METHOD FOR IDENTIFYING REQUIREMENTS FOR CHANGE IN INFORMATION SYSTEMS BASED ON CHANGE IN BUSINESS PROCESS

METODE INFORMĀCIJAS SISTĒMU IZMAIŅU PRASĪBU IDENTIFICĒŠANAI PAMATOJOTIES UZ BIZNESA PROCESU IZMAIŅĀM

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Information system requirements, Change in information system

1. Introduction

Traditionally requirements for change in information system (IS) are proposed according to the change management plan [1]. Management of change in IS defines what kind of changes in IS it is necessary to perform in the planned period of time. Adoption of change in IS for an organization requires certain period of time therefore it is necessary for an organization to identify possible requirements for IS as soon as possible.

According to IS development theory [2], change in IS causes crisis situations in organizations. Based on this theory, organizations need to have: 1) a person who identifies crisis situations, 2) a person who offers innovative solutions to prevent crisis situations, 3) a person who chooses the best solution and implements required changes in IS.

The greatest difficulties for an organization arise when it can not identify crisis situations and are not able to find solutions to overcome these situations [3]. In similar cases, definition of requirements for change in IS is delayed, consequently change development and implementation is delayed, too, which brings losses for an organization.

As a solution for such problems we propose a method, which provides possibility to identify possible requirements of change in, IS based on previously acquired change regularities instead of IS user requirements. It provides a possibility to identify independently of user requirements possible change in IS even before the emergence of crisis occurs in an organization. Foreknowledge of the possible requirements for change in IS provides a possibility to develop and implement required change project timely. Thereby an organization can avoid losses which occur as a result of delayed IS reconstruction.

The proposed method was obtained in an experimental way by performing several analysis of change in IS during many years of research. Requirements for change in IS were examined in relation to change in business process (BP) in order to identify mutual regularities between change in IS and change in BP.

The paper is organized as follows. In the introduction the research problem is described. In the second section the research approach is described. In the third section the definition of change in IS is given, causes of change in IS are discussed, and related literature is analysed. In the fourth section the elements characterised IS and BP changes are identified. In the fifth section examples of change in BP and IS are described. In the sixth section examples are analysed and results of analysis are represented. In the conclusion we give an evaluation of our research and directions for further research.

2. Research approach

The research approach of this paper is presented in Figure 1 in boxes with a continuous line. At first there were analysed the definitions of IS changes [4,5] and IS development theory [2]. Then there were analysed the causes of IS changes, IS change management [1] and researches presented in the

literature. The results of these analyses required to broader the problem domain. Thus the IS change research domain was complemented with BP. The 4th step of this research shows the identification of elements which can characterise the IS and BP interrelated changes. To identify the IS and BP change regularities the elements changes were analysed during IS change projects in six organisations. The inductive reasoning mechanism was used to identify the IS and BP change regularities.
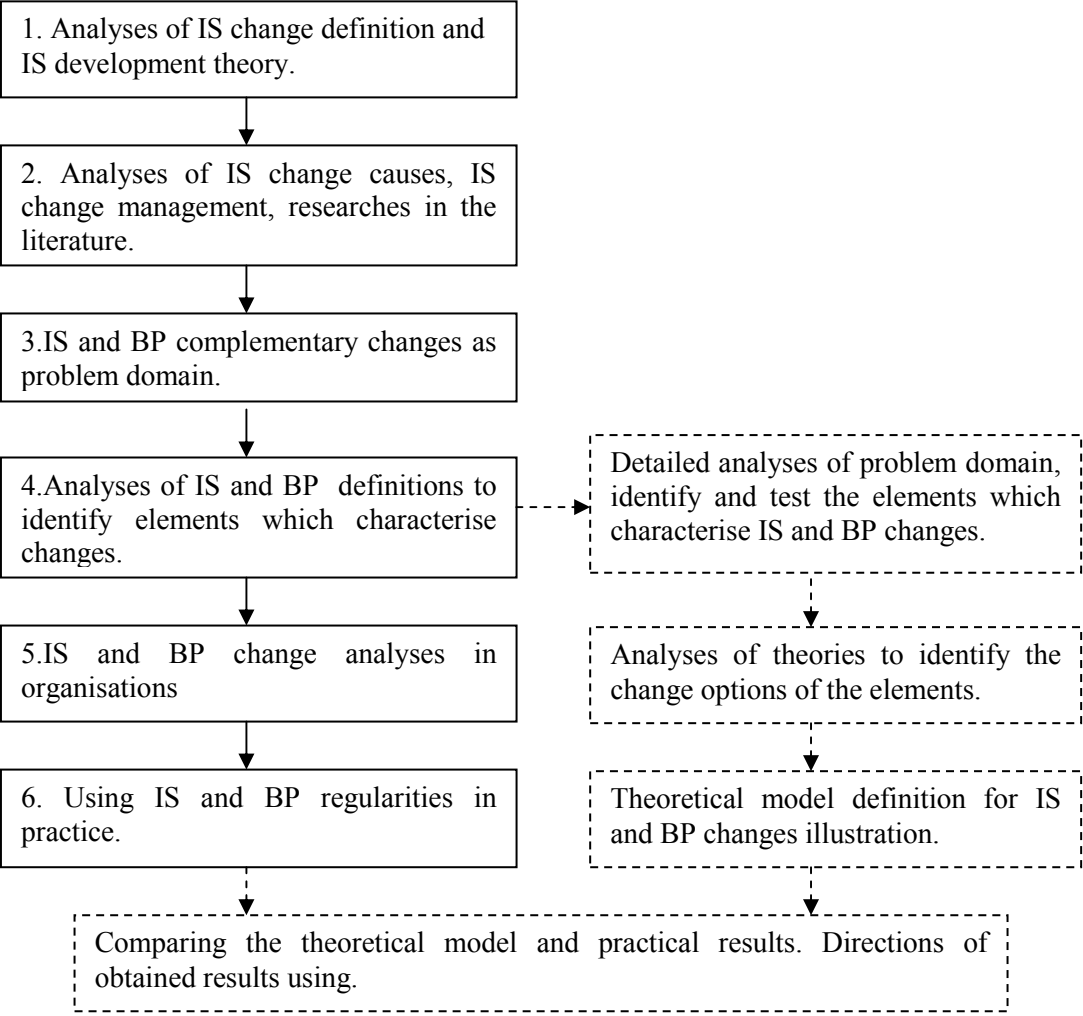
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Fig.1. Research approach graphical representation

The obtained regularities presents the IS and BP changes on meta level. In order to use these regularities in practice it is necessary to proof them and to obtain it on a more detailed level. On the subject of this the research approach was complemented for the future work. It is presented with an irregular line in Figure 1. First of all it is necessary to test and to identify the elements which characterising IS and BP changes more carefully. According to the different nature of these elements there should be performed analyses of corresponding theories. This analysis helps to identify the change options of every single element. Based on a change options of the elements the theoretical model of IS and BP changes should be build. The IS and BP changes analyses in organisations should be complemented with the category data analyses method for proofs of the obtained regularities.

3. Definition of change in IS and causes of change in IS

Change is any planned or unplanned alteration of the current state or process. It includes individual's, group's or organization's planned action which is performed in order to change the current state [4, 5].

In the literature changes in IS most frequently are represented as a transition from the state which was before the alteration *as_is* to the state after the alteration *to-be* (Fig. 2.).

Based on the literature review we have ascertained that the time when change in IS has to be performed is not clearly defined. According to IS development methods [1], change in IS is performed based on requirements from IS users. However, according to [1] there can be situations when users are not able to propose the necessary requirements, for example, in case of reorganization in their department. According to IS development theory, change in IS is performed in situations of crisis [2]. To identify crisis situations, there should be a person who points to such situations in an organization. The questions reminds unanswered what to do if this person doesn't point on crisis situation, or points on it with delay, or if there are several crisis situations in an organization and they are not explicit. In practice to identify change in IS process improvement methods are applied. They are mainly based on individual person's or team's ability to identify the process improvement possibilities.
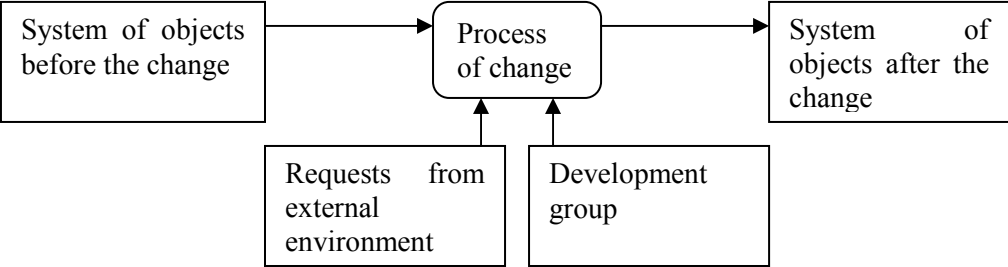
Fig.2. Graphical representation of change in IS

In the beginning the process, which needs to be improved, is identified by applying process cost evaluation methods (Balanced score cards, ABC costing etc.) [6, 7]. After that, the particular process is improved or reconstructed. Change in IS is implemented by applying IS change management methods and standards [8].

According to the definition [1, 7, 8, 9], IS provides BP functioning in an organization. Therefore to identify changes in IS we examine them in relation with changes in BP. Causes of change in IS is represented in Figure 3. Change in IS in an organization may occur without any change in BP as well. It happens in cases when organization is improving processes which provide IS functioning [6, 7]. In this paper we examine only those causes of change which are initiated by organization's BP.
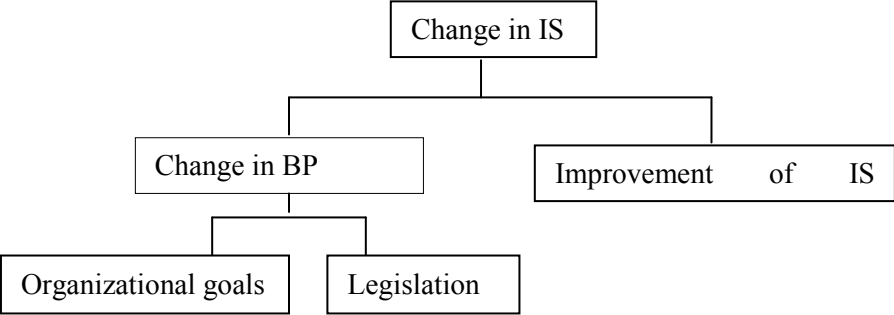

Fig.3. Representation of causes of change in IS

Change in IS has been studied in other research studies as well [10]. These studies were based on establishing the transition from the state of IS before the change and the state of IS after the change. Such transitions were established by comparing two state which characterise ER diagrams and class diagrams. Achieved results help to evaluate stability and alterability of IS. Analyzing IS transition from one state to another [10] authors indicated difficulties to identify regularities of change in IS and indicated necessity to broaden the problem area. In contradistinction to studies made by [10] in our research we are studying change in IS in the same problem area as the causes which initiate these

changes (BP). Unified problem area provides opportunity to identify regularities between causes of change in IS and ongoing alteration in IS.

4. Elements identification for IS and BP changes characterisation

The objective of this research is to develop a method to identify possible requirements for change in IS independently of change requirements proposed by IS users. It is necessary because 1) it gives possibility to identify requirements for change in IS in any time independently of IS users, 2) it gives possibility to develop and implement required project of change in IS in due time, 3) it gives possibility to evaluate requirements for change in IS requested by IS users.

To develop this method it is necessary to identify regularities of change in IS. Change in IS is studied in relation with change in BP. See Figure 4. To identify regularities of change in IS the inductive reasoning mechanism is used. Within this mechanism, *case* means cases of change in BP in an organization, *result* means change in IS performed to provide new requirements for BP, *rule* means regularities between changes in IS and changes in BP. To obtain more precise regularities of change in IS six examples were examined. To represent BP alterations BP was examined according to its definition [7]. For each BP element a number was assigned (numbers 1 to 16, see Figure 5).
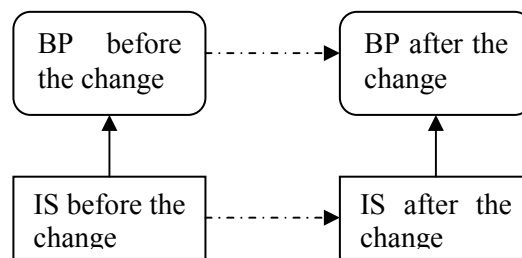
Fig.4. Relationship between change in IS and change in BP

The meaning of each BP element is as follows: 1 – owner of BP or a person who has the rights to make decisions about each BP activity, 2 – BP input supplier, 3 – BP input, may be a product, service or output from another BP, 4 – transformation which results in consumption of resources and input products in order to create output product or service, 5 – result of BP transformation – product or service, 6 – user of BP result, it can be an organization or another BP.
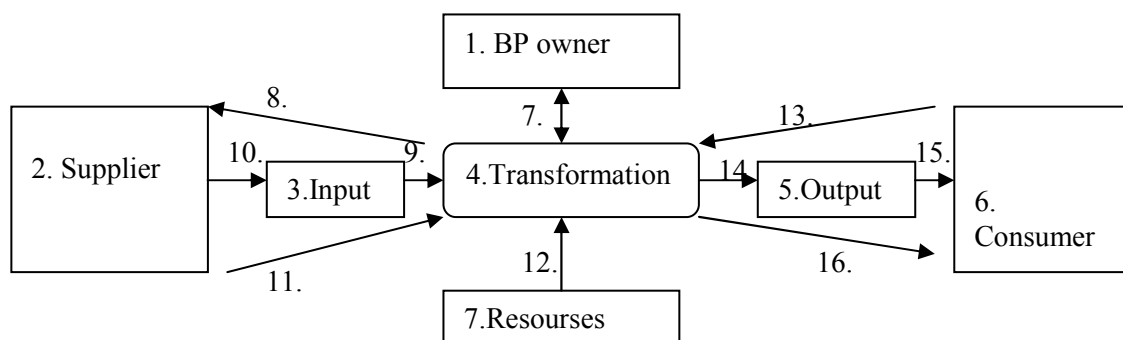

Fig.5. BP structure

7 – exchange of information and control between BP owner and other BP elements, 8 – control of input receipt, 9 – activity performed by BP in order to receive the input, 10 – activity performed by supplier in order to pass the input to BP, 11 – feedback with supplier, 12 – link which characterize resource utilization necessary for transformation, 13 – feedback with consumer, 14 – activity performed by BP in order to pass the output to consumer, 15 – activity performed by consumer in order to receive the BP output, 16 – control of output transfer.

Elements 2 and 6 can be seen as external elements of BP. They remain unchanged during the change in BP. In the structure of BP they are displayed for better representation of BP.

Performing the analysis of each example the change of each BP element and change in IS were examined. Results of change in BP were inserted into the table according to the change in IS. After analysing the change of all examples two types of BP alterations and corresponding IS alterations were distinguished.

To understand what kind of change occurs in IS during the change in BP a decomposition of IS was performed. According to IS definition [1, 7, 8, 9] IS provides users with the necessary information and data. Therefore decomposition of change in IS was performed in two aspects: data aspect and IS user aspect (see Table 1). It was taken into consideration that IS is a system of all kind (not only digital) data processing and storing.

Table 1

Decomposition of change in IS

Data aspect	1. Data processing. 1.1. Time required for data processing. 1.2.Time when it is possible to perform data processing. 2. Data delivery, receipt. 2.1.What is the form of data exchange: direct connection, e-mail, letter, direct contacts. 2.2. Is there a confirmation about data receipt/delivery. 2.3. Are data delivered in the point of decision making. 2.4.Is it necessary to resend the data to other persons within the BP. 3. Data quality. 3.1. Does data fully describe the object. 3.2. Object is described based on other data. 4. Data safety.
IS user aspect	5. Does IS user make decisions based on data. 6. Are all data necessary for user actions available. 7. Is collaboration among users effective.

5. Case analysis of change in IS and BP

During research we chose organizations functioning in different regions in Latvia. To ensure that different changes in IS are not interrelated we were analyzing examples from different industries: motor transport, civil engineering, public utilities, land surveying, trade, and public agencies. In many cases the change in organizations which belongs to the same industry was similar. For example, change in water supply industry was similar in several organizations. In this paper we merged the similar cases and described them as a single case. Changes in organizations occurred during last five years. The only exception is an example of public utility organization where change occurred in the middle of 1990's. The author of this paper has personally participated in all discussed case examples. Examples of change in IS and BP are given in Table 2.

After performing the analysis of change in IS and BP we found out that there can be two types of change in BP: 1) improvement of BP effectiveness (see Figure 6), 2) improvement of collaboration with other BP (see Figure 7).

First type of change in BP or improvement of BP effectiveness is described in the Table 2 examples 1, 3, 5, and 6. Analyzing examples of this kind of change in IS we can conclude that 1) data characterizing BP effectiveness is identified, 2) data is delivered to IS users responsible for making decisions. It is represented with the thick line 7 in Figure 6. 3) BP is integrated in other BP or existing data are applied in other BP. By comparing these results with process improvement methods, similarities in the first and second conclusion can be noticed [6, 7, 11, 12]. However the most important is the third conclusion which points to data integration with other BP.

Table 2

Examples of change in IS and BP

Short description of the change	Change in BP according to Figure 4	Change in IS
1. Improvement of payment accountancy between organization and clients. In documents issued to clients data about state of payments and technical parameters about the service are added.	BP control improved. Items 13 and 16.	Data to consumer is delivered more frequently. More data is delivered to inform the client about services.
2. Water supply organizations. Changing from the payments with each individual inmate to the payments with the whole apartment house.	Improving the BP payments with other organizations. Change in items 5, 14, 15, 13, and 16. Existing service is substituted with the new one.	Creation of new and facilitated service control. Improved acquisition of data characterizing the service. Data becomes free and frequently available. Receiver of the service is changed.
3. Motor transport accountancy, developing unified management information system. Data characterizing all elements of BP are aggregated in unified system.	BP costs for items 7 to 15 are determined.	Identifying data which characterizes BP elements. Improving the quality of these data and providing them to IS users who have decision making rights.
4. Land surveying accountancy. Developing accountancy of land surveying task automatically transfer from one executor to other.	Change in BP items 8, 9, 10, 11, 13, 14, 15, and 16. Collaboration among BP is improved.	Developing automatic registration of delivery and reception of IS users' tasks. Registration is performed about who, to whom, when and at what time delivered the task and what is the current state of this task.
5. Stock accountancy in public agencies. Stock delivery and accountancy was merged with forecasting and compiling the stock order plan.	Change in BP item 4.	Integrating data in BP from other related BP.
6. Improvement of a car centre accountancy. Improved control of components handed out from storage and components used for car repairs.	Change in BP item 4.	Integrating data in BP from other related BP.

According to the definition BP doesn't represent possibilities of data integration. Therefore BP representation was supplemented with an additional box indicating to the data which were integrated with other BP (See Figure 6 items 17 and 18). The third conclusion is similar to the process reconstruction in process improvement methods [6, 7, 11]. Performed research indicates that the basis of such reconstruction is data integration to/from other BP.
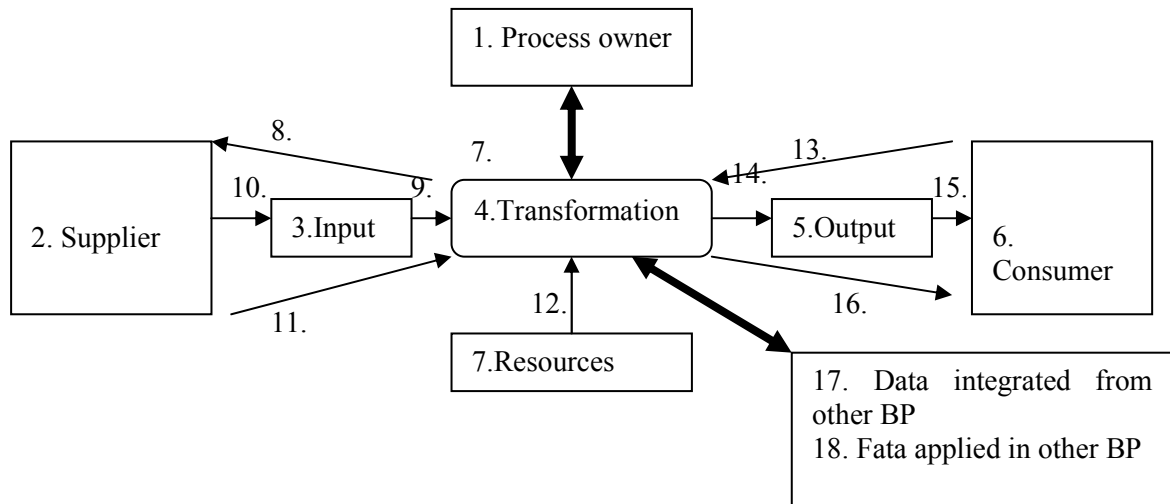
Fig.6. Change in BP for effectiveness improvement

Second type of change in IS or BP collaboration improvement is described in the Table 2 examples 2 and 4. Graphical representation of the second type change in BP is given in Figure 7. The Figure 7 represents the right side of the BP. Second type of change in BP is characterized by the following change in IS:

1) Improved feedback with consumer (Figure 7 item 13) and control of output delivery. It is achieved by automatic registration of task delivery and reception (Figure 7 item 16).

2) Improved links of output delivery and reception (Figure 7 items 14 and 15). Because of this improvement BP output is transformed to make its delivery (14) and reception (15) easily and effectively controllable. During the output improvement process several versions and modifications of BP outputs are tested: 5.Output 1, 5.Output 2, 5.Output 3 (see Figure 7). Thereby outputs with the most effective control are determined. The control is characterized with the costs of links 13, 14, 15, and 16. In the similar way the input of BP is determined to reduce and simplify its control costs.
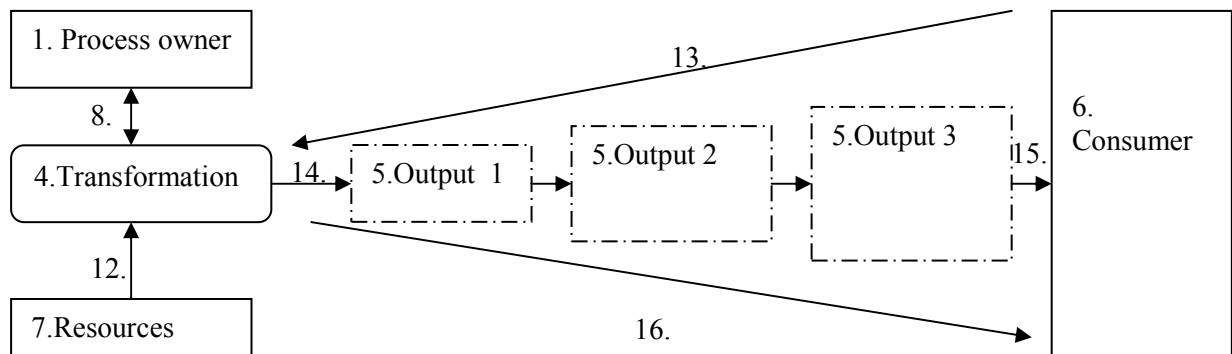

Fig.7. Change in BP to improve its interaction with other BP

6. Results and usability of change in BP and IS

Performing the analysis of change in BP and IS, it was clarified what kind of change occur in IS when BP changes. Description of the interconnection between mutual change in BP and IS is given in Table 3. Change in BP is classified in two types and described in the left column of Table 3. In the right column of Table 3 change which occur in IS organizations when implementing corresponding type of change in BP are named.

Table 3

Regularities of mutual change in BP and IS

Types of change in BP	Change in IS
1. Improving effectiveness of BP • Costs of BP components identified • Automatic registration of BP activities (when it was started, how much time was required to finish it, who accomplished it) • Comparative analysis of different time periods performed	1. Quality of IS is improved 2. Identifying new data characterizing BP 3. Providing IS users who make decisions with the data 4. Integrating data between different BP 5. Classifying the data
2. Improving BP collaboration with other BP • Costs of collaboration identified • Tasks performed to improve collaboration between BP and to reduce the costs • BP output improved (new products or services) • New modifications of BP output created (new products or services) • New forms of collaboration between BP created to reduce costs of the control	1. Identifying data characterizing BP collaboration costs 2. Data exchange is improved – automatic data reception and delivery is created. Without delays, repetitions and errors. 3. Identifying data characterizing possibilities to change the BP output (product or service)

Acquired regularities can be applied in two ways: 1) by performing the change in BP sequential change in IS can be identified, 2) by performing the change in IS aroused change in BP can be forecasted.

In the first case, if an organization is performing change in BP it is necessary to clarify which type of change is being performed. Further, based on regularities given in Table 3, it is possible to forecast what kind of change will occur in IS. This gives possibility to evaluate whether it is necessary to improve the current sate of IS or not and if it has to be improved then it is possible to point out exactly what IS improvements are required.

In the second case, by improving IS the potential possibilities of BP improvement are emerging. Due to these regularities it is possible to see what aspects of BP it is possible to improve.

According to IS development theory [2] the changes in IS occurs during crisis situation in an organization. However, if the regularities given in Table 3 are known, it is possible already before the crisis situation to identify possible change in IS. Thereby, change in IS is identified already in the very first stage of the change in BP. It provides an opportunity to develop and evaluate the project of change in IS in due time.

When analysing given regularities in more details following convergences can be seen:

• Convergence in the IS data aspect. Amount of data characterizing BP is being increased. It is achieved by 1) identifying new data, 2) improving the quality of existing data, and 3) performing the integration of data. In this case data characterize 1) all elements of BP (see Figure 5) and 2) other BP which are related to the studied BP. In this case the first example from Table 2 needs to be considered. In the example BP is integrating data from other functionally unrelated BP. In this case both BP are interrelated in the higher level of detailed elaboration where organizational goals are examined. From this we can conclude that data integration in an organization is determined not only by functional connections between BP but also by organizational goals.

• Convergence in the IS user aspect. Data is delivered to IS users who have rights to make decisions. New user groups are created and decision making functions are allocated to them. Appropriate data is provided to the new user groups to enable them to make decisions [13, 14].

7. Conclusion

The research study described in this paper displays regularities between change in BP and change in IS. Based on these regularities it is possible to forecast the change in IS already on the first stage of the change in BP. It provides possibility to evaluate the IS and to develop the necessary project of change in IS in a due time to achieve IS adequacy to change in organization. Results of this research can be applied to identify possible change in IS in organizations if no crisis situations can be observed or if it is difficult to identify them.

Requirements for change in IS were defined in an experimental way by analyzing mutual change in BP and IS. As a part of this analysis six cases of change in IS in organizations from different industries were studied. As a novelty we can mention following change in IS: 1) data integration with other functionally unrelated BP (see Figure 6), 2) transformation of BP output to identify the most effective type of BP collaboration (see Figure 7). In the process improvement methods these two cases of IS change are defined as process reengineering [7, 11]. Thereby our research specifies the basic principles of the process reengineering which are applied in process improvement methods.

A shortcoming of our research is that all examples are derived from local organizations only, not international. Therefore all change in BP can be characterized by some common traits: common legislation, common economical state, common market of products and materials.

Another shortcoming is that IS development theory [2] doesn't examine organizations based on their level of development [15]. It is possible that in more sophisticated organizations crisis situations occur differently.

Further goal of research is: 1) to analyse the theoretical base of IS change, 2) to find out proof mechanism of regularities presented in this research, 3) to characterise the changes in BP and IS more in detail and 4) to make presented method more clear and easy for using in practice.

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Makņa J. Metode informācijas sistēmu izmaiņu identificēšanai pamatojoties uz biznesa procesu izmaiņām

Tradicionāli IS izmaiņas organizācijā tiek veiktas atbilstoši IS izmaiņu pārvaldības plānam. Sakarā ar to ka IS definīcija un IS attīstības teorija nesniedz skaidru IS izmaiņu definējumu, prasības IS izmaiņām balstās galvenokārt uz lietotāju izvirzītām prasībām vai labākās prakses adoptēšanu. Lielākas grūtības rodas kad organizācija dažādu iemeslu dēļ nespēj patstāvīgi izvirzīt nepieciešamās prasības IS izmaiņām. Šādos gadījumos organizācija nevar savlaicīgi ieviest nepieciešamās IS izmaiņas un var nest ievērojamus zaudējumus. Lai izvairītos no šādiem gadījumiem identificējot IS izmaiņas nepieciešams ņemt vērā arī likumsakarības kuras notiek IS izmaiņu laikā.

Tāpēc šajā darbā tika veikts pētījums lai noskaidrotu likumsakarības kuras notiek IS izmaiņu laikā. Lai noskaidrotu IS izmaiņu likumsakarības IS izmaiņas tika pētītas kopā ar BP izmaiņām. Pētījums balstās uz IS un BP izmaiņu analīzi sešās organizācijās kurās izmaiņas tika pētītas vairāku gadu garumā. Pētījuma rezultātā noskaidrojās ka uzlabojot BP funkcionēšanu notiek sekojošas izmaiņas IS: 1) IS tiek papildināta ar jauniem datiem kuri raksturo BP, IS tiek integrēti dati no funkcionāli nesaistītiem BP, 2) IS izmainās lai uzlabotu sadarbību starp BP vai izmainītu BP produktu. Zinot šādas likumsakarības un zinot vēlamās BP izmaiņas ir iespējams prognozēt nepieciešamās IS izmaiņas un izvirzīt prasības IS izmaiņām. Tas dod iespēju identificēt IS izmaiņas jau sākotnējā stadijā un neatkarīgi no IS lietotāju prasībām.

Makna J. Method for identifying requirements for change in information systems based on change in business process

Traditionally requirements for change in IS are proposed according to the change management plan. IS definition and IS development theory does not provide a clear definition of change in IS therefore change in IS is mainly based on user requirements or adoption of best practices. The greatest difficulties for an organization arise when it itself can't propose the necessary change in IS for several reasons. In such situations an organization can't implement the necessary change in IS in due time which brings losses for an organization. To avoid these situations when identifying change in IS it is necessary to take into consideration also the regularities which occur during the change in IS.

Therefore we are performing this research to identify regularities which occur during the change in IS. To identify these regularities change in IS was studied together with change in BP. Research is based on the analysis of change in IS and BP in six organizations which were examined in a period of several years. As a result of our research we found out that when BP functioning is improved then following changes occur: 1) IS is improved with new data characterising BP and data from functionally unrelated BP are integrated into IS, 2) IS is changed to improve collaboration between BP or to change BP product. Knowing these regularities and knowing desirable change in BP it is possible to forecast necessary change in IS and to identify requirements for them. It provides possibility to identify change in IS already in the first stage and independently of IS user requirements.

Макня Я. Метод идентификации изменений информационных систем основанный на изменениях бизнес процессов

Традиционно изменения ИС в организации происходят согласно определенному плану. В связи с тем, что дефиниция ИС и теория развития ИС не дают полного определения изменений ИС, требования изменений ИС основываются на требования пользователей и адоптирования лучшей практики. Сложности в организации возникают в случаях когда организация по разным причинам не в состоянии самостоятельно определить требования для изменений ИС. В таких случаях организация не в состоянии своевременно внедрить изменения ИС и может нести потери. Для избежания таких случаев при определении изменений ИС необходимо основываться на закономерностях которые присущи при изменениях ИС.

В связи с этим в работе проведено исследование для определения закономерностей изменений ИС. Для определения таких закономерностей был произведен анализ изменений ИС вместе с изменениями БП. Исследование основывается на анализе изменений ИС и БП в шести организациях на протежении

нескольких лет. В результате анализа выяснилось что улучшая функционирование БП в ИС происходят следующие изменения: 1)происходит дополнение ИС новыми данными характеризующими БП а также происходит интеграция данных функционально не связанных БП, 2)происходят изменения ИС в связи с улучшением взаимодействия между БП и улучшения продукта БП. Зная установленные закономерности и возможное изменения БП возможно прогнозировать изменения ИС и следовательно выдвигать требования для изменений ИС. Это дает возможность идентифицировать изменения ИС и определить требования изменениям уже на начальной стадии и не основываясь на требование пользователей.