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THE IMPACT OF INFORMATION TECHNOLOGY AND KNOWLEDGE-ORIENTED MANAGEMENT ON THE OPERATIONAL EFFECTIVENESS IN POLISH HOSPITALS

WPŁYW TECHNOLOGII INFORMACYJNYCH I ZARZĄDZANIA ZORIENTOWANEGO NA WIEDZĘ NA EFEKTYWNOŚĆ DZIAŁALNOŚCI POLSKICH SZPITALI

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Summary: The aim of this paper was to present the results of an evaluation of the effect of knowledge-oriented management and level of information technology on the operational effectiveness in Polish hospitals. The data were collected using a questionnaire survey carried out among managers in Polish hospitals. Structural modelling was employed to analyse the data collected. The structural model proposed in the study turned out to fit the data very well, thus demonstrating the positive and cause-and-effect correlations between the level of IT, knowledge-oriented management and operational effectiveness in Polish hospitals.

Keywords: Information Technology, knowledge-oriented management, operational efficiency of hospitals, healthcare management.

Streszczenie: Celem artykułu jest prezentacja wyników badań wpływu zarządzania zorientowanego na wiedzę oraz poziomu technologii informacyjnych na efektywność działalności polskich szpitali. Dane badawcze zebrano za pomocą ankiety skierowanej do menedżerów polskich szpitali. Zgromadzone dane zanalizowano, wykorzystując modelowanie strukturalne. Zaproponowany model strukturalny okazał się odpowiednio dopasowany do danych, a tym samym wykazał pozytywne i przyczynowo-skutkowe zależności między poziomem IT, zarządzaniem zorientowanym na wiedzę oraz efektywnością działalności polskich szpitali.

Słowa kluczowe: technologie informacyjne, zarządzanie zorientowane na wiedzę, efektywność działalności szpitala, zarządzanie opieką zdrowotną.

1. Introduction

Information technologies, knowledge in an organization and business performance are among the interest of contemporary managers, not only in commercial organizations but also in non-profit entities, including public organizations. This also concerns entities that provide medical services. B. Chaudry et al., reviewed the literature [Chaudry et al. 2006] concerning the effect of IT on the quality and costs of medical services. The studies concerned 257 selected research studies published in 1995-2004 (e.g. contained in Medline, Cochrane and other databases). Support information technology and virtualization of the information processes should improve the efficiency of any business [Jelonek et al. 2013], including the provision of medical services. General conclusions point in most of the cases to the positive effect of Healthcare Information Systems (HIT) on the performance, quality and costs of medical services in all entities that provided such services.

This paper presents the results of an analysis of Polish hospitals. The population of Polish hospitals is about 1,000 entities and the research sample was 156 returned questionnaires. The sample size is sufficient to achieve the appropriate parameters of the statistical model used in the article [Schumacker, Lomax 2010, p. 92]. The analysis concerned mutual relationships between the level of IT, knowledge-oriented management and the operational performance in Polish hospitals. The relationships studied were analysed using the method of structural equation modelling (SEM). This statistical method has been increasingly popular since the end of the previous century. It allows for drawing causal conclusions based on non-experimental studies. N. Cliff argues that SEM is ”perhaps the most important and influential statistical resolution to have occurred in the social sciences” [Cliff 1983, p. 115]. Many multivariate statistics such as ANOVA, MANOVA, multiple regression, confirmatory factor analysis, item response theory and the multilevel model can be considered as special cases of SEM [Cheung 2015].

2. Focus on knowledge-oriented management of hospitals

P. Drucker believes that “the most valuable assets of a 20thcentury company were its production equipment. The most valuable asset of a 21st-century institution, whether business or non-business, will be its knowledge, workers and their productivity” [Drucker 1999]. Contemporary managers more and more frequently consider knowledge as a very important resource in any economic entity. Knowledge management is becoming an important area of responsibility of managers, similar to e.g. capital management, economic performance and physical and human resources [Dziembek 2012]. The effective utilization of knowledge resources in an organization requires the professional management of this knowledge. This causes most of economic organizations to improve their economic performance, increase

the productivity and quality of their services and extend their innovative potential [Du Plessis 2007].

Similar views were presented by I. Nonaka and N. Konno, who emphasized that an essential task in contemporary organizations is the creation and appropriate use of knowledge to achieve competitive advantage [Nonaka, Konno 1998]. Managers in most of contemporary business organizations, both commercial and non-profit, including public organizations, should approach the management of knowledge, management of information processes [Nowicki, Sitarska (eds.) 2010] and other intangible resources as critical components used throughout their professional careers. This concerns in particular medical activities that consist in providing medical services which represent what is termed as professional services. These services are of essential importance to patients. They must be performed by qualified staff using the most recent achievements of science and medical technologies.

3. Healthcare information systems

Based on a literature survey, B. Chaudry et al., separated the basic functions and tasks of [Chaudry 2006] HIT systems (support areas). These include:

- clinical documentation (health information/data),
- results management,
- order entry management,
- decision support,
- electronic communication and connectivity,
- patient support,
- administrative processes,
- reporting and population health [Bal, Dwivedi, Naguib 2005].

A similar characterization of HIT systems was presented by D. Jelonek and A. Chluski [Jelonek, Chluski 2014]. These authors emphasized that two basic parts (medical and administrative) can be separated in the organizational structure of the medical entity. The medical part, also referred to as "white", provides medical services. The administrative part, termed "grey", deals with the business aspects of the operation of the whole organization. Information systems in an organization must correspond to its organizational structure.

HIT systems are becoming more and more critical to the effectiveness of the health care system. This concerns not only "pure" technology (e.g. utilization of software, computer systems and communication systems) but also workflow redesign and changing approach to management of "human factor" (e.g. the increased contribution of computer technologies in communication rather than direct interpersonal contacts i.e. the substantial limitation of non-verbal contacts).

Due to the interest of managers in contemporary business organizations in the management of information technologies, methods are being developed to order and

standardize this type of activity. One of them is IT government. According to this concept, managers in economic organizations should focus on [Jelonek 2009, p. 125]:
- strategy of IT development,
- integration of IT solutions in the organization,
- development of IT infrastructure,
- internal communication and communication with the surroundings of the organization.

4. Operational effectiveness of hospitals

Operational effectiveness of hospitals is a complex problem, mainly due to the fact that the operation of hospitals is oriented at the achievement of social goals such as health care services, i.e. improving and saving the health and lives of patients rather than generating profits.

J. Leowski emphasized [Leowski 2004], that the main objective of the system of health care is to ensure the health safety of the state i.e.:
- meeting individual health needs, that is, needs that result from illnesses, health problems and accidents,
- meeting collective health needs such as conditions of living, working, eating, relaxing, and to minimize, eliminate and prevent the risk of losing health and life.

An evaluation of the effectiveness in health care must be adjusted to the specific nature of the sector. The analysis of effectiveness should focus on:
- a hospital as a business entity,
- activities (health services) performed by hospitals,
- pharmacotherapy.

In this paper, the effectiveness of hospital activities is approached comprehensively. This concerns both providing health services and making managerial decisions. High-quality health services are claimed to have such characteristics as:
- availability,
- justice,
- efficiency, utility,
- adequacy,
- social acceptance,
- performance [Whitfield, Surowiec, Kautsch 2001, p. 312].

Availability means constant reaching the patients who need such services or should be provided with them. The time of waiting for services should be the shortest possible. Justice is viewed as the possibilities of using the services by all the people who need them, regardless of wealth and social status. Efficiency means the level of meeting the expectations of health services' recipients. This is evaluated based on the level of meeting the patients' needs. A health service is effective (useful) if, with specific resources, their effect is the highest possible. Adequacy is considered as the

appropriate health services which reflect the clinical needs and the hospital resources. These should meet the patient's expectations. Social acceptance (religious, cultural) means that the hospital has the individual consent of the patient or the social consent for providing specific health services. Efficiency with respect to health services means the achievement of beneficial relations between expenditures and effects obtained. Evaluation of effect might concern individual services (groups of services or the whole organization) or it might be referred to macro scale.

5. The theoretical model and hypotheses

According to the main research hypothesis of this study, knowledge-oriented management and level of information technology have a positive effect on the operational effectiveness of hospitals. More detailed research hypotheses are:

- H1. Profile of information technologies has a positive effect on the focus on knowledge-oriented management.
- H2. Profile of information technologies has a positive effect on the effectiveness of hospital operations.
- H3. Focus on knowledge-oriented management has a positive effect on the effectiveness of hospital operations.

The research model concerns three areas which represent theoretical constructs:

- focus on knowledge-oriented management,
- profile of information and communication technologies in a hospital,
- effectiveness of hospital activities.

Based on previous literature survey and consultations with managers in selected hospitals, the basic dimensions of the construct "focus on knowledge-oriented management" (focusKnow) were identified. They represent the following elements:

- maturity of management of the physical property of the hospital,
- perception of importance of knowledge and intangible values in hospital management,
- measurement and evaluation of value of knowledge and intangible resources in hospital.

The construct termed in the study *information technology* (IT) was characterized by D. Jelonek [Jelonek 2009, p.127], by means of the following components:

- IT strategy,
- IT supervision,
- IT infrastructure,
- communication,
- IT integration.

In the model used in a study by A.-M. Croteau and F. Bergeron [Croteau, Bergeron 2001, p. 89], a similar IT construct was formed by the following dimensions:

- importance and role of IT,
- technological architecture,

- infrastructure of "software and procedures",
- evaluation of utilization of information systems.

In the model proposed in this study, the IT profile of hospital (pIT) is determined by:

- strategic role of information technologies,
- degree of utilization of applications,
- degree of utilization of technologies,
- degree of integration of applications.

The construct "effectiveness of economic organization's activity" has been defined by various researchers in different ways. Economic outcome (income and profit) is its basic element in commercial organizations. Public organizations and other non-profit entities should also operate in a manner that allows for the balancing of broadly understood expenditures with sources of finance. Other aspects [Mazur, Rószkiewicz, Strzyżewska 2008, p. 32] that determine this construct are:

- competitive position of an economic organization in a specific sector,
- development and changes in economic position in time, including achievement of the plans adopted for operation at strategic and tactical level,
- share in the market connected with quality and availability of products and services.

Obviously, the perception of the effectiveness of the operation of an economic organization depends on the type of stakeholders in this organization.

In the research model, the construct termed „effectiveness of hospital operation" (effOp) has three dimensions:

- quality of services,
- availability of services,
- financial result of operation.

Each construct is determined by specific variables. Furthermore, measurement of the variables is performed by means of indices in the form of questions prepared based on the review of related literature concerning similar studies and consultations with experts. The questionnaire contains statements which respondents were asked to agree with (using a scale from 1 to 7). The term „question" will be used further in the paper with respect to these statements.

Table 1 contains a characterization of observable variables and latent variables that formed the research model.

Figure 1 presents a diagram of the model of dependency of variables ***effOp*** (*effectiveness of hospital operation*) and ***focusKnow*** (*focus on knowledge-oriented management*) on variable ***pIT*** (*profile of information technology*). Variable ***pTI*** is an exogenous variable, whereas variables ***effOp*** and ***focusKnow*** are endogenous (a variable is exogenous if it only affects other variables of the model but is itself never affected by other variables and a variable is endogenous if it is directly affected or influenced by at least one of the other variables).

Table 1. Characterization of observable and latent variables in the research model

Observable variable		Latent variable
Observable variables	**Symbol**	profile of information technology **pIT**
IT strategy	**stratIT**	
Using technology	**useTech**	
Degree of IT systems integration	**degInt**	
Using applications (software)	**useApp**	
Quality of services/products	**qualServ**	efficiency of hospital operations **effOp**
Availability of services/products	**availServ**	
Financial effectiveness	**finEff**	
Degree of maturity of management of intangible resources	**maturMatRes**	knowledge-oriented management **focusKnow**
Importance of intangible resources	**impIntan**	
Importance of measurement and reporting of intangible resources	**impRepIntan**	

Source: author's own elaboration.

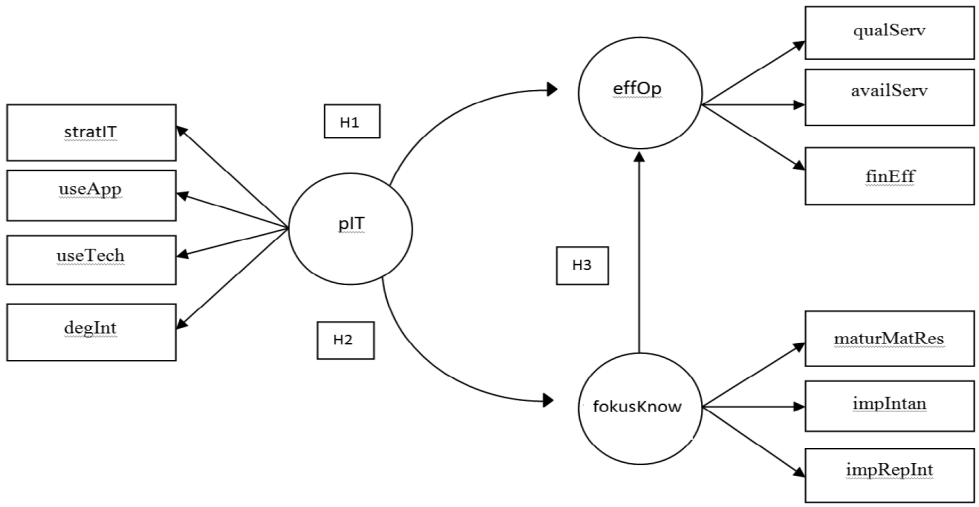

Figure 1. Model of dependency of variables effOp (effectiveness of hospital operation) and focusKnow (focus on knowledge-oriented management) on variable pIT (profile of information technology)

Source: author's own elaboration.

The SEM research model is comprised of three measurement sub-models and a structural sub-model. The first of them determines the relationships between

observable variables stratIT, useApp, useTech, degInt and a latent variable pIT which correspond to the profile of information technologies.

The second sub-model concerns a latent variable ***effOp***, which corresponds to effectiveness of hospital operation and the related observable variables *qualServ, availServ, finEff*. Similarly, the third sub-model concerns relationships between ***focusKnow*** and ***maturMatRes, impIntan*** and ***impRepIntan***. The structural sub-model concerns relationships between latent variables i.e. variables ***pIT, effOp*** and ***focusKnow***.

6. Analysis of empirical data

The examinations used for the evaluation of the appropriateness of the model proposed in this study were carried out with a questionnaire containing three questions to measure each observable variable (see Table 1) using the Likert scale. It was assumed that variables have range character. Questionnaires were obtained from 156 randomly selected hospitals based on the Polish Register of Health Care Centres.

Table 2 shows the values of parameters for individual paths of relationships between specific variables, presented in the form of arrows in Figure 1. Symbolic denotation of paths of relationships is presented in the first column of the table. The table also contains standard error for evaluation of the parameter, T statistic and probability level, which for all the parameters is lower than the value of significance level adopted for calculations (0.05). In the case of parameters concerning observable variables, the probability is negligible.

Table 2. Evaluation of selected parameters in the model

Estimates of model parameters				
	parameter estimate	standard error	T statistic	p-value
(pIT)-->[stratIT]	*0.541*	*0.073*	*7.375*	*0.000*
(pIT)-->[useTech]	*0.557*	*0.072*	*7.689*	*0.000*
(pIT)-->[degInt]	*0.650*	*0.067*	*9.735*	*0.000*
(pIT)-->[useApp]	*0.700*	*0.064*	*10.888*	*0.000*
(effOp)-->[qualServ]	*1*			
(effOp)-->[availServ]	*1.399*	*0.203*	*6.900*	*0.000*
(effOp)-->[finEff]	*1.165*	*0.160*	*7.304*	*0.000*
(focusKnow)-->[maturMatRes]	*1*			
(focusKnow)-->[impIntan]	*1.475*	*0.272*	*5.416*	*0.000*
(focusKnow)-->[impRepInt]	*1.347*	*0.242*	*5.559*	*0.000*
(pIT)-->(effOp)	*0.180*	*0.070*	*2.588*	*0.010*
(pIT)-->(focusKnow)	*0.204*	*0.061*	*3.355*	*0.001*
(focusKnow)-->(effOp)	*0.314*	*0.144*	*2.182*	*0.029*

Source: author's own calculations by means of Statistica package.

In the case of the relationship of focusKnow – effOp, value $p = 0.029$ is close to the boundary value of the adopted level of significance, i.e. 0.05. In conclusion, it can be assumed that the evaluated levels of parameters in the model are statistically significant.

Table 3. Indices of goodness of fit to the data

Noncentrality-Based, Goodness-of-Fit Indices			
	90% lower boundary of confidence interval	Estimated point	90% upper boundary of confidence interval
Steiger-Lind RMSEA Index	0.039	***0.071***	0.100
McDonald's Index of Noncentrality	0.851	0.923	0.975
Population Gamma Index	0.939	***0.969***	0.990
Adjusted Population Gamma Index	0.896	0.946	0.983

Source: author's own calculations by means of Statistica package.

Table 3 presents selected indices of the model's goodness of fit to the data. Parameters exceeding the adopted boundary values are printed in bold and italics. In the model studied, root mean square error of approximation (RMSEA) and Gamma index for population reaches values that exceed the boundary values of a goodness of fit.

7. Discussion and conclusions

It can be concluded based on the results of SEM modelling that there is a statistically significant correlation between profile of information technology pIT and variable that corresponds to the focus on knowledge-oriented management focusKnow. The coefficient that corresponds to this correlation is 0.204. Furthermore, the correlation between the variable pIT and variable effOp can be estimated at the level of 0.180. The parameter that determines the correlation between focusKnow and effOp, i.e. the effect of knowledge-oriented management on the effectiveness of a hospital's operation is also statistically significant ($p = 0.029$) and amounts to 0.314.

It was adopted for the research model that the variable pTI is exogenous, whereas variables focusKnow and effOp are endogenous. With this division of variables, the causal relationship can be also demonstrated between pTI and focusKnow and effOp. The problem of the importance and role of causality in SEM analysis causes much controversy concerning using this statistical model. Opinions on this issue are divided from extreme opponents to enthusiastic supporters [Konarski 2009, p. 533]. With regard to the above different views and other limitations of SEM analysis, it should be assumed that the confirmatory character of this type of model necessitates a firm theory to support the phenomena studied.

In summary, it can be concluded that knowledge-oriented management and the level of information technologies in the model proposed positively and statistically significantly affect the effectiveness of operation of Polish hospitals.

Future research should focus on exploring the relationships between the operational effectiveness of hospitals, level of information technologies and comprehensively viewed intellectual capital in Polish hospitals.

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