.

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