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METHODOLOGY OF THE REALIZATION OF PRE-IMPLEMENTATION TASKS RELATED TO INTRODUCING INTEGRATED INFORMATION SYSTEMS INTO SMALL AND MEDIUM-SIZED COMPANIES

Abstract

The article briefly presents the methodology of the integrated information systems implementation, reviews methodologies described in literature and put into practice, and points out the limitations when they are used in small and average-size companies. Next, the general model of the integrated information systems implementation is discussed with the careful consideration to all activities performed at the pre-implementation stages which are described in details. Finally, the main focus is on the most important factors that determine the failure of the realization of the implementation projects.

1. INTRODUCTION

Modern company management is a very complex process. This is caused by (among other things) a multitude of streams of goods (raw materials, spare parts, semi-finished products, ready-made goods, etc) and of streams of information that merge and complete each other. In order to control these two streams optimally in the operating scale and be able to make various decisions that are advantageous for a company and customers, the varied pieces of information coming from different sources, must be effectively used. Considering all these matters, one of the key elements in business development nowadays is the ability to use information technology and telecommunications industry in an effective and successful way. They are the devices that provide advanced cooperation and integration of the most important functions together with both internal and external company processes, beginning with research and development, then continuing with goods delivery, logistics, production, and then ending with marketing and distribution.

Integrated information systems play a special role here. They are the tool of streamlining and operational research in a company. Hence, more and more small and average-size companies decide to introduce ERP class systems (or now ERP II), recognizing that although it is a difficult and expensive undertaking, there are no other alternative solutions. Moreover, another reason is the fact that nowadays the business application market is being made available for more companies, and especially for the sector of small and average-size companies. It is impor-

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tant to emphasize the fact that the financial limits on introducing ERP systems have been reduced because of improved flexibility of providers and the increased EU funds accessibility to small and average-size companies.

The introduction of integrated information systems that help managing a company and are designed to improve the company efficiency, is an overall undertaking that includes all functions and processes carried out in a company. Due to this fact, the necessary element of introducing these class systems is the analysis of the company managing system and the production process realization and possible redesigning or designing them again from the beginning. Such actions to be implemented in an efficient way, require a methodological approach.

Implementation methodology is a detailed standard description (including the division into separate stages and activities) of operations launched during the implementation process. It includes all operations starting with the project preparations till the stage of post-implementation testing of the introduced system.

The basic task of methodology is organizing and systematizing all operations connected with the information system implementation. This task is of special importance because it should be remembered that in an implementation project, at least two (sometimes three and more) unfamiliar working teams (consumer's implementation team, provider's implementation team, independent consultants, etc) have to cooperate effectively and efficiently.

Strategies and methods of information system implementations in companies have been described in literature e.g. [1], [2], [3], [6], [9], [10]. Also, most major companies on the market providing integrated information management support systems, developed their own methodology used in the implementation of these systems (Tab. 1.).

Tab. 1: Selected company methods used by integrated information system vendors

Company	Information system	Methodology
Digitland	Digitland Enterprise i TE	(own methodology)
Exact Software	Exact	Extract II
Hogart	Fourth Shift	Fourth Shift
ICL	MAX	MAXIM
Intentia-Vimex	Movex	Implex
JBA	JBA System 21	JBA Advantage
Normax	JDEdwards	REP - Rapidly, Economically, Predictably
QAD	MFG/Pro	Q-Managment
Quantum	MEGA	MEGA
Qumak	Platinum/MMRP	Epicor i Kewill
SAP	R/3	AcceleratedSAP - ASAP
Scala	Scala Global Series	Signature
TCH Systems	Baan IV	Target

Described in the literature, general-purpose and universal methodologies for the IT projects implementation, relate to projects in large organizations for many project teams, and small and average-size companies do not have the resources for this. Besides, those methodologies (in

most cases) do not consider the specificity of projects involved in introducing integrated information systems and these projects combine technological aspects with the organization of the whole company thus, as a consequence, all organizational units in the company have to be engaged.

Integrated information system implementation methodologies that are put into practice by IT companies usually refer to specific systems and are presented vaguely in order not to reveal providers' *know-how* who provide these solutions.

All methodologies consist of a few or several stages that include different range of operations completed sequentially or parallel. However, despite the differences that can be found between various methodologies, they contain three basic stages [6]: pre-implementation operations, system implementation, usage and development.

The basis of effective and efficient accomplishment of integrated information system implementation into companies is the appropriate performance of pre-implementation operations. Because they are time consuming and labour-intensive and the results cannot be easily seen at first, a lot of companies – both providers and especially consumers of integrated information systems – do not pay due attention to the appropriate realization of pre-implementation operations. Thus, in order to streamline the realization of an integrated information system implementation process in the company management structures, the methodology of proceedings was developed. It is related to operation accomplishment at the pre-implementation stage. It is a very extensive issue and the stage of choosing the integrated information system is not going to be discussed in this article.

2. THE MODEL OF THE INTEGRATED INFORMATION SYSTEM IMPLEMENTATION IN COMPANY MANAGEMENT STRUC-TURES

Fig. 1 shows the basic stages of the integrated information system implementation in company management structures. In the picture, the detailed stages of the pre-implementation operations accomplishment and elements supporting their completing, are presented.

Pre-implementation operations
This stage involves the analysis of strategic principles of the project related to an integrated information system implementation and the analysis of the former ways of process accomplishments within an organization. These form the basis for preparing the concept of computer system functioning in a given industrial works, also the range of its customization and essential organizational changes to be introduced in a company are determined. At this stage, a course of action related to launching the direct implementation operations and introducing organizational changes is worked out.

This stage and its documentation are of a special importance to the effective realization of pre-implementation operations and their progress control.

To improve the efficiency of the task accomplishment at this stage, the following were described: an information system model, a production model, a group of factors that influence the production process realization, an introductory schedule of the integrated information system implementation process and a set of possible algorithms of the production process.
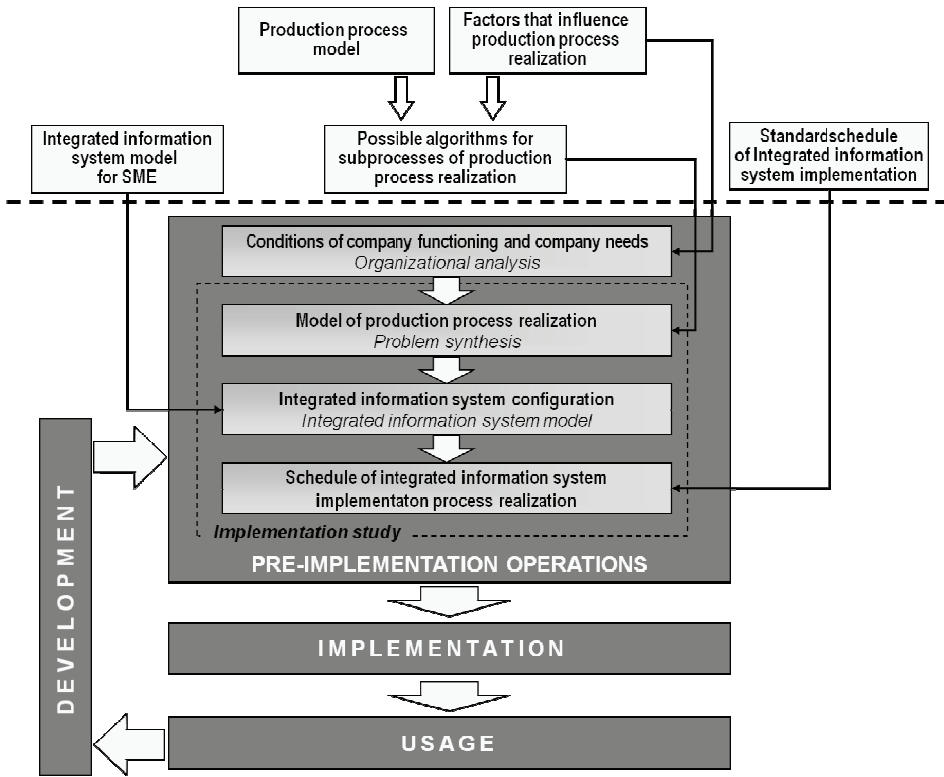
Fig.1: Model of integrated information system implementation

System implementation

The next stage is putting the conception into effect in accordance with demands and a course of action as specified in the pre-implementation documentation. The basic operations to be taken at this stage are:

- introductory training of project participants and key users,
- system parameterization and programming related to adapting the system for company requirements,
- training of end users,
- testing the system,
- creating position instructions relating to the way of work in the system at different positions,
- updated records in the pre-implementation operations documentation,
- system acceptance.

This stage ends when all the functions and processes described in the previous (pre-implementation) stage are completed.

System usage and development

After finishing the system implementation process, the phase of its productive use by its direct users follows. At the beginning it is essential to support the system users who often have to complete their tasks (often under new changed working conditions due to reorganization) working with the new tool.

Another element at this stage is system "adjusting" or "polishing" when the employees are learning about the advantages and inconveniences of the introduced solutions (both technical and organizational), and they also discover potential errors in the system. It is very important to differentiate between real errors and conclusions that facilitate the job of system operators. The former must necessarily be removed, and the second should be reviewed for reasonableness and cost-effectiveness of their implementation (comparison of benefits obtained with the costs of their introduction).

After a complete assimilation of new developments in the company, the next step is to assess to which extend the implemented solutions meet the stated objectives and how the possessed tool can be used to improve ongoing processes. This stage is an element of continuous improvement of company processes and can be the factor initiating another project related to an integrated information system.

3. METHODOLOGY OF PRE-IMPLEMENTATION WORK REALIZATION

3.1. The analysis of company functioning conditions and its needs

The work related to an integrated information system implementation begin with identifying the company functioning conditions and analysing the company needs – the stage of organizational analysis.

Basic aims of this stage are following:
- introduction of the project team members on information system provider's side to the system consumer's company;
- introduction of the project team members on information system provider's side to the current process realization in the system consumer's company – with reference to process participants, its course of action and a related documentation;
- specifying the limitations of hitherto existing production sub-process realization, defining predicted changes and giving potential suggestions regarding the new way of a process realization by the system consumer;
- setting the basic goals for an information system implementation by the system consumer.

The basis for this stage realization can be, among others, the discussed group of factors that influence the process realization in a company [4], [5]. These factors are mostly connected with each other, however the relationships between them are complicated and difficult to grasp. They can be analyzed on the basis of the questionnaire (see [4], [5]) or a survey conducted in a company where the implementation project is going to be introduced. Acquired experience revealed that more effective method is conducting a direct survey by a software vendor as it eliminates mistakes in question interpretation and if the need arises, it allows to expand the question or the answer. The duration of the process accomplishment depends on the size of the

company, the complexity and specificity of the production process, and also the involvement of members of project teams of both the software provider and customers.

This stage can be realized at the same time as forming the model of the production process realization

3.2. The model of the production process realization supported by an integrated information system

On the basis of organizational analysis results and the set of possible algorithms of individual sub-processes realization - a part of a wider process, the model of the production process realization supported by an integrated information system is developed. Discussed algorithms of the individual process accomplishment include positions [5], [8]. Individual process accomplishments presented do not use all options. Every company has prepared or should prepare such proceeding procedures that are best adapted to its specific activities. The algorithms presented should be considered as a hint on possible methods of an individual sub-processes realization within the production process and a help at the stage of the organizational analysis and implementation study in a company.

Elaborated, at this stage, the model of the production process realization is a simplified diagram of all processes accomplishment in a company with the use of a computer system. It defines the basic course of production processes in a company, includes the concise idea of system work, takes into account the expectations of the software consumers. It considers the integrated information system present functions and capabilities and determines the program modifications (system customization) that are necessary to the system introduction into a company. Fig. 2 presents a general model of the production process realization prepared for an exemplary enterprise that produces plastic household articles. Certainly, the general model is completed with detailed models of every sub-process accomplished in a company. For example, production orders are started according to MRP procedure, that compares, for each product, the number of placed orders from all customers, stocks, production orders currently completed and on this basis generates quantitative needs to start production orders for specified products Z_w (formula 1).

$$Z_w = \sum_{v=1}^{V} R_{wv} - \sum_{x=1}^{X} S_{wx} - \sum_{y=1}^{Y} P_{wy} \qquad (1)$$

where: Z_w– product w quantity produced as a part of the production order that has been started,

R_{wz} – product w quantity necessary to v order realization (planned w product expenditure over an analyzed period of time),

V – the number of all uncompleted orders over an analyzed period of time.

S_{wx} – current stock of w product in an x storehouse,

X – the number of all storehouses,

P_{wy} – w product quantity produced as a part of a y order that is being completed (planned revenue of w product over an analyzed period of time),

Y – the number of all planned and completed production orders.

In addition, the following condition must be met: the quantity of production order must be not smaller than the established quantity of minimal products batch (formula 2).

where: Z_w – w product quantity produced as a part of the production order that has been started,
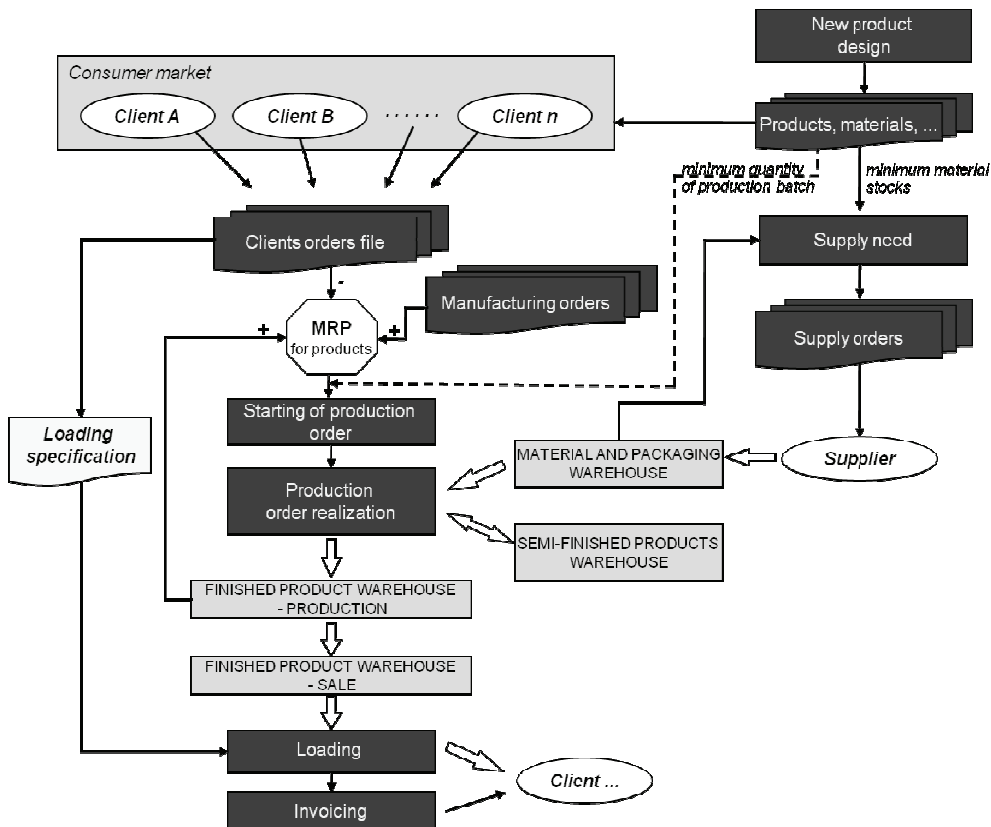
– minimal batch of w product.

Fig. 2: General model of the production process realization in an exemplary enterprise

This model is reviewed together with staff of the software consumer project team, the essential organizational changes are determined and the program modifications (system customization) are agreed on.

The fundamental aim of this stage is preliminary verification of the adjustment of the offered information system to company demands and requirements – a clash of consumer's needs with system capabilities, and also, determining the scope of information system introduction, and deciding on required program modifications as well as the essential spectrum of process reorganization in a consumer's company.

3.3. The integrated information system model

Based on the prepared model of the production process realization (implementation study) and the integrated information system general model (see [4], [5]), an information system configuration and parameterization phase follows – building the target model of information system that is going to be used in a particular company.

This model includes the set of properly parameterized and mutually connected functional modules to information streams that are vital to operate a production processes in a particular company (according to the system implementation previously determined). It includes the system consumer demonstration data that enable to make a simulation of the computer system use (usage).

It should be noted that this model should already take into account the specific needs of the company for additional, specialized modules. It also should include an analysis of how the classification and coding of products, materials, tools, appliances, machinery, etc. should be done.

Fig. 3 presents a simplified diagram of an integrated information system model in a partic-ular company and illustrates the demonstration information system modules and information connections between them.
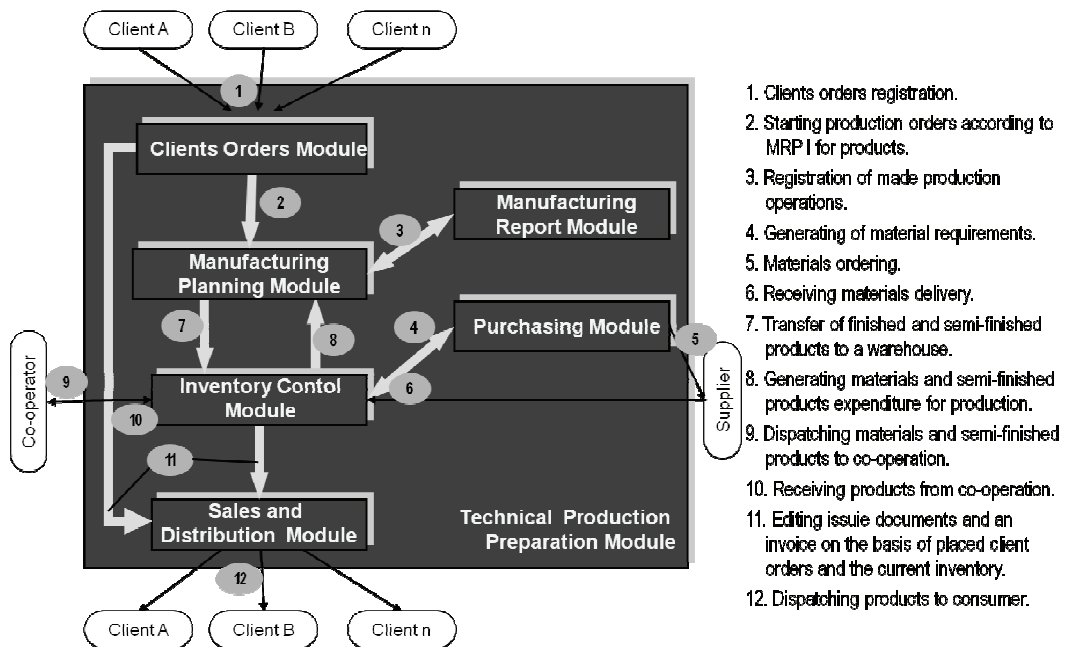

Fig.3: Diagram of an integrated information system model for an exemplary enterprise

The purpose of the above model presentation is to demonstrate the way in which the proc-esses executed in the company are operated with the use of a information system by the system

consumer. It should be emphasized here, that such model does not yet include the required system modifications, implementation of which demands additional outlays.

3.4. The schedule of the implementation accomplishment

Definition of labour intensity and tasks time consumption

Labour intensity means the number of working hours (man-hours) that is necessary to complete the task. Its quantity results directly from the range of the implementation project realization and the company specificity. Based on that, labour cost related to a task realization can be estimated.

Time consumption (time needed to complete the task) is the period of time devoted to a task realization. It is the basis for preparing the schedule of the implementation process realization and it directly influences a deadline for a task realization. The following factors affect the time of a task realization (formula 3):

- labour intensity – R,
- the number of employees completing the task – I,
- qualifications and skills of employees completing the task – U,
- percentage of working hours that workers completing a task can spend to accomplish it – P,
- organization of project work (e.g. regulations of working hours) – O.

$$(3)$$

Generally, labour intensity can be influenced by the change of each listed factors. Attention should be paid to the fact that the influence of some of the factors is non-linear and it depends on the specificity of a completed task. Sometimes the change in the factor quantity does nor affect considerably the task time consumption. Fig. 4 illustrates a demonstration relation between a task time consumption and the number of workers that realizing their tasks.
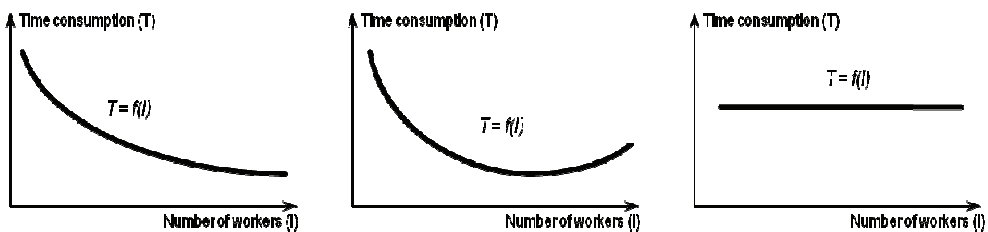

Fig. 4: Demonstration relations between time consumption and the number of workers realizing their task

In order to estimate labour intensity and time consumption of an integrated information system implementation into company management structure, seven general tasks can be distin-

guished that have to be completed as a part of every company process while an information system is being introduced:

- Organizational analysis and implementation study. This task includes all pre-implementation operations and it begins with the analysis of integrated information system consumer's company functioning, through establishing the model of the production process realization, and it ends with constructing an integrated information system model and drawing up the implementation schedule.
- Preparations for training and implementation work. They are tasks completed only by the information system vendor. The tasks refer to preparing software updates, preparing reports and summaries according to consumer needs determined at the pre-implementation stage, they also involve planning the details of the training, preparing course materials and training examples.
- Software modifications (information system customization).Tasks completed by the integrated information system provider (producer), connected with programming and testing new functions, solutions, summaries and printouts according to consumer needs determined at the pre-implementation stage. As a part of task realization, additional – specialised modules are built, and they consider specific company needs.
- Operations related to process reorganization in the integrated information system consumer's company. Operations performed in the information system consumer's company, connected with the changes in individual processes realization as a part of the production process. The spectrum of the changes is determined at the pre-implementation stage.
- Training – implementation work. The tasks, first of all, refer to the training of individual information system modules users, consulting the system functions and the task realization supported by integrated information system elements. These operations involve also the software, reports and summaries updating at a software consumer's place.
- Entering data into a information system. Operations connected with completing the system database. The data are usually entered into the system by the system consumer. In the justified cases, the data can be transferred from the external systems used at consumer's.
- Starting the process realization and its verification. The early period of using the information system for an individual process realization in the consumer's company. This period of time is connected with developing proficiency in using the information system by its end users and verifying its operating correctness in real terms of a company performance.

Estimating the periods of time of the individual tasks realization (both their labour intensity and time consumption) can be done with the use of different techniques, e.g.: the technique that uses the similarity to other operations, the technique that uses historical data, the technique that applies the experts pieces of advice, the Delphi technique, the technique of three points (formula 4), the Delphi averaging technique [11].

$$ t = \frac{t_o + 4t_n + t_p}{6} \qquad (4) $$

where: t– expected time of task realization,
  t_o – optimistic (the shortest) time of task realization,
  t_n – the most probable time of task realization,
  t_p – pessimistic (the longest) time of task realization.

The tab. 2 includes the summary of maximum and minimum labour intensity of an integrated information system implementation into company management structures. This data were interpreted on the basis of the analysis of labour intensity of series of integrated information system implementations in production companies with different spectrum of production [4]. Attention should be paid to the fact that regardless of the company branch, the total labour intensity of tasks completed by the information system consumer is bigger than provider's labour intensity. As can be seen, the heavy work burden falls on the company where the information system is being implemented and not on the implementing company.

Tab. 2: Summary of project labour intensity of an integrated information system implementation

Task	contractor	Labour intensity			
		providers		consumers	
		min	max	min	max
		[hours]	[hours]	[hours]	[hours]
Organizational analysis and implementation study	provider and consumer	74	216	34	97
Preparations for training and implementing operations	provider	31	84	-	-
Software modifications (information system customization)	provider	0	570	-	-
Operations related to process reorganization	consumer	-	-	0	432
Training – implementation work	provider and consumer	88	272	88	272
Entering data into a system	consumer	-	-	84	1236
Start and verification of process realization	provider and consumer	46	184	132	670
Total:		239	1326	338	2707

The schedule of implementation accomplishment

The final stage of pre-implementation work is to plan the schedule of system implementation.

When the scope of using the information system is precisely planned, the way of the process realization and function operations supported by an integrated information system is defined, the range of software modifications and organizational changes is also determined, then it is necessary to plan the schedule of the integrated information system implementation in a company.

At this stage the order of an individual process implementation is established, time relations between tasks and stages are set and the time of individual tasks realization is estimated. At this stage it is also worth to generate the detailed task list to complete, and determine the key tasks that condition the next stages of implementation.

The schedule has to be planned together with the project teams of the software provider and consumer. It has to consider:
- time consumption of work connected with the adaptation of the IT infrastructure,
- integrated information system consumer's needs and specification concerning the order of the computer system implementation into separate areas,
- the schedule of required software modifications made by the provider,

-   time consumption of training-implementation work performed in separate areas (the time consumption results from both the provider's and system consumer's potential),
-   time consumption of work related to processes reorganization in the company,
-   time consumption of work linked to entering data into a system – completing the database,
-   start and verification time of individual processes operation.

Pre-implementation work can be carried out in series, parallel or in series-parallel depending on the accessibility of human and financial resources of the company and the software provider, and the software consumer's needs. Variants differ on:
-   human resources involvement on the part of the company (the more parallel jobs, the bigger resources involvement),
-   human resources involvement on the part of the software provider (the more parallel jobs, the bigger resources involvement),
-   the time of a project realization (the more parallel jobs, the shorter time of project accomplishment),
-   time consumption of a project realization (the more parallel jobs, the bigger time consumption),
-   the cost of project realization.

At the same time, as a part of each variant, the implementation in separate process areas can be introduced in a various order and it can include task operations of different ranges – it enables to divide the project connected with implementation into series of stages what results in:
-   better project management,
-   dividing the pre-implementation work in time,
-   focusing, in the first place, on company critical processes.

Drawing up a schedule of implementation work can be done on the basis of the demonstration schedule [4]. This schedule is being adjusted to the exact company demands, taking into consideration the following:
-   an estimated time for a separate tasks realization,
-   integrated information system consumer's determined needs and requirements,
-   defined model of a production process realization,
-   an individually configured integrated information system model,
-   a fixed range of organizational changes,
-   an established scope of system customization.

4. SUMMARY

According to [7], on the Polish market only about 10% of the ERP class system implementation is successful, i.e. the complete implementation of the entire (assumed) range of the company functioning areas serviced by the information system, exceeding the established budget and schedule not more than 50÷70%. About 30% of projects have been finished with an incomplete implementation - it means that only a part of planned economic processes is dealt with. However, the research conducted by Gartner Group organization revealed the following:
-   80% of implementation projects ends with failure, i.e. there are projects in which, at least, the budget or the implementation time was exceeded,
-   over 30% of projects is cancelled before finishing,

- about 16% of projects in terms of software stays within the date and cost limits,
- in a big companies, only 9% of projects finishes on time and within budget,
- the average time overrun in projects is about 222%.

Owing to the above results, the attention should be paid to the most significant errors that occur during the implementation project realization [3], [4]:
- defects in defining the finished quantity, exact and targeted (determined in quantity) goals of the integrated information system implementation,
- lack of funds,
- wrong choice of a information system or its provider,
- consumer's conviction that the system provider is responsible for system implementation,
- treating an integrated information system implementation project strictly as an IT project,
- insufficient involvement of the board and senior management in the implementation,
- resignation from the chosen stages of the integrated information system implementation process,
- the schedule of the implementation too optimistically accepted,
- defects in the project documentation,
- lack of sufficient attention to human factors.

Most of the causes of information system implementation projects failures are due to lack of awareness of the complexity of such an undertaking, the underestimate the importance of own involvement in its implementation and negligence and simplifications at the implementation and documentation stage of the pre-implementation operations. Hence, there is a need of effective and verified principles and tools used at this point.

Presented methodology of proceedings on the phase of pre-implementation operations, is based on the analysis of the functioning of several companies in various industries (engineering, metal, automotive, plastics, textiles, furniture) and the analysis of the projects related to the implementation of an ERP-class integrated information system into these enterprises. Based on the conducted research:
- a set of factors influencing the way of a production process implementation was determined,
- relations between individual factors and the accomplishment of sub-processes in a production process were revealed,
- the way of individual sub-processes realization was generalized and a set of standard algorithms of their performance was created,
- methodology of the integrated information system implementation adapted for small and average- size companies' needs was developed,
- a model schedule of the implementation process realization was created - including essential tasks to complete at the separate stages of the project implementation,
- the analysis of the labour intensity and time consumptions of the individual tasks realization as part of the integrated information system implementation project was carried out.

Developed proceeding procedures related to the realization of pre-implementation operations bring the following benefits in practice:
- shortening the time of the realization of pre-implementation operations connected with the analysis of the company functioning, preparing a model of a production process accom-

plishment, constructing an integrated information system model and developing a schedule of implementation operations,

- costs reduction of the information system implementation in small and average- size companies related to both the use of standard algorithms for the production processes realization and the software of a module and open structure, then applying the accurate organization of the system implementation process,
- the possibility of a multi-stage information system implementation into areas of a production process support thanks to a module structure of a computer system and the proper implementation process planning.

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