

Aleksandra CZUPRYNA-NOWAK
Silesian University of Technology
Faculty of Organization and Management
Department of Computer Science and Econometrics

EFFICIENCY DETERMINANTS OF INFORMATION SYSTEMS IN MANAGING THE COMPANY

Summary. Nowadays, when every activity of a company is burdened with huge uncertainty, companies willing to survive in open market's reality target their activities at limiting investments which are unprofitable and which don't bring measurable benefits. It is similar with integrated information systems. Despite the fact that their goal is to bring unmeasurable benefits, it would be good for the enterprise of introduction of integrated information systems to be efficient and effective. The article shows integrated information system's users' opinions as far as efficiency of these systems is concerned.

Keywords: integrated computer system, effectiveness, enterprise management

DETERMINANTY WYDAJNOŚCI SYSTEMÓW INFROMATYCZNYCH W ZARZĄDZANIU FIRMA

Streszczenie. W dzisiejszych czasach, gdy każda działalność firmy jest obciążona ogromną niepewnością, przedsiębiorstwa pragnące przetrwać w rzeczywistości otwartego rynku ukierunkowują swoje działania na ograniczanie inwestycji, które są niedochodowe i które nie przynoszą mierzalnych korzyści. Podobnie jest ze zintegrowanymi systemami informatycznymi. Pomimo, iż ich celem jest dostarczanie niemierzalnych korzyści, istotnym dla przedsiębiorstwa jest wprowadzenie zintegrowanego systemu informatycznego, który jest skuteczny i wydajny. Artykuł przedstawia opinie użytkowników zintegrowanych systemów informatycznych dotyczące wydajności tych systemów.

Słowa kluczowe: zintegrowane systemy informatyczne, efektywność, zarządzanie przedsiębiorstwem

1. Introduction

Currently, there are about 200 producers of information systems supporting management process operating in Polish market. It is not true that every system can be implemented in any company. Hence, the producers of the systems naturally divided themselves into producers specialised in providing systems for small, medium and large companies, public administration and banks. In report from April 2006 the authors made a comparative analysis of information systems. This report showed only that proposed systems are not very different from each other, they include the same modules, they can similarly adjust to processes in the company [13]. On the other hand, on companies' market different finals of introducing information systems can be observed. Some of the companies buy the system only for improving their image in the market and they do not even try to introduce the bought system, others "give up" introduction stage. So, if the systems on offers are not very different, and buying them the companies presuppose that the system will not be used, or the introduction process will not be completed which make it impossible for them to benefit from the possibilities given by the bought system, it is possible to make a thesis that using these systems is senseless and groundless. However, the enumerated cases are exceptions, and benefits given by information system are worth it to take a risk of purchase and attempt to implement it. Any implementation, however, should be economically justified and graded from the rationality of the introduction point of view. Grading any activity we grade also efficiency of the activity. Likewise, the information systems. The efficiency can be evaluated from the performance and effectiveness' poing of view. K. Sobolewski [14] claims that if the methodology of determining the level of effectiveness is the subject of the survey then the survey should concern three aspects: complete list of features which the sought effectiveness indicator should include, elements of the given feature which fully describe this feature and level of minuteness given in the measure which will be finally introduced in order to estimate the given indicator. Then, the author conditions finding the correct quantitative term of effectiveness level on taking into account these three aspects in the sought formula.

The article concerns the first aspect enumerated by K. Sobolewski, namely the lists of features which the sought indicator of effectiveness of integrated information systems should include. The aim of the article is to identify effectiveness determinants of integrated information systems and to present them in categories of importance. It consists of two parts. Part one is identification of efficiency determinants of integrated information systems. The identification was conducted in the main areas of company's activities. Part two is selecting main classes of importance of separated determinants. It is important to mention here that the article includes fragment of doctoral thesis of the author [2].

2. The issue of integrated systems

Effectiveness of integrated systems seems to be a very important issue. It is because the benefits the company can gain from introducing information system are quite considerable. According to American Production and Inventory Control Society implementing of integrated system brings results [6]:

- increase of work efficiency for 10 – 19%,
- profitability increase up to 50%,
- reduction of reserves for about 50 – 70%,
- reduction in order reaction time for about 20-40%,
- improvement of delivery time up to 95%.

Of course, the implementation results depend on many factors, such as branch within which the company operates, sector, company's strategy or the process of implementing the system. Productivity of the system is its property which is extremely difficult to define. It is because the productivity itself is in many publications very often mistaken or interchangeably used with such concepts as: effectiveness, efficiency, productivity or performance. In fact, these concepts are synonymous, however, they are not identical and treating them in such a way is a methodological mistake.

Quoting T. Kotarbiński [7] it is "... action that leads to result intended as a goal..." Similar definition is given by J. Stoner [18]: it is "... ability to set appropriate goals: "doing the right things" ..."

Efficiency is most often erroneously identified with effectiveness. Effectiveness is a result of taken actions, described relation of results to the outlays invested. Effectiveness measurements are done on the basis of fragmentary, synthetic indicators of productivity and resources usage. Effectiveness can be determined according to ex post and ex ante. Assessing ex ante effectiveness, the foreseen results with the engagement of particular resources eg. time are estimated. According to ex post, the foreseen results are juxtaposed with particular results of particular actions.

The consequence of effective action is its efficiency, so, if the action is effective it is also efficient. Efficiency entails not only effectiveness, but also accuracy and economicality. T. Kotarbiński claims that efficiency is totality of positive features of practical actions.

Alongside efficiency, the effectiveness belongs to the main criterium of economicality and quality of action. It is function of the action itself as well as the system which is realizing given task.

3. Areas of efficiency of integrated systems in managing the company

Factors of efficiency of integrated systems have been identified in certain areas of company's activities. Efficiency of information system is influenced not only by those factors which are connected with the system, but also those which result from the environment in which the system operates. The company however, is not separated creation. It operates in certain environment which influences it, forcing changes. The company environment while forcing changes in the company also forces changes in the information system. Efficiency determinants were thus identified in the area of the company environment, the company alone and information system. Identification of determinants was also broadened including human factor connected with information system which is its creators and users. Areas in which the efficiency determinants were sought were marked: I – company's environment, II – companies, III – information systems creators and IV – information system. Determinants are shown in successive tables of the article.

Determinants resulting from outside environment of the company are shown in Table 1. It is worth remarking that the factors appointed in this group are of general character. However, in other groups it is also possible to find factors connected with the company's environment.

Table 1

Efficiency determinants resulting from external environment of the company

Name of the determinant
Society's acquaintance with information technology (I/1)
Level of education and qualifications on the labour market (I/2)
Stability and cohesion of economic system (I/3)
Stability and cohesion of legal system (I/4)
Level of information culture (I/5)
Changes rate on the market of company's activity (I/6)
Rate of exchange (I/7)
Regulations connected with obligation to obey the production and technological norms (I/8)
Inflation (I/9)
Changes in market shares (I/10)

Source: Own study.

For example in the group of determinants connected with information system there are determinants connected with Polish legislation concerning enterprise (VAT Tax Act, Accounting Law, Income Tax Act, Entrepreneurship Act, International Accounting Standards) (IV/27), ZUS regulations (IV/22), ISO norms (IV/23), environmental protection norms (IV/24) and regulations concerning obeying productivity and technological norms (I/8).

In the second group there are determinants connected with production company. To this group belong 30 determinants, among which the most important seems to be the size of the company. The object of production company is manufacturing production realised through production processes. Complexity of these processes will also be significant in the process of purchasing the system (II/16). The efficiency of system implementation will also be affected by sort and quantity of manufactured products (II/11), type of production (II/12), product's place in its cycle (II/15) and production scale. Production of big products in small quantities is very obstructive. Frequent changes of production plan, changes in production schedule and material demands forces need to form flexible system which will enable introduction of plan changes in such a way that it would cause minimum perturbations [1], [5].

The next group is a group of determinants connected with creators of information systems. It's imperative to notice that these are mostly determinants connected with features of character which the creators as well as users of the systems should possess. Part of the determinants refers to relations which should be present during information system implementation. Problems connected with introduction of information system incrsimplicity importance of the whole process in relation to information system [6], [8], [10].

Table 2

Efficiency determinants of information systems connected with production company

Name of the determinant
Size of the company (II/1)
Having standards by the organisation (II/2)
Clarity of standards and procedures which are obligatory in the company (II/3)
Organisation culture (II/4)
Management style (II/5)
Vision and strategy of company's activity (II/6)
Organisation structure (II/7)
Organisation structure formalisation rate (II/9)
Quality of company's information system (II/10)
Inclination to invest (II/11)
Quantity of products produced (II/12)
Production process type (II/13)
Production cost (II/14)
Automatisation rate of production process(II/15)
Life cycle of the product (II/16)
Complexity rate of productive processes(II/16)
Clearly set goals of informatisation of the comapny(II/17)
Propensity to risk taking (II/18)
Position of IT departament in the company's organisation structure(II/19)

con. tab. 2

Simplicity of gaining funds for investments (II/20)
Employees' engagement in the process of informatisation of the company(II/21)
Users' of information system acquaintance of information technology (II/22)
Engagement and motivation of employees on the highest positions(II/23)
Employees' consciousness of the goal of introduction of information system(II/24)
Educational structure in the company(II/25)
Employees' fluctuation in the company(II/26)
Employees' training(II/27)
Educational level of employees(II/28)
Earnings level in the company(II/29)
Employees' identification with the mission of the company(II/30)

Source: Own study.

Table 3

Efficiency determinants of information system connected with creators of the systems

Name of the determinant
Information systems' creators' knowledge of the problems of work organization and management (III/1)
Ability to work in a team (III/2)
Approach to clients (III/3)
Knowledge of methods, techniques and managerial tools by the creators of information systems (III/4)
Information system creators' interpersonal and communicative skills (III/5)
Information system creators' assertive abilities (III/6)
Pro-active approach to solving clients' problems (III/7)
Information system creators' personal culture (III/8)
Information system creators' ability to work under stress and in conflicting situations (III/9)
Information system creators' salary (III/10)
Experience and knowledge of systems' designers (III/11)
Information system creator' education (III/12)

Source: Own study.

Table four includes efficiency determinants connected with information system itself. In the group of these determinants there are 32 determinants. Users in research over factors emphasised importance of possibility of various changes which can be introduced during information system usage. The next very important issue is information systems openness for cooperation with other application programmes (IV/7). Openness of information system means that there is possibility to broaden the systems with new modules and joining it with

the external systems. It is essential for information systems to enable cooperation with eg. office applications (MS Office, OpenOffice)¹. Adjusting information systems to office packages brings additional benefits. Users who are used to working with office packages will learn faster how to work with integrated information system (IV/17). Additionally, if the interface is clear (IV/18) employees' training can be shortened significantly which will decrease system implementing cost. It also brings additional benefit, namely, the users which are used to working in one environment will find it much easier to adapt to the new environment.

Table 4

Efficiency determinant of information system connected with information system

Name of the determinant
Flexibility of information system (IV/1)
Complexity of information system (IV/2)
Time of data availability (IV/3)
Life cycle of the system (IV/4)
Reliability of data in the system (IV/5)
Method of system formation (IV/6)
System's communication with environment (IV/7)
Functional complexity of the system (IV/8)
Data safety (IV/9)
System personalisation (IV/10)
Sort of used equipment platform (IV/11)
Sort of client/server architecture (IV/12)
System purchase cost (IV/13)
System service cost (IV/14)
Information system modules integration (IV/15)
Information system stability (IV/16)
Simplicity of interface service (IV/17)
Interface clarity (IV/18)
Easy communication with the system (IV/19)
System conformity with tax directives and UE customs code (IV/20)
System's conformity with work safety and hygiene regulations (IV/21)
System's conformity with ZUS regulations (IV/22)
System's conformity with ISO norms (IV/23)
System's conformity with environmental protection norms (IV/24)
System's conformity with work procedures obligatory in given company (IV/25)

¹ An example of integrated information system adjusted to office applications is DUET system which was created as a result of Microsoft cooperation with SAP,

con. tab. 4

System's conformity with real processes occurring in the company (IV/26)
System's conformity with legislation concerning enterprise (IV/27)
Possibility to copy production process and production control processes (IV/28)
Possibility to implement changes into information system (IV/29)
Information systems adaptiveness (IV/30)
Possibility to create new solutions in the system (IV/31)
Simplicity of system implementation in conditions of particular implementations (IV/32)

Source: Own study.

4. Forming importance classes of efficiency determinants of integrated information systems

Users of management information systems took part in research over efficiency of integrated information systems. Those users were divided into two groups: information systems users which consisted of those users who have been working with information system for over two years. The second group consisted of information systems creators whose seniority was over two years. They were asked to evaluate individual determinants in the scale from 0 to 10. Jointly, 84 determinants were subjected to evaluation.

In the research 174 polls from information system users were obtained and 103 from information system creators. The whole stage of obtained results was divided into several substages. Firstly, the analysis of the sample was done in order to answer whether the examined expert groups are agreeable as far as efficiency of integrated information system is concerned. Therefore the Kendell and Babington-Smith's² concordance coefficient for both groups was calculated. Value of the coefficient was shown in table 5. For both groups the coefficient's value is satisfying.

Table 5

Juxtaposition of critical values χ^2 for expert set

	Users group	Creators group
Number of experts	$J = 175$	$K = 103$
Number of determinants	$n = 84$	$n = 84$
Kendell and Babington-Smith's concordance coefficient	0,20	0,43

Source: Own study.

² Kendell and Babington-Smith's concordance coefficient is the most common and used coefficient of expert groups' accordance [15]. It is calculated base on the formula: $W = \frac{12S}{J^2(n^3 - n)}$, where: n – number of determinants, J – number of experts in the group of users.

Next, it was examined how the determinants behave in the area of each sample in accordance to: company environment, company, information system creators and information system itself. The analysis was done by the use of a number of statistic analysis. The next step was to find those efficiency determinants as to importance of which the examined groups were unanimous. By the means of appropriate descriptive statistics the determinants were divided into importance classes in areas of individual research group and then all determinants were grouped into adequate importance classes for the whole population. Established in the work was also determinants order in the areas of individual importance class and in the areas of characterised efficiency aspects. On account of amplexness of the research, only the final results are presented in the article. Whole research is available in doctorant work of the author.

In order to form importance groups of information systems efficiency determinants, the determinants were divided in the areas of individual groups by the means of quintals, gaining the ranges:

- below $Q_{1/5}$ – very important determinants,
- $(Q_{1/5}; Q_{2/5}]$ – important determinants,
- $(Q_{2/5}; Q_{3/5}]$ – determinants of medium importance,
- $(Q_{3/5}; Q_{4/5}]$ – determinants of little importance,
- powyżej $Q_{4/5}$ – determinants of very little importance.

In the individual importance groups there are determinants to which expert groups were unanimous. Individual determinant importance groups are presented in table 6. As the table shows, to the group of the most important determinants belong:

- information systems' creators' knowledge of the problems of work organisation and management (III/1),
- reliability of the data in the system (IV/5),
- experience and knowledge of system designers (III/11),
- data safety (IV/9),
- information system's stability (IV/16),
- simplicity of interface service (IV/17),
- system's conformity with legislation concerning enterprise (IV/27),
- system's conformity with real processes occurring in the company (IV/26),
- system's conformity with ZUS regulations (IV/22),
- possibility to implement changes into information system (IV/29).

It is important to notice that to the group of very important determinants belong determinants connected with information system and information systems' creators. The rest of the determinants were assigned to groups of lower importance.

Table 6

Juxtaposition of importance groups of efficiency determinants of integrated information systems

L.p.	Very important	Important	Of medium importance	Of little importance	Of very little importance
1	Information systems' creators' knowledge of the problems of work organisation and management (III/1)	Pro-active approach to solving clients' problems(III/7)	Knowledge of methods, techniques and managerial tools by the creators of information systems(III/4)	Size of the company (II/1)	Regulations connected with obligation to obey the production and technological norms(I/8)
2	Reliability of data in the system(IV/5)	Employees' engagement in the process of informatisation of the company(II/21)	Information system creators' ability to work under stress and conflicting situations (III/9)	Sort of client/Server architecture(IV/12)	Level of education and qualifications on the labour market(I/2)
3	Experience and knowledge of systems' designers(III/11)	Organisation structure formalisation rate(II/9)	Position of IT department in the company's organisation structure(II/19)	Organisation structure (II/7)	Stability and cohesion of economic system(I/3)
4	System's conformity with work procedures obligatory in given company(IV/25)	Flexibility of information system(IV/1)	Acquaintance of information technology by the users of information system(II/22)	Formalisation rate of organisation structure (II/8)	Stability and cohesion of legal system(I/4)
5	Information system stability(IV/16)	Information system modules integration(IV/15)	Level of information culture(I/5)	Quality of company's information system (II/10)	Rate of exchange (I/7)
6	Simplicity of interface service(IV/17)	Easy communication with the system(IV/19)	Vision and strategy of company's activity(II/6)	Production cost (II/14)	Inflation (I/9)
7	System's conformity with legislation concerning enterprise (IV/27)	System conformity with tax directives and UE customs code(IV/20)	Complexity of information system(IV/2)	Simplicity in gaining funds for investments (II/20)	Society's acquaintance with information technology (I/1)
8	Data safety(IV/9)	Possibility to create new solutions in the system(IV/31)	System's communication with environment(IV/7)	Employees' fluctuation in the company(II/26)	Changes in market shares (I/10)
9	System's conformity with real processes occurring in the company(IV/26)	Simplicity of system implementation in conditions of particular implementations(IV/32)	System personalisation(IV/10)	Information system creator' education (III/12)	Quantity of products produced(II/12)

con. tab. 6

10	System's conformity with ZUS regulations(IV/22)		System's conformity with work safety and hygiene regulations(IV/21)	Functional complexity of the system(IV/8)	Inclination to invest(II/11)
11	Possibility to implement changes into information system(IV/29)		System's conformity with ISO norms(IV/23)	System's conformity with environmental protection norms(IV/24)	Production cost (II/14)
12			Information systems adaptiveness(IV/30)	Educational structure in the company(II/25)	Propensity to risk taking (II/18)
13				Organisation culture (II/4)	Earnings level in the company(II/29)
14					Life cycle of the product (II/16)
15					Method of system formation (IV/6)

Source: Own study.

5. Conclusion

In the article the final results of the research over efficiency determinants of integrated information systems were presented. The efficiency determinants of integrated information systems were formed in the areas of: company environment, company itself, information systems and creators of those systems. Together 84 identifications of efficiency determinants were performed. Next, they were grouped into individual importance classes. The main goal of the article, which was presenting and grouping into individual importance classes of determinant was completed.

List of formed factors from the angle of further works over efficiency of integrated information systems seems to be very important. It stands for necessary factors which should be taken into consideration by users of managerial information systems on every stage of “purchase of the system” process: choice, implementation and user of the system. Each of the formed efficiency determinants is important and essential. Including all of them increases probability of realisation of the goal.

The article presents research results based on opinion of the users and creators of integrated information systems. Efficiency determinants of integrated information systems were examined according to information system creators, information systems, production company and the information system itself. Determinants were grouped basing on quintals and five importance groups of those determinants were formed.

It is important, however, to emphasise the fact that presented in the article list of factors based on literature analysis and empirical research is not a closed list. This list will be increased according to the changes in the company, range of information system implementation or the set implementation goal.

The topic of the article is of developmental character because it entails many research areas. An interesting direction of the research seems to be analysis of individual determinants aiming at setting their influence on the efficiency of integrated information systems. Further research should also aim at attempts of normalisation which, as a result, can lead to attempt to construct an indicator of information system.

Bibliography

1. Chmielarz W.: Systemy informatyczne wspomagające zarządzanie. Aspekt modelowy w budowie systemów. Dom Wydawniczy Elipsa, Warszawa 1996.
2. Czupryna-Nowak A.: Skuteczność zintegrowanych systemów informatycznych w zarządzaniu przedsiębiorstwem produkcyjnym. Praca doktorska. Politechnika Śląska, Zabrze 2008.
3. Grudzewski W.M., Hejduk L.K.: Metody projektowania systemów informatycznych. Difin. Warszawa 2004.
4. Kotarbiński T.: Traktat o dobrej robocie. Zakład im. Ossolińskich Wrocław, Warszawa, Kraków, Gdańsk 1975.
5. Kijewska A.: Systemy informatyczne w zarządzaniu. Wydawnictwo Politechniki Śląskiej, Gliwice 2005.
6. Kisielnicki J., Sroka H.: Systemy informacyjne biznesu. Informatyka dla zarządzania. Metody projektowania i wdrażania systemów. Wydawnictwo Placet, Warszawa 2001.
7. Krostek J., Jagodziński M.: Realizacja algorytmów planowania potrzeb materiałowych i zdolności produkcyjnych w zintegrowanym systemie informatycznym, [w:] Knosala R.: Komputerowo zintegrowane zarządzanie. Tom I. WNT, Warszawa 2007.
8. Kruk A.: Czynniki ludzkie jako element skuteczności zintegrowanych systemów zarządzania przedsiębiorstwem. Wydawnictwo UMCS, Lublin 2000.
9. Krzyżanowski L.J.: Podstawy nauk o organizacji i zarządzaniu. PWN, Warszawa 1992.
10. Kuraś M., Nęcki Z.: Psychologiczne aspekty komunikacji z użytkownikiem. <http://ki.ae.krakow.pl/~kurasm/artykuly/szczypsy.html> (28.11.2006).
11. Lech P.: Zintegrowane systemy zarządzania ERP/ERP II. Wykorzystanie w biznesie, wdrażanie. Difin, Warszawa 2003.
12. Męczyńska A.: Wspomaganie procesów zarządzania w przedsiębiorstwie przemysłowym metodami heurystycznymi. Praca doktorska, Akademia Ekonomiczna, Katowice 2001.
13. Obłój K.: Wyzwania najbliższego okresu w oczach prezesów wielkich firm. Rzeczpospolita, dodatek Ekonomiczny z dn. 10.11.2002.
14. Sobolewski K.: O pojęciu skuteczności i pojęciach związanych. Wydawnictwo Politechniki Koszalińskiej, seria Zarządzanie i Marketing, Koszalin 1998.
15. Stoner J., Freeman R., Gilbert D.: Kierowanie. PWE, Warszawa 2002.

Reviewers: Dr hab. inż. Jan Kałuski, Prof. nzw. w Pol. Śl.
Prof. dr. hab. Jerzy Mika