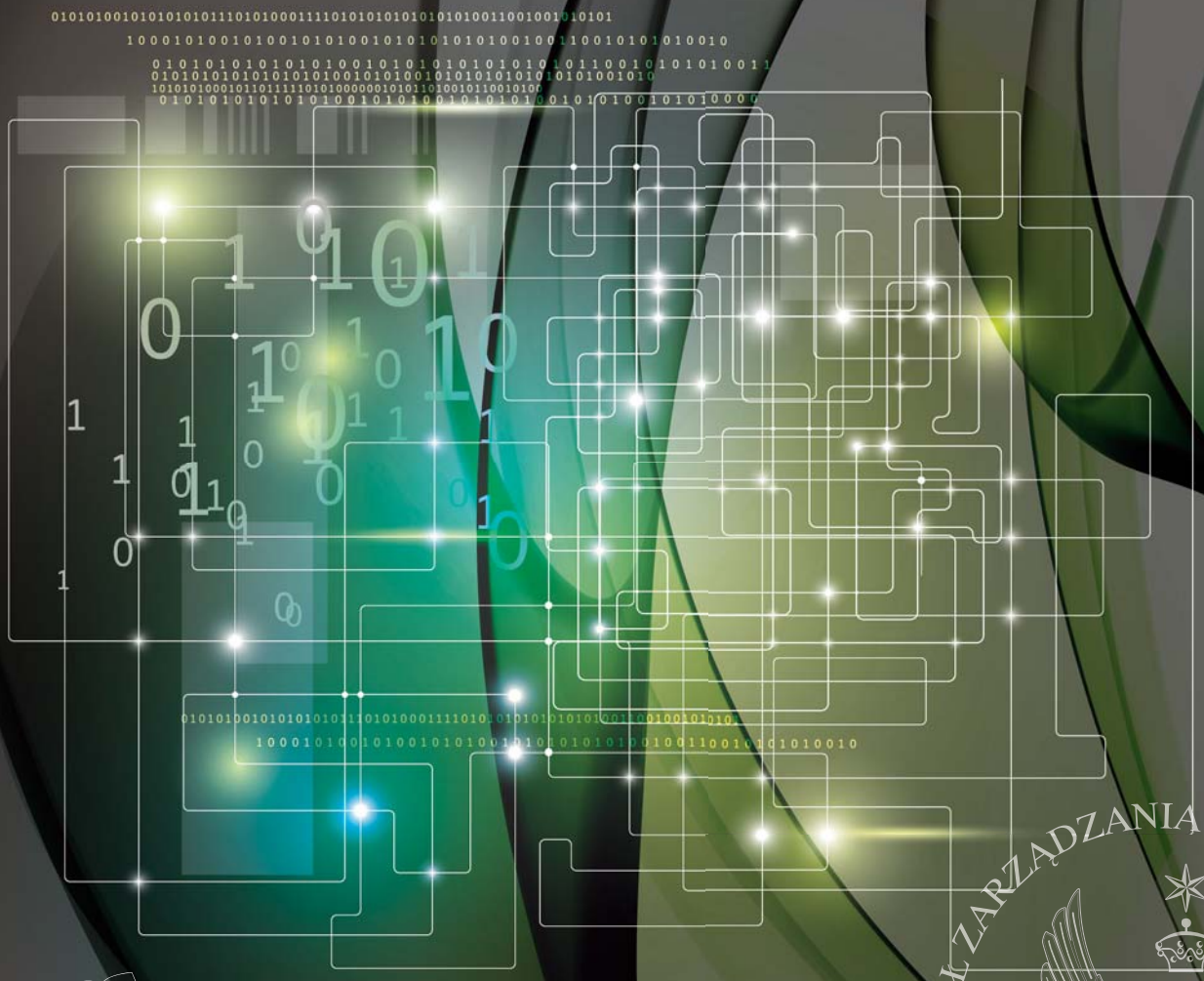
Witold Chmielarz

INFORMATION TECHNOLOGY PROJECT MANAGEMENT



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Wydawnictwo Naukowe
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Uniwersytetu Warszawskiego

WYDZIAŁ ZARZĄDZANIA

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Introduction

In this publication the author presents a synthesis of theoretical considerations concerning methodological and practical aspects of designing and developing computer-aided management systems. At times, it seems that the question of the creation and application of IT systems supporting management is perceived by some people as completely abstract. Surprisingly, the latter concerns even those who use a computer on a daily basis, both in their personal and professional life. The present situation may be seen as a specific aftermath of the developments taking place in the 1990's, which is the time when:

- the market was dominated by standardised, non-dedicated systems and their implementation was often carried out without any deeper analysis of users' requirements,
- the electronic market was developing in a rapid and uncontrolled manner, very often through copying models and imposing developers' ideas and their realizations on the clients.

The main cause of the situation described above was the negligence with regard to promoting relevant methodology and implementation methods. Widespread availability of the Internet resulted in the fact that its users, especially those concentrating on its social aspect, tended to forget about the relationship between what you see on the screen and the necessity to develop software which displays it.

Unfortunately, unfamiliarity with the problem goes much deeper: the relationship between the software and the need to create the project is frequently ignored. In addition, asking the future user to consider the questions concerning the software requirements may even result in aggressive attitude: in the minds of the society it is enough to use the existing programmes and solutions.

In the case of large, complex, innovative projects another stereotype associated with information technology is brought to daylight: namely, the work connected with the adaptation of information technologies in an organization is believed to be troublesome and in the employees' view it interferes with the performance of daily duties in the organization. Here, we refer to the management of IT projects – another aspect of informatization, which is still not well recognized in the context of digitalisation of the company by the user to date.

In general, even though we all use software on a daily basis, we may still see the lack of both: knowledge of the interrelationships of the previously enlisted spheres and the awareness of their constant, dynamic development. However, in recent years, we observe a shift of focus towards the needs of the end user and the necessity of proper adjustment of the software to match the functionality of the organization and to improve the economic effectiveness of IT systems' applications, the tendency which, in contrast to the blind rush towards adaptation of information technologies at all costs at the beginning of the XXI century, seems to be a major step forward. Interestingly, the above mentioned problems concern also some professionals, the circle of IT specialists, who may not go beyond the area of well-known and well-studied solutions which do not always match the virtual (and non-virtual) reality (because … *in IT there is nothing new… all innovations have already been applied*…).

I hope that the present publication will disprove some of the myths and change some of the habitual behaviour in the area, remind and refresh old truths, help to see the problems from a new perspective and explore new approaches which may be used to address the problems.

The structure of the book, which results from the above considerations, consists of three main parts:

– the first part concerns the directions for the development of IT systems' management under dynamically changing theoretical and practical conditions, which break some of the patterns of thought that function almost as axioms in the field,
– the second part presents the concept of combining the development of methodologies applied in the analysis and design of the IT systems with the development of, on the one hand, technological aspects of the systems' development, on the other, computer-aided management systems in commercial methodologies of process and project management,
– the third part presents the results of project activities – IT systems supporting management with the application of the author's own concept of the analysis of their development and a brief description of their selected features.

In this publication the author tries to demonstrate and analyse the relationship between the ideology ("pure" theory), and theoretical (but resulting from practical experience) and commercial methodologies of IT projects' management. The author also seeks to answer the question: whether, how, why and in what ways the development of IT systems supporting management and their multi-dimensional integration took place. The cognitive aim was:

– the analysis of the basis needed to understand the project and the process as well as the differences and similarities in managing them,

– the analysis of the theoretical methods of the analysis and design as well as the commercial methods of project management,
– characteristics of the origin and development of IT systems supporting management.

Methodological objectives were:
– critical analysis of the methodologies used in the field,
– comparison of traditional and modern methodologies,
– listing their strengths and weaknesses,
– presentation of a new approach to the concept of the development of computer aided management systems.

The practical objectives of the work were:
– awareness of the liquidity and flexibility of the boundaries between managing projects and managing processes,
– analysis of the needs and application of the project management methodologies,
– proper classification and identification of IT systems in order to apply an appropriate class of systems within the organization.

Meeting these objectives affected the logical structure of the author's work which consists of Introduction, Conclusion and three substantive chapters.

In the first chapter the author focuses on defining the basic concepts of project management and its development both with the consideration of traditional and modern approach.

In the second chapter the author reviews the most commonly applied commercial process improvement methodologies used in project management: Project Management Institute, Capability Maturity Model (CMM) and Capability Maturity Model Integration (CMMI), Prince II, ITIL, TOGAF, Six Sigma as well as quality management according to ISO standards.

The third chapter contains a presentation of the author's own approach towards the directions of the development and integration of IT systems supporting management in three main areas: logical complexity of the systems' structure; functional integration and the development of network solutions.

This book is a monograph intended not only for academic instructors and students of computer science for economics. The publication should be interesting to both professional and non-professional readers, also those from non-academic circles. This book may be a valuable source of knowledge and an ideological guide in the daily work for the business people involved in project management. For the managers who have occasional contact with

the problems associated with the development of IT systems supporting management in organizations it can provide instructions on how to formulate their own requirements in cooperation with contractors.

This publication has been created based on the questions and interests of my students, in particular those of e-business specialization and postgraduate students of the Faculty of Management of the University of Warsaw as well as a circle of friends who are involved in the management of the design and implementation of IT systems on a daily basis, mainly analysts, designers and project managers. I would like to express my gratitude for their enquiries and support, and I hope that I have been able to provide satisfactory answers to some of their questions and explain some of their problems.

Readers will be able to assess whether my attempt has been successful.

1. Characteristics of the evolution of IT projects design methods

1.1. Evolution of the notions and concepts of project management

In the classical form the term *project management* appears in two possible semantic ranges, with narrow and wide definitions.

In the narrow, practical sense *"…it can be defined as a set of managerial activities related to the implementation of the projects and a set of principles, methods and means used in these operations…"*[1]. *"…Traditionally, project management is viewed as planning, scheduling and controlling of the project aimed at achieving its objectives…"*[2] In fact this represents *"… an integrated and unique collection of information and decision-making activities performed to achieve the required range of specific project goals, limited by available means, carried out according to specific methodologies applied with their assigned techniques used to realize specific tasks…"*[3]. Integrated – because it must lead to achieving the objectives of the project. Unique – as it results from the uniqueness and distinctiveness of the project tasks. Here, methodology, as a science concerning scientific research, its effectiveness and cognitive value, appears as a kind of tutorial, a collection of guidelines and rules for presenting what should be done at a given moment in the project, but not showing how it should be performed in the particular case which is being analysed[4]. The latter is shown by a method which is understood as a set of activities and techniques which allow, within a specific methodology, for the formalization of the project and answering

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1 Trocki M., B. Grucza, K. Ogonek, *Zarządzanie projektami* (Warsaw: PWE, 2003) 27 after: Kruger W, *Projektmanagement*, [in:] *Handworterbuch der Betriebswitschaft*, Schaffer-Poeschel Verlag, Stuttgart, 1993. 3359.

2 Bukłaha E., *Zarządzanie projektami informatycznymi*, [in:] *Informatyka gospodarcza*, edited by J. Zawiła-Niedźwiecki, K. Rostek, A. Gąsiorkiewicz (Warsaw: CHBeck Publishing House, 2010) volume II, 21.

3 Chmielarz W., K. Klincewicz: *Zarządzanie projektami*, Section 5.4., Chapter 5 titled *Zarządzanie w kontekście zmian* [in:] J. Bogdanienko (ed.): *Organizacja i zarządzanie w zarysie* (Warsaw: Wydawnictwo Naukowe WZ UW (University of Warsaw Faculty of Management Publishing House) Elipsa Publishing House, 2010) 239.

4 see Pieter J.: *Ogólna metodologia pracy naukowej* (Wrocław: Ossolineum, 1967).

the question of how to achieve the objectives of the project. Methodology presents a specific, formal procedure of achieving the objectives by means of a set of appropriate tools and specific techniques. Specific technique is the presentation of procedural use of tools by means of which methodology is being implemented.

From a broad, theoretical point of view this is a specific field of science, based on theoretical solutions of practical problems arising „*… from the need to satisfy the analysed customer's requirements with the use of available skills, knowledge, methods, techniques and implementation tools…*"[5]. Thus, this is a study concerning the effective achievement of the assumed objectives by means of a rational use of resources (human, financial, material resources, etc. and relations between them) within the projected timescale. Variability connected with the dynamics of economic environment is typical of this scientific field. If it is to be a response to current economic problems, it should always be adapted to the possibilities of solving them. The latter is not necessarily consistent with the classical understanding of the concept of project management and, as we may note, it appears to evolve towards process management.

This results from the fact that undoubtedly a project is the subject of project management and, simultaneously, its main component in all the above definitions. There exist many very similar and non-contradictory definitions of projects, where the main characteristics of the concept are highlighted. Authors agree on the definition with regard to the content, and only later in the cycle of project implementation they postulate the requirements which cause the fact that their approach to the project seems to be somewhat different. Nevertheless – irrelevant of individual definitions – the essence of the project is an efficient and methodical execution of a particular enterprise. A project is understood as a complex sequence of not necessarily sequential and complicated actions, carried out according to the adopted plan. It follows that the project is innovative, unique, complex, group, coordinated enterprise which has a fixed timeframe, limited financial resources and it is aimed at achieving a specified objective, with a predetermined range of frequently strategic and generally high quality requirements. The project is realized with specified methods and techniques contained therein, applied with full premeditation or in an intuitive way, usually according to a specified schedule, following a cost estimate established for particular stages according to the documentation required by law. The scope of this concept is still very wide – from the creation of new objects (items, goods, information sets), modernization of existing ones, addition of new values or extension of previously defined objects, the elimination (replacing

[5] Mingus N.: *Zarzadzanie projektami* (Gliwice: Helion Publishing House, 2009). 21 after: Project Management Institute, Inc.: *A Guide to the Project Management Body of Knowledge* (PMBOK Guide), Third Edition, 2004,

with new ones) of old objects or activities consisting of the combination of these operations.

Generally, the features of contemporary projects are as follows:

- purposefulness – activity aimed at achieving the results defined for the contractor or the ordering party. It should be noted that the ordering party sometimes becomes aware of new circumstances in the course of the project and demands modification of the project even beyond the framework set forth by the signed agreements, and therefore the adaptability to the changing goal may be important,
- complexity – of course, you can manage even a simple project with the focus on its correct implementation; nevertheless, the activity is not so complicated as to require special methods or executive techniques. Therefore, in general, the concept of the project refers to an enterprise which is complex enough for one person not to be able to activate the entire project and which creates a need to coordinate the functioning of many individuals, teams, organizational units and even organizations. The complexity, enhanced by technical and organizational progress and rapid changes in particular fields, often requires adjustments (through change) of initial project assumptions,
- uniqueness – a specific feature – novelty, conceptual and executive uniqueness, is treated in reality in a rather flexible manner. Sometimes an original object (with some modifications, or used in another field (industry)) is treated as a unique object. Therefore, we may describe some projects as standard and repeatable ones, where innovativeness and uniqueness consist in generating specific and unique parameters of the project created for an individual customer. Implementation of the latter is much more expensive than standard, repeatable projects. Other interpretations speak of the specificity of one-off projects where we use the knowledge and experience gained through participation in previous projects in subsequent projects,
- determinism – the definiteness in time (space), scope and budget. The budget, scope and timeframe remain in specific mutual relations, limited by resources. Unjustified interference with that particular equilibrium (technical project triangle) influences the change of other parameters. Project management also includes risk management, risk under the conditions of uncertainty, etc. There are also special methods of resolving these issues. We need to be aware that in the economic reality there are relatively few clearly defined situations, and in managing projects we refer only to determined models of generally random events, carrying a certain amount of risk. Projects, especially large and innovative ones, usually exceed the forecast schedule and the expected budget level, and do not keep within the scope of activities; therefore, the risk connected with their implementation is relatively high. In recent years we started to pay more attention to the fourth ingredient –

the requirements of the end user (the ease of use of project solutions, high speed of obtaining the final result, the accuracy of projections – even at the expense of partial deterioration of quality and obtaining the acceptable results instead of optimal ones), which greatly increases the possibilities of manipulating of the variants of project implementation,

- risk – connected with the difficulty of implementation – since it is usually a complex, complicated, innovative enterprise and, as such, burdened with high costs, there are many factors that can interfere with the normal cycle of the project implementation. Moreover, methods and techniques which support decision-making processes occurring in project management are often based on models, i.e. a specific simplified reflection of economic reality. If this reflection is incorrect, the implementation risk increases, despite the mathematical excellence and testability of methods and techniques. Even in the case where only one of its initial assumptions is not realized, the usefulness of the final result proves very doubtful. However, it seems that for the decision-makers, even such approximate information represents a greater value than a complete lack of it,
- autonomy – the total (e.g. outsourcing in its various forms) or partial independence of from the contractor's/customer's organizational structures. It usually means a separation of project operations from routine organizations' tasks. The concept of non-routineness thus admits the form of a project which is being implemented within a particular organization, even though its complexity would indicate the necessity of the realization supported with the use of external forces and measures.

Summing up – in the classical term, project management is a unique, individual project undertaken in order to create a quantitatively and qualitatively defined unique product or service, using the allocated human, material and financial resources, limited in time by its clearly defined starting and end points, which are connected by particular implementation stages within a specified method.

At present – as the foregoing considerations point out – determinism, uniqueness and statistics in setting out the characteristics and results of the projects move towards probabilistics, indeterminacy and dynamism. Theoretically – the discrepancy between the two basic kinds of action distinguished in a contemporary organization: projects and processes should increase. Still, projects are defined as unique, individual projects, which require proper preparation, while the processes are repeatable, may be automated or they may become a routine activity. The main difference is the fact that processes are being conducted all the time and they are inherently repeatable, while projects are being realized whenever a new need arises, and each project is different. However, in principle, in a sense, projects are seen as sub-sets

of processes – these are all processes that can be described as non-routine (change-directed) ones, innovative, pragmatic, burdened with high risk and unique (rseef.: Figure 1). This is due to specific similarities – both activities are carried out by selected teams by way of planning, controlling, monitoring particular actions, determined by specific resources limited in time.

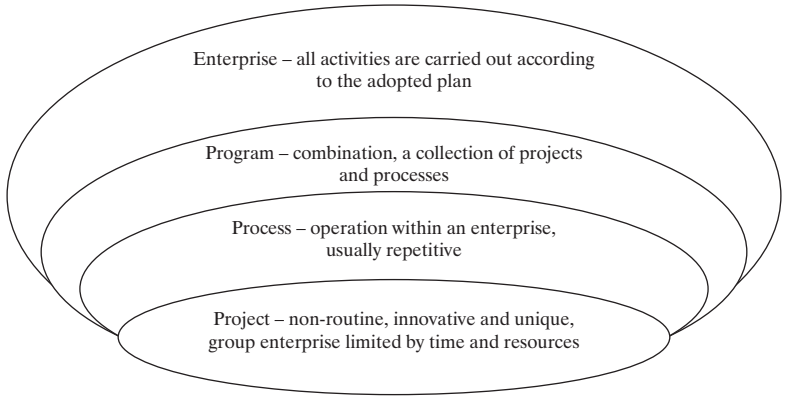

Figure 1. Relations between projects, processes, enterprise and programme
Source: the author's own work.

This, in turn, causes the fact that changes in process management directly affect project management. Projects are carried out in order to improve existing processes, creating entirely new processes and solving specific problems connected with the necessity of process changes. In every organization there occur both process and project actions. Contrary to its classical definition, projects generally do not end. Every end of one project establishes the beginning of the next one (e.g. in IT: pre-implementation work, implementation work, etc.); in total, they are sometimes an endless cycle of projects which we cannot even refer to as sub-projects, because we never know – due to uncertainty and high risk – the directions in which the requirements of end users would develop. However, the most symptomatic for the project development is the fact that the methodologies of project management were created, generalized, "fixed", codified, etc. in order to best normalize processes occurring in the project. The paradox – as we may see – consisted in the fact that they were closer and closer to process management methodologies as they were aimed at operating standard rules of solving non-standard problems, which they sought to standardize (or change into processes) by a far-reaching formalization. One may be under the impression that the distinction which occurs in literature (see Table 1, first column) savours of artificiality and does not reflect the reality.

Table 1. Similarities and differences between projects and processes

Project – traditional approach	Process	Project – current approach
Dynamism, change management	Stability in the sense of repeatability	Dynamism influenced by economic pragmatism
Uniqueness	Routine	Good practice of management
Pragmatism	Automatism	Knowledge management
Change management (revolution)	Modifications (evolution)	Adaptability to changes
Non-implementation risk	Low risk	Minimising risk
Innovativeness, novelty	Traditionalism of conduct	Pattern-controlled non-conventionality
Involvement of management	Lack of influence of management on the processes	Cooperation of teams and management
Conflicts in the organization	Cooperation in the organization	Cooperation in the organization aimed at minimizing conflicts

Source: the author's own work

Sometimes interchangeably with the concept of a project, we apply the notion of the programme either as a project in non-commercial areas, or as a bundle of projects (a very complex, expensive, risky and complicated project, etc.). For some time the definition of a programme has been evolving in the direction of "…*a structured set of interrelated projects, which are both desirable and necessary as well as sufficient to achieve the business goal and deliver the value expected by the sponsor of the programme…"*[6]. Programmes consisting of many projects, in contrast, are not limited in time. Therefore, it might seem that one of the directions of the development of projects and project management may be programmes. Perhaps the problem lies in the maladjustment of narrow limits imposed upon the classical term of project in relation to the theory and practice of project management?

[6] Pańkowska M., *Środowiska projektowe przedsięwzięć informatycznych*, 238–252 [in:] *Informatyka ekonomiczna, Informatyka w zarządzaniu*, edited by J. Sobieska-Karpińska, series: Prace naukowe UE we Wrocławiu no. 15 (Wrocław: Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu, 2010) 244.

1.2. Determinants of effective project management

In the traditional project management, it is believed that the basic determinants of the project are time, costs and scope. The time of implementation is the result of specific "attachment" to the typical methods of solving problems occurring in project management, where the establishment of the start and the end of the project was a necessary condition for obtaining the results in the applied methods (especially with regard to networks). The costs of the project are connected with the available resources and the scope and limitations related to a particular field in which the project is to operate. The three listed elements constitute the so-called "golden triangle" of project management[7], in which particular parameters are connected by the so-called equilibrium equation. The area between the vertices of a triangle defined by time, cost and scope contains the solutions which are acceptable for the contractor, but they are not optimal paths. Extreme values are established by means of a combination of the values of the triangle vertices. In this way the determination of the two values results in the fact that the third one is the total: a change of one of them dictates the necessity of changing the remaining ones. Thus, shorter time of implementation means higher costs or reduced scope of the project. Increasing the scope may raise the costs and/or extend the time of realization. Reducing costs will generally result in reducing the scope and increasing the implementation time. Extending the time of realization does not necessarily mean reducing costs or increasing the scope of the project. At times[8] we also add the quality as costs. Including quality as the resultant value in relations to the realization of the remaining parameters appears to be justified – because the combination of the scope of the project, its cost and time are decisive factors for the quality of the project. The costs of realization are treated by most authors interchangeably with the planned costs in the budget, which can be omitted here.

On the other hand, extending the time of realization does not necessarily mean reducing costs or increasing the scope of the project. The causes and consequences of the lack of reflexivity of these relations depend on the final recipient of the project. Therefore, there appears a postulate to include another, fourth parameter – the requirements of the recipient[9]. This approach increases the range of available solutions as well as the number of potential combinations

[7] popularised by Kerzner H.: Zarządzanie projektami. Studium przypadków (*Project Management. Case Study*) (Gliwice: Helion Onepress Exclusive, 2005).

[8] see e.g.:. Kisielnicki J.: *Zarządzanie projektami. Ludzie – procedury – wyniki* (Warsaw: Oficyna Wolters Kluwer Business, 2011); Schmidt P.: *Dlaczego warto zarządzać projektami? http://grupapm.pl/files/NiS_07-8_2010.pdf*, 2010.

[9] we may also come across the attempts to add the quality factor to this basic parameters set, which at times is associated with the range of tasks and the risk connected with the realization of the projects; however, it is not justified in the present section.

Table 2. The average scale of project realization analysed by Standish Group in selected years in the period 1994–2010

Year	Success rate	Failure rate
1994	16%	84%
1996	27%	73%
1998	26%	74%
2000	28%	72%
2002	34%	66%
2003	33%	67%
2004	29%	71%
2006	35%	65%
2008	32%	68%
2010	37%	63%

Source: the author's own work on the basis of: J. Johnson, *CHAOS Rising*, Standish Group, Conference Materials of II National Conference of the Quality of IT Systems, (II-ga Krajowa Konferencja Jakości Systemów Informatycznych), Computerworld, June 2005, p. 11; Standish Group, *The Standish Group Report 2007*, West Yarmouth, Massachusetts, 2007, The Standish Group, Caos Summary, West Yarmoth, Massachusetts 2009, p. 1, The Standish Group International, Incorporated, CHAOS Report 2009, http:/blog.standishgroup.com/news, http://www.controlchaos.com/storage/S3D%20First%20Chapter.pdf, November, 2012.

of events which may occur in the course of the project implementation. This explains a number of phenomena occurring in the course of the implementation of the projects in the economic reality.

The research conducted in 1994–2012 by Standish Group International concerning the assumed realization of the projects show that the success rate in such enterprises remained at 16%–37% (see Table 2). Of course, the high rate of failure is due to the adoption of a rather restrictive assumption which states that any deviation from the basic parameters of the project (e.g. exceeding the budget, failure to meet deadlines, failure to realize the scope of work) is seen as a failure (the failure rate is remarkably high). Unfortunately, the failure rate does not decrease with time – despite technological progress, it still remains at around 35%.

If we consider, for instance, what the reasons for the high failure rate were, then among the factors affecting the difficulty in the project implementation we distinguish a set of soft parameters connected with the human factor – they constitute up to 40% of all determinants of failures classified in the first ten positions, both in 2000 and in 2008. Strictly technological factors are 50% less frequently mentioned and they are in lower positions in the classification (see Table 3).

Table 3. Factors affecting the implementation of the project

	Factor affecting the implementation of the project	Percentage of responses	
		Ranking 2000	Ranking 2008
1.	**Lack of involvement of business users and information from them**	2	1
2.	Incomplete business and functional requirements or their change	6	2
3.	Inexperienced project manager	4	3
4.	**Lack of support from the company's management**	1	4
5.	Lack of technological competences	5	5
6.	**Lack of resources for the project implementation (human resources)**	8	6
7.	Unrealistic expectations of the implementation team	10	7
8.	Vaguely defined requirements (goals)	3	8
9.	Unrealistic project schedule	9	9
10.	Frequent and radical change in technology	7	10

Source: the author's own work on the basis of: J. Johnson, *CHAOS Rising*, Standish Group, Conference materials of II National Conference on the Quality of IT Systems (II-ga Krajowa Konferencja Jakości Systemów Informatycznych), Computerworld, June 2005, p. 11, The Standish Group International, Incorporated, CHAOS Report 2009, http:/blog.standishgroup.com/news

Another approach to the factors determining the implementation of the project is presented in the report entitled *The Silence Fails*, which is a summary of research conducted by VirtalSmarts training company and The Concours Group[10].

Project managers identified and characterized five critical areas representing the greatest obstacles with regard to achieving success[11]:

– incorrectly conducted analysis of the project requirements – caused by the lack of interviews and discussions with the contractor concerning the experience drawn from previously conducted projects, which may be used in the current

[10] *Executive Summary. The Five Crucial Conversations for Flawless Execution*, VitalSmarts, 2006, http://www.silencefails.com/downloads/media/SilenceFailsExecutiveSummary.pdf.; *Silence Fails: The Five Crucial Conversations for Flawless Execution*, VitalSmarts, 2006, http://www.silencefails.com/downloads/SilenceFailsFullReport.pdf.

[11] see Galant-Pater M., *Przyczyny porażek i sukcesów informatyzacji biznesu w świetle badań empirycznych*, http://www.ptzp.org.pl/files/konferencje/kzz/artyk_pdf_2009/035_Galant-Pater.pdf, April 2012; Waszczuk P., *Warto rozmawiać*, 2008, http://www.computerworld.pl/artykuly/323361/ Warto.rozmawiac.html

project, at an early stage of project implementation. In general, the first meeting of the project team starts a discussion over an already constructed timetable, with fixed resources and settled deadlines for their use,
- lack of support on the part of the sponsor of the project – the client is trying to get involved to a minimum degree in the project implementation. Lack of the cooperation results in imprecise information and incorrect organizational diagnosis, on the basis of which it is difficult to create correct specification of solving the problem and modelling the processes which would lead to it. Projects are more and more delayed, or/and they do not meet the requirements of the sponsors. These problems may be avoided thanks to regularly organized meetings of the contractor with the client,
- lack of knowledge about the progress of the project – hiding the problems which occur in the team from their superiors for fear of their reaction and attempts to solve them on their own or omit them, passing on the information about critical events in the project on other team members,
- avoiding responsibility for the priority tasks of the project – starting the implementation of the project (against the schedule) from the easiest and not necessarily the most important tasks in the project, ignoring at the beginning the most difficult tasks or the priorities which carry a risk of failure. It may lead to the lack of coordination across the entire project,
- shifting responsibility for the tasks that the team members are unwilling to take or they are unable to perform due to the lack of knowledge or lack of practice. Creating artificial barriers (…*it is impossible, it is unprofessional, it will cost a lot*…) which allow the transfer of tasks to others, or even lead to the abandonment of the tasks.

The presented study shows that in the case of the lack of analysis and proper reaction to the above situations in the project which is being carried out, the probability of the failure of the project (defined as exceeding the adopted budget and timeframe as well as the failure to meet all the client's requirements with regard to the scope, quality and functionality of the product created) increases to 85%. However, if a remedial action concerning "critical areas" is successful, then the chance of failure is reduced by 50–70%.

On the basis of its own study, the Standish Group[12] has published ten key factors contributing to the success of the project:
- customer's involvement in the project implementation,
- the support of the management (sponsor) of the project,
- a clearly defined business goal of the project (specified requirements with the consideration of existing limitations),

[12] Standish Group, *The Standish Group Report 2007*, West Yarmouth, Massachusetts, 2007.

– optimized scope of the project (adopted to the possibilities of performance),
– agile design methodology in place of a traditional one,
– experienced and qualified project manager,
– proper management of the budget of the project,
– educated human resources,
– a formal methodology for the project management,
– standard software tools and infrastructure.

Among them, a similar percentage (as with failures) depends on the human factor, and only 20% relates on the technology-related factors. Generally, this indicates that technological progress seems not to have such a great influence on the realization of project management, as the funds involved in its development might suggest.

For these reasons, the notion of success at present evolves towards the assessment which goes beyond the classic, narrow triangle of balance between costs, time and scope. We adopt here the recipient-user's point of view and his/her way of seeing the project, both in internal projects (in which both individuals implementing the project and the project's customers are employees within the same organization, and the final product of the projects stays within the same entity), and in external ones (products are made for customers outside organizations and are a source of generated revenue). The mere extension of "golden triangle", with the fourth parameter will also expand the opportunities for making decisions regarding its realization (every decision is already described by four ordered parameters (time, scope, costs, requirements), and not three as in the previous case). While the relationships between parameters are – it seems – non-equivalent; the requirements of customers are superior in relation to other parameters. It appears that the impact of the immediate environment effects the changing relations between project management and process management. The environment in which projects are realized is divided into[13]: economic (prices, tariffs/customs, taxes, exchange rates, interest rates, economic policy, markets, the degree/stage of economic development), legal (legal system, its adaptation to the conditions of implementation, licenses), technological (technological development, the state of technology in the organization, quality standards), organizational (organizational structures, management style, skills and knowledge of management staff and employees, functionality of the organization, method of project management), psychological (culture, resistance to change, degree of innovation, implementation and execution security) and political environment (geopolitical conditionings, development trends, alliances, trends).

[13] see Stępień P.: *Wprowadzenie do zarządzania projektami*, part I, http://www.skuteczny-projekt.pl/ artykul.htm?AID=65, February 2012.

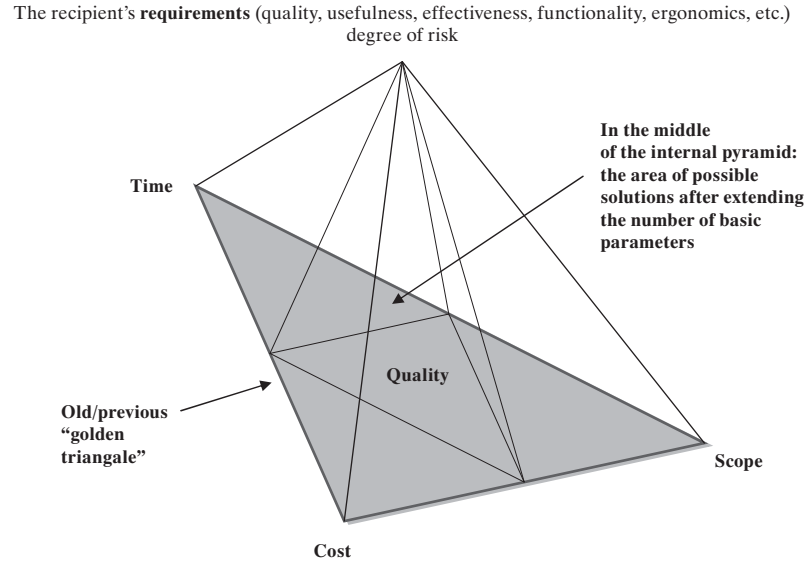

Figure 2. The area of possible combinations of basic parameters of the project and its extension

Source: the author's own work.

At this point there appears another important issue. The success of the project in the classical approach and the success of the project in the contemporary approach (involving its management) based on practice are significantly different. In the classical view (and this is the approach taken by many studies) the success (particularly performance) means that we not exceed the costs, we operate within the schedule and the deadlines and the work carried out is compliant with the tasks specified in the project. Including the point of view of the user (recipient, client) means adding the evaluation of success to other criteria: the issue of client's satisfaction with the obtained product or service. Including the dynamic environment, in consequence, means reducing the risk of failure, efficiency, effectiveness, flexibility, adaptability, functionality, etc. And the evaluations are very close to the evaluation of success of proper process management in the organization. The analysis of the findings obtained by the Standish Group points to very practical determinants of success. The result of project implementation in the general view may be radically different from the one which results from the classical approach. On average, almost three quarters of the projects in recent years exceeded the costs, missed the deadlines or did not perform the workload and still they were considered a success, both on the part of the contractor and on the part of

the customer (client, recipient, and user). During the interviews, they claimed that the most important thing for them was the fact that the project has been implemented and that it was the basis for further action (often starting a new project or its modification). Another situation might appear when the project which exceeded the costs and the schedule has been considered a success due to the realization of the increased range, and another project has been considered a failure even though the two parameters i.e. costs and schedule were observed, and the scope was exceeded. Obviously, sometimes there are situations where the contractor's evaluation radically differs from the client's assessment, but increasingly it extends beyond the canon of non-compliance of the three basic parameters. If the management of the project is successful, it does not mean that the project was successful; however, it might mean that the success was also proper timing in relation to a departure from the project assumptions (change management).

At every stage of the project planning and implementation such an enterprise may be seen by some stakeholders as a chance and by some as a threat.

Therefore, we may observe here the inter-organization interplay which has its beginning even before the project starts (e.g. concerning the issue (preliminary definition), whether the project is needed at all) and may not stop even after the project is completed (the question is whether the project will be considered a success or a failure).

Nevertheless, a sample list of criteria may – taking the above comments into account – have the following form[14]:

- achieving the project objectives,
- the satisfaction of a client, recipients (users) or contractors,
- compliance with the schedule (e.g. at the level of the entire course of the project, at particular stages, project completion in relation to the proposed changes and modifications),
- compliance with the costs (e.g. in relations to particular items, groups, keeping within the budget (savings) or exceeding the budget in certain situations),
- compliance with the scope of activities (e.g.: keeping within the assumed scope of the project, performance of the most important elements or planned tasks, agreed decreasing or increasing of the scope of the project),
- conformity with the requirements: (e.g. reaching a higher level of effectiveness, acceptable functionality or usability, maintaining quality at a certain (agreed, normative, comparable, etc.) level,
- product or service which is successful in the market,
- appropriate risk management (e.g. minimizing the risk, adequate response to an unforeseen situation).

[14] see http://zarzadzanie-projektami-it.pl/sukces-projektu/, March, 2012

Another problem which always appears in the evaluation of projects is a preference scale in relation to particular criteria. At the moment of adopting the assumption that we have more than three equivalent (and balanced) criteria (as it was in the case of the classical theory), then in the case of equivalence of criteria we may have difficulty determining whether a given project was actually successful or not. We can then either agree with the stakeholders of the project with regard to the issue of which of the criteria (and to what extent) is the most important to them or apply one of the relational methods (e.g. compromise methods – AHP/ANP T. Saaty types[15]) or functional (e.g. multi-criteria methods) in evaluating them.

Project management in the classic form has been defined as "*…the application of knowledge, skills, tools and techniques in relation to the activities realized in the project, complying with the realization of the requirements of a particular project. The application of knowledge requires the effective use of appropriate processes…*"[16] Process in this case means a set of interrelated activities undertaken in order to obtain specific products and services. It is characterized by its associated outlay, resources, time, implementation tools and expected results. The uniqueness of the analysed and modified processes consists in the so-called organizational assets containing the principles and criteria of adapting the processes to the specific needs of projects. Generally, the processes may be divided into two groups:

– organizational processes which ensure the efficient execution of the project (how?, in what order?) – the sequence of actions, operational variants, can we conduct the activities in parallel?
– object-oriented processes which allow for establishing more precise conditions of the implementation of the project or service (what?, in what way?, using what techniques?)

The processes are intertwined with each other at successive stages of the project, and they may occur simultaneously and come in numerous interactions. Standard PMI[17] characterizes project management through the prism of mutual interactions between the processes and within the processes, and also through the perspective of the purpose they serve. The processes were classified into five groups, which are subsequently realized in the next phases of the project implementation as the projects are being implemented according to a certain

[15] see e.g.: Saaty T.L: *Fundamentals of the Analytic network process*, ISAHP, Kobe, no. 8, 1999.

[16] *A Guide to the Project Management Body of Knowledge (PMBOK Guide)*, Project Management Institute, Inc., Four Campus Boulevard, Newtown Square, Pennsylvania, USA, Third Edition, 2004. 39.

[17] ibidem, 41.

specific order of activities performed by particular project teams. This model of sequential and parallel realization of the project tasks in the specific time and/or locations, with limited resources we call the *life cycle of the project*, and the term corresponds to the life cycle of a biological object from birth (the initiation of the project) to death (the end/completion of the project). In fact, it is a representation of the process of real actions in the course of building an object or a process, taking into consideration the different phases of the cycle in the previously described or recorded traditional, standard form, or properly adapted because of the circumstances disrupting the established pattern of conduct, resulting from the need of adjusting to the needs of a specific organization (based on the knowledge within the organization) or adapting to the consensus worked out by the contractor or client, or imposing solutions arising from the requirements of the client's organization (based on their own judgment of the client's requirement). The most complex, the largest and the most difficult to realize are projects connected with the implementation of IT systems.

The rapid and multidimensional development of IT technologies brought about the revival of the interest in the development of methods of designing IT systems supporting management. After years of standstill caused by the practice of implementation of mainly repeated integrated systems and constructing the systems of e-business by the compilation of ready fragments of software it turned out that the systematization of procedures, ordering this field and developing new ways of analysing and designing is becoming indispensable due to the quality, usefulness, functionality and effectiveness of the devised IT system. Frequent and troublesome aberrations in this regard, resulting in 60–80% failure ratio of the realization of IT projects induced the circle of practitioners and academics to look for solutions to the problems connected with devising IT systems. They started to pay attention to the factors which seemed insignificant so far when compared to technology, procedures, methodologies and other "hard" factors. This was in contradiction with the current practice and the behaviour of project teams (which until now was intuitive) ought to be "proceduralised". We could note the emergence of a number of "soft" (agile, modern methodologies) of diverse character and function.

The main aim of the present chapter is to analyse the above directions of methods of designing IT systems. The analysis is carried out against the background of the traditional approach presented so far.

1.3. Overview of the IT systems design methodologies

Generally, in the process of designing IT systems supporting management we may distinguish four phases, which occur against the background of deep transformations of IT hardware and software, which enabled them:
- intuitive functional design,
- formal structural design,
- formal and intuitive object-oriented design,
- intuitive and formal socio-psychological design.

However, intuitiveness and formalism in this period should not be treated literally. They concerned mainly the initial phases of the project and in each of the presented periods of the dominance of particular type of IT system design; the types had different scope, reference and character. The intuitiveness of the functional design was initially caused by the deficiencies in the theory of information technology connected with the analysis and system design. The recognition of user's needs and their transformation into the record allowing for creation of the system on this basis was frequently conducted – at the time – by non-professionals according to methods drawn from the analytical analysis of an enterprise or statistics (surveys, interviews, lists of questions, etc.). The documents produced – concerning the entire system – were frequently characterised by excessive information, resulting from globalization of the problem (the system was treated as a whole without separation of particular tasks), the ambiguity of interpretation, a high amount of unnecessary details and repetitiveness, connected with the lack of distinction between relevant problems or processes and those irrelevant ones, long time of implementation, where the user needs were frequently changed and a long time needed for conversion into a version which would be useful for software development[18]. High ineffectiveness of such activities on the one hand, and changing information technologies on the other (especially those connected with the processes of sourcing, gathering and using data) necessitated the creation of new methods of analysis and design of IT systems. The two most serious problems which the creators of these methods had to face were:
- simplification of the detailed functional analyses carried out as it were before the creation of an IT system (especially a complex one), by dividing it into simpler components and reducing it to the information which is truly necessary for the construction of the system (this way the structure of the problem is more important than the details of the description),

[18] see Chmielarz W.: *Zagadnienia analizy i projektowania systemów informatycznych wspomagających zarządzanie* (Warsaw: Wydawnictwo Naukowe WZ UW (University of Warsaw Faculty of Management Publishing House), 2000).

– simplification of communication methods, particularly with the end user of the system by creating graphic languages (mapping) of the analysed problems and programmes (CASE – Computer Aided System Engineering class) supporting individual phases or the entire project.

Gradual resolving of these problems led to the emergence of the group of structural methods (main representatives: T. DeMarco, V. Weinberg, E. Yourdon), being improved to this day, different from each other within various "schools of thought" of analysis, design and structural programming. The main concept behind the structural approach boils down to two characteristic features – the descending, decomposition method (top-down – definition of the scope and the criteria of detailed division) – resulting from the previously acquired output of system analysis and defining for each element of decomposition: data mapping (statistics), dynamics, i.e. the transition from one state to another and the functional scope (transformation of input data into output data). Mapping of data as statistics, and their dynamics are usually presented in the form of explicit language, using specific notation (ensuring the unambiguity of created models). The data are linked with hierarchical and relational dependencies. The functionality is determined by means of algorithms specifying the system operations according to user requirements. The structural approach in the early stages of IT system design consists of three elements:
– analysis – where the logical system model is defined and user requirements are formalized; a detailed specification of the tasks and functions performed by the system, are usually presented next to the description with the use of graphic presentation languages e.g.: DataFlow Diagram, Process Specification, Entity Relationship Diagram, Data Dictionary, SteeringFlow Diagrams, HIPO (Hierarchy Input-Process-Output) and State Transition Diagrams,
– design – creation of the physical model of the system (processor model, task model and model of programme implementation),
– implementation – transformation of a physical model into software, testing and implementation.

The group of structural methods, derived from system analysis, from the moment of their inception, were understandable and seen as acceptable by analysts, designers and developers. With increasing formalization they were also adopted to be used by developers. They were particularly popular in the seventies when the applications which support database were created. Detailed methodologies, which are a part of this group, are being improved and used in practice to date.

The development of programming languages (starting with languages designed for simulation (Simula 67), the concept refined as Smalltalk) towards

object-oriented programming necessitated the emergence and development of design methods adapted for this concept. The idea of object-oriented programming consisted in defining programmes by means of objects which are functionals of their characteristics, relations between them and types of behaviour (functionalities). The system communication basis aimed at task implementation in structural programming were the relations between the data tables, used to provide specific procedures, whereas in object-oriented programming these were relations between groups of procedures realised by separate objects. In order to design such systems object-oriented design methodologies were required.

Their precursor was the so-called Jackson's operational method, where the basic concept is the transformation of input data into output data (modelling software system structure on the basis of data structures), starting from the separation of objects and functions performed by them, combined into processes, decomposed in the next step to the physical model level.

This is an intermediate method between structural and object-oriented methods, and the method is classified once as one category, and then assigned to another approach. It consists of three basic parts:

- analysis – consisting in building data structure model, aimed at transmission of input data to the final output stage. The basic tool used for modelling are: Data Structure Charts – allowing for hierarchical modelling of data (distinguishing objects),
- specification – construction of flow diagram of data structures through programmes that provide links between the data (separation of functions performed by each object). The basic tool used at this stage is System Specification Network,
- implementation – defining a model of the structure of programme models reflecting the earlier designed data structures. The tools are diagrams for Program Structure Charts, using exactly the same tree-pattern notations which appeared during modelling data structures.

Object-oriented design has taken over from the operational design the separation of objects and classes of objects which are characterised by specific attributes. However, it went further than Jackson's method because in the definition of the object it took over its features and relations, as well as the procedures supporting organizational processes carried out by the object. It results in the fact that objects take an additional dimension allowing for more effective modelling of complex economic processes. Generally speaking, these are the methods which allow, unlike the previous two, to model data and processes in a particular area at the same time.

The various groups of methods that were developed were based on data structure analysis (e.g. G. Booch, D. Coleman), events (e.g. J. Martin, J. Odell), or scenarios of events (R.Wirfs-Brock, B. Wilkerson, L. Wiener). Despite significant differences between the listed methodologies, in most of them you can differentiate the following stages of the project:

– system specification and analysis – creating a model of the objects and application variants (static system structure) e.g. by using Object Diagrams and the interface models (dynamic structure of modelling system by means of scenarios (Scenario Diagrams)), Operation Model, Data Dictionary, model of relations of object systems (System Interface Graphs),
– project – implementation of particular operations distinguished at analysis stage. Defining the process of interaction of objects for example in the form of description: of graphs interaction and the visibility of objects, graphs, inheritance and description of classes, processes and modules.
– implementation – converting models of project phases into software. It uses the previously created diagrams of the stages and their changes, and then generates or creates a code.

In the eighties, especially in the second half of the 80's it was believed that object-oriented design would become a dominating methodology due to the common use of the object-oriented C++ programming languages as an extension of C language adding object features to most popular programmes languages (such as BASIC, Pascal, Ada, Lisp etc.). Especially because there has been a significant increase in popularity of graphical user interface where the object-oriented programming proved very useful. An additional argument supporting the emergence of dozens of schools of design and object-oriented programming. However, on the other hand, adding object functions to programming languages gave rise to a number of problems connected with the integrity of modified systems, where previous versions were not compatible with the subsequent ones. Also, many designers believed that structural programming has a number of features which they became used to, and which the object-oriented programmes did not have. In particular, they objected to the intuitiveness of separating of classes of objects which sometimes led to far-reaching reproducibility of programming. Therefore, the object-oriented features were disseminated rather in connection with lower order languages (assemblers) or network (Java) than in its pure form. For many years there was an ongoing discussion which of the approaches – structural or object-oriented one – is better with regard to achieving a specific consensus – in IT systems supporting programming frequently we have two groups as available options to choose from, and frequently specific groups of methodologies are

used customarily or deliberately for a particular type of system (other for small and medium-sized systems, other for large, integrated ones, other for services, and still other for e-business).

Somewhat on the margins of formal methodologies soft methodologies (also sometimes called social) have been developed. These are methods where analysis and system design are based on the theory of conflict resolution – organizational, sociological and psychological negotiations of changes with teams and groups creating the system. The desired form of the system, its objectives and functions is the result of the negotiations concerning structural changes. Subsequently, the desired form is then being programmed. In the process of IT system design this methodology emphasizes the need to take into account the issues concerning the satisfaction with the performed work on the part of the user and of the system designer, participation of all people and organizational units in the creation of the system, a broad engagement of all parties and stakeholders in the design procedure (represented by: W. Mumford, P. Checkland, B. Wilson). In this methodology – in the initial stages of the creation of the system – in addition to the use of procedures taken over from the field of organization and management, we apply various sociological and psychological methods. In this approach we differentiate the following stages:

- analysis and system assumptions – going from the definition of the problem situation and model mappings of the structure and dynamics between the positions and organizational units, formal and informal relations, to the characteristics of the structure and dynamics of the problematic situation with the descriptions of participants and their roles in the process of designing a system and creating conceptual sequence of interrelated processes realised as a part of the action plan,
- verification – relating the system of conceptual models to reality, identifying and conducting necessary changes feasible due to the organizational culture,
- formalization and implementation – technical mapping onto a physical model focusing on the interactive techniques of prototyping, packets aided with risk analysis, probabilistic systems, multi-criteria, artificial intelligence systems.

1.4. Development trends in traditional methods of IT systems design

Changes in the development and implementation of IT systems supporting management, which occurred at the turn of the centuries have somewhat changed the perception of the current methods. Most methodics presented in the previous sections, based on the present, now conventional models of IT system life cycle, are categorized as traditional methods.

The life cycle of an IT system is seen as a sequence of stages of operations modelled on the life of organisms, whose ultimate goal is the construction, implementation, modifications and withdrawal (or replacement) of the IT system, starting with the first idea concerning the subject (birth), until its liquidation (death). The idea of the life cycle (project, system, process engineering) is identical in all these concepts, the differences exist in the number and naming of stages (phases), their logical order or paralleling and the ordering and the relations with the environment, particularly with the final user. The differences have intensified in the last decade, together with the moment of widespread use of light (agile) methodologies.

According to this approach in creating models of project life cycle we differentiate the following methodics:
- classical (traditional, heavy) such as e.g.: cascade (linear), incremental, evolutionary, database, prototype, spiral methodologies,
- modern (agile, light) – such as e.g.: XP (eXtreme Programming), Scrum, Feature Driven Development (FDD), Dynamic System Development Method (DSDM) or Adaptive Software Development (ASD)[19].

The classical forms of the life cycle of IT system design is derived from the historical development of IT project management methods (structural, operational, object-oriented and social schools) on the one hand and the development of system technologies on the other. These were long-term, dynamic and radical processes – therefore, in theory, we deal with better and more detailed descriptions of traditional design methods. It consists in the realisation of linear sequence or parallel stages, which may be reduced to the following phases:
- initiation – consisting in: identification of the objective, the current stage of the project and perspectives for the development of IT system or its changes,
- analysis of the system – which consists of identification of the environment, communications with the environment, subsystems, system components and present and future conditions for its operation,
- system design – concentrating on the detailing of analytical assumptions, creating a logical and physical model of the future system, or possible changes in the functioning of the present system,
- system software (implementation) – consisting in designing software for the physical model, construction of the programme or IT system,

[19] more on the subject in e.g.: Chmielarz W.: *Projektowanie systemów informatycznych* [in:] *Informatyka gospodarcza*, volume 1., edited by: J. Zawiła-Niedźwiecki, K. Rostek, A. Gąsiorkiewicz (Warsaw: C.H. Beck Publishing House, 2010) 359–402.

– testing – checking the correct functioning of the system in semantic, technical and substantive terms,
– implementation – launching and installing the system at the end user, loading the parameters which are necessary for its functioning, connecting it to the current data sources, final training of the end user,
– operation – starting, monitoring, evaluation and modification of the system,
– system withdrawal – after the profitability study, developing a transition procedure to the new IT system, maintaining the maximum possible number of positive features of the old system.

The best-known, most widely used and the most characteristic of the models of operations in traditional methods – carrying out the above stages – was a linear (cascade) model. In the cascade model we adopted the following assumptions:
– at the beginning of each project there is a stable set of needs and information requirements of the user and objectives which need to be met,
– the needs do not change during the life of the system,
– the process of building the system takes place gradually, only after completing one phase the next phase is started,
– each subsequent stage means detailing and bringing the project closer to reality,
– at the moment where an error is being discovered we need to return to previous stages and there arises a need to correct the error.

In the classical cascade approach we distinguish five basic phases (see Figure 3), which as far as concept is concerned appear also in other traditional methodologies[20]:
– initiating and defining projects,
– identifying the structuring projects,
– planning the course and resources of the project,
– controlling the course of the project,
– closing the project.

The phase of initiating and defining projects consists of three basic stages: initiating the project, defining the project and organizing the project team. Initiating the project includes the analysis of the needs and requirements of the customer, together with the articulation of the initiatives of undertaking the

[20] Chmielarz W., K. Klincewicz: *Zarządzanie projektami*, Section 5.4., Chapter 5, *Zarządzanie w kontekście zmian* [in:] J. Bogdanienko (ed.): *Organizacja i zarządzanie w zarysie* (Warsaw: Wydawnictwo Naukowe WZ UW (University of Warsaw Faculty of Management Publishing House), Elipsa Publishing House, 2010) 238–252.

project and submitting the proposal to the management (unless they are the authors of the undertaking); and subsequently, the evaluation of the initiative and its acceptance for further implementation, its rejection or modification. Defining the project is a stage where the clarification of the initiative in the sense of specifying detailed objectives, which will be realized in the course of the project, identification of the project risk (through analysis and evaluation), a preliminary estimate (sometimes a variant one) of costs, outlay and effects connected with the adoption and implementation of the project – and iteratively – the adoption, modification and rejection of the defined project take place. The last – but nevertheless an important step – is to appoint a project manager and the project team. First, we determine the institutional and organizational form of realizing the project. After making a decision, we select the project manager and the project team. The manager of the project is a person who has the greatest influence on the initiation, implementation and the final result of the project. The project manager directly participates in the process of project management through coordination, motivation, elimination of problems and minimization of risk. Also, the project manager has a considerable impact on obtaining the optimal composition and organization of work (including a timetable) of the project team.

The next development phase determines its structure. It consists in further clarification of the project objectives, which in the initiation phase might have been ignored or underestimated. This usually requires additional information concerning the user's requirements (on the part of the client), and subsequent structuring of the existing assumptions. Owing to the regularity of project implementation – especially in the case of complex and innovative projects – we determine the criteria for dividing the project into its constituent parts and we determine its vertical and horizontal structure. In the course of determining the structure of the project, institutionalization of the form of project management takes place. It means the scope and the way of connecting the project's organization with the structure of an enterprise in which the project is being carried out. It consists in selecting an appropriate structure which would ensure the most effective implementation of the project out of a variety of management structures (e.g. linear, line-staff, matrix, project, separate-project, internal realization structure, etc.). The institutional form of project management is determined by the problems which arise in connection with its realization; therefore, we cannot pre-determine the best institutional form. At times it is being modified during the implementation – new elements are added, e.g. appointing an additional team of independent experts as a management team of the previously established structure. Dilemmas concerning the scope of functionality and competence of the established structure emerge – whether the organization should focus primarily on the

realization of the current tasks or the project implementation. Undoubtedly, with various institutional forms the problems related to coordination and the instability associated with it differ. The created structure also depends on the size of the project, degree of its complexity, and its scope of innovation (also the costs associated with it, which are still not settled, yet already borne in mind, because they were initially set out in the first phase of the project).

The third phase of the project is planning the process and resources for the project. The project plan should contain the specified main purpose and the sub-goals resulting from it, associated tasks in the structural division established in the previous phase, delegating contractors and sub-contractors to perform the tasks, as well as setting the time of realization of particular project tasks and particular activities performed within the tasks (if it is required for the sake of the entire project). In order to ensure the timely implementation of tasks and activities, the work schedule is drawn up. In the schedule we mark the critical moments of the project (milestones) and points of verification (monitoring of activities (and relevant criteria), the acceptance of work (acceptance principles), transfer of work to the user). This also reduces conflict within the project team, the conflicts arising between the project team and the organization for which the project is being realized, and it reduces the risk of failure. Planning the resources of the project is particularly important in this phase. This action consists in estimating physical resources concerning people, materials, raw materials, tools needed for the project and (sometimes in the form of a normative) their proportional use for specific tasks (sometimes in the form of alternative substitutes). Subsequently, an estimation of costs – physical resources – is being performed – compilation concerning values and the documentation of such estimates. Following the cost assessment, a cost management plan is created, and the cost management plan should include principles on handling implementation deviations from the initial project assumptions in this regard. In order to realize the plan, the so-called budgeting – i.e. assigning the anticipated costs of realization to particular plan elements – is being performed. The distribution of projected costs over time allows further comparison with the current costs and possible corrective actions in case of any deviations. After accepting the planned actions and allocated resources a decision is to be made on the further implementation of the project.

The estimates for this phase are made on the basis of a number of additional techniques such as: analytical technique, analogy technique, techniques of parametric evaluations as well as correlation evaluations, evaluation techniques and scoring evaluations as well as functionality assessments (e.g. software systems).

Another phase of the project life cycle is controlling its course. Basically, it consists of three interpenetrating stages: organizing the project execution, coordination of the preparation and realization as well as monitoring and control. The basis of the activity is the previously prepared plan of the course of the project. In order to realize it, we need to obtain the funds for its implementation, prepare the delegation of project tasks, "secure" suppliers, negotiate and make arrangements with subcontractors, contract the necessary supplies and services, develop appropriate motivational systems and strive to achieve proper quality of the project execution. In the process of implementation the coordination activities take place: deciding upon the terms of the performance of work, resource consumption, costs, risk, quality and cooperation between the members of the project team. Controlling: the deadlines for task completion, resource consumption, the amount of incurred costs, timeliness of deliveries, minimization of implementation risk, ensuring the proper quality, the work of the project team and its cooperation with the organizational environment is indispensable in this phase. We may use the quantitative and qualitative results, timeliness (meeting the deadlines), resource consumption (including financial resources) and increasing the risk incurred at various stages of the project as a standard reference.

The final phase of the project process is project closure. Activities in this phase include the preparation of the final report on the project implementation, gathering views and reviews on the course of the project (if required), transfer (acceptance) of the project to the client, the final settlement of the project results (what was successful, what was not, what has been realized in a different way than initially planned) and making final arrangements with regard to the after-project activities (maintenance, modification mode, etc.). A further step is to decide on the project completion and disbanding the project team (or transforming it into a team supervising the proper functioning of the project output).

Processes in particular phases of the project need not to follow sequentially, but they may be realized in parallel. In each phase particular processes are interconnected with the so-called input and output. Knowing the methods, tools and techniques of transforming input values into output values, we may describe each process in particular phases of the project.

In practice, there are projects which do not go through all the listed phases of the life cycle. In some of them a decision is made at a certain stage on the withdrawal from the specific, adopted methodology of the project implementation.

Unfortunately, in reality the first assumption generally does not work (at the outset users do not have specified needs), so we may not meet the user requirements. Moreover, it is a very expensive combination, because in the case

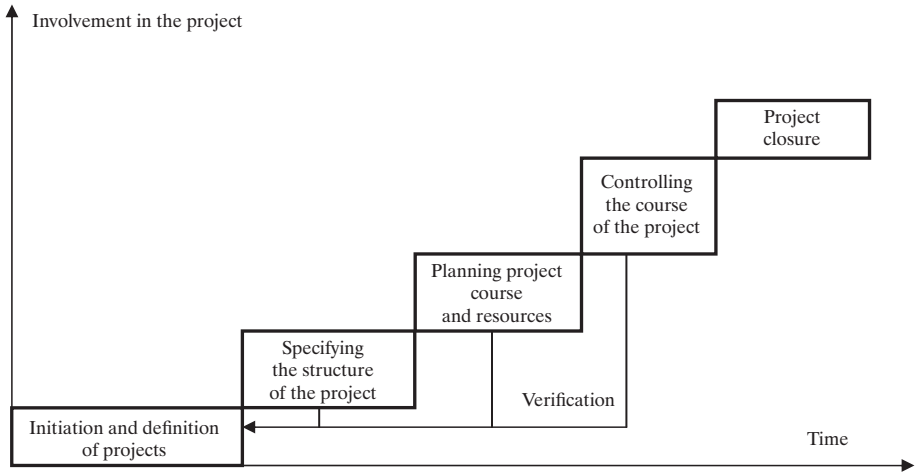

Figure 3. Basic phases of the project life cycle in a cascade model
Source: the author's own work.

of the implementation of one project by a particular IT company in a given time, there arises a need to keep the team partly involved during the implementation of subsequent stages. Moreover, in practice we note that particular stages overlap. Thus, this approach requires a number of modifications.

The assumptions of evolutionary model are as follows:
- the entire system is divided into modules,
- each of them goes through subsequent stages of the cycle of construction of the system,
- approaching the end of the project activities we proceed to a specific stage consisting in integration of the entire system and carrying out the tests,
- in the system divided into parts whose realization was postponed it is easier to adapt to changing objectives of the operations.

Because each module is initially an organically separate part we should pay attention to the danger connected with the necessity to integrate modules into one whole. Very often it becomes a major cause of the failure of the project.

The presented solution is cheaper to implement than the previous one because it may – after postponing the implementation of particular modules in time – be managed by a smaller number of employees. When analysts finish working on one module they proceed to another, and their place is taken by programmers. Unfortunately, the evolutionary model does not always deliver on its promises. Individual subsystems – which for large projects are built by different teams – even despite creating special integration procedures, could

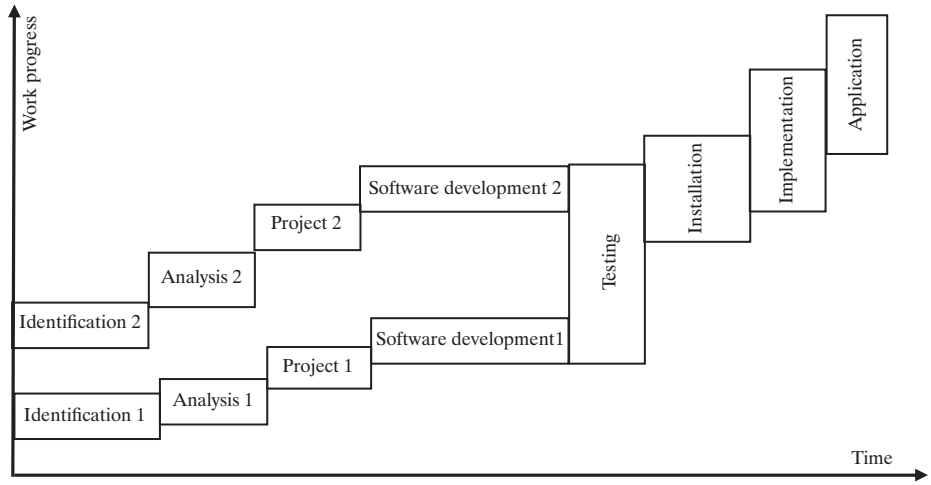

Figure 4. Conceptual scheme of the system life cycle in the evolutionary model
Source: the author's own work.

not be fully integrated due to factors such as different visualisation, functioning mechanisms, etc. They clearly lacked the assumptions consistent within the entire IT system. Therefore, the cascade model evolved further – to create an incremental model. The incremental model was characterised by the following assumptions.

- the identification and analysis are conducted for the entire system, thanks to which the overall initial concept of the system is created, supported by the general analysis of the entire system,
- then – the system is divided into implementation modules, it is designed, programmed and tested consecutively by specialised working teams carrying out technical projects for each module and testing them,
- the consistency of the system is guaranteed by the original assumptions of the system and joint final stages of the installation and implementation, where the full system integration is being carried out.

Similarly to the previous case, this procedure is most effective in the case of limited resources, and available for the whole team designing the system. Each subsystem may be created separately, the whole team works only at the beginning of the process when they devise the overall concept of solving the problem and at the end during the integration of particular subsystems into one organic whole. The incremental procedure is better than the evolutionary one because integration mechanisms work both at the beginning and at the end of the design process. Apart from the recognition and analysis, at the beginning

of the cycle we also create common norms and rules for the implementation of each project module. It facilitates the subsequent integration in the final stages. In the evolutionary and incremental cycles we can also respond to changing user requirements, though only to a limited degree.

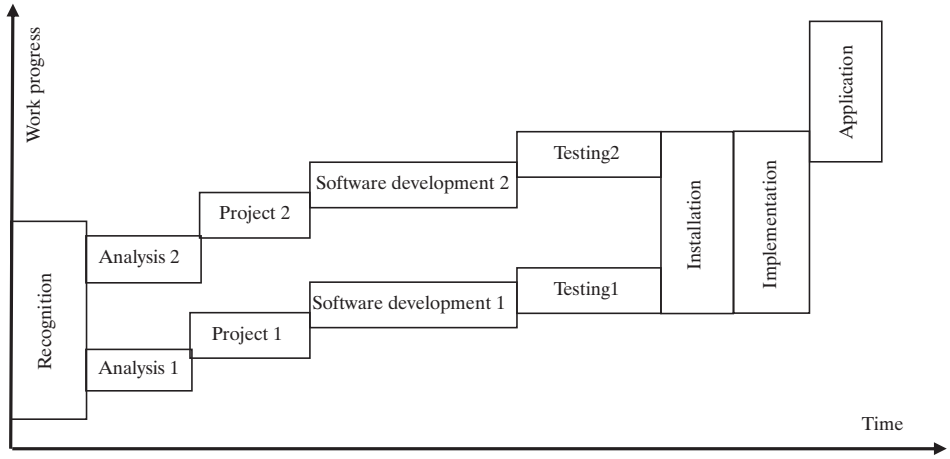

Figure 5. Conceptual scheme of the system life cycle in the incremental model
Source: the author's own work.

A completely different scheme is assumed by a model of building databases (Fry[21]). In the life cycle based on creating a database structure we differentiate the following stages:
- identification and analysis – where we identify and collect the user information requirements concerning information,
- technical design, consisting of two stages concerning the creation of:
- a logical project – the description of the model of future data processes in the system,
- a physical project – the database project structure (sets and relations between them), document templates, processing technology, internal specifications, etc.,
- software and testing – consisting in creating a database and application software based on the data contained in the database and software testing,
- implementation – installation of software on a specific platform, hardware configuration and introduction of parameters specified by the user for the purposes of customizing and preparing the system for operation,

[21] see also: Fuglewicz P., Stąpor K., Trojnar A.: *CASE dla ludzi, Inżynieria oprogramowania series* (Warsaw: Lupus Publishing House, 1995).

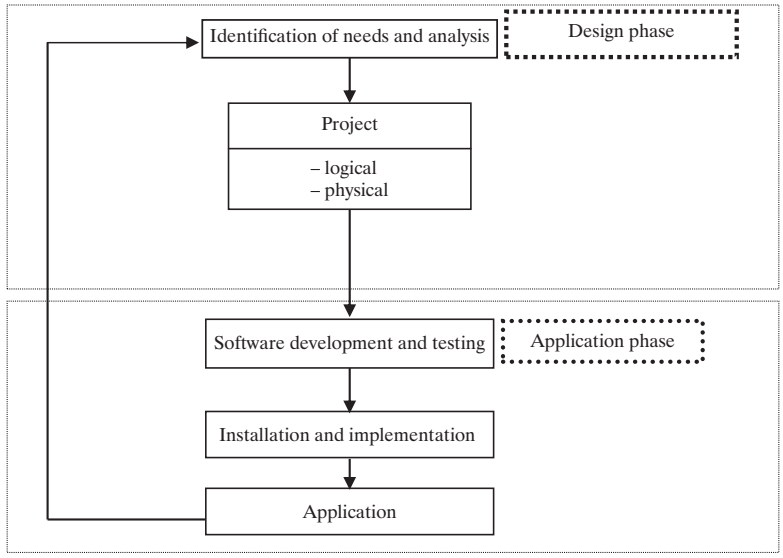

Figure 6. Conceptual scheme of the model of creating a database structure
Source: the author's own work

– use and control of the operation – consisting in the trial of the system, ensuring its compliance with the adopted norms and user requirements,
– potential modifications and adaptations – improving the functioning of the system as a result of new requirements – if a need arises, we return to initial stages.

The basic idea of the life cycle is to create the project of the system database structure and database software at the beginning of the project life cycle – which will facilitate the registration of basic facts from the life of the organization, and subsequently, the creation of application software for the database, the software which uses the same data in the database for various applications to handle e.g. sales, deliveries, contacts with business partners and contractors, etc. Many database systems emerged this way, and they are used to date. However, it is a method where the end user sees the results of designer's and programmer's work only after starting to use the database and its first applications. Only then can the user check conformity with the arrangements agreed with the project team. However, it is possible to see the projects' compliance with the requirements much sooner if we apply the prototyping model.

The most essential element of the prototype model is software at the start of project activities – the system scheme, preferably agreed with the future user. The objective of this procedure is as follows:

– reduction of the time needed to note software results and presenting the final user with tangible realization results,
– quick "coupling" of the user with the project team,
– reducing the number of errors and iterative (potential) negotiations with the user on e.g. system visualisation,
– greater user involvement in the analysis and the project.

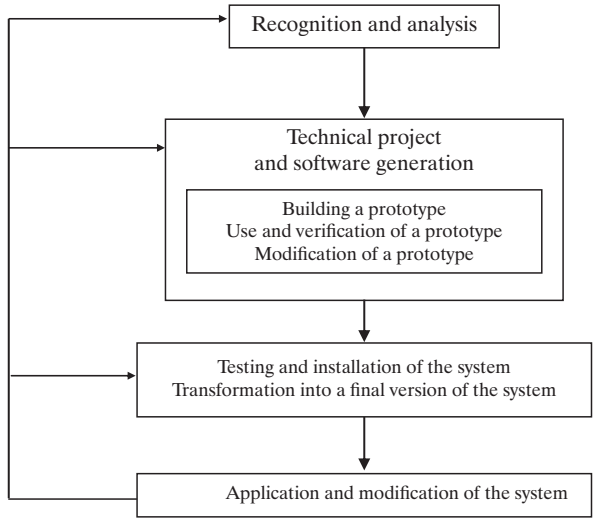

Figure 7. Conceptual scheme of the model with the creation of a prototype
Source: the author's own work.

It consists of the following stages:
– identification and analysis of user needs,
– technical design together with the generation of software – at this stage a prototype is created, and later it is successively modified in the interaction with the user,
– after testing, in subsequent versions of the prototype, its improvements and the installation, the system is converted into the final version, which is handed over to operation – and wherever necessary – modified with a tool by means of which it was created.

Efficient implementation of the prototype system requires the application of appropriate software of CASE (Computer Aided System Engineering) class, which unfortunately results in the fact that its immediate and full application is sometimes limited by the properties of this tool. And additionally, this may

also increase the costs of the project. Therefore, despite the clearly visible advantages of this approach many designers and programmers prefer to use one of the traditional approaches.

The most developed form of the traditional model is a spiral model.

The phases of the spiral model are as follows:

- establishing goals – the determination of specific goals and rationale for the concept and arranging plans for their implementation – construction of the model begins with the initiation and the definition of the project (setting preliminary requirements) and the initial risk analysis of the project; and on this basis the first prototype is built and the conceptual plan (schedule) of the total project is created,
- identifying and reducing threats – after the next phase of the risk analysis of the first prototype (identification of the most important threats, sources and ways of preventing threats) and exploring possible alternatives; another prototype of the project is built and the requirements concerning project limitations and resources are specified,
- creating and approving – at this stage there follows a process of the development of the subsequent part of the product, based on the most suitable model, selected on the basis of the evaluation of threats; subsequently an implementation plan is drawn up and another stage is completed with the creation of the overall project plan,
- assessment and planning – this is a stage where the work progress is being reviewed and the subsequent or final phase of the project is completed; the results of last circulation of the cycle are: the detailed project, tests, project implementation and its completion.

This model differs from the remaining ones due to its multiple repetition of particular phases of the basic life cycle model and – after each "sub-cycle" – there occurs the risk analysis concerning the feasibility of the whole system at the current stage of the development (see Figure 8)

Despite the abovementioned shortcomings, the high popularity of traditional methods, especially those realised in the linear cycle stems from deep (historically recognized in various environments) identification of ways of using this methodics, simplicity of logic of application, deep (sometimes resulting from proceduralization of earlier intuitive decisions) formalization (in particular techniques), evolution possibility (i.e. the incremental and evolutionary model) and the possibility of limited adaptability (the popularity of the implementation of standard, repeated systems).

The direct, iterative contact with the final user starts to occur only in the prototype methodologies; nevertheless, it is still closely regulated, formalized and subordinated to the initial concept.

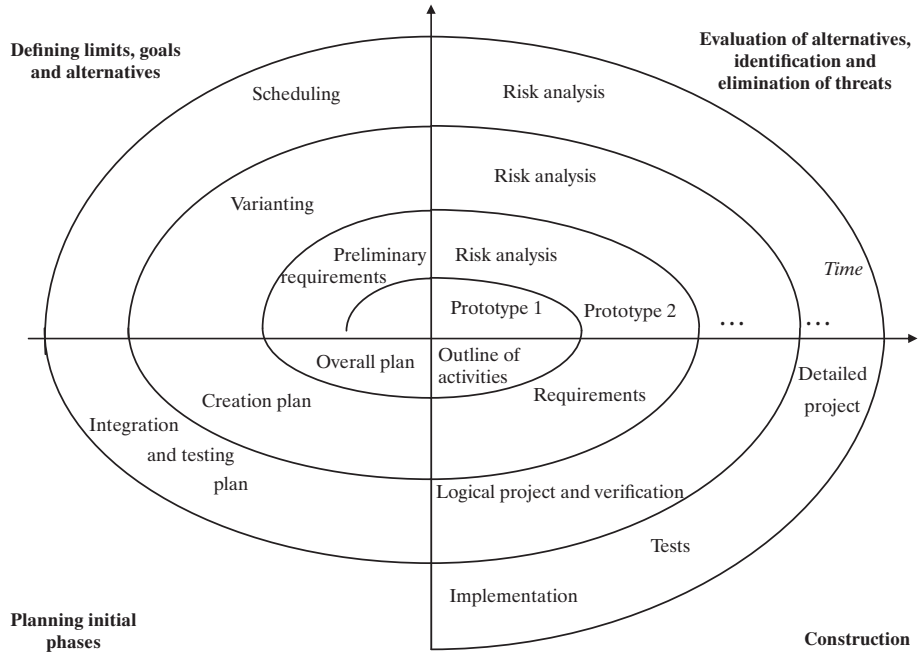

Figure 8. Schematic diagram of the project life cycle in the spiral model

Source: the author's own work on the basis of Boehm B.: Software Engineering Economics, Englewood Cliffs: NJ, Prentice Hall, 1981.

The situation is even worse with regard to risk analysis of potential changes during the project implementation. The approximate approach to this problem occurs in the variants of the linear method (in the evolutionary model, which is divided into modules, it is easier to keep up with the changing needs of the user), but only in the spiral model each cycle is preceded with the analysis of chances of success.

The issues related to the impact of human factor on the success of the project is dealt with only in the group of social ("soft") methods; however, in the conditions of the environment in which they were created they had no chance to compete with the remaining methods, due to the adopted assumptions which state that technical ("hard") factors are more important and easier to grasp in accounting terms and that the remaining methodologies are simply cheaper to implement.

A group of traditional methodologies has existed for a long time. The regime which they impose on the project development impacts, in a sense, the course of the project implementation. However, this does not guarantee the success of the project. Methods are so "rigid" and structured that compliance

with all the steps, formulas and procedures markedly slows down the whole project development process.

The methods are characterized by the following features:

- predictable and repeatable approach towards the project development process – in classical methodics we assume increasing specificity together with the process of implementation of particular phases and stages of project development and covering the entire period from the beginning to the end of the project. Deterministic, detailed techniques are generally used for analyses conducted with the very low degree of abstraction. The result obtained by means of these techniques is true until at least one of the initial assumptions will not be changed. Therefore, we assume deterministic, non-changeable, non-adaptable and rather inflexible schedule, budget and resources, and a complete division of tasks for each team creating a product or a service built on that basis,
- comprehensive documentation – the traditional approach of project realization assumes that the documentation is created after each phase, and frequently also after each stage in the project life cycle. In the most conventional form of a cascade model we assume that the scope and user requirements are collected and agreed in the first phase of the cycle, and subsequently, based on the information, a product is being created and a service is being realized. The assumptions are not changed until the end of the project life cycle; part of the information and documents collected and converted into recommendations need to be changed in the course of the project implementation,
- process-orientation – the aim of classical methodics is basically the definition of the process/processes which will be universal and repeatable, i.e. will be functioning in a proper way (and they will be useful to anyone who will be using it in any situation where they might be applicable). Each process, consisting of activities, should be carried out according to procedures set out in advance by a specific, assigned group of employees or the contractor responsible for it,
- orientation towards tools and techniques supporting implementation – we should provide the tools supporting management to perform each task specified in the project.

1.5. Development of modern ('agile') methods of designing IT systems in practice

1.5.1. Overview of modern ('agile') methods

The shortcomings of traditional methods of designing IT systems are being eliminated, or at least mitigated by modern light (agile) design methods. In a sense, taking into account the existing external conditions the precursors of these methods were soft social methodologies. In *Manifesto for Agile Software Development*[22] we pay more attention to the importance of people and their interactions rather than processes and tools; operating result rather than vast documentation; cooperation with the client takes precedence over formal arrangements and responding to change over following the plan. This corresponds to the demands, mentioned previously, which result from the evolution of views on the projects and their management. The main factor that differentiates the agile methods from the traditional ones is the recognition of people as the basic success factor in the project, which is connected with focusing on efficiency and incorporating changes. This is also seen as a specific response to business challenges, resulting from rapidly changing global markets.

Below the author presents the assumptions of agile methodologies, which may be also treated as the main differences between agile and traditional methodologies of project management[23]:

- orientation towards the project stakeholders – according to those methodologies the most important factor connected with the project development and, simultaneously, a task for the team managers of agile projects is to focus on people with specific qualities such as: ambition, skills and mutual communication. If people are not involved in the project, no process will compensate for their inadequacy,
- adaptability – in this approach the emphasis falls on change management. This encourages the user to engage their knowledge to a greater degree than the minimum expected in the project. Change management involves a continuous response to constant changes in the project. Environmental changes are most difficult to assess and respond to because we cannot eliminate them: we should strive to minimize the costs associated with them,

[22] Beck K.: et al. (2001), *Manifesto for Agile Software Development*, Agile Alliance, http://www.pmbriefcase.com/methodologies/50-software-development/55-agile-software-

[23] Awad M.A.: *A Comparison between Agile and Traditional Software Development Methodologies*, The University of Western Australia, 2005, http://www.scribd.com/doc/55-475190/A-ion-Between-Agile-and-Traditional-SW-Development-Methodologies, March, 2012.

- conformity with reality – we pay more attention to the conformity of the obtained results with the project output than the consistence with the initially assumed objectives (acting according to business assumptions rather than the plan).
- flexible scheduling – the basic problem of planning a project is the lack of possibility to foresee the implications of the development of plans of innovative enterprises (all projects should be included in this category), because the environment where they are created is highly dynamic. In agile projects, contractors need to consider how they may avoid the irreversibility of their decisions – enforced by the habit of minuteness of traditional planning which leads to extensive specificity. Instead of trying to make the right decisions at the beginning of each cycle (traditional planning), it is better to take decisions in such a way so that in the next stages the decisions may be reversed,
- reliance on empirical processes – in traditional methods processes occur as deterministic and linear while in agile methods they are seen as an empirical process (probabilistic, incorrectly or poorly structured), or a non-linear one. A deterministic process in which you can always expect the same results from the beginning to the end. Projects, because of their uniqueness, singleness, etc. cannot be defined as deterministic processes, because at the time of their implementation both the product and the project team may be developing. It is highly unlikely that any set of predefined steps lead to a desired, predictable result, as technological requirements and the people engaged in the project team change,
- using a decentralized approach – a decentralized management style can significantly affect the project because we may save more time than in the case of an autocratic approach. In light methodologies we delegate some of the tasks connected to decision-making to all the team members (in reality it is not always doable),
- simplicity – in the planning process carried out by means of light methodologies we always use the simplest route leading to achieving our goal – we assume easy model changes and the changes will be adapted to current needs and may occur at different times. We do not create any additional functionality apart from the one which is required at a given moment and we do not produce the documentation where we are trying to predict the future of the project. This reduces the focus on finding the information needed for the forecast[24],
- communication – based on the cooperation with the customer (end user) and internal cooperation – the client of the project should cooperate

[24] Gibson M., Hughes G.: *Systems Analysis and Design. A Comprehensive Methodology with CASE*, Boyd & Fraser, 1994.

closely with the project team, providing all the necessary information and reporting current remarks and comments concerning the project. Due to the decentralization, the members of the executive team in the case of agile methodologies should continuously communicate with each other.
– operation through small self-organized teams – responsibilities and tasks are delegated to the team as a whole, and the team which delegates them further, ensures their best implementation. In small teams the idea of continuous communication proves to be the best solution. The structure of the process and specific practices create minimal, structural framework for self-organizing teams. Their proper use significantly reduces the risk associated with the human factor.

The modern (agile, light) design methods generally include: XP – eXtreme Programming, Scrum, Feature Driven Development (FDD) – methodology of programming the development directed at selected features (characteristics) of the project, Dynamic System Development Method (DSDM) and Adaptive Software Development (ASD). Ideas, the essence and practice of using these methods, listed below, are consistent with the presented assumptions, but they do not always cover the whole life cycle of the system.

The basic assumptions and recommendations of XP methodics are as follows[25]:
– project specifications are almost always incomplete, ambiguous, and sometimes even contradictory. We may assume that a good and constant contact with the informed client can compensate for the lack of specifications; however, it only applies to small projects,
– reversible planning – the contractors estimate the time required to perform the tasks commissioned by the client and subsequently the client specifies his or her requirements at the time. The next step are negotiations concerning the adaptation to the time of implementation of these requirements and particular tasks to be carried out within the specified time,
– iterativeness – each application is created in successive iterations, each of them brings the planned version closer to final requirements. The system is designed in subsequent iterations, one stage ahead. After completing one stage and creating a version which meets the requirements adopted for the iterations, another iteration is planned, etc.
– homogenous communication language – creating a specific language (set, log), where each category has the same meaning for the contractor and the client,

[25] Beck K., C. Anders: *Extreme Programming Explained: Embrace Change*. Addison-Wesley, Second Edition 2004, ISBN 0-321-27865-8.

- the simplicity of the architecture – the obtained product should be as simple as possible and complex proposals should be replaced by simpler ones. On the other hand, architecture is labile – if changing it should accelerate or facilitate the realization of the current iteration and it does not worsen the testing results, obtained in previous iterations, then the changes should be implemented,
- refactoring – restructuring the system through eliminating redundant elements, improving communication or simplifying the model, without changing the complex functionality of the programme. All amendments are carried out before the implementation of a new functionality,
- job sharing – alternate performance of the commonly assigned task in order to improve substitutability, mutual learning and plausibility checks, which enhance the quality of the performed work. Both individuals have a chance to get to know the source code of the programme and correct errors (which eliminates the consequences of the IT sayings …*may you correct another person's errors*…). It may reduce the efficiency of work, at least initially. In practice, job sharing may take a different form than the one which was assumed (one person prepares analyses and current projects; the second one designs software),
- shared responsibility for the project – each team member may, at any time, change individual effects of the previous project results. On the other hand, it is a serious inconvenience – there is no single person responsible and everyone can interfere with the code,
- immediate and *continuous integration* of new fragments of work with the emerging software and testing integrated solutions,
- self-discipline expressed by assigning specific time to the project tasks of each team member and compliance with the standards with regard to communication, formal and substantive requirements established at the start of work (in practice it is frequently realized as arbitrarily as in the case of evolution method),
- maintaining regular contact with the client – the client requirement specifications based on the analysis are frequently ambiguous and incomplete. Therefore, it is necessary to revise them continuously through regular contacts with clients who verify the obtained results.

The project life cycle according to XP model (see Figure 9) consists of six phases:

- analysis and initial assumptions – cost effectiveness analysis in the light of specified user requirements and limitations, the construction of the overall business structure and the tasks the contractor needs to deal with, the selection of the environment and implementation tools and contract

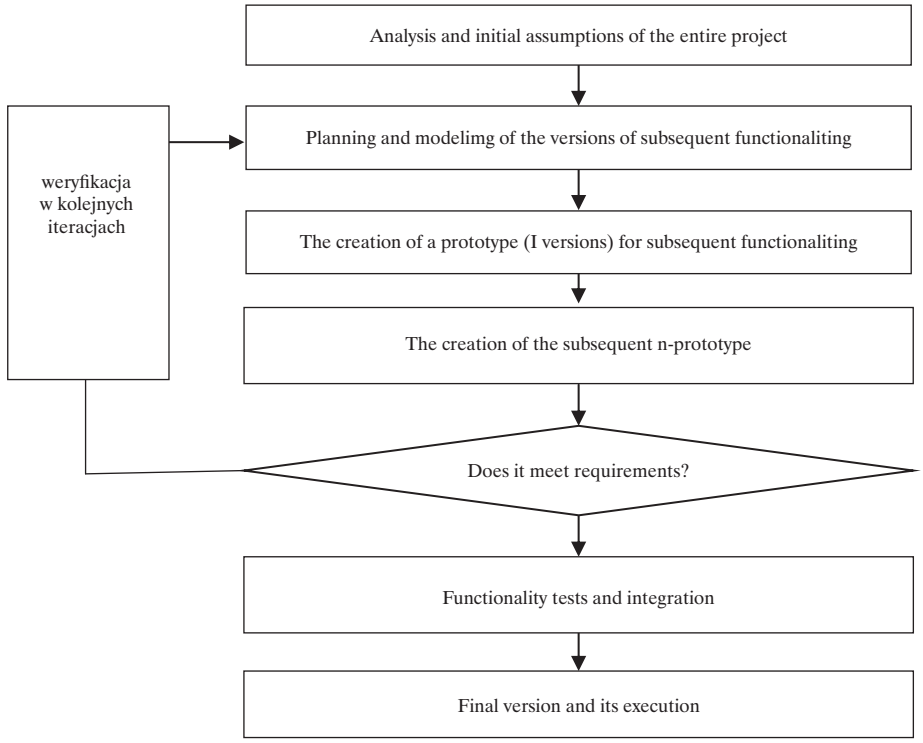

Figure 9. Basic phases of the project life cycle in XP model
Source: the author's own work.

negotiations. This stage is common for the entire project, though it is not always included in the methodology,

- planning and modelling of a version – presentation of possible variants of the project development for each functionality where we use the arrangements of the previous stage, dividing the project into the tasks presented by the clients, assigning priorities and placing them in the implementation schedule,
- subsequent iterations – the emergence of a prototype on the basis of a previous stage, presenting it to the client, introducing changes, creating another prototype, etc. and as a result – the creation of architecture and implementation of selected functions of subsequent versions,
- functionality tests – subsequent versions presented to the client are tested before next modifications, which at this stage may suggest that after creating the final version of each functionality, its integration with other versions takes place,

- delivery of the final version of the project and its implementation – the last iteration leads to the creation of the final, complete version of the project, which is then carried out,
- project implementation.

Extreme Programming methodology focuses on small and medium-sized high-risk projects. In addition, the sponsor of the project cannot specify exactly the aim of the IT project or its desired functionalities. As a consequence, it is difficult to establish the exact schedule of the project with resources allocated to its particular stages. A practical method of project operations is thus action "per analogiam": the assumption is to take similar action as in the case of projects that have been successful. Thus, it is frequently based on the use of "good practices" (sometimes even contradictory ones) within a single project, using the experience through elimination or at least reduction of errors encountered in previous cases. The greatest drawback of this methodics is the lack of exact specifications for the entire project. It is to be compensated by constant presence and availability of the client's representative. However, this may lead to instability of the system when that particular person is incompetent or simply indecisive.

The name Scrum is derived from a team pack in rugby where everyone in the pack acts together to move the ball down the field and suggests the need for rapid adaptation to the dynamically changing circumstances. The action is supported with the basic practices used in the Scrum methodologies. The design practices are as follows:

– creating the registry of orders (*Product Backlog*) – the list of all user's requirements: functions and changes agreed with the person executing the changes and priorities, waiting for the implementation (responsible end user – *Product Owner*),
– work cycle – *Sprint* – the stage of work of a project team (from one to six weeks, with the recommendation of regularity and uniformity of the duration of each iteration, e.g. a month). In each cycle the user is provided with the next working version of the product prototype to test and evaluate,
– work cycle planning – Sprint *Planning Meeting* – consists of two parts: analysis and implementation plan. In the first phase the project team and all users determine a complete (at a time) set of objectives and functions of the system. In the second one – the project manager (*Scrum Master*), together with the team, agrees the best way to implement the project within a particular sprint,
– creation of the register of orders concerning a particular sprint (*Sprint Backlog*) – a list of new or changed functionalities assigned to the next sprint. At the time of its implementation the new version of the prototype is created,
– verification of progress (*Daily Scrum Meeting*) – takes place during the obligatory daily meetings of the project team. It consists in identification of

necessary changes and determination of conditions of their implementation by the team (based on self-realization).

The life cycle of the Scrum[26] method proceeds as follows:
- recognition of general requirements and preliminary analysis of the entire system,
- identification and analysis for the next sprint,
- sprint planning (analysis and technical design),
- ongoing verification of the assumptions during daily meetings,
- system implementation and generating software for the next prototype – design and application,
- testing the system after the next sprint,
- operation and potential, future modifications of the system.

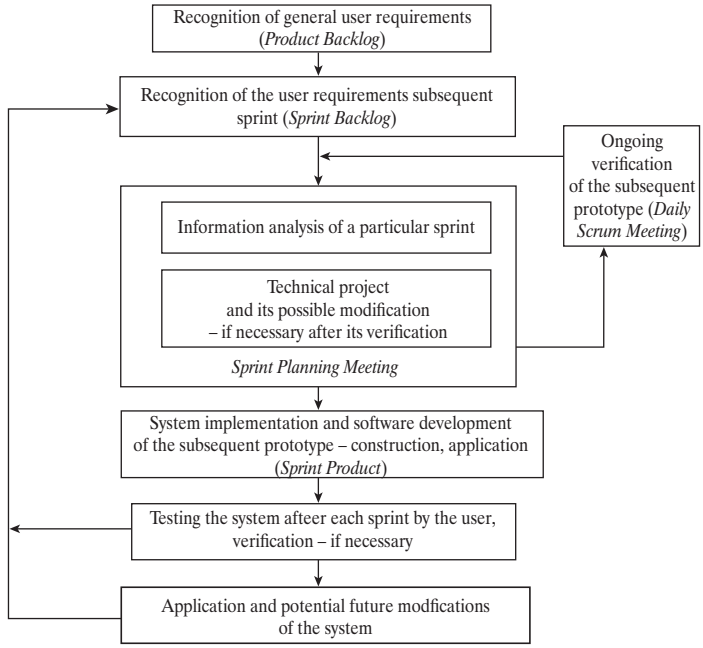

Figure 10. The life cycle of an IT system in Scrum methodology

Source: the author's own work, based on: Schwaber K., Beedle M.: *Agile Software Development with Scrum*, Prentice Hall, NY, 2001; Schwaber K.: *Sprawne zarządzanie projektami metodą Scrum* (Warsaw: Promise, 2005).

[26] Schwaber K., Beedle M.: *Agile Software Development with Scrum*, Prentice Hall, NY, 2001; Schwaber K.: *Sprawne zarządzanie projektami metodą Scrum* (Warsaw: Promise, 2005).

Before each *sprint* a meeting of the implementation team and users is held. During the meeting the participants identify priority tasks (define the scope, content and user's intent) and convert them into the future system functionalities. On this basis, a software execution plan in the present iteration (priorities, task division, and specific activities) is created. At the beginning of each day of sprint (in some interpretations of this methodics at the end of the day) at a closed meeting the project team verify the implementation of the tasks (progress, general and detailed implementation problems and their solutions). It is aimed at coordination and synchronisation of daily work of the project team members. After each iteration the meeting with the user takes place in order to present him or her with the subsequent iteration of the project and assess whether the direction of changes is in accordance with the user's expectations or requirements. It should enable the client to define what the next stages should be. On the basis of the conclusions drawn at this meeting the product will be delivered for testing and use or submitted to further modifications in the next iteration.

The assumptions of Feature Driven Development (FDD) methodology – feature-oriented programming, concentrated mainly on the following design and implementation stages[27]:

- the main element is a feature of the product – a specified scope of functionality important from the client's point of view,
- a list of features is created after constructing a general business model (non-formal object model containing the objectives and the idea of the product and its assumptions and alternative solutions). Its content must correspond to the requirements provided by the client (user),

The life cycle of this methodology is presented in Figure 11.

- on this basis we create an implementation plan of features which specifies the order in which the features of the product will be realised as well as the timetable for its implementation together with delegating particular tasks to member of the project team,
- the application of "interpretative" procedure consisting in providing subsequent, working versions of the project in iterations involving the mixing of the detailed design phases of selected features of the product and their implementation, to reach a consensus with the end user.
- implementation of this procedure is performed by assigning the features selected for implementation in a particular iteration to dynamically created small (2–3 people) groups of software designers and programmers. Each

[27] Rising L., N. S. Janoff: *The Scrum software development process for small teams*. IEEE Software, 17 (4). 26–32.

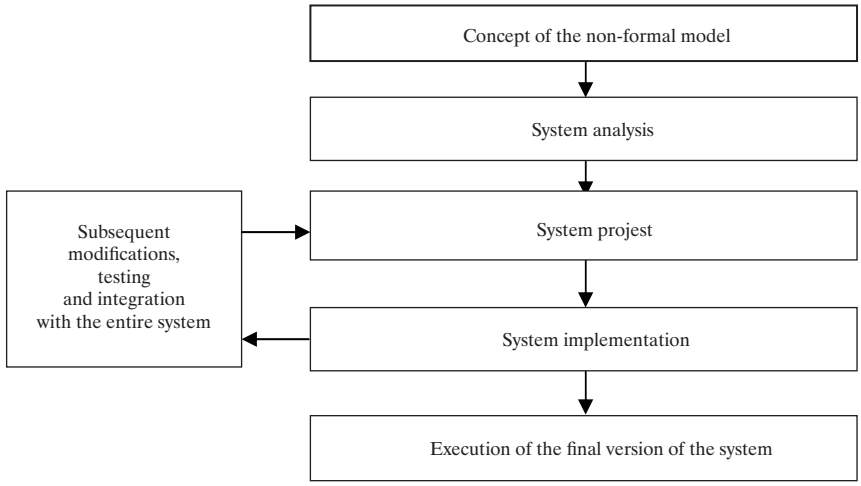

Figure 11. The life cycle of an IT system in FDD methodology
Source: the author's own work.

of them is assigned a business class connected with the functionality of a particular feature. The remaining members of the team test the created software component and integrate it with the remainder of the product.

The phases of the cycle of this method are as follows:

- construction of the concept of informal general model – building a general descriptive model of the system architecture – specific assumptions of the system design,
- system analysis – constructing user specification for selected, small, useful elementary features of the system, which are then grouped into functional areas, and, if necessary, subject-specific areas,
- design of the system – according to the above specifications, software design is created in agreement with the client, according to selected features realised in line with the final user's priorities. At this stage we frequently additionally estimate the workload of the execution of particular software modules and the risk related to its implementation. Work on the project is conducted by the team created at the time for each iteration that is made up of representatives (owners) of classes of features being considered at the moment. The team modifies or provides detailed information for the project and accepts it for implementation,
- system implementation – the user is presented with the next version of the system for another set of features. In the next iteration it is either modified according to the user's suggestions or it is accepted for implementation,

– the two last phases are repeated iteratively until the end of the project. After each iteration the client is provided with the next version of software.

Dynamic System Development Method (DSDM) is a combination and an extension of agile approaches to software development and practices known from iterative (prototype) methodics. Its approach is partly connected with RAD (Rapid Application Development) methodology which is based on the construction of new prototypes in the design of ready-made components. This allows us to obtain programming results really fast at an early stage of the project.

The main assumptions of the methodology based on the fact that the system tasks may undergo constant changes are as follows:

– at the beginning of the project there is an inspection of applicability, which includes the justification of the application of this method and the identification of potential threats to its successful implementation,
– subsequently, we create a business model which includes: description (conceptual characteristics of the system) and specification of the scope of the system, the outline of the system architecture and prototyping plan,
– on the basis of a business model we build a detailed iterative functional model, which consists in an alternate analytical process and construction of subsequent prototypes which are constantly improved and agreed with the end user. The result is a general functional model which is supported with software prototypes. In each iteration we create a list of the currently developed functionalities and related prototypes to be implemented; users' remarks, comments, recommendation – or the ones to be consulted with the user; the remaining non-functional requirements (organizational, economic, technical, psychological, legal ones, etc.); the analysis of the profitability risk connected with the continuation of the work on the project,
– in subsequent iterations new projects are created which are even closer to the user's requirements,
– the final functional model is programmed, and the tested prototypes are included in its (adapted) scope. A new product includes the previously agreed and tested set of functionalities,
– the finished product at the moment of implementation is supported with the final documentation, instructions and training for users.

The main advantage of DSDM methodology is the fact that at every stage of design and construction of the system the product is evaluated by the designers and the users, and comments resulting from its evaluation are being implemented in next iterations. Other advantages of this methodology

are high quality, adaptability to changing requirements and, similarly to other agile methodologies, short time of providing particular versions of the product. This methodology resembles traditional prototype methods. However, it differs from other methodics as far as the initial analysis of feasibility risk is concerned.

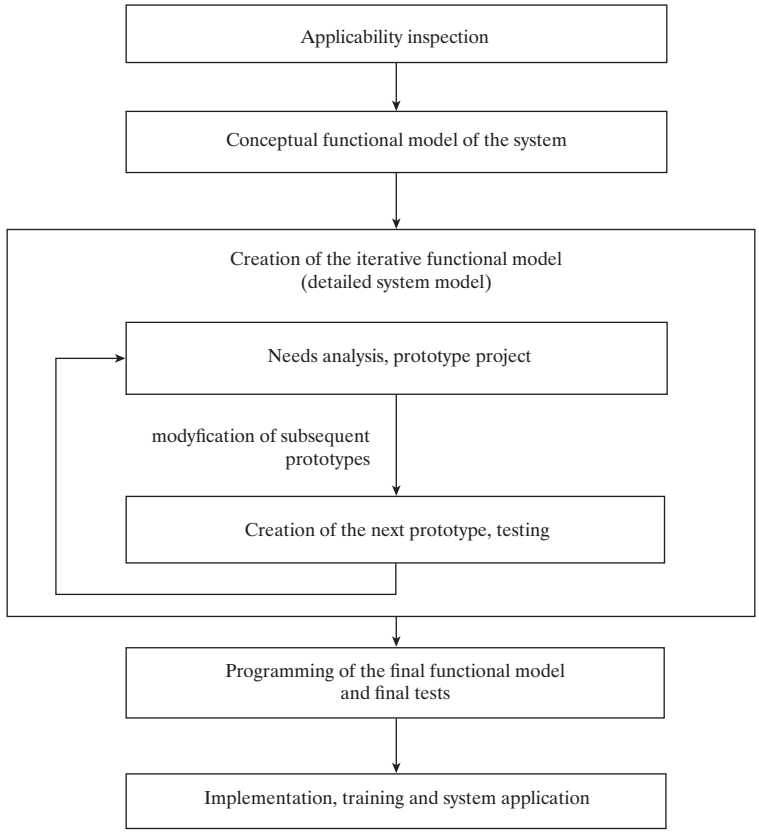

Figure 12. Life cycle of an IT system in DSDM methodology
Source: the author's own work.

The main objective of Adaptive Software Development (ASD)[28] method – is to support large, complex, innovative and continuously modified projects, which allow for better adaptation to its dynamic environment. It uses primarily iterative and incremental software development, where we also include "soft" elements of the project – the culture of the organization, negotiations concerning

[28] Highsmith J.: *Adaptive Software Development*, New York: Dorset House Publishing, 1999.

the user requirements, science, etc. Less attention is paid to supporting tools, formal procedures and conclusions resulting from the current design practice.

The most important characteristic features of Adaptive Software Development, applied in the case of dynamic and frequently modified projects are as follows:

- reliance on dynamic speculations (considerations of variants and potential changes), cooperation with the user and drawing conclusions based on the current situation (science),
- identification and explanation of all assumptions necessary in order to implement the project (speculations),
- close cooperation based on immediate, fast and effective communication between members of the project team (or possibly smaller groups),
- rapid response to errors and deviations from project specifications and possible changes in requirements (learning).

Unlike the traditional approach, where the deviation from the plan (caused by objective reasons or user requirements) is treated as an error to be corrected, in adaptive approach, created by ASD, such deviations lead to proper solutions as they are treated as proper and desirable changes. ASD methodics does not have such detailed rules and procedures as other modern methods, but it constitutes only a collection of guidelines, a specific instruction on how to encourage team members to cooperate and learn in the process of implementing a project. It changes a statistical action plan for the one which is modified over time – dynamic, depending on the results of previous stages (following the changing objective).

The life cycle of an IT project is divided into three overlapping, iteratively performed phases divided into standard project stages[29]:

- speculation (initiation, recognition); defining objective; determining the duration of the project, specifying the maximum number of approximations of subsequent prototypes realized in iterations and their duration; selecting the functional scope and the objective of each prototype; prototyping, discussing results of each iteration, further modifications and acceptance of the final form,
- cooperation – testing and implementation of the final form of the system, creating documents in close cooperation with the system user, sharing knowledge and joint decision-making concerning implementation.

[29] Ref.: Highsmith J.: *Agile Project Management : Creating Innovative Products*, Addison-Wesley, 2004.

– learning – after each iteration, there is a stage of the quality assessment of the prototype from the point of view of its usability for the client, innovativeness and quality of the applied technical solutions, effectiveness of the functioning of the project team and the current state of project implementation (its status).

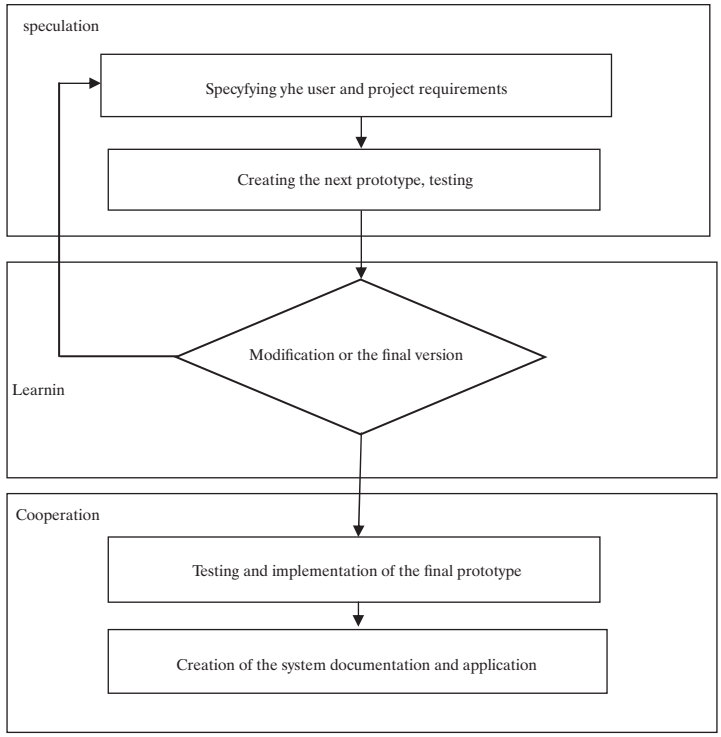

Figure 13. The life cycle of an IT project in ASD methodology
Source: the author's own work.

When applying ASD methodology we focus on the necessity of close and intensive cooperation between the end user and project team during the project, which is to ensure the creation of the system which is closer to the assumed range of client requirements which were agreed in the course of adaptation of the design process. Specific openness of the procedure requires the successive (according to the iteration cycle) periodic risk analysis to guarantee the project implementation, but allows for the possibility of introducing changes resulting from the learning process. Moreover, such an approach increases the probability of proper completion of an IT project.

In conclusion, we should note many similarities both in modern and traditional individual, specific methodologies:
- despite the assumed differences we note the similarity of particular project life cycle stages and the entire project procedure,
- despite the declared innovativeness and distinctiveness (*Manifesto for Agile…*) we notice "drawing on" the achievements of previous hard or socio-psychological methodologies,
- despite the complex terminology we note the similarity of the character of the operating procedures,
- despite the declarative specificity we observe the similarity in reliance on the approximate data, which frequently leads to the differences between the user expectations and the final outcome.

However, we also see the differences between the degrees of coverage of particular stages of the project life cycle. The process is presented in Table 4.

Table 4. Coverage of the stages of the life cycle of an IT project by selected agile methodologies

Life cycle stage/Agile methods	Initiation/ concept	Analysis	Design	Programming	Testing	Implementation
Adaptive Software Development		X	X	X	X	
Dynamic System Development Method	X	X	X	X	X	X
Extreme Programming		X	X	X		
Feature-Driven Development		X	X	X		
SCRUM		X	X	X		

Source: the author's own work

The above analysis shows that there are many methodologies of IT project management and there is no one universal method which may be applied in all potential cases which may be encountered in business practice. It stems not only from the fact that methodics is only a set of models, principles and formulas which helps us to avoid errors, but it does not eliminate them completely. The variety of examples generated by reality and the changes in user requirements prove that it is not possible to adapt the method specifically to a group of cases. Nevertheless, the mere awareness of the existence of various ways of

solving problems arising during the IT system design process brings the project team operations closer to optimum solutions. Also, it creates a sense of control over an enterprise, maintaining the full commitment of all interested parties and justifies the sense of security of implementing the business strategy of the sponsor.

The development of IT system design methods once again moved towards the use of approaches which are seen as more intuitive. However, the presented statement is not entirely true. We should rather say that formalization of soft (and inherently intuitive) factors which are decisive for the project success, e.g. cooperation, trust, good communication, etc. was possible due to the development of information technologies. At this point we need to state that the methodics of this type are not applicable for every type of project. The possibilities with regard to applications of new solutions in this field will be influenced by the following factors:

– the type and timeframe of financing the works stipulated in the contract with the client – if we assume that in a particular case an exponential manner of financing the project should be applied then we should engage agile methodologies. In these methodics we assume that priority factors such as mutual trust and cooperation of business partners are more important (at least declaratively) than negotiating contracts. At the moment of signing the agreement and pre-scheduling we may adopt the project implementation which from the outset is favourable for the client (slowly increasing at the beginning of the project, exponentially together with the delivery of the products agreed and accepted by the user or based on the contracts with low degree of risk for the project contractors (e.g. agreements reimbursing the cost according to fixed prices)). If, however, we apply the logarithmic function of the budget (high costs in initial stages, stable in later phases of the project), then, especially in the case of well-established market positions, it is beneficial to adopt one of classic methodics,
– type of budget – The project budget which is unevenly distributed in time, enforcing the varying intensity of work and high degree of uncertainty, suggests applying agile methodics. The budget financing the project in a manner which is uniform and stable in time supports the use of classic methodics,
– character of the schedule arrangements – fixed timeframe of the planned tasks imposed in the schedule supports the use of classic methodics; the estimate or relative deadlines – suggest the use of agile methodologies,
– the amount and level of documentation and the quality of software, i.e. meeting the complex requirements associated with formal documents standards, licences or certification necessitates the application of a classic

methodology of project management; the project where we focus more on software quality and its development possibilities is more in line with the agile methodology,
- the approach towards the non-implementation risk – low non-implementation risk is better covered in the case of classic methodologies, where we assume the creation of risk reduction plans or emergency situation,
- communication with the client – agile methodologies assume continuous and direct communication with the client and there all the factors connected with the possibility of misunderstandings concerning the implemented tasks are being limited. In classic methodologies we prefer a less frequent contact with the client which often leads to misunderstandings when we need to present and deliver the designed system,
- organizational structure necessary to implement the project – enterprises characterised by a hierarchical or similar structures which incorporate specialized units in their structures prefer classic methodologies. Enterprises with e.g. matrix, project or other, where they are able to delegate project tasks to smaller teams and where we do not have a strictly defined organizational hierarchy should opt for classic methodics,
- project sector, often associated with organizational structures, also substantially affects the project implementation. Industries which from the outset have a limited amount of raw materials and produce limited number of finished goods are better suited for the use of classical methods of system design,
- the size of the project – some groups of software designers who implement large-scale systems believe that classical methods are better suited to such projects. In agile methodologies, in the case of larger projects, even repeated ones, it is difficult to coordinate the activities of many small groups involved in the project,
- the type of system for which the project is implemented – expert systems or knowledge-based systems often require specialist knowledge about the issue being implemented. If these systems are by definition designed as self-learning methodologies it is recommended to use modern methodics, otherwise – for systems based on fixed models of behaviour – classic methodologies,
- psychological factors which include the experience of the team responsible for implementation process in using agile or classic methodics; the organization's reliance on the project team which is to implement the project within the organization; high level of involvement of specialists on the part of the future user (the number of specialists delegated by the client engaged in the project team) in mixed project teams, etc..

Nevertheless, the Standish Group[30] statistics cited earlier show that the proper approach to designing information systems with the application of agile methodology produces the 42% of success rate, while traditional methodologies produce only 14% success rate (see Figure 14). It is believed that projects realised by modern methods allowed us to respond quickly to clients' changing needs, and allowed to mitigate the risk and better adapt the software to the organization's needs.

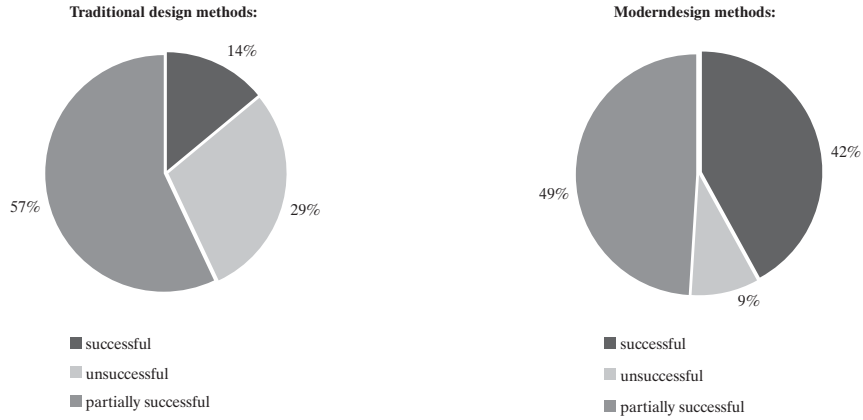

Figure 14. Comparison of the success rate of the projects realised by means of traditional and modern methods

Source: http://www.controlchaos.com/storage/S3D%20First%20Chapter.pdf after Schwaber K., Sutherland J.: Software in 30 Days: How Agile Managers Beat the Odds, Delight Their Customers, And Leave Competitors In the Dust, Wiley & Sons, NY 2012, Figure 1.2.

The analysis conducted above shows that there are many design methodologies and there is no one universal method. Methodology is merely a certain set of standards, principles and formulas which help us avoid errors, but they do not eliminate them completely. Even though, a consequently implemented methodology creates a feeling of control over an enterprise, maintaining the full commitment of the stakeholders and supports the sense of security of the implementation of the business strategy of the sponsor.

Therefore, more and more organizations which depend on the implementation of projects are interested in managing through projects, consisting in practice (to put it simply) mainly in the parallel execution of the maximum number of projects. It enables a comparison of their characteristic features (schedules, costs, resources) realized for businesses of various sizes, in many industries and in many locations. This allows for multi-dimensional evaluation (including

[30] http://www.controlchaos.com/storage/S3D%20First%20Chapter.pdf

comparative, effectiveness evaluations, etc.) of ongoing projects and provides project managers with models of good management practices and evaluation of effectiveness of particular organizational units which realize projects. The analyses of project implementations also provide indications for sharing project resources (including technology, know-how, etc.), calculating time and evaluating the competence of contractors and the valuation of products and services generated in the project. *Managing through projects* is a management style which develops entrepreneurship and is a specific "golden mean" between the real needs of the client company (as defined by its specificity), knowledge (both theoretical and practical) and design methods[31]. Such a pragmatic approach allows for the creation of best practices for the implementation of particular types of the projects, which facilitates the creation of strategies not only for organizations that depend on the creation and implementing projects (and, increasingly, not just IT projects). This approach towards groups of projects may take various forms and characteristics.

In the literature[32] we come across the following types of modern management of project groups which, as it seems at present, determine the trends in project management:

- management of programmes – i.e. organized collections of interdependent projects supervised by an external body – the objectives of projects are imposed by the sponsor (manager), these projects are different but mutually compatible in terms of implementation carried out by different independent teams. All resources are agreed upon and determined by the sponsor of the agenda; risk and quality management occur at the level of particular projects and the whole programme[33],
- multi-project management – concerning a group of projects, which are related to the evaluation of project results determined by an appropriate organizational structure (e.g. project management headquarters). Projects are autonomous, but hierarchies of objectives and its range are established. There is a central division of resources, while budgetary decisions are proportionate to potential benefits of particular projects. The risk connected

[31] see Stabryła A.: *Zarządzanie projektami ekonomicznymi i organizacyjnymi*, Wydawnictwo Naukowe PWN, Warszawa, 2006,

[32] see Pańkowska M.: *Środowiska projektowe przedsięwzięć informatycznych*, 238–252 [in:] *Informatyka ekonomiczna, Informatyka w zarządzaniu*, edited by J. Sobieska-Karpińska, series: Prace naukowe UE we Wrocławiu no. 15 (Wrocław Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu, 2010) 238–252; Cohen I., Mandelbaum A., Shub A.: *Multi-project scheduling and control: A process-based comparative study of the critical chain methodology and some alternatives*, Project Management Journal, no. 35 (2), 2004,

[33] see Wysocki R., McGary R.: *Efektywne zarządzanie projektami* (Gliwice: Wydawnictwo Helion, 2003).

with non-implementation is managed at a multi-project level. It is possible to reduce the level of risk through moving tasks between projects, resulting from close interaction between project partners. The quality of the project is managed both at a central level and at the level of a particular project,
– managing a project portfolio – it consists (similarly to multi-project management) in managing a portfolio of projects which are competitive projects selected in such a manner as to optimize the benefits resulting from the management of the entire collection. The projects are accepted into the portfolio according to the ranking defined by economic criteria based on the priorities pertaining to the entire project. The scope of the projects is not mutually agreed. The decisions associated with the budget are made in relations to the contents of the entire portfolio, and projects compete for resources. The risk is assessed at the project level, and the preference is given to those projects which are most likely to be implemented. The projects are carried out in parallel, their quality is evaluated independently of the portfolio,
– roll-out projects (reference to a product model) – sets of projects with the scope and specified objectives similar to the model[34], projects are partly similar, they differ in terms of specific features of the environment where they are realised (e.g. implementation of the standard, repeated IT projects). Each sponsor sets out their budget separately. Projects can be implemented in sequence or in parallel (in this case they are competing for resources). They are evaluated both by sponsors and contractors; however, they are controlled by contractors.

The outlined and indicated directions of the development of project management result from dynamic changes which occur in the project environment in recent years. Generally, they primarily pay more attention to change management leading to increasing dynamism, flexibility and adaptability of projects and transformation of relations with main project stakeholders. The technology development allows for integration of different types of innovation projects, which may be managed in the project network. However, they do not solve all the dilemmas connected with the development of project management presented in the previous chapter.

The above considerations show that the development of modern project methods of information projects supporting management is more directed towards the completion and improvement of methodics of system design in the areas that have relatively recently appeared in the economic reality (e.g. mobile systems, e-business systems, etc.), than in the direction of total replacement of

[34] see Flasiński M.: *Zarządzanie projektami informatycznymi* (Warsaw: Wydawnictwo Naukowe PWN, 2006).

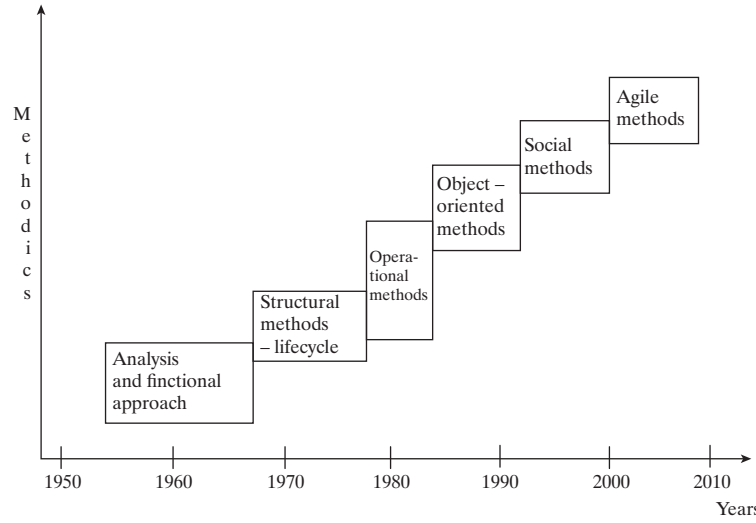

Figure 15. Trends in the development of methodics of IT systems design
Source: the author's own work.

classic, traditional methods. The necessary changes which need to occur are a result of rapid development of information technology, in particular CASE information systems supporting design processes.

1.5.2. Realization of Agile Design and Service Design methods – Confrontational Pattern Design Method

Modern design methods sometimes also include service design solutions[35]. Their basic recommendations are[36]:
- focusing on the user's needs,
- full cooperation of the parties during the project,
- presentation of the full realization of the service on an ongoing basis,
- formalization and specific "materialization" of all service elements in a manner which is understandable for the user,
- comprehensive coverage of the service process by a single contractor.

However, they have one fundamental disadvantage. They do not build theoretical knowledge in the form of models, procedures and practices. Thus,

[35] Meroni A., Sangiorgi D., (ed.) (2011), *Design for Services*, Lancaster University, Farnham, Gower,

[36] ref. : Sikorski M. (2013): *Usługi on-line. Jakość, interakcje, satysfakcja klienta (On-line Services. Quality, Interaction, Customer Satisfaction)*, Wydawnictwo Polsko-Japońskiej Wyższej Szkoły Technik Komputerowych, Warsaw.

they are not rooted in an economic or a wider praxeological context. They are not used to optimize the investment in information systems (especially services), or to create new projects of IT services (based on the added value for the global and multicultural customer) and realize projects which minimize exclusion from the realm of operating systems. This is particularly important for the electronic commerce tools.

The integration of these solutions with basic assumptions of modern management methods and some of the best proven traditional solutions can bring, as it seems, very good results with regard to creating design patterns. This conclusion is supported with a number of experiments conducted by the author and his collaborators during the research into the assessment of e-business[37] and the possibility to use the findings in system designing. In the study the team of researchers used an iterative approach to identify ex ante needs of the user and confront them with the ex post experiences resulting from a deep analysis of the existing IT solutions of confrontational pattern design.

The basic assumptions and recommendations of *Confrontational Pattern Design* refer to the concept of *Service Design*, on the one hand, and *Agile Design* methods on the other[38]. They are as follows:

- in many cases user's requirements, even in the case of an informed client, are dominated by existing habits connected with the IT systems used in the organization: in the clients' opinion the questions concerning additional functionalities introduce elements of ambiguity, or even contradiction,
- project schedule becomes the result of negotiations between the user, expecting to reduce the time of the realisation of the project, or even be provided with the finished product immediately, and the possibilities of the contractor and his desire to offer a product which is of higher quality than the existing solutions,
- iteration between the initial recognition of the user's needs (even if they tend to be reduced to the experience of the previous installation), and best practices derived from the analysis of the existing solutions on the market; each successive iteration is a compromise bringing us closer to the final solution,
- there are methods of identifying best practices, consistent with the scientific basis of the evaluation of IT systems (and common sense); we should aim at constant improvement or creation of an IT system which allows for

[37] Chmielarz W, Szumski O., Zborowski M.: (2011), *Kompleksowe metody ewaluacji witryn internetowych (Complex Evaluation Methods of Internet Websites)*, Warsaw, Wydawnictwo Wydziału Zarządzania UW, Warsaw.

[38] Detailed description of the author's method see in Chmielarz W**.:** *Confrontational pattern design method – new method of website design*; w: The Online Journal of Applied Knowledge Management; Vol. 2 Issue 1, 2014, pp. 153–168.

automatic selection of the method best suited to a particular decision-making situation,
- the user shows a specific tendency to overcomplicate systems, thus, we should aim at their greatest simplicity at the level of design, content, service and methods of solving basic design problems,
- parallel analysis of the user's requirements – on the one hand, the application of traditional analytical methodologies (questionnaires, interviews, conversations…), on the other, consideration of the user's evaluation of the existing systems in order to extract certain components which can meet his needs in the best possible way,
- coordination of the language describing design requirements with the assessment criteria of existing solutions,
- ongoing integration of selected components in accordance with previous arrangements in the present version of the project,
- solving, by way of negotiation, confrontational requirements resulting from the projection of the user's requirements, performance and usage analyses as well as expert requirements resulting from the best practices of completed projects in the same area.

The life cycle of the project according to CPD model (ref.: Figure 16), consists of four basic phases:
- confrontational analysis of the user's needs – parallel examination of the needs of the final user and of the existing IT solutions in the field. Identification of the user's needs and identification of the best solutions resulting from the present software. Based on the list of the best solutions, we create a project based on the optimal design patterns used in the existing portals. The comparison of the user's needs with the constructed model. In the case of differences – negotiations with users which aim at bringing their position closer to the position resulting from the analysis of best practices,
- on this basis we create a prototype of an IT system – subsequently, it is presented to the client; in the case it does not meet the user's expectations – introduction of changes, creation of another prototype – presentation of the prototype to the user; in the case of fulfilling requirements – testing stage,
- functionality tests – subsequent versions presented to the client are tested before next modifications, which client may suggest at this stage. In case of doubts, we return to the creation of the next prototype and working on the final version of the project,
- the last iteration leads to the creation of the last, complete version of the project, which is then executed.

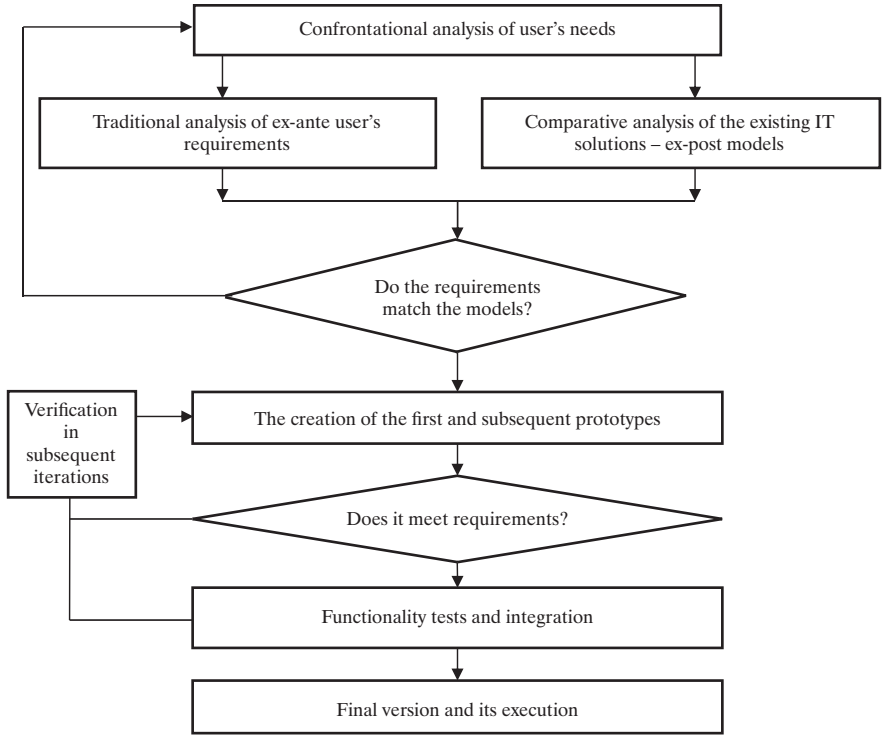

Figure 16. Basic phases of the life cycle of the project in CPD model
Source: the author's own work

Methodology of the confrontational pattern design concerns mainly small and medium-sized e-commerce projects. It assumes full access to the existing software, from the user's perspective, and such a situation is taking place in the Internet. Apart from the classical analysis of the user's requirements, the practical approach consists in the examination of the existing solutions enabling:
- specification and accurate research into the area in which the software works,
- creating a ranking of IT solutions existing on the market,
- identification of the features which make particular solutions better than others.

In the course of the project such a procedure:
- minimizes the need of in-depth analysis of the user's needs,
- reduces the possibility of errors (we learn from others' mistakes),

– offers an opportunity of introducing solutions valued by the customers of the existing software,
– is used to train the user with regard to negotiations with analysts and IT system designers, increasing the effectiveness of their cooperation.

However, there are concerns regarding:
– the creation of a coherent methodology which needs to be applied in the examination of the needs of a user of existing IT solutions,
– interpretations of findings of practical analyses,
– the necessity of taking into account the high dynamics of technological innovation in this field,
– the necessity of developing the mechanism of negotiations of the proposed solutions with the end user.

Simultaneously, the proposed solution is compliant with the assumptions of agile methodologies:
– project stakeholders, on the one hand, present their requirements with regard to the project solutions; on the other, they provide opinions on the possible application or their improvement thanks to the adoption of the best design patters from the best IT projects existing in the field. Mutual, iterative communication is conducive to the creation of the approach which meets the needs in this area,
– such a solution represents far-reaching adaptability – expressed through change management. It allows the user to suggest greater expertise than the one resulting from his efforts and skills,
– this procedure assumes full compliance with the reality – after all, you use the available patterns built on existing solutions, modified only by additional user requirements,
– presenting the users with the best market practices and allowing for their modification leads to greater flexibility in planning,
– empiricism is the basis for the creation of the best design patterns,
– the use of two parallel sources of research into the user's needs decentralizes the approach and the style of project management, which may result in saving time, more than in the case of an autocratic approach,
– in the majority of cases, we apply simple methods in the analyses of the existing solutions, which subsequently leads to greater simplicity of the applied solutions,
– we observe constant communication with the user at the stage of the analysis and project design (the need for iterative confrontation of the identified user's requirements with the results of the analyses of existing systems),
– parallel work on the analysis and design process enforces operating in small teams.

The issue of creating a project of a comparison site may be used as an example of the application of this method. The findings of a research company Tradedoubler[39] shows that Polish clients use comparison sites more and more frequently, anticipating constant growth of e-commerce (Poland and Czech Republic noted over 30% increase of internet sales in 2012, while the average in Europe is 22%[40]). In 2013, research has been conducted in eight European countries. In the study it turned out that 85% of the surveyed Poles declared using this class of software. For the sake of comparison: in Italy, the results were in the range of 83%, in Sweden the ratio reached 68% and in Great Britain 66% of respondents declared using this kind of service. The determinants of the success seem to be: the novelty effect, limited financial resources, which consumers may spend on shopping, promotional activity of comparison sites, the growing awareness of the opportunities posed by internet shopping, and the price, which is a key criterion in the case of buying branded goods. The destimulators are mainly phenomena such as:

– not all shops in Poland, especially new ones, present their offers on comparison sites,
– offers are not continuously updated,
– errors concerning the presented product price,
– there is no active verification of the prices provided by the shops[41].

Internet comparison website is the software belonging to the class of *intelligent agents,* used to support the decisions made during the process of selecting a supplier of goods in electronic commerce. Their main function is to compare selected features of products sold in many shops on one website. They work in the interest of B2C *(business-to-customer)* in the field of e-commerce, where products, promotions, availability, delivery time, etc. and their prices are available to everyone and they are the same for each customer. The information about the product features and their prices are supplied to the comparison website directly by the e-shops' owners. At present comparison websites are improved, modern versions of previously created software which may provide information not only with regard to the best price of the product, but also – in the case of traditional sales, they may indicate the nearest shop where the goods may be found. The software provides information about the prices of goods from the real world (not participating in the production chain), realizing its business strategy entirely in the virtual

[39] http://www.tradedoubler.com/pl-pl/informacje-i-zasoby/, November 2013.
[40] http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/E-commerce_statistics, November 2013.
[41] http://wiadomosci.mediarun.pl/artykul/internet-internet,czy-dzieki-porownywarkom-cen-faktycznie-kupujemy-najtaniej,44430,2,1,1.html, November 2013.

space. The most sophisticated comparison sites have mechanisms allowing for building business knowledge with inference based on the information about a client, product range, the value of purchases in the time unit, etc. More and more frequently they play an additional social role – apart from information about the lowest prices, they also present product reviews, information about the shop where the item has been bought and terms of purchase and delivery, etc., coming from other buyers. The application of the newest technologies makes it possible for the software to operate not only on websites but also as mobile applications. At present many customers start the purchasing process with checking all the characteristics of the product in the Internet (e.g. the producer's websites), and subsequently, they look for more detailed description in e-shops, and, finally, they wish to know the prices of goods offered in particular shops – they may be found in comparison websites. In the case of material products, the so-called showroom, where you can check the product in a way which is not attainable in the Internet: taste, exact size, fragrance, texture, etc. is an additional chain link. The most popular software of this class on the market are: Ceneo.pl, Skąpiec.pl, Nokaut.pl and Okazje.info.pl. The client verifies the price, brand of a product, reputation of a shop, client's opinions, and subsequently, based on the available data, he or she chooses the most attractive offer. At present, comparison sites are widely known and more commonly used – therefore, they prove to be very useful in conducting the mass research into the needs of the so-called average user of the Internet.

The assumptions of the study were as follows:

- the objective of the study is to design an online comparison service so that it meets the users' needs in a way which is optimal in terms of the qualitative characteristics: functional, technological, etc.,
- we should analyse users' requirements concerning the basic usability parameters of the portal. The study's objective is to indicate the parameters which are most important from the point of view of the websites' clients (considering the class of electronic agents),
- based on the above findings, we create a list of the most important evaluation criteria of the existing comparison websites,
- the list of criteria is used for individual evaluation of comparison websites known to users (one user can evaluate more than one website),
- the group of respondents is not chosen at random, it belongs to the class of convenient samples as the respondents are students of the selected universities in Warsaw (Faculty of Management of the University of Warsaw and Faculty of Information Technology of the Academy of Finance and Business Vistula); they represent all types of studies (B.A., B.Sc., M.A., PhD studies),

- the evaluation will be standardized according to the ten-point scale used to examine other types of IT systems. The following scale of ratings has been adopted:
- the results of the analysis of user requirements will be confronted with the evaluation of the characteristics of the existing comparison websites in order to identify the best possible implementation of those characteristics which are most important from the user's point of view,
- the analysis will be performed first by a scoring method, and, subsequently, by means of AHP/ANP (T. Saaty) method, the preference scale will be automatically calculated for particular criteria,
- multiplying the preference scale by the table of results of the scoring analysis will allow for the realignment of the findings with the application of relations among particular criteria,
- the realignment will result in finding the design patterns of comparison websites which are considered best from the point of view of management, and which may be used in the creation of the design of the website of this class.

Initially, among the randomly selected five students of the Faculty of Management of the University of Warsaw and Academy of Finance and Business Vistula, declaring the use of comparison websites for making purchases, the authors carried out a pilot study concerning the factors which are most important when using software of this class. After the users' suggestions and as a result of standardization (unification of terminology and concepts of particular categories proposed by them), the following groups of characteristic features have been identified: design (visualization), information presented on the site and the ease of navigation, text search, data operations: selection (filtering) and sorting the results according to selected criteria and additional functionalities used for increasing user-friendliness.

The final evaluation of the website depends on the set of criteria used in the comparison process (therefore, their selection is frequently considered vital for the research). The set of various characteristics of comparison websites has been proposed by the author of the research, and the importance of its elements has been verified by the users during the interviews and the observation of their behaviours in the course of their work with a selected comparison website. After the activation of the comparison website the first impression, usually visual one, depends on the graphic design of the homepage. The next important element is the possibility of entering the data concerning the attributes of a particular product or service. After the identification of a particular product, the mechanisms of its dynamic search: extended and expanded mechanisms of sorting and selecting a list of products are important. Also, the price of the product and the costs of

its delivery are the information which is of particular importance for the client. Taking this into account, we pay attention to the possibility of sorting not only according to the selected price range of the product but also according to the additional costs connected with transport. Therefore, in some comparison sites we may find an option of sorting by a shop name (the cost of delivery frequently depends on the distance from the shop). Moreover, in the case of majority of comparison websites we also note additional functionalities – destined mainly for experienced clients. They are an advantage which attracts new customers to particular websites and they help to maintain the loyalty of regular users. Of course, all typologies of characteristics are generally arbitrary and frequently interrelated. Nevertheless, they are recognizable by the users in such a form.

Conclusions from the observation of students' behaviour supplied the initially established sets of features with the detailed criteria and subcriteria, which were thoroughly discussed with the respondents before placing them on the list used in the evaluation. The final list of criteria included:

- visualisation, information available on the website and the ease of navigation:
- brand awareness (the ease of memorizing data and reasons why we like the website),
- main page (readability and clarity of the main page, the ease of navigation and finding particular functions),
- the consistency of graphic elements, clearly marked colours, matching colours of elements, background colouring, icons symbolizing categories of products, colours and clarity of the text, carefully selected pictures of good quality, etc.),
- photo gallery (large, readable and clear images, which do not obscure navigation and present the actual features of the product etc.),
- completeness of information (characteristic features, minimum/maximum price, product image),
- clarity (appropriate font size, distinct colouring, the appropriate distribution of elements on the website),
- avoiding distracting elements (too much advertising, excessive number of photographs, etc.),
- opinions about shops (logo, delivery time, minimum price, clients' opinions),
- product reviews (if they are available, in what form, whether they meet clients' requirements),
- comparison engines (operating according to features specified by a client – e.g. price, number, delivery time),
- the ease of using categories (availability: lists, subcategories, characteristic features, etc.),
- the form of presentation of the product list (lists, different views, presentation according to the product features, icons, photos),

– rankings of products/shops (position in the ranking of shops/product categories),
– suggesting products (prompting – the latest model, at a similar price, other customers also bought…, etc.);
– functionality of the text search (dynamic search of the selected product, without the necessity of looking through many categories):
– the accuracy of search results (the name of the product, the name of the product+ producer, etc. combinations),
– prompting (lists displayed during the search, text field with autocomplete: prompting the name in the early selection stage, etc.),
– spellchecker (automatic correction of spelling);
– filtering and sorting results (simple and easy selection of products):
– filtering functionality (a large number of criteria, speed, limitations on operations which may be performed by a client; the possibility of creating complex selection rules, etc.),
– sorting functionality in the product list (criteria of ordering and its combinations),
– sorting functionality in the list of shops (map, city, list according to prices);
– additional functionalities (functions improving usability) for the user (individually for websites):
– ordering at the level of a comparison site,
– memorizing a list of products,
– creating sets of products,
– loyalty program,
– the possibility of using mobile applications,
– price alert,
– tracking the changes concerning your favourite products (prices, characteristics).

In November 2013 the authors conducted surveys in the selected universities. Over 110 people filled the survey; however, only 86 respondents completed them correctly. Among the survey participants: women constituted 2/3, 1/3 of respondents were men. Most people, 80%, were in the age group of 18–25 – typical for students of full-time studies and 15% from the age group of 26–35 – characteristic of students of part-time studies. The participation of people over 35 years of age was small – 5%. 58% of the respondents were representatives of the cities with over 500,000 inhabitants, 22% of towns with 10-100,000 inhabitants, only 6% were from rural areas. Over 60% declared having secondary education, 28% were students of BA studies and 7% of MA studies. Three-quarters of the group declared the status of a student, 15% are employed in the private sector, 6% in the public sector and 4% are

self-employed. Over a third of the sample belongs to the income group with over PLN 4,000 per month, 28% 2,000–2,500, 23% to PLN 1,500, and 12% to the remaining groups.

The first part of the survey available in the Internet and distributed in its traditional form was used to verify the importance and relevance of the list of criteria established in the interviews and direct discussions (information analysis) with clients of comparison websites (students) in a pilot survey. For all respondents, all the criteria connected with visualization, information contained on the website and the ease of navigation turned out to be the most important factors (34.2%). The second place was taken by the functionalities of the text search (33.8%); the last position (32%) was taken by the functionality of filtering and sorting results and additional functions improving usability. The differences in those groups were not very significant (up to 2 percentage points). For particular selected criteria, the differentiation did not appear to exceed (to a great extent) the observed results. The difference between the highest and the lowest scores amounted to 2.1%.

Relatively highest scores were assigned to the accuracy of search results – 5.68% and the completeness of information – 5.58%; the lowest were given to: suggesting products – 3.58% and additional functionalities – 3.83%. In total, this indicates the proper use of this tool (compatible with the objectives behind its creation) and its use in an elementary, rather than extended, range. In the case of website comparison websites, the evaluation of visualization criteria turned out to be very high – the graphic designs of home page obtained the score of 5.56%. The results of the analysis are presented in Table 5.

In the evaluation of the usability of criteria, 40% of responses were very high scores and about 31% of responses claimed that the criteria selected for the study were good: this means that almost ¾ of criteria specified in the pilot survey are regarded as accurate. On average, only 3% of the respondents considered the criteria as poorly matched to the assessment of comparison websites. Small differences in the average scores do not induce the author to reject any of the criteria.

A similar situation occurs when we refer the average values of the obtained scores to the maximum possible score in the evaluation of comparison websites (ref: Figure 17).

In this way we obtained a list of functionalities of a comparison website which, from the users' point of view, best suits their expectations with regard to this type of service. Its importance has been verified by means of a survey conducted among the clients of selected comparison websites. All listed elements obtained more than 50% of the maximum possible value, so they may be applied in the ex post analysis of the existing comparison websites.

Table 5. Preference scale for particular criteria of comparison website

Criterion	Weighted average	%
Accuracy of search results	9.00	5.68
Completeness of information	8.85	5.58
Main page	8.81	5.56
Avoiding distractions	8.10	5.11
Photo gallery	8.06	5.09
Ease of using categories	8.01	5.06
Filtering functionality	7.96	5.03
Clarity	7.83	4.94
Consistency of graphic elements	7.76	4.90
Product reviews	7.76	4.90
Product comparison engines	7.73	4.88
Opinions about shops	7.58	4.79
Sorting functionality in the product list	7.56	4.77
Presentation of the product lists	7.45	4.70
Prompting	7.07	4.46
Sorting functionality in the list of shops	6.90	4.36
Spellchecker	6.90	4.35
Brand awareness	6.77	4.27
Rankings of products/shops	6.57	4.15
Additional functionalities	6.07	3.83
Suggesting products	5.67	3.58
Total	158.42	100.00

Source: the author's own work

In the second part of the study, the authors conducted an examination of the comparison websites according to the previously adopted criteria. The examination analysed the four selected comparison websites which are the most popular among clients and the fifth one, which was selected individually by respondents.

The surveys conducted with the participation of comparison websites' users confirmed that at present attractive design and the ease of navigation are

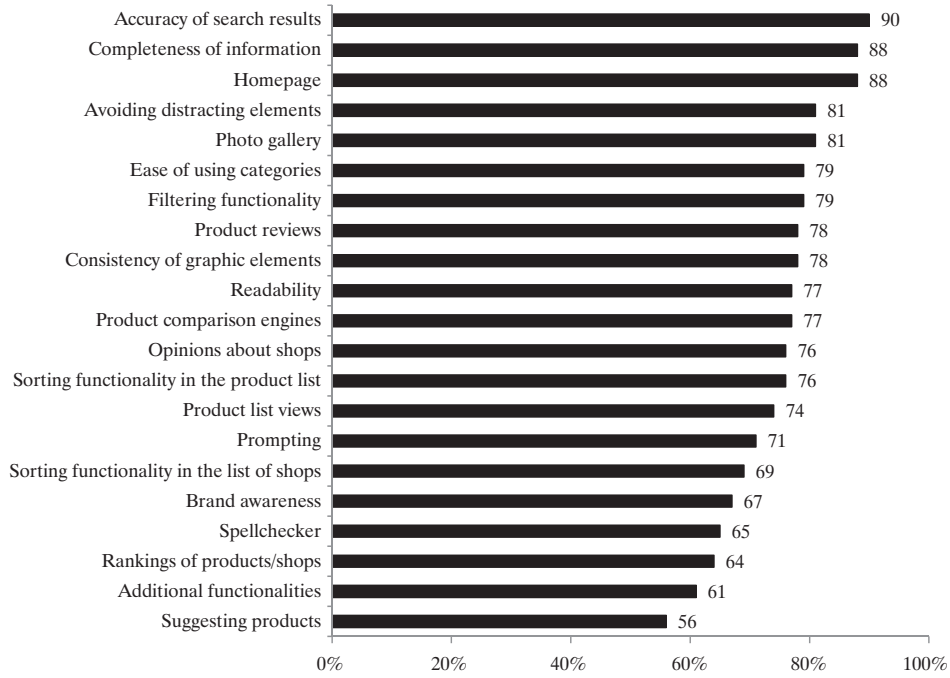

Figure 17. The degree of the suitability of particular criteria for the assessment of the quality of comparison website

Source: the author's own work

a standard requirement in a website. If a website is characterised by attractive design and distinctive look, brand awareness and intuitive use, a client will continue using the website he is familiar with; he will not look for alternative solutions and he will be promoting it among his friends. Therefore, a good impression made when the user is loading and navigating a website for the first time is of particular significance. Consequently, one of the most important factors is the first visual impressions of the homepage. Its readability, clarity and ease of interaction encourage the client to use a particular website in the future. As far as visualization is concerned, the websites of all analysed comparison websites are presented without any major problems. Nokaut.pl has the most characteristic graphic design: it is a combination of transparency and distinctive colouring (large, clear photos of a family) and icons representing product categories. The website of ceneo.pl is more toned down (lack of large graphic elements), which combined with the large spacing between elements results in greater readability. Okazje.info.pl, where the categories and selected products are presented in a clear manner, makes a similar impression on its

user. Skapiec.pl displays a centrally located *box* with categories/icons placed in particular compartments, which makes it easy to find the right product. During the examination the users did not note any advertising banners in websites, which significantly improves the usability of the service.

Due to the character of the website, in all analysed programs the text search functionality has been clearly marked. In all cases it was positioned in the same line as the logo of the website. Additionally, in the case of okazje.info.pl when the page is scrolled down the text search is always in the same place on the top of the page, which provides constant access to this functionality. Also, we could observe that navigation by categories is usually very easy. In the case of ceneo.pl after the user hovers the cursor over the main categories, a list of subcategories appear and a selection of the most popular items is placed next to the list. Similar solutions can be found in okazje.info.pl, but in this case the number of main categories is smaller, which facilitates navigation (it is compensated with additional links to recommended categories). The solution which improves navigation in the website is, according to clients, placing the category field horizontally, which allows for displaying all of them without the need to scroll the page.

The lists of all the presented products in all analysed websites include the following data concerning: the name of the product, minimum price (websites okazje.info.pl and nokaut.pl additionally present the maximum price), photo of a product and the description of its basic characteristics. Ceneo.pl distinguishes itself with large photos of products, larger than in the case of other websites. Okazje.info.pl offers only one way of presenting a product list. In the case of ceneo.pl and skapiec.pl the list of products may be displayed in two ways, and in the case of nokaut.pl the list is available in three different views. In the list view, where the greatest amount of information is being displayed, ceneo.pl and nokaut.pl display only three features of a product, okazje.info.pl present four features of the product and skapiec.pl shows five features, which, after clicking the right button, increase to more than a dozen. Unfortunately, small font in combination with a large number of parameters in this case reduces the readability of data. Therefore, when we consider the readability factor, it appears that the most attractive websites are ceneo.pl and nokaut. pl; skapiec.pl turns out to be the worst when this criterion is taken into account.

Product reviews are a very important element helping customers to choose the right product. The websites ceneo.pl, skąpiec.pl and okazje.info.pl present both a link to product review and the general assessment of the product by other buyers. In nokaut.pl the product list presents only information concerning the position in the ranking of popularity in a specific product category (overall assessment and links to reviews are presented only on the product data sheet).

After navigating to the characteristics of a product (included in the so-called product data sheet) in all comparison websites we first note the list of shops offering a particular product. Apart from the basic information about the shop, all the analysed websites present information about the evaluation of the shops and opinions about them. The most readable list is presented by ceneo.pl, next by nokaut.pl, where the information about the delivery time is clearly visible. In skąpiec.pl there are no logotypes of the shops, and in the case of okazje.info.pl the links to shops are not presented in a very readable way. The greatest amount of information and the clearest presentation of the product are provided by skąpiec.pl and ceneo.pl. Nokaut.pl provides a description with low readability.

A client using the comparison website should have a possibility to compare the products according to the parameters selected by them. The most intuitive comparison website is nokaut.pl. Adding products to compare does not cause any difficulty. In the case of ceneo.pl adding products to the comparison engine for the first time is not so obvious. In skąpiec.pl we may compare products from the same category (being at the same time in the same category may pose a certain problem). Okazje.info.pl does not have the functionality of comparing products with each other.

The average results of the survey are shown in Table 6 below.

The study shows a ranking of selected comparison websites. It is presented in Figure 18.

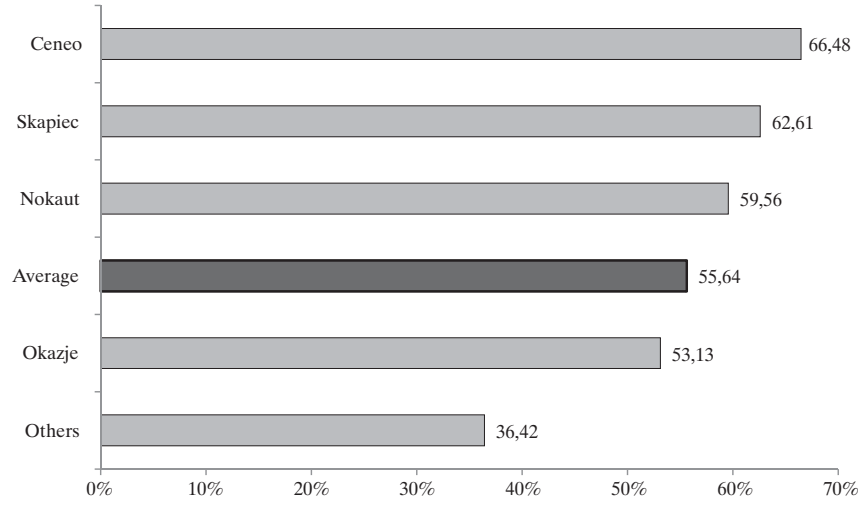

Figure 18. Ranking of selected comparison websites

Source: the author's own work

Table 6. Weighted average of the scores obtained from the evaluations of selected comparison websites

Description/Website /Evaluation	Ceneo	Nokaut	Skapiec	Okazje	Other	Total	Average
Brand awareness	7.89	7.40	7.34	4.78	1.67	29.08	5.82
Homepage	7.42	6.32	7.03	7.12	5.00	32.89	6.58
Consistency of graphic elements	6.96	6.72	7.07	6.76	3.33	30.85	6.17
Photo gallery	6.75	6.20	6.48	6.35	4.00	29.78	5.96
Completeness of information	6.77	6.70	6.39	5.65	4.67	30.17	6.03
Clarity and readability	7.25	6.56	6.76	5.71	3.83	30.11	6.02
Avoiding distractions	6.14	5.71	5.75	4.41	3.67	25.68	5.14
Opinions about shops	7.11	6.38	6.46	5.06	2.67	27.67	5.53
Product reviews	7.04	6.38	6.52	4.71	3.83	28.47	5.69
Product comparison engines	7.06	5.95	6.48	4.94	4.00	28.43	5.69
The ease of using categories	7.15	6.26	6.96	5.41	5.00	30.78	6.16
Product lists views	7.24	6.59	6.70	6.00	4.50	31.04	6.21
Rankings of products/shops	6.98	5.87	6.33	5.35	3.33	27.87	5.57
Suggesting products	6.17	5.83	6.04	5.00	5.00	28.03	5.61
Accuracy of search results	7.59	6.87	7.14	5.71	1.83	29.14	5.83
Prompting	6.44	5.70	6.14	5.00	4.00	27.28	5.46
Spellchecker	6.06	5.60	5.96	5.38	3.33	26.32	5.26
Filtering functionality	7.35	5.91	6.46	5.00	2.00	26.73	5.35
Sorting functionality in the product list	7.19	6.78	6.63	5.13	4.17	29.89	5.98

Sorting functionality in the list of shops	6.78	5.96	6.48	5.24	3.50	27.95	5.59
Subtotal	139.34	125.67	131.14	108.69	73.33	578.18	115.64
Ordering from the level of comparison engine	6.81	5.08	4.85	4.45	3.17	24.36	4.87
Memorizing a product list	6.03	5.17	5.69	4.73	2.67	24.29	4.86
Creating sets	5.38	4.50	5.23	4.73	2.67	22.50	4.50
Loyalty scheme	4.91	4.73	5.55	4.40	3.83	23.42	4.68
The option of mobile applications	6.14	5.00	5.58	5.45	4.00	26.18	5.24
Price alert	5.23	5.75	5.17	6.00	4.17	26.31	5.26
Tracking changes in favourite products	5.65	4.91	5.83	5.00	4.50	25.90	5.18
Additional functionalities	40.16	35.14	37.90	34.76	25.00	172.96	34.59
Average total	6.79	6.11	6.41	5.35	3.64	28.30	5.66
Total	179.50	160.81	169.04	143.45	98.33	751.14	150.23
% maximum score	66.48	59.56	62.61	53.13	36.42	27.82	55.64

Source: the author's own work

The first three websites: Ceneo, Skąpiec and Nokaut have obtained a total score above the average; okazje.pl and individually chosen websites (different from the most popular ones (cenuj.pl, webkupiec.pl etc.)), are positioned below the average.

Generally, there emerges one regularity which may be applied when establishing analytical characteristics for the project – it indicates which of the existing websites of this class can be used as a basic pattern to be imitated when creating a new website. Generally, we may conclude that ceneo.pl will serve this purpose in the best way. However, the detailed analysis of the results is not so clear or univocal. In terms of the consistency of graphics, loyalty scheme and tracking the changes in the favourite products, the leading position is taken by skapiec.pl, in case of price alerts – okazje.pl. Skąpiec.pl, which takes a second position in the ranking, does not offer price alerts which are of considerable importance to clients. Okazje.pl, which takes the lowest place in the ranking, occupies the second position when we take into account the evaluation of the homepage and creating sets and a third place with regard to the photo gallery it presents on its website.

We can also consider individual sites taking into account the features which are evaluated as the best and the worst (ref: Table 7). In the most popular

Table 7. The map of the website criteria with the highest and the lowest scores (where: G – best-rated features, B – worst-rated features)

Description/Website/Evaluation	Ceneo	Nokaut	Skapiec	Okazje	Other
Brand awareness	G	G	G		B
Homepage	G			G	G
Consistency of graphic elements		G	G	G	
Photo gallery				G	
Completeness of information					G
Avoiding distractions	B	B	B	B	
Product reviews				B	
Product comparison engines				B	
The ease of using categories					G
Accuracy of search results	G	G	G		B
Spellchecker	B	B	B		
Filtering functionality					B
Additional functionalities	B	B	B		

Source: the author's own work

websites there occurs a puzzling consistency of the best and the worst scores. In other services some of the characteristics are beyond the scope of the list. Hence, we may assume that, basically, the most important elements of the comparison websites are: brand awareness, home page, consistency of graphic elements and the accuracy of search results. However, whenever a particular website feature receives the lowest scores, it points to the fact that potential customers attach great importance to this particular element. Therefore, avoiding distractions, lack of spellchecker (or inappropriate corrections) and lack or limited number of additional functionalities should be added to the list. Also, we must appreciate the three remaining, important elements: completeness of information, the ease of using categories and filtering functionality. Thus, the design of the optimal comparison website should take into consideration at least the set of criteria presented in Table 8.

Table 8. The percentage assessment of particular comparison websites

Evaluation/Comparison website	Ceneo.pl (%)	Nokaut.pl (%)	Skapiec.pl (%)	Okazje.pl (%)	Other (%)
Unsatisfactory	3.50	4.00	3.45	10.65	**45,68**
Poor	8.94	18.55	15.36	**23.49**	19.14
Satisfactory	27.66	32.55	27.12	**33.66**	19.14
Good	40.95	33.45	**41.38**	24.70	9.26
Very good	18.96	11.45	12.70	7.51	6.79

Source: the author's own work

We may also analyse the results of the examination considering the number of scores in particular categories. Ceneo.pl was a leader in the ranking because it obtained the greatest number of very good scores. Also, the greatest number of good scores was assigned to skapiec.pl, which came second in the ranking. The comparison website: okazje.pl obtained the largest number of satisfactory or poor grades, other comparison websites – unsatisfactory. Nokaut.pl does not distinguish itself in any category. This table shows that it would be best to refer to the design patterns of ceneo.pl and skapiec.pl when creating a new comparison website.

Apart from the possibility of limiting the number of basic features important for the creation of a prototype – which results from the studies of the existing websites in this category, the presented study shows a high discrepancy between the initial, average results of the clients' opinions concerning comparison websites and their characteristic features and average scores obtained from the ranking

of the most popular websites existing in the Internet (ref: Table 8). Based on the initial evaluations, the first three positions are taken by: accuracy of search results, completeness of information, and the design of the homepage. When we take into account the evaluations of website analyses, the most important factors are: homepage, views of the product list, consistency of graphic elements. The same situation occurs in the case of other features of comparison websites.

However, if we consider not the values of the total of evaluations, but average values from initial analysis and the ranking of websites, then the importance of the features resulting from evaluations from initial analyses, more or less coincides with the importance of the features shown by the ranking of websites.

What is the reason of such great variances between the opinions concerning the usefulness and importance of particular criterion for the evaluation of the comparison website, and low scores of these features in the analysis of particular comparison websites? It seems that the situation is caused by the users' awareness of high requirements which it should meet and, on the other hand, dissatisfaction with the implementation shown on the websites of existing comparison engines.

It is also a clear indication for the system designer – we should not use the ready-made patterns in the cases where we observe high discrepancy between the user's expectations and the importance of the feature and its fulfilment. We should focus on these elements so that they are presented in the form which would meet the users' expectations.

On the basis of the above findings we may create a detailed basic design pattern – a prototype which is a compilation of the best features of comparison websites, identified on the basis of the websites' evaluation provided by their users. The prototype should be confronted with the clients' expectations emerging from their individual preferences. The findings also allow for specific flexibility in shaping subsequent prototypes: out of the 29 features eventually identified as important for the first phase of the conventional study into the users' needs, only 13 of them (which constitutes 44.83%) seem to be the most important criteria from the point of view of the existing patterns (ref: Table 9).

We may see that more than 55% of the features may be shaped at the user's discretion, without referring to any patterns. This is the area where we may carefully match the user's requirements to the possibility of creating the website and modifications resulting from the latest trends in this field. Particular attention should be paid to the criteria where the discrepancy with regard to the expectations and implementation is the greatest.

In subsequent iterations, by means of this very "confrontation" with the possibility of manoeuvre gained by obtaining a specific pattern, we improve the final prototype and we can move on to the next phase of the project. i.e. functionality tests and integration of the project and, eventually, the installation, testing and launch of the final version.

Table 9. The ranking of particular criteria sets of comparison websites in the initial, average users' evaluation and the average score resulting from the conducted study concerning the selected comparison websites.

Criterion	Preliminary analysis – position	The ranking of websites – position	Average of the total	Absolute difference value
Accuracy of search results	1	9	5.00	8
Completeness of information	2	5	3.50	3
Home page	3	1	2.00	2
Avoiding distractions	4	21	12.50	17
Photo gallery	5	8	6.50	3
The ease of using categories	6	4	5.00	2
Filtering functionality	7	19	13.00	12
Clarity/readability	8	6	7.00	2
Consistency of graphic elements	9	3	6.00	6
Opinions about products	10	11	10.50	1
Comparison engines	11	12	11.50	1
Opinions about shops	12	17	14.50	5
Sorting functionality in the product list	13	7	10.00	6
Product list views	14	2	8.00	12
Prompting	15	18	16.50	3
Sorting functionality in the list of shops	16	15	15.50	1
Spellchecker	17	20	18.50	3
Brand awareness	18	10	14.00	8
Rankings of products/shops	19	16	17.50	3
Additional functionalities	20	13	16.50	7
Suggesting products	21	14	17.50	7

Source: the author's own work

2. Overview of business re-engineering systems

As the author already pointed out in the previous chapter, the properly applied methodics, even though it does not eliminate all potential errors resulting from the diversity of the information processes used in business entities, helps to manage IT enterprises. Therefore, methodics, supplemented with a number of techniques and detailed methods (with specific application examples to improve processes and a complex structure), constitute sophisticated systems supporting business and organizational processes within a company. Some of them – some rather far-fetched, some winning national or regional quality certifications – are defined as "standards" of designing, modelling and creating business processes. However, one correct methodics of IT systems design does not exist, just as there is no one, unique and proper system for re-engineering of business processes. All of them, to a considerable degree, use the ideological and theoretical output of the previously presented, relevant techniques, which at best introduce minor adjustments, sometimes just small changes which do not affect the essence of the problem. Despite the aggressive propaganda of the institutes, producers and suppliers of particular project management systems, there constantly appear new systems which minimise the number and impact of errors of the previous systems and tend to generate new errors, which, in turn, will be eliminated, or at least reduced, by the new solutions compliant with new technologies. The general innovation progress (not just in this field) is based on this mechanism. An additional problem is a high level of heterogeneity of the systems – some are very abstract (methodological guidelines), some concentrate on the automation of graphic notation languages with regard to the communication of the designer and the user. The previously mentioned problems related to definition and classification are still not entirely solved: it appears that the full formalization of the processes enables control and change management; however, there emerges a question if we still refer to projects (seen as a collection of innovative processes and their relations), or is it a collection of familiar and predictable, often repeatable (standard) processes? Therefore, the creators and propagators of some re-engineering processes instead of the concept "IT systems design", opt for the safer and less obliging term – "modelling processes in IT systems". Modelling is always the reflection of reality, which should present new, integrated and homogeneous knowledge concerning its characteristic features in a given field and serve

particular purposes, e.g. supporting decision-making processes. Modelling, until it is not transferred into the real world, does not imply economic consequences – definitely, it is cheaper that experimenting in reality. It can offer many variants to select from, which after considering additional criteria (e.g. economic ones) may be used in the process of designing systems. The result of IT systems design is specific software, after its verification (tests, corrections/adjustments, etc.) and the implementations functioning at a given moment in a particular organization. Modelling is seen as one of complex design techniques, equipped with many, additional, automated tools supporting the analysis and design processes of management support systems.

Re-engineering of business processes is a wide category, which includes management of IT projects, as standard methodologies of project management may be applied in any sector or field of human activity. Detailed and specific processes within a project may be refined with narrower or supplementary methodologies and techniques of improving processes such as CMM (Capability Maturity Model), CMMI (Capability Maturity Model Integration), Six Sigma, Prince2, or IS09000. Project management is a structural methodology used for project evaluation, definition and management – one of the widest aspects of improving business processes[1]. All created and available project management systems apply the same basic rules and, irrelevant of the fact which one is currently used, they are bound to differ only with regard to details and supplements. They can be applied together with other programmes used to control and improve the quality of processes.

One of the most important conditions of efficient and effective project implementation is applying homogenous procedures, common methodics and unified, standardized knowledge concerning the project design and implementation. The role of unified procedures and methodology becomes more and more important due to the fact that they guarantee the consistency of solutions, even in the case of projects in virtual organizations (where particular elements of the project are remote in terms of distance). The designed and verified methodics of the IT projects implementation are increasingly seen as a useful tool in achieving successes in IT project management[2]. As the author already mentioned, more and more frequently IT companies create original methodologies for implementation of project tasks for their own needs or adapt the existing and commonly accepted methodologies.

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1 see Snedaker S.: *Zarządzanie projektami IT w małym palcu* (Gliwice: Helion, 2007).

2 Szyjewski Z.: *Metodyki zarządzania projektami informatycznymi* (Warsaw: Placet Publishing House, 2004).

Methodics is defined as … a set of principles concerning the ways of performing a given task …[3], methodology – as a science concerning the usefulness, quality and effectiveness of scientific research. It means that methodics, in contrast to methodology, aims at showing how to best perform the work, not what should be done, namely, what are the relations of the applied methodics to other methodics used in the field?, what is its innovativeness?, in what cases it is most effective to use, or what is its empirical value?

It can be also defined as … the standardised approach to problem solving in a particular field. Methodics disregards the factual context of a given area, and it focuses on the methods of realizing particular tasks, especially with regard to management methods …[4]

Each methodics has been built on the basis of practical knowledge (know-how) accumulated by the companies for many years. It can be seen as a plan of actions which includes all activities performed within the project. It is a formal record, action plan and a tool enabling the control of activities in the project. Methodics is also a practical guide indicating which activities should be carried out in particular stages of the project. It constitutes a basis for the verification of project activities, their control and evaluation; it is a specific map of the project from the current to the desired stage[5].

Process management can be understood as a set of techniques and solutions allowing for more efficient realization of the assumed project objectives, but it can also be applied as a method of managing the organization. In the first case it is seen as a set of good practices[6] in management, enabling achieving project objectives, without any critical changes in the functioning of the organization. In the second – management by processes, in a sense, replaces functional management of the enterprise, which requires vast changes in the organization. The most frequent change is appointing the owners of processes and – once again – defining their place and role played in the organization. It is accompanied by the process of flattening of the organization and establishing new structures supporting process management (e.g. Business Process Management – BPM). Additionally, process management is aimed at providing supporting techniques and mechanisms, which are based on the knowledge of the organization's strategy, and establishing the final – desirable – state of the organization (and its processes) as well as the ways in which we

3 Bralczyk J. (ed.), *Słownik 100 tysięcy potrzebnych słów*. (Warsaw: Wydawnictwo Naukowe PWN, 2008) 395.

4 http://pl.wikipedia.org/wiki/Metodyka

5 Chmielarz W., Klincewicz K., *Zarządzanie projektami* [in:] Bogdanienko J. (ed.), *Organizacja i zarządzanie w zarysie* (Warsaw: Wydawnictwo Naukowe Wydziału Zarządzania UW, 2010).

6 whether in fact they are good, in the case of projects it turns out ex post (the author's note)

can proceed from the current to the final stage. In turn, the progress from the current to the hypothetical desirable stage may be treated as a project in which methodics of process management may help to achieve the assumed goals and enable project implementation enter the next stage of the organization development.

Methodics presented later in this chapter belong to the group of practices in the field of IT project management, recommended and offered by various companies and research institutes and used in different economic conditions. In general, they include all or individual stages and sometimes also the areas of the process of analysis or creation of an IT system. They also differ in terms of the degree of abstraction, with regard to how their basic assumptions are presented, the degree to which they are used in the organization as well as the general development trends.

The issue, which appears frequently in this publication, the approximation of project management methods and process management methods (based on the progressive formalization) results in the fact that the methods of process re-engineering (in particular their management) are more and more frequently applied in the process of management of unique and innovative processes, i.e. projects. Therefore, some of them are seen as methodics (and sometimes, due to many studies and publications on the subject, connected with the continuous development – as project management methodology), whereas others are perceived as process management methodics, which either appear alone, or in cooperation with others involved in process re-engineering.

2.1. Project Management Institute (PMI) methodology

Project Management Institute (PMI) is considered to be an absolute leader with regard to project management in the USA, setting standards in the field. Its specific popularity results from a great number of members (with 301,000 members in 2009[7]; 334,000 in 2010[8]; over 600,000 in 2011 from 184 countries[9]; and in 2012 more than 650,000 from 185 countries[10]) and a wide and diversified scope of activity and a possibility of issuing certificates in the field of project management.

[7] http://www.pmi.org/en/About-Us/About-Us-Annual-Report.aspx; http://entangled.com/2010/07/13/pmp-certification-growth-rate/

[8] http://www.pmi.org/en/About-Us/~/media/PDF/Media/PMI%20AR%202010%20Combined%20FINAL.ashx

[9] http://www.pmi.org/en/About-Us/~/media/PDF/Media/PMI%202011%20Annual%20Report%20-%20FINAL.ashx

[10] http://www.pmi.org/About-Us.aspx

PMI concentrates on systematizing, classifying and developing knowledge and skills related to project management. Many companies create their own models and systems of project management; however, only some of them – as it seems – found them on the basic assumptions, methods and procedures designed and still developed in the Institute. The general character of the solutions and the implementation framework may be applied in any project, irrelevant of the sector, size, complexity or budget. In general, most of the commonly applied methodics (in particular those which are considered standards recommended by the certifying institutions) in the field of IT project management sufficiently standardise the manner in which a project is managed in terms of defining its particular phases and activities, which should be planned and realized. There are also collections of best practices in the form of compendium of knowledge concerning project management, which may be useful in their effective implementation[11]. Nevertheless, *A Guide to the Project Management Body of Knowledge*[12] (originally published in 1983 as the so-called *white book*[13], in 1996 as the first official edition, in 2000 the second, and the fifth edition is planned in 2013[14]) is still considered to be the first, leading and the most abstract in the ideological sense. It is a collection of the continuously developed standards and solutions in the field of project management, completed and published by the members of PMI (*Project Management Institute*). Standard PMBOK Guide is a collection of generally accepted practices which are applied in project management.

This document divides processes concerning project management into five groups of processes (with sub-processes) and nine areas of knowledge. Due to the lack of the requirement of the sequencing of processes in the project the groups of processes, even though presented in a particular order, may overlap while the project is being realized.

The groups of processes and relevant sub-processes are listed below:

1. Initiation processes – processes which are used to define and approve a project or its stage in the organization. Including the sub-processes: preparing an opening document, determining the initial scope of the project,
2. Planning processes – defining and specifying the objectives of the project and the selection of the best available ways of operating, allowing to achieve the objectives of the project – these are processes which provide answers

[11] see Kasperek M.: *Zarządzanie projektem* (Katowice: Wydawnictwo Uniwersytetu Ekonomicznego w Katowicach, 2011).

[12] Polish edition of the II English edition titled.: *Kompendium wiedzy o zarządzaniu projektami*. PMI MT & DC, Warsaw, 2003).

[13] white book – an authoritative report or a coursebook helping the readers to understand and solve the problem and make the right decision

[14] http://en.wikipedia.org/wiki/A_Guide_to_the_Project_Management_Body_of_Knowledge

to the following questions: how and in what way we should realize the assumed objectives; it also defines the resources, time, and order of events, etc. Including the sub-processes: devising a plan of project management, planning the management of the scope of the project, defining the scope of the project, devising the structure of the task division, defining tasks, ordering activities, estimating the resources of the activities, estimating the duration of particular tasks, devising a schedule, estimating costs, budgeting costs, quality planning, human resources planning, communication planning, risk management planning, risk identification, qualitative risk analysis, quantitative risk analysis, planning response to risk, procurement planning, contract planning,

3. Implementation processes – coordination of people and other resources in order to realize the adopted plan, including sub-processes: leading and managing of project implementation, quality control, recruiting team members, team development, information flow, gathering offers from suppliers, selection of suppliers,
4. Control processes – ensuring the implementation of project objectives through systematic monitoring and measuring of the project implementation, allowing for detection of deviations from the plan and taking corrective actions. Including sub-processes: monitoring and supervising of project tasks, integrated change management, verifying the scope, control of the scope, monitoring the schedule, monitoring the costs, quality control, team management, progress reporting, management of shareholders (stakeholders), monitoring and control over risk, contract administration,
5. Completion processes – formal acceptance of the results obtained in the project or data of the stage of the project and proper completion of a project or stage. Including sub-processes: closing a project, closing the contract[15].

Particular stages are not executed in the above presented order. In the process of realizing particular projects or its stages they intermingle or overlap. The example of the realization process is presented in Figure 19.

The processes of project implementation presented in the PMBOK guidelines are a logical consequence of actions which may be carried out during the realization of every project. Depending on the kind of a project, its complexity or innovativeness, some of the processes may be of more detailed character than others; some can be even omitted in extreme cases. Still, however, it is difficult to question particular processes (or sub-processes) or point to other postulates resulting from management organization from the point of view of processes being carried out within the organization.

[15] based on: *PMBOK Manual*, downloaded from: http://www.pmi.org, February, 2012.

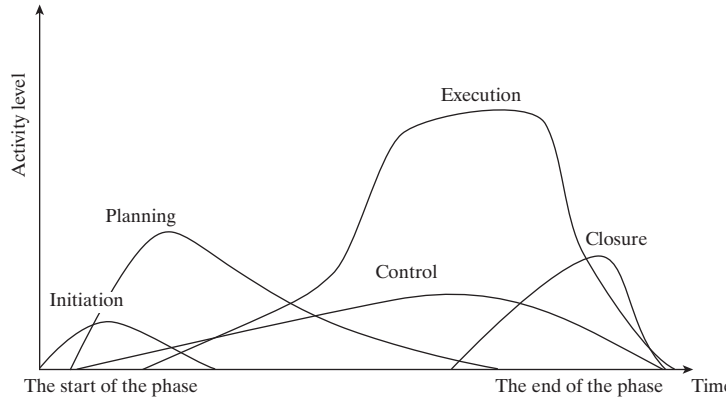

Figure 19. Overlapping of the groups of processes within a particular project stage
Source: *PMBOK Guide 2000 Edition*, (Warsaw: MT & DC, 2003) 39.

The areas of knowledge covered by the scope of the project are treated in a slightly different way. Despite the fact that they present a rather logical, consequent and coherent approach towards the project implementation, they do not include particular recommendations resulting from the corporate process management, which would connect them directly with the guidelines concerning processes. The areas are shaped in the following way:
- management of the project integration,
- management of the scope of the project,
- time management in the project,
- cost management in the project,
- quality management in the project,
- human resources management in the project,
- communication management in the project,
- risk management in the project,
- order management in the project.

1. Project integration management – includes devising a plan of the project, realization of the project plan and integrated control over the changes. PMBOK presents the specification of the input data for the creation of a project plan so that it consists a coherent whole and is compliant with the remaining tasks realized in the organization. However, the analysis of the information (documents, historical information, organizational guidelines, limitations with regard to project implementation, assumptions for the project) does not include business processes and their impact on the realization of the project of a new system.

2. Managing the scope of the project – which includes: project initiation, scope planning, defining the scope, verification of the project scope and control of the changes in the scope. The lack of project integration management in relation to the progress of the processes also results in the lack of integration of scope management (and in consequence, project requirements) with the progress of business processes in the organization.
3. Time management in the project – is made up of: task identification, establishing the order of activities, estimating the duration of tasks, devising and control over a working schedule. There are no guidelines pointing to the need for analyses of impact and interdependencies, related to corporate business processes in the above-mentioned categories. Sometimes, taking into consideration the circumstances resulting from the process realization will be more obvious (e.g. the process of bookkeeping and closing of accounts procedure is usually considered when planning the implementation of the accounting systems), but the process of a regularly conducted marketing campaign, in a different company sector causing a greater number of postings, influencing the engagement of project resources, may not be so obvious for people participating in the project time management[16].
4. Managing the project costs – including: planning resources, cost estimation, cost budgeting and cost control. PMBOK provides detailed recommendations for managing this particular area, as it constitutes one of the most important elements of each project. Placing the planned costs on the general map of the business processes in the organization may provide very valuable knowledge on the planned start of the training process, which may influence e.g. the necessity to pay costs associated with employees working extra hours. The cost factor is also important when analysing the profitability of the project, which usually precedes the decision to start a project.
5. Quality management – including planning quality, quality assurance and quality control. PMBOK recommends constant analysis of the project products with regard to their quality. However, every project should be embedded in the earlier adopted indicators of the quality of the project management process. Considering the above, the project which may be regarded as successful in terms of its quality is the one which led to the assumed support of business processes or the one in which certain functional assumptions have not been realised, but it was completed in the assumed time and within the planned budget.
6. Human resources management – consisting of the sub-areas of organizational planning, recruiting personnel and forming a team. According to PMBOK,

[16] Wojtkiewicz K.: *Metodyka definiowania i wdrożenia strategii informatyzacji w przedsiębiorstwie zarządzanym procesowo*, PhD dissertation supervised by W. Chmielarz, WZ UW (University of Warsaw Faculty of Management), Warsaw, 2012,

members of the project team should have appropriate knowledge, experience, good interpersonal features, which fit within the whole team. Moreover, they should be appropriately motivated to realize the project. PMBOK proposes forming a project team through the prism of functional position within the corporate structure. It should provide the organisation, according to the presented methodics, with the human resources who are well qualified to realize a specific project. Building a team on the basis of the functional competences of their members and delegating the main roles to IT specialists results in the fact that projects of IT implementations are realized by the teams who are not interested in the overall success of the project, because they have no possibility to improve the business processes they participate in.

7. Communication management – which consists of: communication planning, information flow, reporting results and administrative closure. PMBOK methodology assumes that the project will help to form competences ensuring internal and external communication of the decisions made in the project, the progress of project tasks and passing information influencing the project environment.
8. Risk management – which is made up of: risk management planning, risk identification, qualitative risk analysis, quantitative risk analysis, planning the reactions to the risk and monitoring and controlling risk. PMBOK defines risk as all events which may negatively affect project implementation, both with regard to internal and external events. Among them, we can distinguish the events which reduce the possibilities of project realization and adversely affect the planned tasks. The factors which influence risk identification are: stakeholders' tolerance of negative events, identified risk threats, cost estimates of risks and the influence of those factors on the project schedule. PMBOK presents advanced analytical methodics with regard to assessing the probability of risk occurrence and the analysis of plans which are to prevent risk and introduce corrective measures.
9. Order management – including: planning orders, planning offers, requests for proposals, collection of offers, selection of suppliers, administration of contract and contract closure. PMBOK provides detailed methodics with regard to order realisation process. Generally, it can be used in all ordering processes of an enterprise. Usually, however, companies have already developed ordering procedures which need to be considered in the project management, not the other way round.

In the case of IT project management, where we deal with designing software, PMBOK methodology is supplemented with principles concerning software engineering provided within the CMMI methodics presented below.

2.2. CMM (Capability Maturity Model) methodology and CMMI (Capability Maturity Model Integration) methodology

The creation of CMI model was commissioned by the US Department of Defence to solve problems connected with the quality of software designed for their needs in the eighties of the XX century. Due to the subjectively imposed 5-degree maturity scale users raised numerous complaints. Therefore, it has been continuously developed, which in the nineties resulted in the creation of an integrated system, whose form from 2006 *(CMMI – DEV (for Development))* contains two previous versions – *CMMI -CR – Continuous Representation* and *CMMI – SR – Staged Representation*)[17]. CMMI – DEV should be treated as a collection of the best practices used to create and use software in the entire product life cycle from the initial concept stage, through its design, software, implementation to delivery and maintenance. In the present extended model *(IPPD – Integrated Product and Process Development*) we also consider the importance of the role of project teams in integrated processes.

This method is used to provide a comprehensive evaluation of the design and application of software for the organization through qualifying it into one of the five (stages representation) or six (continuous representation) maturity levels. In the staged representation model they are as follows:

- Stage 1. *Initial* stage – a company undertakes efforts in order to manage IT projects (design, development, integration, testing),
- Stage 2. *Manager* stage – in the company there are basics of project management (requirements engineering, project planning, monitoring and control of the projects, management of contracts with suppliers, project quality assurance),
- Stage 3. *Defined* stage – in the company there are standardized processes of IT project management (requirements development, defining the process, risk management, IT environment integration, management of suppliers),
- Stage 4. *Quantitative Management* – quantitative management and quantitative management and measuring processes of quality management in IT;
- Stage 5. *Optimizing* – constant development of IT project management processes (innovation implementation, continuous control and development).

[17] Czarnacka-Chrobot B.: *Wymiarowanie funkcjonalne przedsięwzięć rozwoju systemów oprogramowania wspomagającego zarządzanie* (Warsaw: Oficyna Wydawnicza SGH, 2009).

In the present CMMI model we can distinguish 22 process areas[18]. Each of them has its own assigned specific goals, and each goal has its own specific management practices, characteristic for each process. Also, there is a group of goals and practices, which are not assigned to any individual process. In order to realize a particular area we should achieve all specific and general goals assigned to it, while the accomplishment of all goals for the group of process areas means achieving a particular maturity level.

2.3. PRINCE2 (*Projects In a Controlled Environment*) methodology

PRINCE2 is the most popular standard in Europe, where after numerous generalizations it constitutes an alternative for PMBOK. This methodology is based on the experience obtained by project managers from Anglo-Saxon countries. It was created in 1970s of the XX century as Prompt II (Project Resource Organisation Management Planning Technique II). In 1989 after selling it to LBMS, British government agency, Central Computer and Telecommunications Agency (CCTA, at present a part of Office of Government Commerce), published a new standard – PRINCE (*PRojects IN Controlled Environments*), defining it as a collection of best practices in IT project management. The work on Prince2 was completed in March 1996 with the *The Stationery Office*'s publication of a handbook *Managing Successful Projects with Prince2*[19]. In 2009 the latest version of this standard has been released: in Great Britain it is an actual standard applied to carry out all kinds of projects. This standard is used both in a private and public sector, so as to satisfy the existent users and continuously develop it on the basis of the experience which is being gathered. It has been designed for IT projects, but its flexibility makes it possible to apply it also to projects in other areas[20]. The design and development of this methodology lies in the hands of a consortium of management specialists and over 170 organizations, both from the private and public sector (Review Panel). It is difficult to estimate the number of users – considering the number of people taking the Prince 2

[18] see *CMMI Product Team, CMMI for Development, Version 1.2*. Software Engineering Institute, Carnegie Mellon University, Pitsburg, August, 2006, Flasiński M.: *Zarządzanie projektami informatycznymi* (Warsaw: Wydawnictwo Naukowe PWN, 2006).

[19] http://www.best-management-practice.com/Knowledge-Centre/Publication-Reviews/PRINCE2/?DI=622360

[20] http://www.prince-officialsite.com/; http://www.best-management-practice.com/Publications-Library/IT-Service-Management-ITIL/ITIL-2011-Edition/

Foundation and Practitioner examination; it amounted to over 50,000 people in 2009[21].

Popularity of this methodology results from the application of the process approach to prepare, carry out and close a project, which at the same time enables a relatively easy adaptation to specific conditions and the scale of an IT enterprise. Every stage of the work realised according to the PRINCE2 methodics is set and reviewed in terms of the obtained results. Every project in this methodology is described by means of elements of the input and output stage with the assumed, clearly defined goals and the actions taken at particular links between individual stages[22]. At present, this methodics is applied in projects carried out by global corporations, but it can be also used in projects conducted by small service companies. The 2009 version is very flexible – it allows for answering the questions *what?* and *why?* should be done in the project, and it allows for broad interpretation (in the sense of actions and techniques) of the ways of obtaining goals (it does not specify *how?* it should be obtained). It enables the structuring of the project – its division into smaller, and as a result more manageable, parts. Attention is paid to the financial issues, starting with business justification of the project, ending with its evaluation[23]. Prince2 methodology defines a project as: *…management environment created in order to deliver one or more business products, according to specific requirements presented by business users …* The development of the methodology takes the following path towards:

- less command and greater flexibility,
- the approach based less on theory and more on good management practice,
- the principles applied in the methodology become less fixed and superficial, and closer to reality,
- adapting the method to particular cases is explicitly defined by making guidelines concerning adaptation available to users,
- product is integrated with other programmes of the company ensuring *Managing Successful Programmes*, *Management of the Risk* etc., and the combination with other standards and knowledge resources available to the users is clearly visible,
- "soft" aspects of management are developed and emphasised,
- methodics becomes less bureaucratic – the required information and decision-making actions based on them is more important than working meetings[24].

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21 http://www.best-management-practice.com/Knowledge-Centre/An-Interview-with/?DI=571463

22 OGC: *PRINCE2 – Skuteczne zarządzanie projektami*. London: TSO, 2010. 5–78

23 http://mfiles.pl/pl/index.php/Og%C3%B3lna_charakterystyka_metodyki_Prince_2

24 http://www.best-management-practice.com/gempdf/PRINCE2_2009_Overview_Brochure_June2011.pdf

Prince2, version of 2009, consists of the following components:
– justification of the business venture,
– project organisation,
– quality assurance,
– plan hierarchy,
– risk management,
– change management,
– control of the progress of the project.

In the justification of a *business case* we present the reasons for carrying out a particular project, possible options of obtaining the project goals, expected benefits of the project realization, the list of threats and barriers in its execution, the calculation of the project costs, schedule and expected economic effects of its realisation (profitability evaluation). The last action is iteration to ensure that despite the changing business goals (the user learns in the course of the project and sometimes changes requirements) this activity proves profitable.

In the component called "project organization" we define the roles of particular actors of the projects (managing and execution) and suggest (in 2009 version) the scope of their competence and responsibility arising from it. At present, we also define organizational behaviour, apart from the obligations, for the Project Board.

This methodology defines eight basic roles in the project:
– Project Board,
– Project Manager,
– Project Assurance,
– Team Manager – optional,
– Project Support – optional,
– Senior User,
– Senior Supplier.

The Project Board represent the project externally to the Management Board and it is made up of people who are responsible for strategic management, decide on the allocation of resources (especially financial ones) and supervise the project.

The Executive represents the common interests of the supplier and the recipient of the product, settles disputes, chairs the Project Board meetings and supervises the project. He or she is personally responsible for its appropriate execution.

Project Manager is responsible for: planning and managing of the project, devising plans, product delivery, delegating tasks, accepting tasks, documents,

registering project tasks, updating plans, analysing changes, presenting reports to the Project Board, managing and motivating staff engaged in the project.

Team Manager is responsible for devising plans and managing tasks as well as reporting on reaching the project milestones (checkpoints) to the Project Manager.

Team Members should have the necessary knowledge and skills to produce the project work, develop it according to the assumed schedules, and be responsible for preparing it for the quality control and ensuring the compliance of the produced work with the expected, standard quality.

Project Support provides administrative help, oversees project management standards and quality standards, prepares documents, registers the project themes, updates plans and analyses the consequences of changes, prepares document drafts as well as the reports of the meetings and quality controls.

Senior User represents the interests of future product users, assigns priorities to particular projects, evaluates and accepts products, supervises the fulfilment of functionality principles and proper quality of products, is responsible for the effects and expected benefits of the accepted products and carries out partial supervision over the part of the project which concerns him.

Senior Supplier represents the interests of the product executives, allocates and frees up necessary resources, is responsible for the integration of planning and execution of the specialist project tasks and carries out the specialist supervision over the project and future use and maintenance of the product.

In the component Plan Hierarchy there are three levels of the plan: a superior (Project Plan), partial (Stage Plan) and detailed (Team Plan) level. Additionally, there is also an Exception Plan in each case where we may observe deviations exceeding the assumed limits.

Risk management consists in eliminating, minimizing and maintaining the risk level within the assumed limits. It consists of such elements as: risk identification (recognition and registration) and risk management (minimizing negative impact). Registered risk is analysed in the course of the project and reduced according to the risk reduction plan.

Quality management is a long-term policy which consists in ensuring (quality control) that products fulfil the previously assumed criteria of quality standards (quality assurance).

Change management in the project concerns small modifications, which do not affect business and architecture concepts. They involve: request for change – concerning changes in requirements or the product, the register of exceptions (off specification), suggestions, queries and defining general problems connected with modifications (general issue).

Progress Management, which did not occur in previous versions, basically replaced Control and Configuration Management, taking over their functions.

On the one hand, it is to ensure project management according to the adopted schedule and within the planned budget; on the other, control the integration of creating products. It contains elements of staged and end evaluation.

Prince2 method created in 2005 did not cover the scope of the project environment. The present version contains extensive guidelines concerning the adaptation of the project to various environmental constraints and realization extensions such as e.g.: projects combined into programmes, projects of clients/ suppliers relations management, projects which are integrated with others and working in project of various sizes.

In Prince2 (2009) methodology, we can distinguish seven basic processes:
- Starting up a project,
- Directing a project,
- Initiating a project,
- Controlling a stage,
- Managing a Stage Boundary,
- Closing a project.

The process of *Planning the project* from the previous version has been eliminated and its sub-processes were assigned and incorporated into each of the remaining processes, including the final stage.

The recognition and preparation of the project assumptions (*Starting up a project*) consists in the recognition whether, in what way and under what financial conditions, the project may be realised. Its execution starts with defining project goals and appointing the project team, whose task is to achieve these goals and ends with economic justification and defining initial parameters of the project (schedule, budget, management elements, and formal agreements).

Strategic management of the project (*Directing a project*) refers to coordination and Project Board's decisions which are crucial for the development of the project, such as the decision whether the project should be continued. Project Manager is responsible for day-to-day management of the project, apart from the crisis situations (management by exception) when deviations exceed the admissible variation tolerance limit. As a result, the role of the Project Board is reduced mainly to authorizing: project initiation, project execution or a stage of exception plan, making decisions resulting from emerging threats and decisions to close the project.

Initiating a project consists of accurate planning of the project execution and estimating resources (financial means, human resources and equipment) needed in order to accomplish the project goals. This is further specification of the initial assumptions which will be included in the basic document of the process, i.e. Project Initiation Document. Basic sub-processes of the process, such as e.g.: specifying project justification, project planning, quality planning,

defining decision elements/checkpoints, information structure and the project documentation as well as creating Project Initiation Document.

In the process of *Controlling a stage* we deal with the day-to-day management of the project by Project Manager. The number of stages depends on the sector where a particular project is being realised, the scope of work, the scale of an enterprise, the degree and estimate of the risk and the number and importance of the so-called milestones – the most important checkpoints, where the decisions concerning the cost-effectiveness of the continuation of the project are being made. After authorising the execution of a group of tasks, we need to perform regular evaluation of the works – reviewing a particular stage and checking its compliance with the analysis of the registered project issues. In the cases of documented and justified deviations from the assumed values we make decisions concerning corrective actions, changes, ongoing modifications, creating reports about important events and accepting a group of tasks.

Managing a Stage Boundary – each level of the methodology needs to be completed and accepted by the Project Board, before proceeding to the next stage. It involves work on a day-to-day plan of the stage boundary, its update together with the potential correction of the business justification and the risk as well as working out corrective actions (if necessary) and creating the end stage report.

Closing a project consists in checking whether all ordered products were executed in the form compliant with the norms, delivered to the user and accepted by him. According to Prince2 methodology it should be carried out in an ordered and controlled manner. The experience from the project is thus gathered and registered. After its completion, project actors organize a review where they evaluate the project and draw conclusions for the future, which, in turn, is included in the project report together with the analysis of the evaluation.

Planning is a continuous process which takes place throughout the entire project life cycle, which means that its sub-processes occur in all remaining processes. It encompasses mainly steps such as: identification, establishing the order of actions to obtain proper characteristics of the product (sequencing), defining subsequent events in the project and their mutual relations, the estimates of labour costs, working out the schedule of actions together with the risk evaluations by means of appropriate tools.

The summary of the most important elements of Prince2 methodology (processes, components and techniques) is shown in the table above.

The advantages of Prince2 methodology are as follows:

– it contains generalized, systematized, partly formalized expert knowledge concerning project management,

Table 10. Elements of PRINCE2 (2009) methodology

Processes	Components	Techniques
1. Starting up a project 2. Directing a project 3. Initiating a project 4. Controlling a stage 5. Managing a Stage Boundary 6. Closing a project.	1. Business Case 2. Organization 3. Quality 4. Plans 5. Risk 6. Changes 7. Progress	Two basic techniques: 1. Product-Based Planning 2. Quality review and a number of other techniques based on the project knowledge resources 3. Changes Management 4. Exception Management

Source: the author's own work on the basis of: Managing and Directing Successful Project with Prince2, in: http://www.best-management-practice.com/gempdf/PRINCE2-2009_Overview_Brochure_June2011.pdf, January 2013.

- it is a good communication medium – it is a widely-known methodology which facilitates communication between all project stakeholders; in addition, it helps to establish well- functioning communication channels between all project stakeholders,
- there occurs a possibility of better control over the resource consumption by the designer and the recipient/client of the project,
- it enables correct structuring of the tasks from initiation until completion,
- it enables regular monitoring of the progress concerning works and automation of the control of deviations from the adopted plan,
- the distribution of the checkpoints is less formalized than in other methodologies,
- it ensures the involvement of the Project Board through relief from current tasks and, thanks to the management by exceptions principle, it gives Project Manager the opportunity to act without the undue interference on the part of the Project Board, with their support in emergency situations,
- thanks to its application we note a high degree of repetitiveness and standardization, especially in the case of universal projects with common terminology, approach and documentation, which, on the one hand, allows for using the applications again in similar cases, and on the other, ensures the possibility of improving competences,
- standardization is enhanced by providing complete patterns (and even documentation templates) with full consistency and comparability,
- despite the standardization, it contains mechanisms of limited adaptability to specific requirements of the organization or the project,
- it is based on the best management practices (under the circumstances),

– it is widely available, which limits the necessary contribution in the created project,
– there are no requirements of copyright fees within the projects.

The disadvantages of Prince2 methodology which have been noticed in the course of project execution are as follows:
– the randomness of the method application, without paying attention to basic principles present in it,
– widespread availability – which, apart from benefits, brings about the abandonment of the users' own efforts to improve project management methods,
– the practice of creating excessive documentation in the processes of controlling project execution (which we try to move away from starting with the 2009 version),
– at times it causes excessive communication (regular exchange of information between stakeholders) in the project, where working meetings are so frequent that they interfere with the course of the works,
– no directly defined analysis of user requirements, which on the one hand, speeds up the design work, but on the other, may lead to the adoption of false or incomplete assumptions,
– excessive scale of the workload, caused by too literal acceptance of Prince2 methodology principles, when adopted for small projects, it may result in the lack of profitability of its application.

PRINCE2 assumes a complex, hierarchic organization of the project, which posits the existence of many decision-making levels, including those where strategic project decisions are made. This structure is also involved in the processes of monitoring, risk analysis and quality assurance in the project. This methodology assumes that the project needs to prove the justification for its existence: projects which no longer have their business case should be closed prematurely, regardless of the funds already expended.

2.4. ITIL (Information Technology Infrastructure Library) Methodology

ITIL (Information Technology Infrastructure Library) should be treated as a library of models that are examples of best practice with regard to IT Service Management, which is used as the aid in their implementation. This library includes a specific map of processes and their additional characteristics (terms,

relations, organizational roles and measures) containing expert knowledge concerning the entire life cycle of each specified IT service from the perspective of a client and an IT company. In fact it is a collection of generalized instructions and recommendations of IT sector, specifying an effective and efficient way of offering and implementing IT services. The above remarks show that it is a methodology which:

– describes only the best practices of IT services management, on the basis of which we create the procedures for a particular company – it does not implement ready-made instructions prepared for every type of organization,
– it is not a tool, but a collection of processes describing, in a comprehensive way, the entire IT organization, containing expert knowledge on the management of IT services,
– it is a collection of advice, recommendations and instructions on avoiding basic mistakes in IT services management and implementing complex solutions, proved successful in other organizations, remembering about strong relations between particular areas occurring in ITIL.

Materials relating to ITIL methodology appeared on the market already in the eighties, as a collection of loosely connected publications concerning selected best practices in management. The first book *HelpDesk* was published in 1989. It was published by a British government agency called OGC (*Office Government Commerce*)[25]. In subsequent years, in cooperation with IT Management Forum, a second version of the methodology was developed in 2001, and it was published as a collection of seven books. Based on the best practices presented in them, a British BS15000 Service Management norm was developed, on the basis of which in the 2005 ISO/IEC20000 (Service Management) norm was created[26]. In recent years a third version, developed in 2007, which is an update of the previous one, reflecting the latest views on effective IT management is becoming one of the recognized standards in the field[27]. The Stationery Office (TSO) is an official OGC publisher, responsible, among others, for the printing and distribution of publications of ITIL library. Before being published, they need to be accepted by The International Publications Executive Sub Committee (IPESC).

ITIL methodology, in the third version, is made up of five items, which are thematically integrated, analysing all stages in its life cycle. According to this assumption the books are titled as follows:

– Service Strategy,

[25] http://pl.wikipedia.org/wiki/Information_Technology_Infrastructure_Library; http://www.itil.org/en/vomkennen/itil/index.php; http://www.15000.net/; http://www.itlife.pl/

[26] http://itsm.itlife.pl/content/view/10037/82/

[27] http://www.itil-officialsite.com/AboutITIL/WhatisITIL.aspx

– Service Design,
– Service Transition,
– Service Operation,
– Continual Service Improvement[28].

Service Strategy – initial phase of a life cycle of a service, during which strategic goals are set, which are to be obtained through realization of the offered services and rules of operation together with the resources which are necessary to fulfil the assumed objectives[29].

The service strategy comprises of:

– service portfolio management – the process responsible for identifying user's needs and creating an offer of IT services for him, which would take into account the benefits for the user. Service portfolio consists of such elements as: planning the services provided, service catalogue and the register of services which reached end-of-life (archived in the knowledge base, specific services already completed, made available in similar cases)[30]. Service portfolio management includes four stages:
– defining (list of services, case studies, verifying data in the portfolio),
– analysing (suggested values, agreements, negotiating and establishing priorities, balance of supply and demand),
– acceptance (determination and authorization of an agreed service portfolio),
– design (transfer of decisions and the allocation of resources to realize the IT services portfolio).
– finance management – providing information about the values of IT services and forecasts of their size (budget planning, IT service provider, costs of providing services, charges for IT services),
– demand management – identification of patterns of user behaviour and the policy of diversifying charges for the desired customer behaviour – so that they bring the greatest benefits to both parties (user and the company providing IT services). The client does not want to use the offer which does not produce benefits.

Service Design – on the basis of business requirements and guidelines from the previous phase, we design new or modify already existing services, which will be implemented. The primary objectives of this stage are: designing

[28] http://pl.wikipedia.org/wiki/Information_Technology_Infrastructure_Library; http://www.itil.org/en/vomkennen/itil/index.php; http://www.15000.net/; http://www.itlife.pl/

[29] see *ITIL® Foundation Handbook*, ITILV3, Hanna A., John Windebank J., Adams S., Sowerby J., Rance S., Alison Cartlidge A., Wydawnictwo: TSO (The Stationery Office), 2009, ISBN: 9780113311972.

[30] see http://itilservicestrategy.blogspot.com/

services and related processes, designing safety measures, designing assessment measures (efficiency, usability, etc.), identification of the project risk, creating and updating documentation, designing improvements of the IT services quality.

The processes occurring in the service design include:

- Service Catalogue management – realised in accordance with *Service catalogue* divided into: business catalogue (containing information on IT services transmitted and visible for the client) mapping (overlapping) IT services to business processes and a technical catalogue (containing information on the services delivered to the client, but not visible to him), mapping IT services to IT infrastructure,
- availability management – a set of actions responsible for effective participation, analysis, planning and improving the availability of IT services. Its implementation consists in ensuring the compliance of the available, realised services with the assumed goals of the project in two spheres: passive and active. In the passive sphere there are such activities as: monitoring, measuring effects and analysis of reports of service availability and study of possible non-availability of services or potential corrective actions. In the active sphere we distinguish: risk evaluation and management, planning and designing new or changed services, implementing preventive measures, the review of new or modified services as well as conducting availability and resistance tests,
- information security management process – a set of actions responsible for: the adequate availability (on request), confidentiality (for authorised persons), the integrity of the organization's resources (modification only by authorised persons, information is complete and accurate) and authentication and non-repudiation (trust transactions),
- capacity management process – procedures leading to effective (in terms of costs and appropriate time) compliance of technical characteristics (ability to perform services) of the delivered IT services and IT infrastructure with the level of service agreed with the client. As a part of the process we analyse and allocate resources to the delivered IT services taking into consideration three factors: capacity management for the delivery of services to clients, management of the feasibility of services by the supplier and management of component characteristics[31],
- supplier management – steps to ensure the fulfilment of the commitments agreed by the suppliers,
- IT service continuity management – the management of risk which may disrupt the performance of the service. It aims at ensuring the client that

[31] http://www.itlibrary.org/index.php?page=Capacity_Management

the supplier is always able to deliver the service at an acceptable level. The life cycle of this process consists of five stages:
- initiation (establishing the policy of ensuring continuity, defining the scope, initiating the launch of the project),
- the analysis of requirements and establishing the strategy of the continuity of actions (business impact analysis, risk assessment, development of strategies for IT service continuity),
- planning of continuity and implementation (designing plans for IT service continuity, designing IT plans, organization planning, development of testing strategy),
- launch and operation (training, raising user awareness, overview and audit, testing and change management).

The result of the stage Service Design is Service Design Package, which includes all information concerning a new or modified service, especially with regard to its usefulness and the guarantee of its operations.

The stage of implementing services and change management (Service Transition) – consists in management and coordination of all elements needed to build, test and implement the service at the client, according to the agreed terms. It consists of the following elements:
- change management – the process of coordinating modifications during implementation of IT services with the agreed goals and schedule. It includes activities such as: registering changes, evaluation of their importance, establishing priorities for the implementation, planning changes, testing changes, implementing changes and keeping records of these actions. In the ITIL model we distinguish normal, standard changes (previously envisaged, low risk, easy to implement, low costs) and emergency changes (sudden, unpredictable and significant system error; a fast mode of introducing amendments),
- management of service components and configuration – the process of delivering detailed information on resources and ensuring control over the resources and infrastructure of the organization. In the process a sequence of actions such as: management and planning of service elements and configuration, its identification and control, maintenance of the current status and provision of reports, verifications and audit of components and configuration are being performed,
- knowledge management – the process consisting in: registering, analysis of the use and distribution of information and knowledge in the organization. The basic aim is to avoid the repetition of acquiring organizational knowledge,
- planning and supporting of the implementation of services and change management – the process responsible for planning all processes of service

implementation and coordinating resources for their realization. The main objectives of the process are control, identification and management of the risk of error in the implementation of the service, as well as planning and coordination of resources needed for the implementation,
- evaluation – the process consisting in the evaluation of modified or newly introduced IT services, according to pre-defined measures and criteria, which justifies the introduction of change and verification of the accuracy of the related decision made in this respect,
- management of versions and implementations – the process of controlling and planning of the availability of the test and final version and providing new hardware, software, etc. necessary for the implementation of IT services,
- verification and testing services – the process which is to ensure the adequateness of the service and its compliance with the agreed requirements.

Service Operation – the phase of a life cycle which consists in the management of the systems and IT infrastructure in order to deliver the IT services to users and clients at a level which was previously agreed. Service operation is carried out through the realization of five processes:
- incident management – the process of restoring the proper operation and the removal of negative effects that may have occurred in the meantime,
- realization (fulfilment) of user requests – the process supporting the user in providing standard services and complaints about the non-fulfilment,
- access management – the process of assigning users with access rights and permissions to perform the functions within the range of IT services provided to them,
- event management – the main process in this phase consisting in the detection, response to events, which occur during a life cycle of a service,
- problem management – the process preventing the emergence of problems, and at the moment of their appearance causing the minimization of impacts. It consists of two parts: passive (identification and specification) and active (improvement so that the identified problems do not occur again).

The processes occurring in this phase are realised in the course of four basic functions:
- desktop services – the main medium of communication for reporting irregularities in the operation of the IT system and requests for a particular service,
- technical management – supporting of technical services of systems management (main frame, servers, networks, the Internet, storage, databases, directory services, desktop, etc.),

- application management – is responsible for proper functioning of various types of applications and identifies the needs during the implementation of application,
- IT operations management – management of IT structure, operational control (console control, batch processing, archiving, printing) and management of facilities (data centres, backup data centres, consolidation, etc.).

Continual Service Improvement – is a phase which may occur at any time during the life cycle of the provided services, responsible for improving the quality of services and related processes, which are as follows:
- assessment of the quality of particular IT services – establishing measures and the proper way to evaluate particular components of an IT service,
- development of quality reporting concerning particular services – publication of the results of analyses of service quality evaluation,
- a seven-step process of improving the quality of services – consisting in the identification of the strategy of improving (vision, requirements and limitations, tactical and operational objectives together with the strategy to achieve them), identification of the evaluated components, collecting data concerning the assessment (of the contractor, manner of performance, schedule, establishing criteria for data consistency, establishing operational objectives and measures of the service quality), processing data (determining frequency, format, tools and systems and the accuracy of calculations), the analysis of the results (the resulting trends, new objectives and courses of action, any action which should be improved), the use of assessment (summary of results and action plan) and implementation of improvement actions.

The advantages of ITIL methodology:
The main advantages of the library consist in:
- possible use of resources of knowledge on the proper realization of processes of providing IT services in other organizations,
- minimizing the implementation costs – organization does not incur high costs associated with the implementation of this methodics, apart from the costs of training on the possibilities of its application,
- improving mutual communication – the use of common (in a sense normalized) language and work in IT department according to common, established rules,
- improving customer relationships – focusing on the economic benefits for the client starting with the initial stages of the application of methodology,

– quality management – continuous quality improvement of the organization and IT services implemented in it[32].

The disadvantages of ITIL methodology

– the biggest drawback, according to users, is the fact that this methodology is a library – the list of actions to be performed in certain cases, and it does not offer guidance on how to properly apply the best practices described in it. Therefore, each organization must apply ITIL rules to develop its own processes and their related applications,
– ITIL is only a diagram of actions and procedures, a framework, which must be filled with specific content pertaining to the organization – not every organization has workers at their disposal that would be able to do it themselves. Therefore, they employ people who created the ITIL principles as consultants. Thus, the reduction of costs associated with the use of ITIL is only apparent,
– the use of ITIL requires dedicated training for which you need to pay,
– available manuals presenting the methodology are relatively expensive from the perspective of non-commercial use.

2.5. Other methodologies supporting business re-engineering processes

2.5.1. The Open Group Architecture Framework (TOGAF) methodology

The Open Group Architecture Framework (TOGAF) Version 9 deals with designing, maintaining and introducing changes to IT architecture. In TOGAF methodology there emerges an open framework of implementation structure – in fact, it is a set of tools supporting the development of corporate structure, described in detail. It can be used in any organization interested in developing the corporate architecture[33]. TOGAF appears in the form of architectural framework (but it is not architecture), independent of suppliers, created by way of consensus developed under the Open Group, including a rigorous method of creating the architecture (Architecture Development Method – ADM), which allows for the shift from generic architecture to the architecture dedicated to a specific organization, and consists of a set of services, standards, design concepts, components and configurations[34].

[32] http://itsm.itlife.pl/content/view/10005/50/
[33] http://pubs.opengroup.org/architecture/togaf9-doc/arch/
[34] http://architekturakorporacyjna.pl/wp-content/uploads/downloads/2012/01/Dlaczego_modele_architektoniczne_to_za_malo_Wprowadzenie_do_ladu_architektury_korpora-

TOGAF has been created and is being developed by members of the so-called *Open Group*. The first version of the TOGAF methodology was created in 1995 on the basis of the principles of *Technical Architecture Framework for Information Management (TAFIM),* developed by the American Department of Defence. The Department of Defence has granted the Open Group the permission to use this methodology and its successive versions under the name: TOGAF.

In this methodology there are successive phases of constructing enterprise architecture (including IT)[35]:

In TOGAF methodology there are the following levels of enterprise IT architecture design[36]:

- initial phase – determining the scope of the activity of the organization for which the innovation enterprise (including the implementation of IT solutions) will be realised and the sponsor of this work will be identified,
- vision of architecture – creating a vision of an organisation, which will present the assumed level of innovation maturity (including IT). We need to identify the stakeholders who will establish the objectives and declare their needs. The main risk factors for the planned enterprise are recognized, and the communication plan for the enterprise is set,
- business architecture – it describes the structure of an enterprise pertaining to its business tasks, management structure, business processes and business information. It is a first stage in the establishment of enterprise architecture,
- data architecture (part of the architecture of IT systems) – it presents the structure and characteristics of data involved in the support the business architecture (business tasks, business processes, etc.) and indicates the systems used for processing the data,
- application architecture (part of the architecture of IT systems) – it shows the structure of IT systems, their mutual relations and location in the environment, and it also provides information on how they participate in the tasks described in business architecture and data architecture,
- technology architecture – it characterises technologies used to support the elements of business architecture and data architecture. It also defines the structure of technological components and their mutual relations,

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cyjnej.pdf, Sobczak A.: *Dlaczego modele architektoniczne to za mało? Wprowadzenie do ładu architektury korporacyjnej*,

35 architekturakorporacyjna.pl/wp-content/uploads/downloads/2012/01/Koncepcja_metodycznego_podejscia_do_podnoszenia_poziomu_interoperacyjnosci_w_organizacjach_publicznych_z_zastosowaniem_architektury_korporacyjnej.pdf; Sobczak A.: *Koncepcja metodycznego podejścia do podnoszenia interoperacyjności w organizacjach publicznych z zastosowaniem architektury korporacyjnej*,

36 see Wojtkiewicz K.: *Metodyka definiowania i wdrożenia strategii informatyzacji w przedsiębiorstwie zarządzanym procesowo*, University of Warsaw Faculty of Management, Warsaw, 2012

- IT solutions – they demonstrate how to move from the current architecture to the desired state; they contain descriptions mapping the desired state onto the description of the current state (interim architecture), allowing to determine an action plan,
- migration plans present the detailed plan for the implementation of new systems, taking into account the data migration scenarios, in accordance with the arrangements set out in the previous level,
- implementation management – describes the way of implementing a new IT system into the enterprise architecture, taking into account the connections with other components of the architecture,
- IT architecture change management – aims at maintaining a consistent, timely architecture description which is compliant with the adopted standard while the changes are being made at any of its levels[37].

The last four levels coincide with the range of specialised methodologies concerning the management of an IT implementation project. The details of this methodology will be presented below based on the example of the description of the data architecture level. Naturally, the data architecture is only one of the levels of the description of the enterprise architecture distinguished by TOGAF methodology. However, it seems that collecting and processing data is one of the most significant elements of building competitive advantage, and in the organizations which do not compete on the open market it is frequently the most important element used to perform strategic actions. Data architecture in TOGAF methodology contains a few description levels: conceptual, logical and physical. The author presents their brief characteristics below, starting from the highest level:

- *Conceptual Data Model – CDM* – is a kind of dictionary ordering the architectural concept of the organization. Within CDM we can find a wide range of data categories (e.g. the register of clients, suppliers, inventory of purchases, etc.) used in the organization, constituting the main objects ordering information collected by the company. This model contains also a description of relations between the data presented from the business perspective, irrelevant of the way in which the data were categorised by IT systems processing them,
- *Logical Data Model* – is a dictionary of data records. It is a subsequent stage of specifying data in relation to a higher level of specificity. It presents the data described at the level of a conceptual model in the form of specific data attributes, and it identifies the format of this record showing connections between them (e.g. name, address, type, connection, etc.). In order to obtain

[37] http://pubs.opengroup.org/architecture/togaf9-doc/arch/

a structured record, this model normalizes attributes of data with regard to the entire data architecture. The process of normalization involves organizing and describing data attributes which provide consistency and uniformity of the record, and they also eliminate the duplicates of attributes containing the same information value,
– *Physical Data Model* – is a specific dictionary, translating the attributes of a logical model into their technical equivalents, which may be used in the systems of data management.

Properly documented data architecture is essential for the change management in the company. It allows us to gain knowledge on the effectiveness of business processes, exchange information with the external world, carry out the implementation of new IT components, and finally effectively manage change at all levels of the description of enterprise architecture[38].

Benefits of TOGAF methodology application, visible in the income statement of the organization are presented in the following way:
– more efficient operation of the company presented with:
– lower costs of economic activity,
– flexibility and adaptability of organizations,
– bringing benefits across the organization,
– reducing the costs of change management,
– increasing the flexibility of employment,
– improvement of capacity,
– more efficient use of IT in the organization:
– reducing costs of software, support and maintenance of IT systems,
– increased mobility of applications,
– development of interoperability and easier management of the system and the network,
– development of the ability to solve the most important problems in the scale of the entire enterprise, such as e.g. the security of IT systems,
– easier replacement of software with newer versions and introducing modifications,
– increasing profits from current investments, reducing the risk for future investments:
– reduction of the complexity of business and IT,
– maximizing return on investment from the present activity and IT infrastructure,

[38] Wojtkiewicz K.: *Metodyka definiowania i wdrożenia strategii informatyzacji w przedsiębiorstwie zarządzanym procesowo*, University of Warsaw Faculty of Management, Warsaw, 2012

– increasing the flexibility of the selection between outsourcing and the possibility of purchasing IT solutions,
– reducing the risk connected with the investment,
– faster, simpler and cheaper public procurement:
– purchasing decisions are easier, because information on procurement is readily available,
– ordering process is faster – there occurs maximization of the speed and flexibility of creating and placing an order without losing the architectural coherence,
– the ability to create open systems using many vendors (*multi-vendor*),
– the opportunity to increase the economic potential of the organization[39].

2.5.2. Six-Sigma methodology

Six Sigma is a method of project management focusing essentially on the management of the quality of products and/or services, through minimizing the number of faults and, as a result, improving the organization's performance. At the moment, similarly to other methodologies of such type, it is surrounded by ideological and philosophical ideas. The primary objective of the method is improving the quality to reach the level of the 99.99966% compliance with the adopted, expected standards. The value refers to the average number of 3.4 defects per million (the number of defects per million opportunities – *DPMO – Defect per Million Opportunities*), which amounts to six standard deviations (thus, a name – 6 sigma, the sigma letter is most commonly applied in statistics to determine the standard deviation) from the normal distribution arising from the observation of a particular phenomenon[40]. The one sigma level – is about 700,000 of defects per million and for the company this represents a complete failure. Thirty years ago the three sigma level was considered to be a sufficient quality standard. Six sigma is bringing the quality closer to perfection. So, as a consequence, the objective of Six Sigma is to provide almost 100 percent compliance of the planned results with the actual output. However, it is known, that the majority of economic phenomena do not represent regular distribution. Thus, apparently, the excess above the three sigma level is to compensate for the disturbances of theoretical assumptions of this method. From the philosophical point of view Six Sigma focuses on change management – *…it is better to manage a problem than to have to solve it later…*[41]. The detection of errors and their causes helps to eliminate errors before they occur. Obviously – in

[39] http://pubs.opengroup.org/architecture/togaf9-doc/arch/
[40] ref: StatSoft Polska, *Statistica a „Metodyka Sześć Sigma"*, in: http://www.statsoft.pl/sixsigma.html, December, 2012
[41] see http://www.4pm.pl/artykul/czym_jest_six_sigma-26-1462.html

order to manage the problem you need to have a large number of measurable and, preferably, repetitive observations. Thus, the second major assumption of the methodology – is the measurability of phenomena, which are taken into account when making decisions. From the ideological point of view (and possibly also a marketing-based stance) – the goal of eliminating almost all errors is very attractive from the point of view of the client. However, it is also very expensive.

Created in the mid-80s of the XX century in Motorola by B. Gavin (after his discovery of the interdependence between the number of errors in the production process and the total cost of manufacturing of products and services), identification of defects and elimination of their causes brought about significant savings resulting from reducing costs of discovering and eliminating errors or potential, related complaints. The strategy was developed and applied not only to facilitate production processes (Motorola[42], Honeywell, Alstom, 3M, Microsoft, General Electrics[43]), but also to support administration, finance, insurance, etc. Widely known and recognized, it offers the highest and quickest return on investment.

In Six Sigma methodology there are six basic principles:

- focus on the customer and his requirements – recognition of identified and non-identified customer needs and tools which help to measure them,
- information-based management – specifying the indicators of the company's performance, key evaluation criteria and result optimization,
- process management and process improvement,
- active management – performing activities, preferably before an event occurs, anticipation of events and their consequences,
- unlimited cooperation – understanding the needs of end users and monitoring the documentation flow (workflow) across the organization,
- the objective is to develop processes, with a tolerance of failure – continuous self-improvement and understanding that mistakes cannot be avoided in the management process[44].

However, the core of Six Sigma is not only the application of statistical methods to reduce the number of faults in production. The basis for its

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[42] *…Motorola, the leader of the consortium of the organizations which developed the Six Sigma approach reports savings amounting to $11 billion obtained within the twelve years since the first Six Sigma implementations in their factories based on…*: see http://www.statsoft.pl/sixsigma.html, January 2013

[43] e.g. *… General Electrics, which owing to the Six Sigma implementation saved $ 750 million in 1995*. …Snedaker S.: *Sprawne i efektywne zarządzanie projektami – Zarządzanie projektami IT w małym palcu*. (Warsaw: Helion Publishing House, 2007). 23–24,

[44] see Barney M., McCarty T.: *Nowa Six Sigma*. (Gliwice: Wydawnictwo Helion, 2005).

application is a methodology procedure, named DMAIC after the initials of its particular phases:

- *Define* – in this stage there occur initiation and identification, recognition and description of processes and their weaknesses, defining its objectives, limitations and the areas where processes occur, identification of critical features and tasks to be solved (i.e. identification of problems and processes, which are the cause of the defect and concentrate on those whose improvements will bring the greatest benefits). The analytical techniques at this stage are: cause-effects diagrams, ABC method and the Six Sigma calculator,
- *Measure* – is a way of knowing an objective truth about an object in a clear, precise and exact way: the measurement results should be interpreted in a clear and unambiguous way. It consists in collecting information on the current state of the process in order to establish the reference level and the scale of the problem, i.e. the set of characteristics of the process and the activities which are not acceptable for clients (the number of mistakes and chances of making them), identifying methods for measuring the clients' requirements and carrying out detailed measurements (the evaluation of the clients' or market needs, comparison with competition, etc..). Analytical techniques used in this process are: descriptive statistics, Ishikawa diagram, time series graphs, etc.[45],
- *Analyse* – at this stage we analyse data in order to identify the reasons for the defects and the ways to avoid them, pointing to critical causes of the problems and their impact on the process, analysis and evaluation of measurement, specification of deviations and methods of their elimination (research into various process options). We calculate how much we would gain as a result of the improvement of particular processes by eliminating potential errors. We use: the cause-effect diagrams, tests for the dependent and independent samples and cross-sectional analysis,
- *Improve* – at this stage we indicate the processes which are to be improved and solutions eliminating specified problems to be introduced, the search for new solutions, minimizing deviations, creating changes and their implementation or designing the process so that is meets the clients' expectations; interference with the course of the process in order to reduce the number of errors by reducing deviations. Elements of this stage are: planning, execution and analysis of the findings concerning the key process categories. The analytical techniques are: control charts, Pareto analysis, Six Sigma calculator, cross-sectional analysis, cross-sectional charts,

[45] Galileo Galilei: *"…Measure what is measurable, and make measurable what is not so …"*

– *Control* [46] – represents the completion, verification of the effectiveness of the undertaken actions and – as a result, introduction of new forms of processes, identification and monitoring of results in order to achieve high quality performance by identifying the scope of tasks and roles and the responsibility of the processes' owners for the quality and tests – checking whether the process meets client's requirements. The most common technique of action is the use of control charts.

The traditional methodology of project management is divided into the stages of commencement (initiation), planning (defining and analysis), execution, control and closure, which is analogous to the stages in Six Sigma methodology. Particular stages are supported by additional tools which are created and adapted for this method:
– customer-oriented in order to identify his needs (VOD – Voice of the Customer) – identifying client's needs and his preferences and tracking their changes; monitoring the situation,
– aimed at the quality of the message – converting the clients' requirements into the language which is understandable for the system designer and – in return – the language of a designer and programmer translated into the language of the user and the market (QFD – Quality Function Deployment),
– defining processes and roles in the project (SIPOC diagram (acronym of Supplier, Input-Process-Output, Customer)) – diagnosis and long-term analysis of processes, the place and role of the contractor and the user in the project,
– identifying risk (FMEA – Failure Mode Effect Analysis) – identification of the possibilities of making mistakes (risk), their hierarchy and the way to prevent them whenever possible,
– summarising the results (Balanced Score Card) – measuring the effectiveness of the project and development trends.

In this methodology we recognize a specific (previously mentioned) primacy of the clients' requirements and their management over the remaining limitations of a "golden triangle" – it is the client who finally, according to his needs, makes decisions concerning changes in the scope, budget and schedule of the project.

VOC's task is to recognize and monitor the clients' requirements pertaining to the project. It consists in conducting interviews, discussions and analyses based on the current studies. The Internet with its available tools (questionnaires,

[46] *DMAIC- The Six Sigma Toolkit*, http://www.dmaictools.com/?utm_expid=18088366-3, December 2012

surveys, newsletters, etc.) is an additional analytical medium. Identification of clients' needs, both formal and hidden, and their place and role in the project is only the first stage of the VOC action. The next stage is identifying the way of satisfying them in order to obtain expected final outcome of the project. The well-defined and determined client's needs should be connected directly to the final product of the project and evaluated by means of measurable criteria.

The main objective of creating the SIPOC diagram is to determine the place of the client and his requirements in the realized process. It is used to present the flow of documentation (workflow), and its name is derived from the first letters of the elements of the diagram:
- Supplier – the person providing the resources used in the process,
- Input – resources limiting the process,
- Process – a set of actions – algorithm – processing contribution (input), in order to increase its value,
- Output – products derived from the process,
- Customer – a person or process receiving the final results.

The diagram may be created both for a single process and for the entire organization. The development of such a diagram presents the following benefits:
- client's understanding of his role and terminology used in the project in particular processes,
- client's engagement in the project,
- development of methods of mutual communication in the project,
- identification of earlier non-specified, hidden customer needs[47].

Building a SIPOC diagram relies directly on the accuracy of the analyses of the clients' requirements which were conducted earlier. The results of the process set the beginning for further action. And they consist in increasing the quality – determining the objective established by the client. The problem of the lack of understanding of the parties of the project, especially the programmer/designer and the final user was one of the crucial issues in IT almost from the beginning of software development. The discrepancies between the expectations concerning the designed solutions were a nightmare of the functioning systems. Hence, the numerous attempts of bringing the communication into the area of graphic languages which are more understandable to both parties. Similar actions were undertaken in QFD – a tool of Six Sigma methodology and it was called the House of Quality[48]. This method starts with the construction

[47] ref: http://www.4pm.pl/artykul/six_sigma_czesc_4-26-27-2.html
[48] see http://www.4pm.pl/artykul/six_sigma_czesc_5-26-56-4.html

of a matrix opposing and translating the client's requirements into the final IT product, in a few steps approximating the requirements of the design and implementation of IT systems through mapping of:
- initial requirements onto a fully dimensioned product, positioned in a competitive market environment,
- product onto its detailed specification,
- specification onto the logical and technical design process,
- detailed design process onto determining its course of action and evaluation.

In fact, it consists of a formalization of the activities suggested and performed in many other methodologies of project management. Confronting the clients' requirements with the possibilities of understanding it by the contractors, juxtaposing their vision with the capabilities of the company – usually it was taking place in an iterative process of many life cycles presented in the previous chapter. The difference is in the details.

The first so-called House of Quality is created so that for the customer ideas concerning the project may be confronted with the implementation possibilities within the company. Therefore, a matrix is being built, where the columns reflect the capabilities of the design company (user-friendliness, the speed of action, adaptation to the company's capabilities, easy updates, self-sufficiency, simplicity, compliance of findings, the efficiency of project operations, peaceableness in negotiations, the efficiency of the project); the rows show the client's requirements (the knowledge of subsystems, operating expertise, availability, timeliness, sensitivity, innovativeness, flexibility, change management, transparency, etc.). For each row there are weights with the specified scale (on average 1–5) established subjectively in cooperation with the client, specifying his preferences with regard to carrying out the project by the software developer. Then – graphically – we define the expected development tendencies (directions for improvements) in relation to the possibilities of the contractor (increasing, decreasing (up/down arrows), fixed (circle)). Many users clearly mark (just in case) rising trends. The next step is filling in the table with graphically prepared rankings/ evaluations, according to the following scale:
- empty triangle (1 point), a poor correlation between a particular type of requirements and the possibilities of its implementation,
- empty circle (3 points) – average correlation,
- filled circle (9 points) – a complete correlation with the specified implementation capability of the contractor.

It is a preparatory phase – monitoring of the project showing the approach towards its implementation from the point of view of both parties – the implementers and downstream users. It is recommended to repeat this

action, leading in an iterative manner to specify the map of deviations of the expectations in the implementation of the project.

On this basis the so-called second House of Quality is created. Based on the established evaluations and algorithms we calculate the importance of the considered parameters and carry out the next analysis – a comparative analysis of the contractor with competitive firms. Subsequently, above the matrix of dependencies, we build a matrix of mutual relations (the "roof") between the characteristic features – the capabilities of contractors (stimulation, compromise, mutual harm) on the basis of the interviews with company employees or clients. On this basis we draw conclusions concerning the performance of the user's company and the company of the contractor on the operational and strategic level.

The presented tools are the methods of collecting, ordering and clarifying the source data with regard to the optimal realization of the project assumptions, created on this basis, and, as a result, improving the quality of its implementation. In practice, the realisation of subsequent phases by means of the presented tools represents a continuous process, lasting for many months. The process consists of many activities, performed by cooperating project teams.

Success factors and disadvantages of Six Sigma methodology[49]:

1. success is only possible in the case of correct process implementation, i.e. following certain, detailed and very restrictive methodological recommendations and proper adaptation to specific conditions prevailing in the company. Because the method is based on measurable phenomena with a normal distribution, and in economic realities such distribution is rare, the results – despite the best intentions – do not maintain the 6 sigma standard, or rather they never reach it. The second problem is the desire to minimise the distances from the established values – the assumption to satisfy the minimum level of compliance with client expectations is cheaper and more common in other methodologies,
2. this method is expensive – as we deal with the necessity to train our staff with regard to the implementation of the method and engage professional trainers. However, the outlays are usually regained after about six months,
3. similarly to other methodologies of project management in order to succeed the Six Sigma requires: the involvement of senior management and employees in the project – their proper motivation (especially in the case of tasks which go beyond regular working hours or which require obtaining higher

[49] on the basis of: Modliński W.: *Firma na poziomie 6 czyli mity i prawdy o metodzie Six Sigma*, Personel i Zarządzanie", no. 11/2005, [in:] http://www.4pm.pl/artykul/firma_na_poziomie_6_czyli_mity_i-prawdy_o_metodzie_six_sigma-26-95.html, January 2013; StatSoft Polska, *Statistica a „Metodyka Sześć Sigma"*, [in:] http://www.statsoft.pl/sixsigma.html, December, 2012,

qualifications), the engagement of the most talented workers to create the project team responsible for the implementation (the so-called *master black belts* and those wearing *black belts*), to create the management infrastructure customised for implementation support, constant control of developments and appropriate information policy – dissemination of knowledge on Six Sigma operating principles,

4. reaching 6 sigma level is extremely difficult (the processes in Polish companies reach the 2–3 level), developing processes enable the companies to reach the level of 4 sigma in order to compete in the global markets (it already results in the reduced number of errors e.g. in the production process at the level lower than 1%),
5. this methodology does not outperform TQM, although a significant role is played by advanced statistical methods used to improve quality. However, as usual, the problem consists in its proper application – if this occurs, we may claim that Six Sigma needs less time to achieve results, thanks to better discipline and higher pace of implementation,
6. the scope of application of this method is broad – we can use these methods wherever we deal with processes (manufacturing enterprises, banks, offices, etc.). Prior to its implementation you should always examine the specificity of a particular industry (e.g. safety issues) and economic efficiency of its implementation – the relation of potential effects to incurred outlays,
7. this methodology may be applied across the company as well as in one department or to solve problems connected with one process. They may be related processes connected both with the material sphere (e.g. production) or informational one (administration),
8. the disadvantages of this methodology are: lack of originality due to the reliance on the practical common sense assumptions; questionable gains from the application of the method (many companies resign from using it), the decrease in employee satisfaction (excessive formalism enforces accuracy of actions and does not allow for creative approach in the project, which results in suppression of innovativeness) and focusing on the product that will be profitable.

2.5.3. Quality management system according to ISO standards

Similarly to previously discussed methodologies, ISO (International Organization for Standardization) standards (9000 series which is particularly important in designing information systems) are designed to develop common, repeatable and clearly defined processes, which aim at improving quality of the realised products and services.

…A document established by consensus and approved by an organizational unit, establishing – for common and repeated use – rules, guidelines or characteristics referring to various types of activity or their results and aiming at obtaining an optimal degree of order in a specified range. It is recommended that standards are based on the achievements of science, technology, as well as practice and they are aimed at obtaining optimal community benefits…[50].

The main objectives and potential threats concerning the norm are derived from the definition quoted above. The main objective is creating a modern point of reference for the project implementation. We should also bear in mind that the norm should be constantly monitored, corrected and modernised so that it can play its role properly and fulfil the users' expectations. The standard may be referred to many activities carried out by an organization: from design, through production processes to distribution. Quality management assigned to these standards is directly related to process management. The processes and all activities which constitute them do not need to be analysed in detail. This, in turn, may lead to discovering potential errors, eliminating, or at least reducing them. The norm may be used as a point of reference. Simultaneously, failure to fulfil it means failure to comply with the quality standards.

The standards are of various character. There are standards connected with analysis, design and implementation of IT systems; for instance (ISO 9001:2000) is an organizational, not a technical, standard. Due to its universal character it must be applied to a specific object and it has to take into consideration current and future clients' needs, promote the ways of maintaining the project teams' engagement, support the process approach, accelerate the process of streamlining the organization, formalize the decision-making process – based on the factual base and take into consideration proper relationships with business partners. The certification process shows whether the standards and requirements are met. It is preceded by:

– design of the quality management system and its documentation,
– implementation of the quality management system, with the possibility of the evaluation of its effectiveness,
– the certification (audit of theoretical assumptions of the quality management systems and its documentation, audit of the compliance of assumptions and documents with the actual operations of the implemented quality assurance system).

[50] *Przewodnik 2 ISO/IEC* (Chapter 3.1. of 1986) after: Niemiec A., Grocholski L.: *Inżynieria oprogramowania w świetle wytycznych norm międzynarodowych*. [in:] *Informatyka i efektywność systemów*, M. Goliński, J.K. Grabara, J. S. Nowak (eds.). Katowice: PTI Oddział Górnośląski, 2005. 250.

The methodology of the improvement of operations is contained in the norm or a collection of standards and aims not only at improving the quality of a product or service but also the related processes of the management within the organization.

The main advantages of using the normalization system may be formulated in the following way:

- recognition and reputation,
- presentation in the form of requirements and recommendations – all works ranging from the user's requirements, through design, execution, implementation, use and continuous improvement,
- separation of system work from the content or merit,
- it introduces a formalization of works and processes (organizational structure, responsibilities, competence, basic processes, supplementary processes),
- it recommends the ordering of infrastructure connected with the project,
- it introduces the need for periodic evaluation of clients' satisfaction, quality management system, its level of knowledge and qualifications of contractors, etc.,
- it introduces the possibility of recreation at any given time of the previous actions affecting the quality of the generated product or service.

The basic restrictions of the application of ISO standards include among others:

- excessive formalization of operations, which increases costs of functioning of the organization,
- high costs of the design, documentation, implementation and certification of quality assurance systems,
- extending the time needed to introduce new members to the project team (they need to learn the quality management system based on the standard).

Nevertheless, it seems that potential benefits from the introduction of the systems of standardisation outweigh its potential shortcomings; therefore, we recommend the standardisation methodology to be included in the collection of methodologies supporting project management.

*

Commercial, integrated methodologies of project management using multiple methods and techniques of project management very often enable the consistent generation, and subsequently the implementation of modern information systems supporting management, especially the Business Information Systems type,

based not only on the data warehouse (including the sector data warehouses), but also relevant Business Analytics packages connected with them, containing mechanisms and models of knowledge management.

Especially since the use of new information technology in the organization does not immediately bring about visible benefits. At the beginning – i.e. after the implementation, at the moment of system application the effectiveness of the execution of tasks by the employees decreases (as compared to the previous levels), which is connected with the learning process. This causes – instead of the expected profits – initial loss. Together with the progress of the introduction of the new system, the effectiveness of their work starts to gradually increase. Reaching the previous productivity level as soon as possible is of particular importance. We should aim at minimising the losses incurred by the enterprise and generating benefits using the new technology. This situation is illustrated by Figure 20. The benefits appear when the area below the curve reaches the level of the diagonal designating the previous average level of effectiveness exceeding the area over the curve defining the losses. The emergence of another innovation causes the shift of the curve of effectiveness to a new, higher level, which means that the increase of effectiveness caused by the implementation of subsequent systems may be infinite.

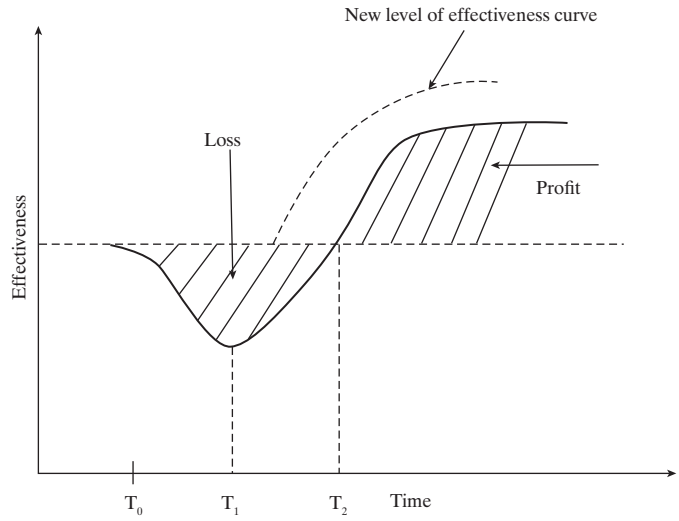

Figure 20. The effects of the implementation of IT system supporting management, generation of losses and profits in the post-implementation period.

Source: the author's own work.

This situation induces the user to undertake the appropriate procedures of project management which guarantee that the decrease in effectiveness after the implementation will be at the lowest possible level; the moment of achieving the previous level will be reached as soon as possible, and the inclination angle after exceeding this point should be as large as possible (as it leads to faster generation of accumulated profit). Achieving these conditions accelerates the use of integrated methods of project management.

3. Development trends of IT systems supporting management

In previous chapters we presented definitions, assumptions, general methodologies of IT projects management and commercial methodologies provided by consulting firms to solve problems related to project management. Attention was also paid to:

- the changes that regularly occur in the area of project management, the expansion of this concept, together with the cyclic changes ranging from formalization to intuitiveness,
- convergence of procedures of modernizing methodologies, despite the diverse terminology and graphic description,
- advantages and disadvantages of their applications.

Now we will proceed to the presentation of characteristic features of diversified products which occur as a result of the project process or project implementation process. Information systems supporting management are such a product. A wide selection of the applied systems, historical implications of their constant development and the dependence on the current innovativeness level cause a specific classification chaos compounded by the phenomena of interpenetration of the traditional economy with the so-called electronic sphere. A wide selection of (still imperfect) methodologies of IT project management, increasing level of their complexity and high dynamics of changes are not conducive to the clarity or understanding problems emerging in this field. Thus, the idea included in this chapter focusing on ordering this sphere may also help designers to understand the implications of these operations in the field of information technologies. The ordering was verified – through "fixing" of particular types analysed and characterised in the context of the circumstances of their historical development, determined by the increase in inventiveness and innovation not only in the technical sphere, but also in organizational, economic and legal areas.

3.1. Literature overview of the approach to development trends of IT systems

Scientists have dealt with the systematics of the development of information systems with a view to manage an organization basically from the moment of inventing the first computer. The subject-matter – in terms of classification, typology, simplifications and standardization, which are necessary to organize this sphere, was repeatedly the subject and the object of considerations of many authors, also on the Polish book market. And – as it seems – all the time it helped to shed new light on the problems related with this sphere. The tradition of writing on the subject was started by the scientific circles from Wrocław with the book *Automatyczne przetwarzanie informacji (Automatic Processing of Information)* from 1971[1] written by Z. Hellwig and subsequent editions of the book *Maszyny cyfrowe i ich zastosowanie (Digital Machines and Their Applications)* from 1975.[2] Secondary in relation to the idea, or simply more up-to-date in relation to a rapidly changing reality, or expanding the subject of analysis including systems and their applications – the books rarely reached a similar level (obviously, there were excellent exceptions to the rule: to name a few works written by or edited by: T.Wierzbicki, W.Radzikowski, W.Flakiewicz, or J. Kisielnicki). Although the IT business environment continued to widen (AE Katowice, Politechnika, later University of Szczecin, AE in Poznań, University of Gdańsk, Warsaw School of Economics (SGH, formerly SGPiS) and University of Warsaw), the publications on the subject were created mainly with a view to satisfy the current needs of existing curricula and they were based on currently existing skills and materials of people who created them, rather than setting new standards. The role of minimum curricula established by ministerial officers was and still is deeply controversial. These recommendations (sometimes due to the lack of knowledge on the latest developments in the field) were at times deeply conservative (unchanged for many years) and sometimes reduced to technology. We might have noticed also inconsistent or even illogical suggestions with regard to curricula. The recommendations, on the one hand, maintain the social feeling of the primacy of IT technicism (i.e. how and with what?, and not why?); on the other, they are able to bring chaos to seemingly ordered material (e.g. adding *Information Technology* as a separate, compulsory subject in many faculties). The academics handled this complex situation very well – see subsequent editions (1998–2003) of books titled: *Informatyka ekonomiczna (Economic Informatics)* edited by

[1] *Automatyczne przetwarzanie informacji* (*Automatic Processing of Information*), edited by Z. Hellwig, PWE, Warsaw, 1971 and subsequent editions,

[2] *Maszyny cyfrowe i ich zastosowanie* (*Digital Machines and Their Application*), edited by Z. Hellwig, PWE, Warszawa, 1975 and subsequent editions.

E. Niedzielska[3], A. Nowicki *Wstęp do systemów informacyjnych zarządzania w przedsiębiorstwie (Introduction to Management Information Systems in an Enterprise)*[4], or *Komputerowe wspomaganie biznesu (Computer-Aided Business)*[5]. These publications competed with such bestsellers as the book by J. Kisielnicki and H. Sroka titled *Systemy informacyjne biznesu (Business Information Systems)*[6], or the book *Informatyka w zarządzaniu (IT in Management)*[7] edited by C. Olszak and H. Sroka. We should note at this point that these books were different from ambitious research publications included in the series of *Studia Informatyki Gospodarczej* (*Economic Science Studies*), created and recommended by prof. T. Kasprzak, or the book by W. Flakiewicz – e.g. *Systemy informacyjne w zarządzaniu (Information Systems in Management)*[8] (Warsaw: C.H.Beck, 2002). They also had a chance to compete with the book *Systemy gospodarki elektronicznej w erze informacji i wiedzy (The Electronic Economy Systems in the Era of Information and Knowledge)*[9] edited by C. Olszak, E. Ziemba published in 2007 and – perhaps – with the book by K. Krupa *Teoria zmian organizacyjnych przedsiębiorstw ery informacji (Theory of Corporate Organizational Changes in the Information Age)*[10]. In recent years we had to pay attention to the work by A. Januszewski *Funkcjonalność informatycznych systemów zarządzania (Functionality of Management Information Systems)*[11], *MIS – Systemy informatyczne zarządzania (MIS –Management Information Systems)*[12] by J. Kisielnicki, or *Technologie informacyjne dla ekonomistów (Information Technology for Economists)* edited by A. Nowicki and T. Turek[13]. Recent

[3] *Informatyka ekonomiczna*, edited by E. Niedzielska, PWE, 1998.

[4] *Wstęp do systemów informacyjnych zarządzania w przedsiębiorstwie*, edited by A. Nowicki, Wydawnictwo Politechniki Częstochowskiej, Częstochowa, 2005,

[5] *Komputerowe wspomaganie biznesu*, edited by A. Nowicki, Placet, Warsaw, 2006,

[6] Kisielnicki J., H. Sroka: *Systemy informacyjne biznesu* (*Business Information Systems*), (Warsaw: Placet, 1st ed. 1999, 3rd ed. 2005).

[7] *Informatyka w zarządzaniu* (*Information Technology in Management*), C. Olszak, H. Sroka (eds.), (Katowice: AE w Katowicach, 2003).

[8] W. Flakiewicz: *Systemy informacyjne w zarządzaniu* (*Information Systems in Management*), (Warsaw: C.H.Beck Publishing House, 2002).

[9] *Systemy gospodarki elektronicznej w erze informacji i wiedzy* (*The Electronic Economy Systems in the Era of Information and Knowledge*), C. Olszak, E. Ziemba (eds.), (Warsaw: PWN, 2007).

[10] K. Krupa: *Teoria zmian organizacyjnych przedsiębiorstw ery Informacji (wybrane aspekty i narzędzia)* (*Theory of the Corporate Organizational Changes in the Information Age (selected aspects and tools)*; (Rzeszów: Wydawnictwo Uniwersytetu Rzeszowskiego, 2006).

[11] Januszewski A.: *Funkcjonalność informatycznych systemów zarządzania* (*Functionality of Management Information Systems*), volume I and II, (Warsaw: PWN, 2008).

[12] Kisielnicki J.: *MIS – systemy informatyczne Zarządzania* (*MIS –Management Information Systems*), (Warsaw: Placet, 2008).

[13] *Technologie informacyjne dla ekonomistów* (*Information Technology for Economists*), A. Nowicki, T. Turek(eds.) (Wrocław: Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu, 2010).

publications were inspired by the latest achievements of series of publications existing for many years on English-speaking markets, like the books by: E. Turban and cooperating authors[14], or subsequent books by Laudon K. and Laudon J.[15].

Almost in all of these outstanding publications we can see a different classification or typology of the development of IT systems supporting management. Sometimes the IT systems are presented in different forms or orders, and they are described in great detail. There was a moment of a complete chaos with regard to terminology, which was strengthened by a common practice in IT to return to terms used in the past and assigning new, modern and frequently different meanings (e.g. transactional systems). Other authors in subsequent editions of their books use varying, individual points of view with regard to classification, which, at times, is completely different than in previous publications.

Thus – after noticing such a need – in the present study the author presents an attempt to organize this sphere based, on the one hand, on integration tendencies, and on the other, convergence tendencies (assimilation and implementation transfer) made possible thanks to continuous technological progress. The author distinguished three kinds of development paths of information systems based on various concept assumptions, associated, at present, with theoretical concepts of corporate platforms.

Integration – in the ideological sense – consists in combining functional elements by means of relations, so as to constitute specific structural components of the whole. Integration is here understood as a process of consolidation and merging of particular different-class characters and forms of interrelated elements in order to create a functional entity, resulting in the usefulness and efficiency which are greater than each of the parts separately. Convergence in the development process – consists in the formation of similar features with regard to construction, function and appearance of various groups of systems operating under the same environmental conditions, regardless of adopted specific innovative solutions. IT system[16] is treated here as an ordered collection of programmes reflecting, in the most useful way, functional requirements of the user through the process of providing adequate technological infrastructure localized both in the organization and its environment. Both software and

[14] e.g. Turban E., Lee J., King D., McKay J., Viehland D., Cheung C., Lay L.: *Electronic Commerce. A Managerial Perspective*, Pearson Education, 4-th ed., 2008, Turban E., Wetherbe J., McLean E., Leidner D., Volonino L.: *Information Technology for Management: Transforming Organizations in the Digital Economy* (NY: John Wiley & Sons, 2007).

[15] Laudon K., Laudon J.: *Management Information Systems*; (Prentice Hall, 2010).

[16] Some of the previously quoted authors treated an IT system in a similar or the same way.

information technologies are the result of historical development, emerging at three main paths of development:

– increasing complexity of logical system architecture,
– functional integration of Information Systems, tailored to the current needs of the organization and the user within the organization,
– expansion of spatial network infrastructure.

These development paths were shaped in parallel, but not next to each other. Frequently, they intertwined and they always benefited from their mutual experience and they used similar tools. Sometimes within a particular development path there occurred a feedback loop – returning to the past in order to realize and develop the concept, previously invented, which was impossible to implement because of the insufficient development of technological innovations.

Some theorists of economic informatics[17] associate the beginnings of the creation of IT systems supporting management with the emergence of the first computer sold commercially in 1951 to the Census Bureau in the USA. Since that time more and more companies adapted computer-based transactional processing data systems (*Transactional Processing Data Systems – TPS or Automation Data Processing – APD)*, single, simple registration systems such as: payroll, account printouts and statistical reports. However, it seems that the fact did not influence their later popularity. The information systems were still expensive, numerical, and separate and assigned to a particular class or brand of a computer. They were not compatible with other types of equipment and this made them very expensive. Additionally, they were difficult to learn, and it was not easy to teach others how to use them. The technical development, which a decade later resulted in the increase in the processing power of computers, has led to the development of software and new techniques for gathering data obtained at the output of transactional systems. Moreover, in the mid-sixties it led – on the basis of the phenomena of standardisation – to the creation of operational systems and programming languages which could be finally used to create software possible to apply in many computer configurations. They were frequently imitated, as we can see at present. The authors state that the information gathered in present transactional systems should be further used in the process of planning and controlling. This observation caused the emergence of a new class of application software. The software comprised mainly such areas of a company's activity as invoicing, registering of payments and purchases, stocks control and warehouse turnover, inventory and accounting, etc. For managers the results of such system operations are

[17] e.g. Silver M. S.: *Systems That Support Decisions Makers. Description and Analysis*, John Wiley & Sons, NY, 1991

presented as preliminarily defined, periodic and standardised reports received on a monthly or weekly basis as a result of transactional processing. These systems started to be called (*Management Information Systems (MIS*)), and their application for the management purposes started to be built on databases. In my view, the era of modern information systems supporting management starts at this point. The development was neither simple nor smooth. Many theoreticians and practitioners dealt with this issue. The presentation of their achievements, commented on at the beginning of this article, still raises some controversy until today. This article is an attempt to join this discussion. The main objective of this study is a presentation of the author's own approach to the directions of the development of information systems supporting management processes centred around the previously listed three development paths, against the background of the integration and convergence trends.

3.2. Development through increasing complexity of the logical architecture of information systems

The first development path – increasing complexity of the logical architecture of information systems – seems to be best recognized in the literature concerning the subject. The greatest number of researchers dealt with it since the early eighties of the last century, and its development was treated as a direct implication of technological progress. Indeed, that was the time of deep changes and dynamic technological progress of IT systems. The progress was so spectacular that finally it started to obscure the greatest achievements with regard to the development of the management in this respect, i.e. creating more and more sophisticated information systems, reflecting actual needs and requirements of the final user of the systems. For the sake of the present discussion, let mi point out the main, successive stages of the development of the systems[18].

3.2.1. Transactional Processing Data Systems – the beginnings of TSP – early fifties – since 1951

In order to give a clear view of the issue, a few comments should be presented with reference to TSP, in their earlier form. These were undoubtedly the first attempts of creating a tool which could be used indirectly to support business management. The basic advantage of such a tool was the speed of performing simple, standard large-scale operations. The basic problem which

[18] see Chmielarz W.: *Selected problems of IT development* (Warsaw: Wydawnictwo Naukowe WZ UW (University of Warsaw Faculty of Managaement Publishing House), 2005).

occurred then was the low level of technological development, which caused the fact that processing, before it could take place, entailed a number of complicated steps and procedures connected with the imperfection of the existing hardware and software. Additionally, this process was accompanied by, as the author has mentioned previously, considerable costs. The lack of reliability and failure rate reached in total 80% of the total working time of such a machine. Designing and processing of the programme which operated on the data which were entered in the computer's memory data was very complex. The limitations were numerous: the problem connected with entering the programme and the data to be processed by the computer, processing of the data and saving the results, distribution of the results among the engaged individuals etc. (processing speed, memory capacity, problems with design and construction of software, etc.). Each of the constructed systems was separate, which sometimes resulted in entering the same data within an organization in a multiple way and frequently in different formats. Other difficulties were: using unreliable input media with the long-term processing and separating the user from processing the data on a computer which he could only prepare. The systems, therefore, were effective in the case of mass numerical calculations whose findings were interpreted "manually". Their usefulness in supporting management was reduced to speeding up numerical calculations.

3.2.2. Management Information Systems (MIS) mid-sixties – since 1964

Management Information Systems from the very beginning of their existence were designed for record keeping of past and current routine information for planning, organizing and controlling operations in functional areas of a business's activities[19]. Management Information Systems are defined by R.M.Stair[20] as "*... an organized collection of people, processing procedures, databases, and applications used to provide standardized information for managers and decision makers ...*" According to E.Turban[21] "*... Management Information System is a formal, computer system, created in order to ensure a selection and integration of distributed information from various sources to provide timely data needed for decision making in management. They are the most effective in routine, structured systems, where there are predictable types of decisions ...*" These systems have had – so far – the greatest influence on the formation of management information systems. In order to do so, they had to undergo a series of profound

[19] see Turban E., Leidner D., McLean E., Wetherbe J.: *Information Technology for Management. Transforming Organizations in the Digital Economy*. NY: Wiley and Sons, 2008.

[20] Stair R.M.: *Principles of Information Systems. A managerial Approach*. Boston: Boyd & Fraser Publishing Company, 1992, 47.

[21] Turban E. and others: *Information Technology…*

transformations. Indeed, in the mid-sixties, when they appeared, no one knew initially how to create such systems. Universal programming languages only started to emerge, hardware – despite fast progress – was still based in the previous era, or it was so new and qualitatively different that the users had to learn to use it. We had to find a proper place in the corporate structure and define the role of organizational units where the system transformations were taking place. Deep changes of the first management information systems were caused by – as it is commonly believed – mainly the replacement from batch system with the system of direct access to a computer. However, the changes with regard to methodology, storing and access to data appear to have been equally important. The most important element in forming still the most popular information systems was the database, especially relational database with its apparatus, which in its basic form was called the database management system. The basic logical architecture structure consisted of:

– end-user with interface, i.e. the collection of programmes, usually of an operation system, responsible for communication with a user, which imposes certain standards of perception and use of other software,
– databases with the database management system – collection of data stored according to certain organizational principles, interrelated, linked by certain defined dependencies, stored in a strictly defined way in the structures corresponding to a certain assumed data model. The software which helps to define, construct, manipulate and share database for applications and users is called a database management system. An additional element of the software may be a query language facilitating the communication with a database (with an even non-qualified user) in terms of accepting queries, its formalization and making its result available to the decision-maker,
– applications – e.g. subsystems, application software consisting of a collection of instructions, whose task is to provide a user with a defined functionality (financial and accounting subsystem, warehouse subsystem, production control subsystem, etc.).

This simple construction of logical architecture has found its application in tens of thousands of systems operating on the market, and it became the basis for building more complex systems, both in terms of adding new elements and handling a number of new features. The user who is making a decision – a manager – aided by means of systems of such kind has his or her professional knowledge, qualifications and skills, intuition of an economist and access to gathered, structured, specific data obtained from the documents which were used in the course of conducting business activity. The way to access, handle and distribute the resulting information is still relatively simple, but in order to use it we need IT knowledge:

– information used in the decision-making process is obtained in the form of reports (processed documents),
– the way of presentation and deep analyses leading to their selection and initial processing depends on the programming language and the database management system,
– in order to obtain the information with a specific cross-section and with a specified range you need at least basic knowledge about the structure of a database,
– there is a relative redundancy of the basic information obtained from a database in relation to the data required in order to make a managerial decision based on the information,
– there are no direct mechanisms of processing the information obtained from the database into the patterns which could be used as the basis for taking a decision.

The logical structure of the management information system is presented in Figure 21.

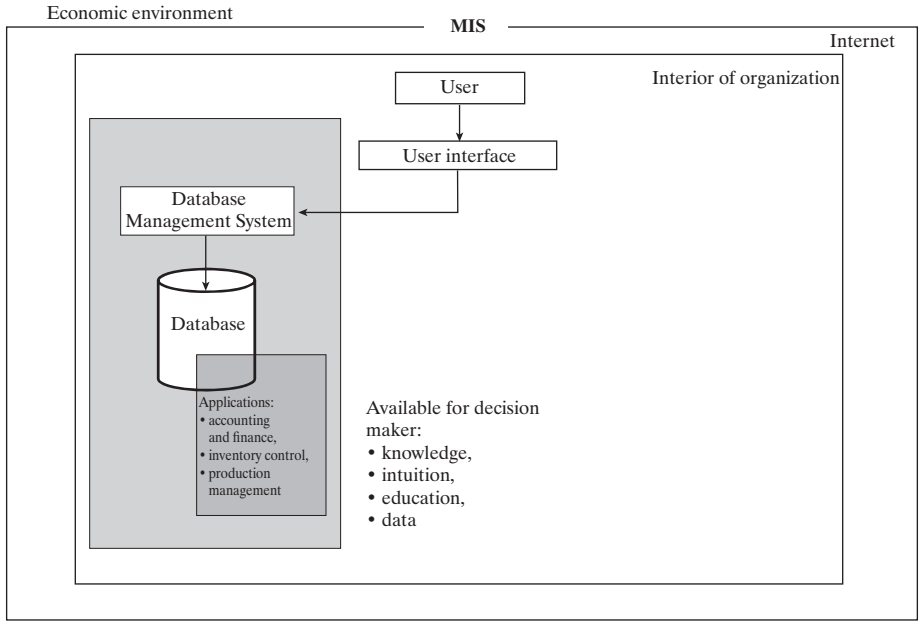

Figure 21. The logical structure of Management Information System
Source: the author's own work

3.2.3. Decision Support Systems (DSS) – since 1978

The basic definition of the decision support systems[22] describes it as … *information systems based upon computer and communication infrastructure supporting the activities of people involved in the decision-making process*…[23] The support is understood as the help provided to the decision-maker in arriving at a decision, not taking a decision instead of him or replacing him in the decision-making process. The main difference in relation to the management information systems is in the fact that thanks to DSS-class systems the decision-maker has at its disposal tools for developing a decision, apart from intuition, knowledge, skills and information. The tools usually take the form of programmes (software packages) consisting of mathematical, statistical and econometric models (or their combinations), focusing on the issues related to corporate management. It means that apart from the deterministic conditions in which the decisions were taken on the basis of verified data (or their combination) from the database. The managers can use the systems to make decisions in probabilistic situations with incomplete, random, sometimes partly erroneous or conflicting data.

We add new elements to the structure used by management information systems:

– Model base – containing routine, standard and specialised models used for decision-making in an enterprise. From a mathematical point of view, there may appear models based on linear or non-linear dependencies, simulation, optimization models and the ones based on game theory or resulting from good management practices. From an organizational point of view models are often divided into in-built (imposed on a user) and constructed by the user from the complete components (subsystems and procedures (rules)), limited only by nomenclature of the tool supporting this process,
– management system of model database – the software containing all tools which are necessary to handle and manipulate ready models, maintain the model base and their modified versions, create new models from elements and construct them according to system principles, integrate the models into one entity or combine new models with already existing ones, mechanisms coordinating the demand for processed models with the database systems, parameters and external data, to coordinate and integrate with the devices further expanding the possibilities of using the model base. Communication

[22] Silver M.S.: *"Systems that Support Decision Makers. Description and Analysis"*. (NY: J. Wiley and Sons, 1991). 13–23.

[23] see Turban E., Leidner D., McLean E., Wetherbe J.: *Information Technology for Management. Transforming Organizations in the Digital Economy* (NY: Wiley and Sons, 2008). 245.

with the model base is performed by means of an interactive language of the model base ((specifying enquiries and requests of the end user), and the models are maintained in appropriate directories.
- Procedure base (solver) – programme or software package used to solve particularly complex mathematical problems arising from the constructed models (linear, non-linear, multi-criteria programming, fuzzy systems, etc.). Addressing a problem is either permanently assigned to a tested, standard model being used or – after possible consultations (usually an option) with a user, adapted to a brand new model which is created by means of mechanisms of model base management,
- database and model parameters – the database, which can contain data which is necessary to run and use a model, derived from historical and current data recorded in the database (model data: parameters and coefficients), external data downloaded and entered "manually" from economic environment (sometimes together with a converter into the format of data used in the model), normalization standards, etc.).

As the author has already mentioned, such architecture allowed for the first time to develop, not the data to make a decision, but, (in a model-based decision-making process) the suggestions of a decision which would be best from the point of view of an assumed criterion or a collection of possible decisions user options. Under the circumstances, we should focus not on the technological solutions which were developed at the beginning of the period, but rather on the creation of an alternative for a decision-maker – a decision developed on the basis of the available (or selected) data versus a decision, which was suggested by the computer on the basis of the applied model problem solution. Emerging opportunities of examining the effects of making various decisions, as well as the projection (forecasting) the future, or in a spatial layout are also important in this case.

In the development of model database and management system we distinguish at least four stages:
- placing a single mathematical models in the system, which if necessary we may refer to as an alternative to making intuitive decision or the one based on data from a database,
- adding the complete mathematical models which describe selected economic events into the structure to provide options for the user,
- including the packages of mathematical models together with relevant procedures, solutions and parameters needed to operate them,
- placing the mechanisms allowing for the creation of one's own individual model from blocks and model components, their integration into one

whole and automatic generation of the collection of data necessary for solving a particular problem in the management system of model base.

Apart from undoubtedly greater opportunities of the application of the decision support systems there occurs one significant problem. (We should note at this point that undoubtedly higher costs of creating such systems are another problem which cannot be ignored.) This is – despite various declarations of designers of such systems – a significant increase in difficulty of using the tools functioning in the system. Apart from the troublesome handling of the model base, we may also observe the problems connected with the necessary skills of using mathematical economic models and – in the case of creating a model – problems with the construction of such a model as a correct (or at least sufficient) reflection of the reality. The subsequent stages of the development of decision support systems were to facilitate their uses by their end user. However, it seems that from the moment of the creation of *Business Analytics* mechanisms in *Business Intelligence* systems, this problem has not been entirely solved.

The logical structure of the DSS system is presented in Figure 22.

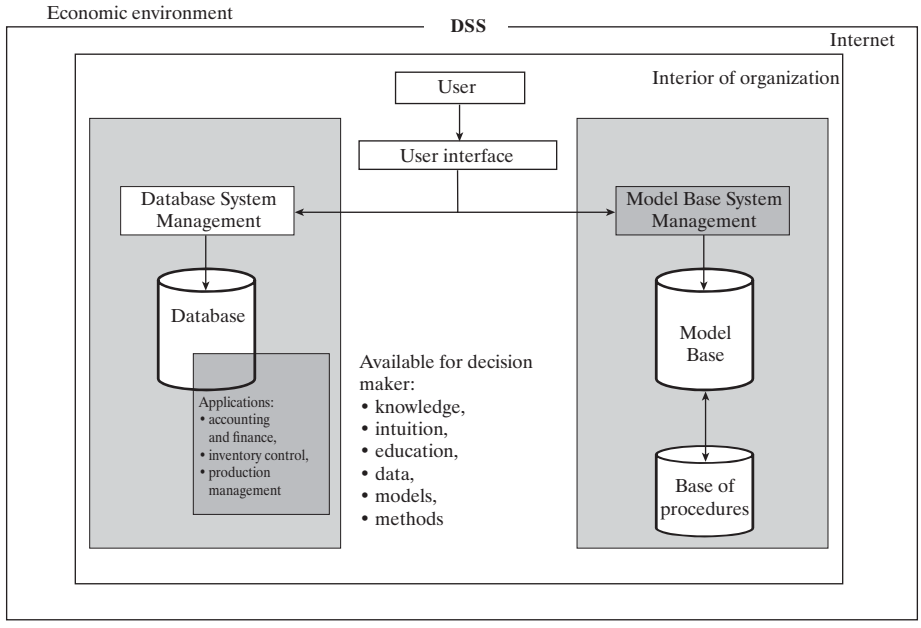

Figure 22. The logical architecture of Decision Support System

Source: the author's own work

3.2.4. Executive Information Systems (EIS) and Executive Support Systems (ESS) – since 1980

Executive Information Systems were to constitute the response to the first of the selected problems. The idea behind their creation was incredibly simple – the systems should provide senior management with direct access to the system capabilities. Initially, it was implemented by increasing the possibilities of the presentation of data from a database and the results of processing models.

In fact, the new elements introduced by EIS systems were only the expansion of the user interface or database management system in order to offer more possibilities to organize and select data (preferably without the knowledge of the database structure) and graphic visualization of the obtained results. Graphic visualization e.g. in the form of a structural or dynamic chart meant that a decision-maker at a first glance was able to evaluate the structure of the analysed phenomenon at a particular stage of its development. Additionally, efforts were made – perhaps for the first time in the history of the IT system development – to ensure the inflow of external data in order to allow comparisons with the situation of other companies in a given sector in the country or abroad.

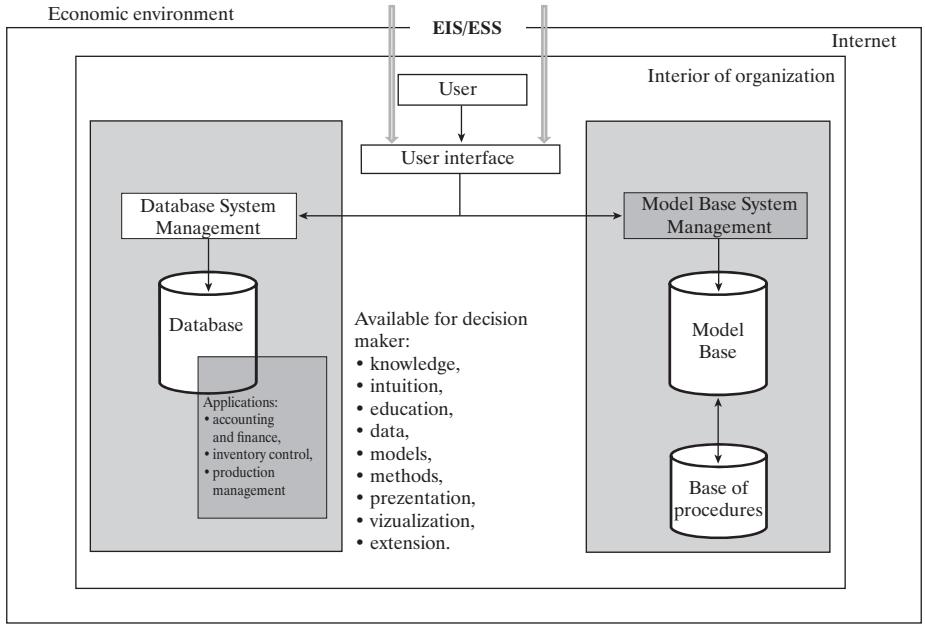

Figure 23. The logical architecture of EIS/ESS

Source: the author's own work

In turn, the ESS systems, which are a kind of a mirror reflection of EIS systems (some researchers considered them to be the next stage of the development of MIS), allowed for an easier manipulation of the results obtained by means of model processing, which was sometimes reduced to a possible transfer of the results of the processing into a spreadsheet. Sometimes, however, the designers created their own software based mainly in the user's interface.

The logical structure of EIS/ESS is presented in Figure 23.

3.2.5. Expert Systems (ES) : ES I generation – since 1978, ES II generation – since 1985

W.A. Freyenfeld[24] described the expert system as *...a system which contains specialised knowledge of a particular area of human activity organized in a way which made it possible to enter into a dialogue (with a user) concerning this field, on the basis of which the system can offer advice or suggestions, and explain the reasoning, which is at the core of the problem...* This old definition seems to be the best explanation of the functioning of expert systems.

The first ES systems (designed already in the seventies) did not contain anything new with regard to their architecture – they were based on the construction of the conditional jump (if you… – …then) or unconditional jump (go to …) which exists in many programming languages. Nevertheless, the first, not very sophisticated, systems which helped to find solutions of health problems (e.g. MYCIN) were formed almost entirely based on this principle. They were related to a specific industry or a problem, and, due to the so-formed functionality, its application was very limited. We may note that the second generation of expert systems, which had its foundation in the ideas of the so–called systems of artificial intelligence, has creatively developed a logical architecture construction of the previous systems. Additionally, the designers distinguished (artificially, externally in relation to the corporate structures) econometric, statistical, forecasting models etc. and they distinguished models based on the latest, at the time, management achievements (Business Process Re-engineering – BPR) – models of best practices of corporate management, analyses and optimization in a colloquial sense, functions and processes taking place in an enterprise, in the existing or modified organization structure of an enterprise.

There appeared new structural elements, and the most important among them seem to be:

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[24] Freyenfeld W.A.: *Decision Support Systems*, NCC Publications, Manchester, 1984; after Chmielarz W.: *Systemy informatyczne wspomagające zarządzanie. Aspekt modelowy w budowie systemów* (*Management Information Systems. Models in the System Construction*), Elipsa Publishing House, Warsaw, 1996 p. 126.

– knowledge base – the knowledge essential for a decision-making process, stored and modified models of best management practices, consisting of models, where we can find facts concerning a specific economic situation (connected according to certain operating practices) where a decision needs to be made along the examples of situations where the decisions were already taken,
– database management system – consisting of a subsystem for obtaining knowledge, subsystem for drawing conclusions, subsystem interpreting the effects of the decisions which were taken and a subsystem widening the knowledge base. Knowledge acquisition subsystem is used to collect, send and process the knowledge concerning a solution to a particular problem, from different sources: "human" expert, textbooks, other databases, special reports, studies, the Internet etc. and has mechanisms supporting the learning process of the systems. The subsystem for drawing conclusions consists of three main elements: translator – interpreter of rules (carrying out specific actions associated with relevant operating practices of the knowledge base); planner – which maintains control of the order of their activities and assesses the effects of applying the rules of drawing conclusions in terms of the assumed priorities and the mechanism used to enforce consistency of emerging solutions.

Subsystem interpreting the effects of the decisions explains how to use an expert system, how particular conclusions were reached. It also shows whether there are any alternative paths to achieve the desired solution, if yes, why some of them were rejected. The subsystem of improving knowledge – gathers the best (among the currently developed) solutions in a given situation from the point of view of the objectives and the assessment criteria.

The system is designed with a view to improve the user interface towards facilitation of communication by means of proper graphics and ultimately – a natural language.

From the point of view of a decision-maker, expert systems provide him or her with a new tool for decision-making: apart from the structured data from a database, model solutions based on the model base there appears a third possibility: suggested solutions built on best practices of management. In each of these three cases the managers also use their expertise, skills and intuition in making business decisions. This way, he or she has better chances to make a decision-making process easier, and the final decision will provide the organization with the greatest possible benefits and it will protect the enterprise from losses.

The logical structure of this solution is presented in Figure 24.

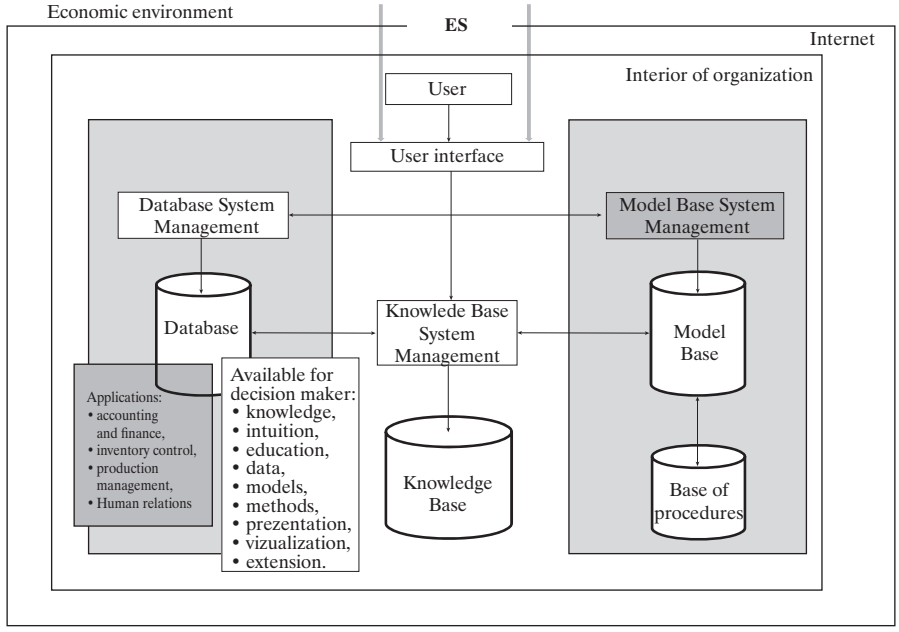

Figure 24. The logical architecture of the expert systems

Source: the author's own work

3.2.6. Business Intelligence Systems – since 1990

It may seem that little can be added to the complex structure which was proposed by expert systems. However, based on solutions developed, on the one hand, by massive data processing, and on the other, by Artificial Intelligence Systems – AIS (which are emerging all the time), scientists started to build new model constructs by improving the structure or functionality of the previous ones. Such a situation (not only in IT) is repeated cyclically, and it was used here as well. The definition of BI states that BI is "… *an analytical information system built on the basis of data warehouse together with data collection mechanisms, using different analytical tools, in particular tools for multidimensional analysis and data mining…*". The definition indicates the directions of changes, which occurred since the emergence of DSS or ES systems.

The first path – a clear extension of a database, connected with the multitude and variety of the data processed in the systems, towards creating a data warehouse. Basically, data warehouse is an expanded corporate database with the mechanisms of data extraction from heterogeneous (including external) data sources and the solutions for their processing into a common database,

which would be suitable for analysts and users making business decisions, supported by the domain or industry database (mart) and mechanisms of cooperation with analytical tools. The main tasks of the database, apart from the standard reporting and defining reports and ad-hoc queries from the user, are: statistical analyses, interactive analytical processing, data mining as well as – to a limited extent – business modelling. So – as the above shows – there occurred a qualitative change at the level of the main source of information in the system.

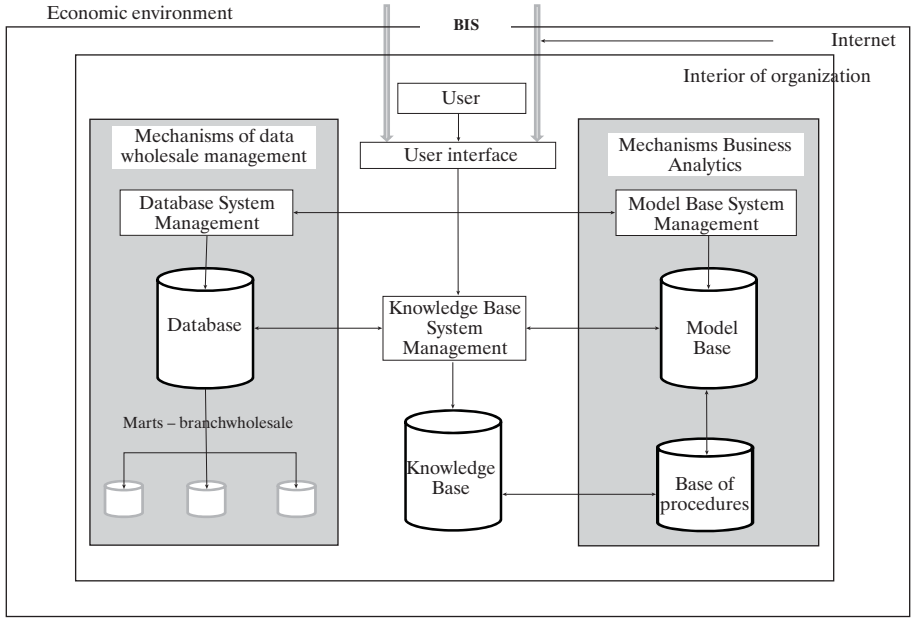

Figure 25. Logical architecture of Decision Support System
Source: the author's own work

When we compare the present system with the previous ones we observe another qualitative change with regard to the support model compared to the previous classes of systems. The so-called Business Analytics are all kinds of tools and analytical applications used for the broadly defined *corporate performance management.* Among the tools and applications used for performance management, we may distinguish universal analytical tools, the tools used for the analysis of spatial data stored in the spatial information systems database and analytic applications designed for specific areas of business management, such as: financial management and strategy management, customer

relationship management, human resources management, supply chain management, etc.[25].

All in all, for his purposes the end user receives multidimensional, extremely complicated tool, whose function redundancy may even interfere with making decisions, even if you reach for new communication media (similar to dashboards).

3.2.7. "Internal" integration of IT systems

Obviously, the information systems did not evolve in isolation. Their practical usefulness actually started with the progress of work on the integration on the level of data and functional visualisation; nevertheless, an equally common phenomenon was combining different classes of systems with each other, which resulted in – sometimes temporary – significant qualitative changes.

For instance, the combination of management information systems and expert systems had bilateral implications. Management information systems in the tandem provide information for expert systems and they facilitate data manipulation. An application programme can use the data directly from a database and it may also use the data collected and preliminarily interpreted by expert systems mechanisms. Expert systems were used in this connection as an extension of a database management system (by monitoring the process of recording, retrieval and updating of the information), facilitate correct database management for the operators, especially in the case of distributed databases, they optimize the queries, search tracks and the amount of the transferred data, or they act as intelligent interfaces in combinations of commercial and structural databases.

Architectural combining of decision support systems and expert systems gave the following results[26]:

– the possibility of a logical explanation of the actions which were undertaken and the results which were achieved – in the case of connecting the expert system to the elements of the decision support system,
– faster execution of an operation where the results of the system's operations are the input data to the expert system,

[25] see e.g. Gołuchowski J.: *Technologie informatyczne w zarządzaniu wiedzą w organizacji* (*Information Technology in Knowledge Management in an Organization*), 2nd ed., (Katowice: Wydawnictwo Akademii Ekonomicznej w Katowicach, 2007) and Olszak C.: *Tworzenie i wykorzystanie systemów Business Intelligence na potrzeby współczesnej organizacji*, (*Creating and Using Business Intelligence Systems for the Needs of Modern Organizations*) (Katowice: Wydawnictwo Naukowe Akademii Ekonomicznej w Katowicach, 2007).

[26] Ref.: Adamczyk A., Chmielarz W.: *Zintegrowane systemy informatycznego wspomagania zarządzania* (*Integrated Management Information Systems*), WSEI Publishing House, Warsaw, 2005,

– correct identification of a problem in the reverse situation,
– widening the user's choice – using the two types of systems connected with a database depending on the current logical needs of a decision-making process,
– generating alternative solutions (decision support systems) and combining them with alternative actions, which should be taken to achieve them.

The basic method of integration of the executive information systems and decision support systems is the using the information generated by executive information system as inputs for DSS systems. In more complex cases, we may apply the existence of a feedback loop which is started by a special intelligent interface, where the executive information system allows for creating queries for the support system, and interpretations and recommendations obtained from the support system will be sent to the executive information system. In short, this process can be summarised in two statements:
– the data after an initial treatment in the executive information system will be used as input for the decision support system,
– the executive information system is used for further interpretations of the solutions obtained by means of the decision support system.

The combination of expert systems and executive information systems is used very rarely in practice. Executive information systems may refer the questions to expert systems to solve specific issues, which the latter deal with and, in return, they receive interpretations of solutions. Executive information systems may also refer to knowledge base of expert system in the situations where the user interface is equipped with communication mechanisms which allow for such action. Sometimes the expert system acts as a regular provider of reports (together with their automatic evaluation of merits) generated on the basis of the data sent from the executive information system.

This type of a relationship, despite its practical advantages, from a theoretical point of view hinders the classification of management information systems. Especially since they both developed through functional integration.

3.3. Development through functional integration of IT systems

Functional integration means that different functions of an information system are realized in such a manner as they would be performed in one single system. This way, theoretically, a single workstation gives us access to all possible forms of activity existing in the system through one consistent interface as well as a possibility to switch between different tasks. In integrated systems this means

access to any functional system and any possible interaction from the level of the system with other tools in the system. Functional integration is not a new idea – from the very beginning of the emergence of the information systems, the scientists tried to realise it, first within a specific area of activity, and later the entire organization. In order to build an integrated IT system you need to create an information base which would be shared by the whole organization, agree upon a uniform standard of gathering, processing and transferring information, a common medium for collecting and processing of information, common tools and development procedures of the system as well as a uniform procedure to conduct a dialogue with a user. Nevertheless, the creation of integrated management systems proceeded gradually, initially by adding (within the operating system) new features to already existing ones in a manner adapted to the current level of the development of information technology. Also, you cannot ignore the fact that building „internally" integrated systems was a response to problems connected with the existence in one company of several sometimes single-discipline information systems supporting management of various form, structure and purpose as well as problems associated with attempts with concerning their "external" integration.

3.3.1. Material Requirements Planning – MRP – since 1959

The idea to create integrated systems was as follows: we design a system that reflects, in the highest possible degree, the processes taking place in an enterprise based on a balance of materials (on the one hand: raw materials, materials, semi-finished goods – on the other, the whole range of finished products), knowing the relationships between them established by binding regulations and standard values. It was assumed that when determining the demand for material resources and the schedule of their deliveries, you can plan the optimal production in terms of costs, production time, profitability, etc.

The first system of such kind – Inventory Control was created in 1964, and it concerned one of the easiest areas of business, which is inventory management[27]. Production control systems were next. Initially, the systems were created for the needs of large-scale manufacturing, in particular electrical engineering. The number of industries which were developing computer-aided operations was growing steadily. The emergence and development of standards and norms of industrial production and norms of production management system contributed to their development.

In 1957 American Production & Inventory Control Society (APICS) was founded in the USA. It aimed at developing the methods of using computers

[27] Adamczyk A., Chmielarz W.: *Zintegrowane systemy informatycznego wspomagania zarządzania*, Wydawnictwo WSEI, Warszawa, 2005.

in the management of manufacturing organizations. In the late 50's APICS developed standard assumptions of MRP (Material Requirements Planning). MRP allowed for calculating an exact quantity of materials and arrangement of their delivery schedule in such a way as to meet the constantly changing demand for individual products. MRP aimed at: reduction of inventory and inter-operational (work-in-progress) resources, establishment of precise delivery times of raw materials and semi-finished goods, the precise determination of production costs, better use of existing manufacturing infrastructure, a faster response to changes in the environment, better control of particular production stages. The extension of MRP specification was through including a Closed Loop MRP, i.e. planning of material requirements and production capacity in a closed loop of a manufacturing process. Owing to the feedback, managers were able to respond to changing production parameters on an ongoing basis.

3.3.2. Manufacturing Resource Planning – MRP II – 1989

It took nearly thirty years to develop a new standard of integrated systems, which was created in the late eighties. In 1989 APICS developed a MRP II (Manufacturing Resource Planning) standard, which started to be used in all larger integrated management information systems. This standard, in comparison to the previous one, was expanded to include elements related to the process of sales and decision support at the level of strategic production management. Together with MRP development, it started to include subsequent areas of an enterprise's activity, and it was gradually becoming a system covering all basic processes taking place in an enterprise. MRP II model takes into consideration all areas of business management connected with the preparation, planning and control of production as well as the sale and distribution of manufactured goods. Apart from materials directly related to production, MRP II also includes support materials, human resources, money, time, fixed assets, etc. In order to make interaction of production modules with the remaining modules possible, the researchers started to base the integration of all subsystems within an integrated system on the financial balance, rather than on a production balance. This, in turn, enabled the transfer of the idea of the system integration within the organization outside the manufacturing sector into the sector of trade, services and finance. It enhanced the extensive development of the systems and entering into new markets.

In terms of the logical architecture, the MRP and MRP II systems did not exceed the realm of management information systems. In subsequent versions and mutations, the integration occurred primarily at the level of functionality rather than logical complexity. Increasing complexity followed in the area of connecting successive cooperating modules, but in fact they

were still the application systems created on the basis on the database and database management system. Their high popularity (up to 80% of markets) was derived mainly from the ease and user-friendliness of the services that reflects the processes taking place in the organization. However, supporting management processes led to delivering reports of limited analytical value.

3.3.3. Enterprise Resource Planning – ERP – since 1995; ERP II – since 1998

The next step in the development of integrated systems – stimulated constantly by adding new subsystems and functions to the existing ones was the adoption in the mid 90's the range of Enterprise Resource Planning – ERP systems. The main aim of those systems was the fullest possible integration of all functions at all levels of corporate management. Modern ERP system quickly became the system covering all production and distribution processes which integrates various areas of company activities, improves the flow of information critical for its functioning and allows to respond quickly to the changes in the demand reported from outside. The information is updated in real time and it is available at the time of decision making. One of the most important parameters of such type is the application of two-way mechanisms optimizing the planning process and an in-built possibility to integrate the system with external entities within the supply chain and sales. Moreover, ERP uses the mechanisms allowing for simulating various activities and the analysis of their effects, including financial activities covering the following areas:

- communication with clients and customer service – customer database, order processing, order fulfilment, electronic transfer of documents (EDI), connectivity with external systems including the Internet,
- the sphere of production – warehouse management, determination of production costs, purchases of raw materials and semi-finished goods, production scheduling, management of product changes, production control, (MRPI/II), forecasting of production capacity, setting the critical levels of stocks/inventories, manufacturing process control, etc.,
- the area of finance – full accounting system, the control of the flow of financial and accounting documents – it allows to prepare financial reports in accordance with the expectations of various audiences,
- integration across the entire supply chain – one of the directions of development of ERP systems (order – delivery – production – distribution – payments).

Generally, despite the transfer (convergence) of the idea of Business Intelligence Systems into the integrated systems (e.g. SAS Institute products),

there were no changes in the basic architecture. In particular it concerned the possibilities of the systems related to the application of the data warehouse. The approach to the directions of integrations within integrated systems changed as well. Firstly, the integration based on systems within an organization, started to give way to the idea of the so-called extended systems – open to the economic environment (it was started in EIS and ESS systems). This extension would mainly include the information from outside, mainly from the Internet and conversion of the information into such a format which can be processed together in the decision-making process. It was possible to cover the entire logistics chain and comparative analyses. Secondly, subsequent implementations made clients and software designers realize that the integration by adding new subsystems, modules and functions at the stage of development reached in the 90's is a road to nowhere. In the hundreds of thousands of functions customers, producers and distributors started to be confused. Large and heavy integrated systems such as SAP R3 were so wide that there were no experts who would know the whole system, and the experts were only familiar with particular modules. The systems were increasingly expensive and they worked more and more slowly.

This was intensified by the so-called "*sunflower effect*". Initially integrated systems, together with the changes in the system environment, were supported with a number of externally integrated subsystems, surrounding an integrated system with related sub-systems. This slows down the operation of the integrated system and creates a need to integrate all these subsystems with the previous integrated level. After some time the process is repeated for the next system which is bigger than the previous one. The shape of mapping the intermediate stages of development of systems integrated in time T2 and T4 resembles a flower – hence the name – "*sunflower effect*" (see Figure 26).

The systems thus become abnormally huge and difficult to handle by the user. Unusual features of the system were difficult to fully integrate with the entire system. The mechanisms which automatically integrated the system modifications (e.g. Dynamic Enterprise Modeller – DEM – of BaaN IV system) ceased to operate. The designers started to return to the industrial systems from the 70's (removing the "redundant" functions, adapting the system to the user's specific needs, creating a tailored-made system – full clustering, etc.). They also returned to the idea of systems based on blocks and modules, i.e. the systems which are modified, where individual elements are combined into one functional whole within the framework set by the system (obviously, within reasonable limits – financial or material balance), according to user's needs. In this situation, the creation of a standard system of ERP class did not seem possible. So, around a standard range of ERP system, numerous variations and mutations started to exist.

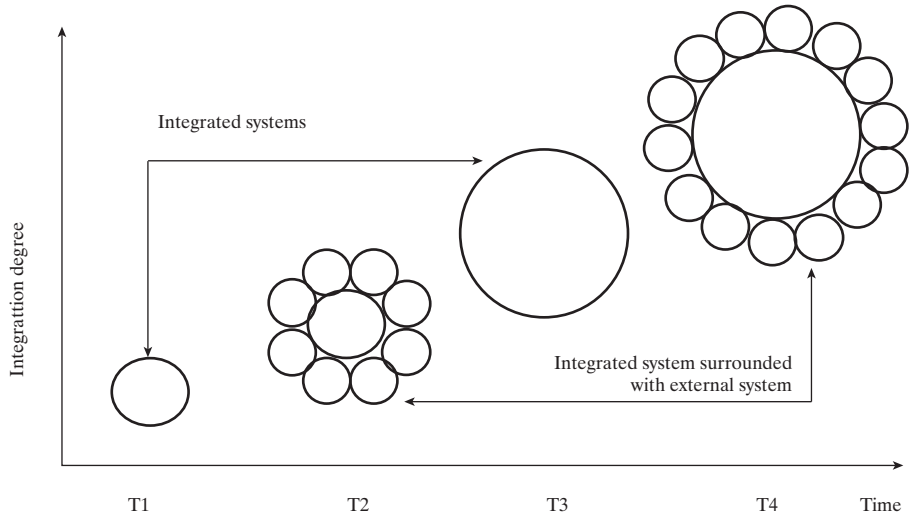

Figure 26. "Sunflower effect" in the development of the integrated systems supporting management

Source: the author's own work

The maximum functional structure of the standard integrated system was presented based on the example drawn from IFS materials. As is shown below, it comprises – similarly to other ERP systems – all possible components of the activities of majority of organizations in the market. The component construction allows you to select the scope of the system depending on the industry in which the organization operates.

The most important feature of the diversity of ERP systems and the emergence of the next generation of systems – ERP II, were their relations with network systems. They emerged in the process of developing subsystems/modules of communication with clients/ business partners. A natural consequence of the development of "manual" and laptop contact with clients was the communication via the Internet. At the time of the creation of websites with external access to the system clients may view the current offer, place orders, inquire about the current status of the order, the state of semi-finished products, etc. Similarly, the organization staff – even outside the company may obtain information of their area of interest. A class of systems was distinguished where the dominating sphere was the Internet space and the basic functions of the system, e.g. those which operate in ERP (electronic Enterprise Resource Planning – e-ERP) sphere were transferred there. Their interaction with e-economy includes the support for various forms of electronic transactions (e.g. B2B, B2C, B2P etc.), the construction of interface to existing e-business systems

(e-commerce, c-commerce types) as well as those connected with mobile systems (m-commerce) and sharing the ERP resources and functionalities through corporate portals within the economic intranet or extranet. Sometimes[28], we also distinguish different types of ERP II integrated systems such as:

- EERP (Extended Enterprise Resource Planning), extended beyond the area of organization of ERP systems, having additional functionalities pertaining to the organization in the economic environment, which is characterised by an increased range of supported business processes,
- @ERP (active Enterprise Resource Planning), or active ERP systems, designed to support modification processes in the design or pre-design of ERP system (transformation of organization structures, BPR, business practices) throughout the life cycle of the system, supported with CASE (Computer Aided System Engineering) tools, based on component technology or on the new approach to system (corporate platform),
- IERP (Intelligent Enterprise Resource Planning), or ERP system with elements of artificial intelligence, allowing for better use of information resources through mechanisms of data warehouse and Business Analytics increasing the possibilities to support the decision-making process, particularly in the area of company value management.

Among the systems cooperating with ERP (and even taking its role) the most popular was the system called Customer Relationship Management (CRM) – the idea of subordinating to the needs of the recipient (and not of the producer or distributor). On the basis of the implementation of this idea we started to build systems which consider the requirements of the external (individual, institutional) client first, and the needs of an internal user in the organization were subordinated to these needs. Another such system was Vendor Relationship Management (VRM), or the system which covers the whole logistic process (Supply Chain Management). It increased the possibility to choose from a large group of integrated systems, decreased an average cost of implementation, but also undermined the faith in the one, single solution of integration at the level of the platform of integrated systems. This also made users realize the existence of the underestimated path of the development through the expansion of network infrastructure.

On the other hand, as already mentioned, the architecture basis of these systems was the use of the idea of information systems of management – applications clustered around a data basis, and then around the database warehouse. In fact,

[28] see *Informatyka Ekonomiczna*, część I, *Propedeutyka informatyki, technologie informacyjne*, edited by Korczak J., Dyczkowski M. (Wrocław: Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu, 2008), 59–60.

these were still simple systems with a number of standard, repeated functions to the ones based on a system – to put it simply – of overlapping balances. And thus for the IC systems it was a warehouse balance, for MRP – material resource balance, for MRPII – financial balance, and in the case of ERP – production-related balance, next for ERP II – logistic and full communication balance for eERP, all in all, constituting the overall balance for the organization. The simplicity of the operation of these systems at workplaces is still an attractive advantage for the users of these systems on individual workstations.

The Figure 27 illustrates these dependencies.

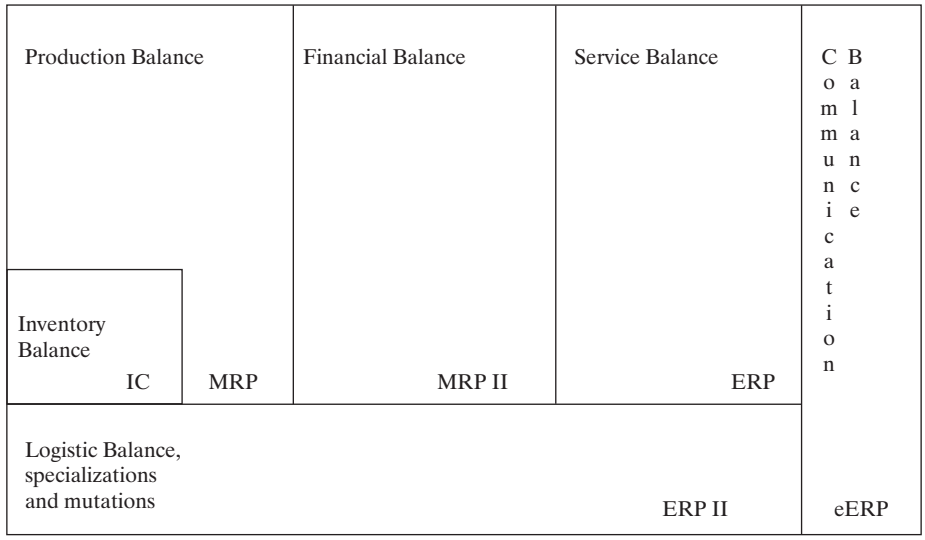

Figure 27. Balance in the integrated systems

Source: the author's own work

3.4. Development path through expansion of spatial network infrastructure

Simultaneously, and in parallel, almost imperceptibly, the development of network systems[29] began. It concerned mainly those organizational activities, where the information is collected in a distributed manner, and the information is later processed in a centralised way, and then re-distributed

[29] Chmielarz W.: *Systemy elektronicznego biznesu* (*Electronic Business Systems*), Difin, Warsaw, 2007 and Chmielarz W.: *Systemy elektronicznej bankowości* (*Electronic Banking Systems*), Difin, Warsaw, 2005.

spatially. The construction of such systems in specialized sectors (airline tickets, banking, tourism, healthcare, etc.) started already in the 60's. Nevertheless, two characteristic features discouraged potential users: the high failure rate and the high price of private, individual networks created for large, wealthy clients. Nevertheless, the purpose of such activities was obvious: on the one hand, it helped to gain a strong advantage by means of a completely new technology, on the other, users' convenience (both in the case of an internal and external customer), who uses the offer which is close to his or her residence and obtains an immediate confirmation. Taking advantage of this tendency, organizational and technological standards started to take shape in the early 70's, and, on the basis of the applied standards, the designers created private networks which would be used mainly to satisfy industrial and narrow sectoral needs.

3.4.1. Systems based on private networks (1970–1990)

The basis for the implementation of most systems based on private networks development were – initially theoretical – concepts of the so-called *Electronic Data Interchange* – EDI. They are based on the exchange, according to specific standards, of structured business data between information systems of two or more organizations conducting transactions[30], and its aim is to streamline and automate the process[31]. EDI is founded on the use of standards connected with the combination of the physical link and EDI documentation standards. They are defined by protocols of information transfer and a document in which it is recorded, processed and presented. In formulating the document over time, two basic ways of its creation developed: based on a single document, made up of individual fields adapted to the situation related to the document (used e.g. in SWIFT) and based on a universal document, in which, depending of the application, only the fields which are essential to its operation (e.g. EDIFACT) are filled.

Electronic exchange of documents definitely accelerates the process of conducting e-commerce transactions, but mainly with regard to contacts between the companies. The literature distinguishes three kinds of relations created for the electronic exchange of documents:

– Corporate (local – coaxial), the oldest connections, which create network platforms for large and very large corporation, bringing together business partners (suppliers, subcontractors, distributors, etc.).

[30] Layland V.: *EDI. Elektroniczna wymiana dokumentacji* (*EDI. Electronic Data Interchange*), Wydawnictwo Naukowo-Techniczne, Warsaw, 1995,

[31] Abt S.: *Zarządzanie logistyczne w przedsiębiorstwie* (*Logistic Management in an Enterprise*), Polskie Wydawnictwo Ekonomiczne, Warsaw, 1998.

– Industry (vertical) – typical for this sphere, supporting individual markets allowing for developing specific characteristics of the specialised sector.
– Multi-sector (cross-section – horizontal) – they concern the functional area of activity, bringing together trade in products from multiple, interrelated industries. It allows for more comprehensive treatment of the client.

Twenty years later, these relations were reflected in the structures based on the Internet.

Nevertheless, the first generation (1970–1990) – a completely homogeneous private, individual and unit networks, internal and individual networks, using private standards (with respect to documentation, communication, transmission), have been created for the needs of specific networks. Communication in this case was made through the network and application software designed specifically for this purpose, and the process of transmission was through very expensive private networks. Therefore, it could apply only to large, wealthy and innovative users, mostly in sectors with high concentration of production and capital (because only those sectors could afford it). Such solutions were safe due to limited access to the network.

3.4.2. Systems based on commercial networks (1991–1999)

Second generation of commercial networks (1991–1999) was based on the development of information technology, progressive standardization (the emergence of new industry and regional standards), communicating on the platform of commercial VAN *(Value-Added Network)* networks – a medium which enables apart from transmission[32], conversion between different systems. It is characterized by a better (less faulty, error-free) and cheaper data transmissions. Reducing the costs would result in the extension of the range of applications of systems of electronic transmission of documents to include also medium-sized enterprises. The networks are still relatively safe in comparison with later internet solutions. Such networks are an alternative solution for the companies willing to use a ready telecom infrastructure created by external companies, paying a subscription fee and paying for data transfer via the network[33]. In parallel with the private networks of such type, the approach has become the most common among large organizations.

[32] Niedźwiedziński M.: *Globalny handel elektroniczny* (*Global Electronic Trade*). (Warsaw: Wydawnictwo Naukowe PWN, 2004).
[33] Laudon J., Laudon K.: *Management Information Systems*. (Upper Saddle River: Prentice-Hall, 2002).

The disadvantages of solutions based on the transfer of electronic documents, such as[34]:
- the range limited to large, wealthy companies,
- the use limited to transactions between companies,
- very high costs,
- inflexibility caused by the standards, resulted in low popularity of network-based systems.

The only positive exception was Minitel[35], a text-video system created in 1984 in France. It allowed consumers to make purchases or book train tickets, airline tickets, hotels, electronic payments, access to databases, etc.[36]. In some scientific and economic circles it was considered to be the most important precursor of the Internet.

3.4.3. Internet-based systems – since 1995

Although the history of the origin and formation of the Internet reaches far deeper into the past in its business applications, we can distinguish three main phases: a primary phase (pre-crisis – until 2001), a transition phase (crisis – 2001–2003) and a secondary phase (post-crisis, social networking since 2004).

In the first – primary phase – after forming of the technical infrastructure of the Internet and providing appropriate conditions for conducting business online (1991) there occurred, on the one hand, the transformation and adaptation of network systems created (so far based on the private and commercial principles) to the conditions of the Internet, and in the Internet we observed the changes which were to support both the relationship between organizations (B2B), as well as relations between organizations and their clients (B2C). The mechanisms of such adaptations evolved until the mid-90's.They was based on a few basic tools: electronic mail; software providing access to web resources and instant messengers.

It appears that electronic mail has become the most important and the most common communication tool among these instruments. Its commonness, universal character and, as it soon turned out, its indispensability in every organization (regardless of the industry and for each individual) are not subject to discussion today. Based on the experience with the mail, the researchers

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[34] OECD: The Economic and Social Impacts of Electronic Commerce: Preliminary Findings and Research Agenda. [http://www.oecd.org/dataoecd/3/12/1944883.pdf], 1998. 12.

[35] Wielki J.: *Elektroniczny marketing poprzez Internet* (*Electronic Marketing via the Internet*). (Warsaw–Wroclaw: Wydawnictwo Naukowe PWN, 2000). 55.

[36] Benjamin R., Malone T., Yates J.: *The Logic of Electronic Markets*. "Harvard Business Review". May–June 1989.

started to create groups and mailing lists, electronic periodicals (newsletters) and the so-called auto responders. A tool used to access internet resources has become another important element of early online systems. Access to information and knowledge was one of the fundamental pillars of the ideology of the creation of this network. However, before the emergence of web browsers, which allowed for easy and simple browsing of the contents of web pages, the availability of this service was problematic for non-specialists. It was connected with the need to organize Internet resources, which should facilitate access to the information stored in the Internet. Therefore, the development of *directories* and *search engines* had to take place. The first phenomenon consisted in creating hierarchical databases (e.g. Yahoo!Directory) in the Internet, which (like directories offline) ordered the content of web pages. The second – through the application of electronic agents first, and later *intelligent e-agents*, present in various forms, multimedia content of the Internet (*crawler, spiders)* and allowing for more sophisticated search in electronic trade. The last group of tools characteristic for this phase of development was *instant messaging* – IM, an application which allows users to conduct a conversation between their users in real time facilitating the processes of communication both for individual consumers and organizations.

In the transition phase – which is a reaction to an overoptimistic undertone of the previous years, due to the burst of "the Internet bubble", there occurred a natural change of the attitude to the electronic sphere. The sphere of electronic business becomes a subject to normal and proven economic principles. Numerous collapses of internet companies both in the United States and in the European countries are caused by the bad relationships of the investment and order fulfilment costs in relation to profits, illogical price competition within a given industry, poor logistics of deliveries, poor organization of work, insufficient market research, reluctance to undertake market research, poor technical infrastructure (considerable investment of 1997–2000 slowly starts to produce effects) and social and cultural factors – no tradition of internet sales, resistance to change and tradition. Since the second half of 2001 until mid2003 there occurred a fast recovery from the crisis – the weakest companies went bankrupt, the remaining ones changed the product range to a different one or they diversified, they started to merge with traditional undertakings or they formed mergers among themselves. The companies started to organize their own logistics, there emerged alternative distribution systems and e-payments systems were developed. Despite the crisis, there occurred a relative and later also a quantitative increase of e-business, caused by a rise in the number of online purchases and tightening relations among enterprises.

A secondary, based on previous experience, evolution phase of the Internet begins with 2004. It is characterized by a number of phenomena both in the

Internet and in its surroundings, which were quite new in comparison to the ones developed previously. First of all, we should pay attention to an increasing, and later dominating (with regard to contacts), role of the multimedia part of the Internet. That was the moment when Web 2.0 technology, based not only on new tools but also the increasing engagement of users, started to develop. As a result, a visible qualitative change with regard to the overall functioning of the global network and the ways to use it by all their users[37] started to take place. The most important tools of Web 2.0 technology are: faster and more efficient new generation search engines, software based on user activity – with Wiki-type mechanisms, a wide range of blogs, podcasts and videocasts, virtual worlds and social networks. Sometimes, this group also includes RSS channels and peer-to-peer networks. The most important here are search engines of a new type e.g. Google, which treat the Internet as a whole, as a „community", geared to adapt to the mechanisms of searching and ordering websites according to the popularity of sites among users. The popularity has a decisive influence on the position of a particular website in the search order. These engines, both general and specialist, have become the most important tool used by the users of IT network systems. The second group of tools of Web 2.0 technology are solutions based on *wiki* mechanisms, which are specific websites that use software developed for the user, giving him or her the opportunity to work together to create specific content sites. The first website of such kind was Wikipedia founded in 2001.

Websites of such type are now regarded by many companies as a tool for the collection, creation and distribution of knowledge. Another category of Web 2.0 instruments are blogs – websites where users make entries on the topics which they are interested in. Created individually or institutionally (a corporate blogging platform) are used to improve internal cooperation and to exchange information and knowledge between employees and they are becoming an important tool of the presentation of the company's innovation. Next tools belonging to Web 2.0 technology are *podcasts* and *videocasts*. They are sound or sound-and-image files, available for downloading by the Internet (e.g. in the form of mp3 file), then played on the user's computer. They can be used to expand and stimulate cooperation and exchange of knowledge among employees. Modelling reality is best reflected in the case of the so-called virtual lives (e.g. SecondLife), in which users have an opportunity to „live" an alternate life and conduct real business using a form of an artificial personality with specific features (*avatar*). One of the most important Web 2.0 tools is social

[37] Fox S., Madden M.: *Riding the Waves of "Web 2.0"*. „Pew Internet & American Life Project". [http://www.pewinternet.org/pdfs/PIP_Web_2.0.pdf]. October 5, 2006.

networking sites (*social networks*, *social network services*). They play the role of online communities gathering users with common characteristics, interests, hobbies, etc. occurring in their private and professional life. Similarly to the previous tools, it will give the Internet users new possibilities to communicate, share various information or materials, texts, photos or video materials.

From a technical point of view RRS channels (*Really Simple Sindication*) are an important element of Web 2.0. They are used to track a particular type of information in the Internet; it facilitates collective tracking of the information which may be relevant to the user, without viewing these sights once again. Especially since he or she may create a pattern of interesting RSS channels of his/her choice. The last important technological tools of the Web 2.0 technology group are *peer-to-peer networks*, which were already popular at the end of the last century (Napster). They enable an exchange of different types of files – music, movies, software, etc. However, they are not instruments important from the point of view of management of the organization.

System based on the development of the network take over not only the strictly economic sphere, but also a social sphere fulfilling the postulates of building the so-called information society and knowledge-based society. The overlapping of these spheres today is so common that it is hardly visible, which is supported by the progress in mobile and communication application.

The development of network-based systems is presented in Figure 28.

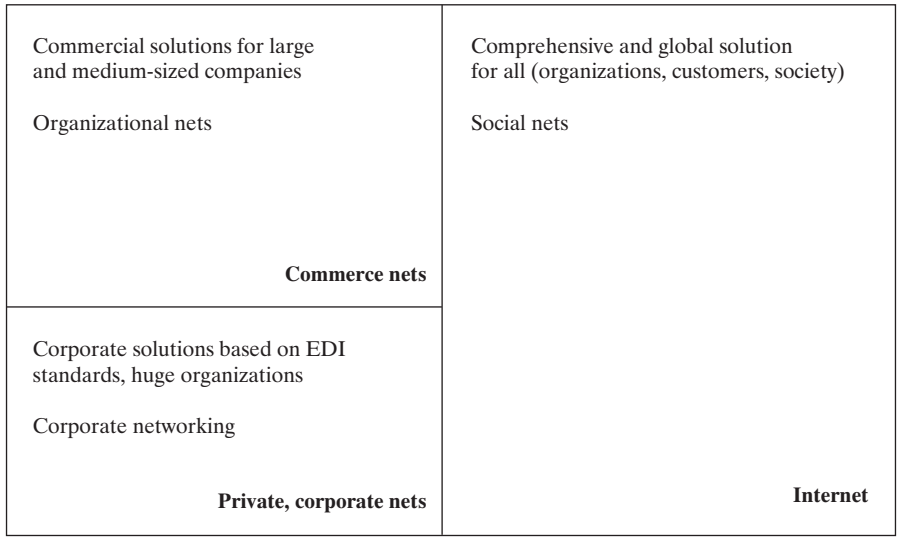

Figure 28. Stages of the development of network-based systems

Source: the author's own work

3.5. Overall system integration at the level of corporate portals

In the last phase of the development of ERP integrated systems – around 2008 there occurred a dispersion of efforts leading to a complete, universal functional integration focused exclusively on internal corporate processes. Together with the emergence of specific parallel internet systems using a completely different technology but having similar functionality (from the point of view of a user (convergence)), ERP traditional scoring systems had to respond to the users' needs. The possible reaction was either expanding the system (sometimes excessively) to include all potentially useful tasks, or opening it and aiming at the creation of a new surface in external space. Their development enabled free exchange of data and information between suppliers and recipients with a system of this class based on the use of e.g. a web browser. Furthermore, in B2B systems the designers more and more frequently and willingly started to use the mechanisms developed and tested in the Internet by creating business intranets, extranets – network solutions consisting in connecting intranets by means of network protocols. The aim of intranet is to provide resources within an organization. The objective of extranets is to share corporate resources between organizations and between organizations and their clients, with no possibility of universal access to the global Internet.

Here, we can see the signs of assimilation of network software applications of private and commercial (inter-organizational) systems to internet systems.

The solution which under the conditions of the development of internet systems started to be applied in lieu of internal integration (data, user interface and internal application interface) was external integration through external corporate portals. A corporate portal is …*a platform which integrates systems and information technology, data, information and knowledge in an organization and its environment in order to provide users with a personalised and convenient access to data, information and knowledge (and their other sources), in accordance with the needs, at any time and in any place, in a secure manner and through a unified web interface*… The main objective of a corporate portal are improvements with regard to access to data, information and knowledge and their sources according to user requirements; regardless of time and location of the web interface, and in a secure manner[38]. The main feature of corporate platforms is the integration of data from internal resources with external data, their conversion into common and jointly processed formats; integration of

[38] Ziemba E.: *Portale korporacyjne* (*Corporate Portals*) [in:] Olszak C., Ziemba E. (ed.): *Strategie i modele gospodarki elektronicznej* (*Strategies and Models of Electronic Economy*) (Warsaw: Wydawnictwo Naukowe PWN, 2007) 344–356.

heterogeneous applications; integration of communication between particular users and providing them with personalized information and knowledge[39]

The emergence of corporate portals is connected with the development of internet network technologies, and the portals operate mainly in an intranet corporate environment. Through this environment – web interface – they are distributed to users, as required information and knowledge.

The impression is that a corporate platform is both an integration instrument and at the same time a convergence tool – on the level, cooperation of both complementary and parallel systems is possible.

The presentation of the processes is shown in Figure 29. In order to present the analysed phenomenon more clearly, the author has illustrated only basic

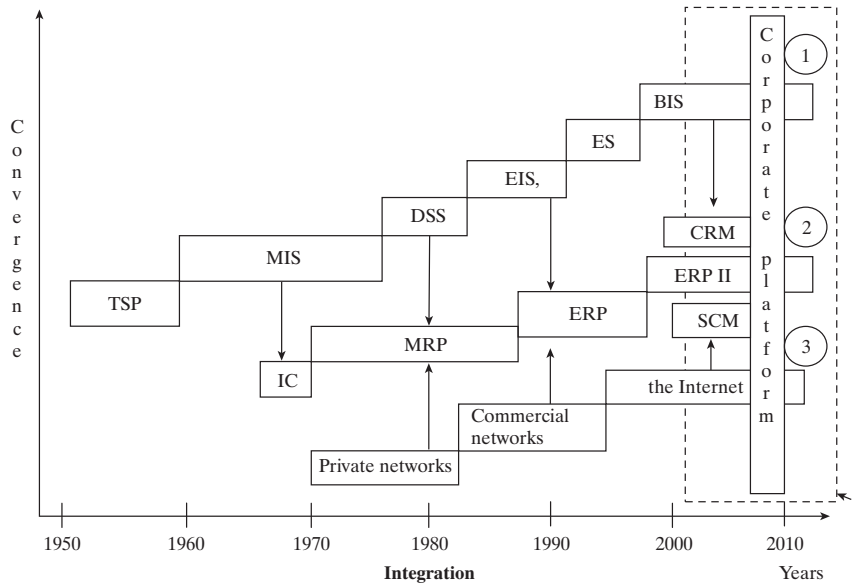

Figure 29. Development paths of IT systems supporting management

Source: the author's own work.

Key:

1. The development path through the increasing complexity of logical architecture
2. The development path through functional integration
3. The development path through network extension

The types of systems: TPS – data processing systems, MIS – management information systems, DSS – decision support systems EIS – executive information system, ESS – executive support systems, ES – expert systems, BIS – business intelligence systems, IC – inventory control, MRP – material requirements planning, MRP II – manufacturing resource planning, ERP – enterprise resource planning, ERP II – enterprise resource planning, CRM – customer relationship management, SCM – supply chain management.

[39] ibid., 346); Ziemba E.: *Projektowanie portali korporacyjnych dla organizacji opartych na wiedzy* (*Designing Corporate Portals for Knowledge-Based Organizations*) (Katowice: Wydawnictwo Akademii Ekonomicznej im. Karola Adamieckiego, 2009).

tendencies in the development of management information systems. For instance, the natural tendencies of connecting and merging of the systems within the first development path were not shown in detail. The author believed that this tendency was a process of intensifying of a previously examined complexity of the logical architecture structure in particular types of the systems, and therefore it does not require further analysis. Also, the author did not illustrate the development of particular internet tools in such a great detail as in the article, assuming that they are still developing very intensively. Nevertheless, there is a clearly visible – possible thanks to a corporate platform – tendency to connect everything with everything (multi-dimensional integration) in terms of transmissivity of the idea of interaction between various information systems on all presented development paths.

Conclusion

At present it is assumed that the focus in the understanding of the notion of computer-

aided management systems moves from the presentation of what can be provided (and usually what cannot be changed, i.e. as a result the user is adapting to the system) towards the idea of constructing a system solving actual problems and prompting the user how he or she should act in a particular situation.

This amounts to the listing of components which the system should be made up of, the choice of a solution model (best management practices) which will be most useful in a given situation and the manner in which the problem may possibly be solved considering the circumstances. The evolution of such thinking, resulting, on the one hand, from the development of project management methods affecting information systems, and on the other, from the development of information systems influencing the directions for modernization of design methods is presented below:

1. in the early seventies IT systems supporting management were presented as – computer-based systems indirectly supporting decision-making, based on relevant reports, experience and training of decision-makers. They focused on solving problems of a single decision-maker. The starting point for their development was the application of information technology for better (faster, more accurate) way of obtaining information registered in the system for the user's needs. Due to the relatively simple logic, in case of most created systems there was no need to apply methods that go beyond the existing experience resulting from the management of an organization (on this basis, the structural management methods were formed),
2. later, the IT systems supporting management were described as interactive computer systems which allow the decision-maker to use the database and model base to solve problems, not only the so-called deterministic problems but also poorly structured ones. The support related not to the decision-making process itself, but to the assistance in the individual processing of data by means of software tools allowed the decision-makers to quickly identify the directions for the development or, for instance, to prepare financial plans for the organization. A paradigm shift of the application of IT systems to create a possibility to model decisions and present it to

the user, triggered the search for appropriate design methods of groups of operational, object-oriented or socially-aware methodologies,

3. in the late eighties IT systems supporting management were seen from the perspective of increasing efficiency: both operational and connected with making (tactical and strategic) managerial decisions. New challenges associated with the emergence of the idea of systems informing and supporting management as well as expert systems, resulted in further development of the concept of IT project management to create fast, modern, *agile* methods,
4. the beginning of the nineties brought about the emergence of new technological possibilities of the computerization of organizations. On the one hand, the dominant position of duplicated integrated systems on the market triggered the search for improved methods of their design and implementation. On the other hand, the development of the systems has been oriented towards the creation of intelligent working environment at all levels of management. More and more frequently, the notion 'IT system' is understood to mean a system capable of using the intellectual ability (knowledge) applied to improve creativity in the decision-making process. Previous experience concerning both the trends in the development of the systems and design methods is beginning to bear fruit, not only with regard to the creation of new classes of system design methods but also the emergence of commercial packages combining organizational, design, IT, etc. experience,
5. with the beginning of the new century isolated (in terms of location within the organization) intelligence of the system started to spread towards extending relations with contractors through traditional and electronic channels. At present we observe the full integration of the systems of various types and the traditional and electronic economy; similarly, it becomes necessary to integrate design methodologies in all these spheres.

The problem of the origin and evolution of the methods as well as the creation of the systems may be seen from the perspective of the development of information technology (especially system components), and the development of modelling techniques applied in the management of processes and projects. The formation of an information system is in this context a specific, natural consequence of meeting the requirements of specific characteristics of the created systems and the changes of the ways of obtaining them. The third factor connecting these tendencies is the emergence of the technology of close, fast and direct interaction between the creators and recipients of the projects (in terms of the place – in the organization – and in terms of space – in the Internet).

In this context the phases of the evolution of information technologies may be summarized as follows[1]:

- *The phase of preliminary data processing* – characterized by the use of a computer to solve individual tasks, mainly as a transaction, where each programme processed its own, dedicated data collections. Handling the data was limited to very simple operations such as: sorting, classifying, aggregation, etc. Modelling appeared only in the form of a single equation, or a group of equations defined by the programme code. The results of the data processing were collected, aggregated and later presented, usually in a tabular form,
- *the phase of systems of collections management and symbolic models* – relied on the use of a computer to process tasks integrated by the performed functions, sometimes making the same collections available to various programmes. At this stage the efforts of designers and creators of the systems focused on the development of the common software for the created collections, providing basic security procedures and data integration. It was accompanied by simple modelling characterized by solving (sometimes in large numbers) sets of linear and non-linear equations. The result of the data processing were the reports obtained after each session of the computer's work,
- *the phase of databases processing* – a special feature of this stage was separating the data from the programmes which processed the data. The created systems guaranteed the reduction of the software necessary to modify the data and used the data models mapping the relationships between the data. From a mathematical point of view modelling is still simple – but it is adapted to new conditions created by the functioning of the databases, especially in the relational data model. The result of the system operation were the reports with predefined structure,
- *the phase of query language systems* – query language systems were the next step in the development of data processing methods in information technology. During their construction the main focus has been on the issue of the contact with the user, especially a non-professional one, providing him or her with direct access to data collections through dialogue or specially constructed user language. The result of the data processing were reports generated upon the user's request, with the form and structure best suited for the user,
- *the phase of hybrid database systems* – this phase, apart from database support, was characterized by the support of the model base with large numbers of parameters and model ratios of the nature, form and structure which were different from the source data stored in the database. Therefore,

[1] earlier on the need of common evolution the systems of processing data and models: Spraque R.H.: *DSS in Contex*, Decision Support Systems, vol. 3, no. 3, 1987.

the operation passes through a series of steps connected with the various phases of mathematical modelling:

- *computational models* – computers at this stage have become important for modelling due to the potential possibilities to reduce large amount of data during the estimation of equation coefficients or solving complex systems of equations,
- *computer models* – this stage covers a period where the programme itself starts to become a model rather than serve mainly to solve the problem. Computer variables are becoming symbols which are manipulated by means of the programme (not by the combined operations of mathematical equations). This approach leads to a situation where, in general, a problem is not being solved, but the programme is run to observe the behaviour of the model in order to identify the modelled situation (simulation, variants),
- *model base systems* – in order to address specific problems (which may be explained by algorithm) the designers started to create the IT systems which by their nature could be treated as a system of models. The software only provided a common format for the input data, similar formats of generated reports and integrated documentation, and such a system could be used by each user individually or it was customized for individual workstations in the organization,
- *interactive models* – their application became possible when there appeared mini- and microcomputers equipped with a model library with models which can be used for various analyses. Unfortunately, a common feature of these models is running individual programmes which usually require different input data with regard to content and structure, but seldom there is any logical or formal relationship between the utilized programmes,
- *the phase of acquiring data (data mining) from the data warehouse* – it is one of the stages of the process of knowledge discovery, consisting in the application of software to find the patterns and dependencies, which remain hidden for a man, in order to obtain knowledge which may serve as a basis for decision-making. It is supported by *interactive model base systems (Business Analytics)* – allowing for any mathematical, statistic or econometric analysis on the data from the data warehouse and supplementary data, including models of knowledge management.

Generally, we may say that the approach to information technology has evolved from the traditional data processing and simple mathematical models towards[2]:

[2] see Chmielarz W.: *Kierunki rozwoju systemów informatycznych wspomagających zarządzanie i ich integracja* in: *Technologie wiedzy w zarządzaniu publicznym, Zeszyty Naukowe Wydziałowe Uniwersytetu Ekonomicznego w Katowicach*, Zeszyt 99 Studia Ekonomiczne

– effective management of large amounts of data,
– introduction of the flexible system of easy access to data for non-programmers,
– increasing complexity and sophistication of mathematical models from symbolic models, through model base and interactive model base, with a decreasing level of complexity of their application,
– detection of interdependencies between the data in order to transform them into knowledge and obtaining the knowledge for the user.

In order to be consistent with the formulated thesis, the presented phases of the

evolution of information technology should correspond to the development phases of general project management methodologies, and, in particular, to IT project management methods.

The phases of the methodologies of IT projects' management were shaped as follows:
– *the phase of functional design* – the analysis of isolated cases of simple programmes and IT systems covering complex routine mass calculations or algorithmic problems,
– *the phase of functional-structural and structural design* – first determined by the technology of sequential data processing, and later by the databases, mainly hierarchical and relational ones. The resulting technological, information and functional integration to date is using the output of the school in the implementations of duplicated integrated systems,
– *the phase of object-oriented design* – it occurred together with the era of the development of computational methods for supporting decision-making – there occurred a change in the approach to design methodologies which was connected, on the one hand, with a huge amount of data to be processed and the relations between them, and on the other, an application of more and more sophisticated mathematical models used in the decision-making process,
– *the phase of socially-aware design* – when it turned out that the designed and implemented IT systems encountered problems not related to technological or organizational obstacles, but rather connected with the problems associated with the management of the social potential of the company,
– *the phase of agile design* – when it became necessary to build systems quickly, more cheaply and there was a demand for the systems which were more related to the user's requirements not only traditionally within a company,

edited by J. Gołuchowski (Katowice: Wydawnictwo Uniwersytetu Ekonomicznego w Katowicach, 2012). 11–24.

but also at the interface between business-economic environment, as well as in the electronic sphere, based on the widely-defined process modelling and its solutions,
– *the phase of integrated design* – when there are scientific and commercial suites of methodologies of IT project management which are the conglomerate of methods of project and process management, best practices of management, organizational methods, sociology and organization psychology, etc., their common application allows for better support of integration processes of modern software systems[3].

Both the final stage of evolution of information technology and the last stage of the evolution of project management have one common feature, namely, we note a convergence with regard to the approach to the final, non-professional user through a complex communication system on the corporate platform. It is probably the basic area where IT systems can and should be developed at present.

However, we may have certain doubts as to the existing awareness with regard to the connections between the changes in the methods of IT project management and the development of computer-aided management systems. Observations of the current development in this field give rise to the following conclusions:
– initially, design methodologies facilitated the development of IT systems and were adapted to the present needs of creating (functional and functional-structural) IT systems. The analyses focused on particular, specified functions of the organization; project on separated, isolated, usually algorithmically simple operations between data, based on symbolic models,
– upon the development of information technology (increased RAM capacity and database) there had to occur a change in the way of analysing and designing of the methods taking into account these changes. First, there emerged, and started to develop, structural methods which are the next stage of system analysis methods of an organization and operational studies, naturally connected with knowledge, experience and skills of designers. Next – together with the development of needs resulting from the development of programming languages – there appeared a group of object-oriented methods satisfying these requirements. The competition between the two schools accelerated the development of more sophisticated systems than the systems based on the database – the first systems of supporting decision-making and expert systems,

[3] see Chmielarz W.: *Kryteria wyboru metod zarządzania projektami informatycznymi*, in: Problemy Zarządzania, Wydawnictwo Wydziału Zarządzania UW, *Uwarunkowania zastosowań systemów informatycznych w gospodarce*. vol. 10, no. 3, 2012, 2012. 25–41.

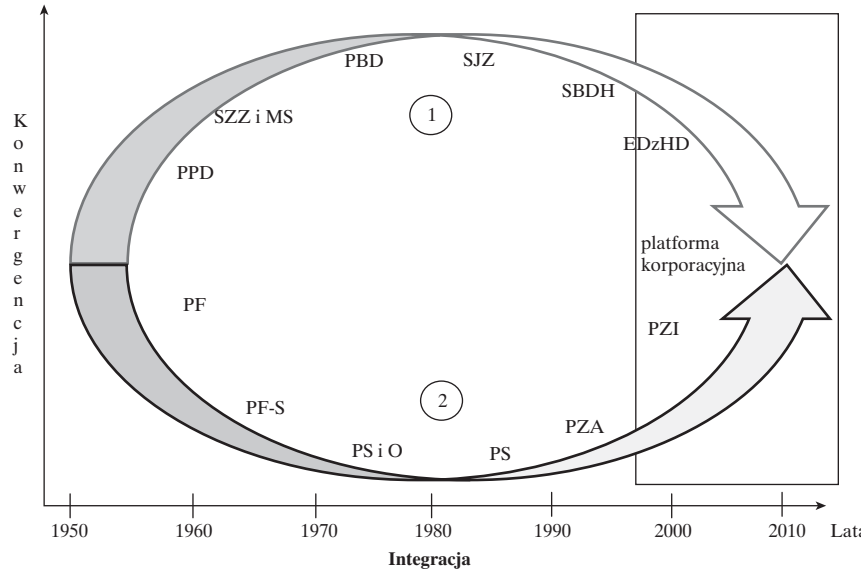

Figure 30. Evolution of information technology due to the changes in the methods of IT project management

where:

1. Phases of the development of information technology
   PDP – preliminary data processing,
   SCM & SM – systems of collections management and symbolic models,
   DP – database processing,
   QLS – query language systems,
   HDS – hybrid database systems,
   DM – data mining, acquiring data from the database,
2. Design phases
   FD – functional design,
   F-SD – functional-structural and structural design,
   OOD – object-oriented design,
   S-AD – socially-aware design,
   AD – agile design,
   ID – integrated design

Source: the author's own work

- the problems of a human with the communication with systems supporting decision-making and expert systems led to the development of the systems based on social factors – the first methods which focused on the client's needs. This also facilitated the work on the systems of informing and supporting management, with more advanced mechanisms of communication of higher level management with the system, visualization method and communication with the outside world,
- facilitation of communication enabled further development of the systems based not only on the database but also on model base and knowledge base.

After private networks, commercial networks and the Internet started to develop and there appeared a need not only to communicate with them, but also to construct systems fulfilling commercial functions in the networks. The old, traditional, slow (though effective) operating design methodologies were not sufficient. Therefore, they have been replaced with agile methodologies, allowing for faster designing, taking into account the user's requirements more accurately, with a lower implementation risk,

– advances in technology and exponentially growing information needs of the systems meant that it was necessary to create a multi-faceted software – on the one hand, providing support for data warehousing, in the sense of extracting the data in the desired system, on the other hand, combining the data from inside the organization with the external data from the Internet and converting it to the format that allows sharing and using it in the decision-making process. It was necessary to apply commercial design methodologies taking into consideration diverse but integrated internal methods and techniques of project management.

The above findings of the present analyses are preliminary, and together with the progress of research they will be further developed. The author hopes that the objective of the study, outlined in the introduction, has been at least partly realized, and the presented summary of his considerations and opinions contributes to widening the literature output on the subject. Nevertheless, it should be noted that the study touches upon a number of important research problems and proposes solutions to the problems, which, hopefully, will be developed by the author's successors and will be analysed in-depth at the next stage of the development of the information and knowledge society in Poland.

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Prof. dr hab. Witold Chmielarz – Head of Management Information Systems, Faculty of Management, University of Warsaw, the founder of one of the schools of the evaluation of the quality of websites, the author of a confrontational method of pattern design, a strong supporter of the evaluation of the usefulness, effectiveness and quality of IT systems from the user's point of view. He conducts long-term research on the condition and dynamics of e-commerce, especially e-banking. The author and co-author of more than 200 scientific publications, including books dedicated to the problems of designing IT systems and several chapters in books, which were published in Poland and abroad. He participated in university scholarships and gave lectures, among others, in the USA and India and a number of European countries. He has worked for many years as an analyst, designer, implementer and expert in the realization of IT projects in a number of IT enterprises in Poland. He is an accomplished expert on e-business, including e-banking; methods of analysis and design of IT systems, including the methodology of adapting IT systems to the requirements of the client and implementations of integrated systems.

Fragment of the review by prof. dr hab. Jerzy Gołuchowski

... To sum up: I believe that the presented work is original and creative contribution of the Author to the methodology of informatization of organization management. The author has rightly observed that not only do we need to properly assess the methodologies of process and project management from the point of view of their usefulness in the field of management informatization, but we also have to generally reconsider the concept of management information systems. The advantage of a book is that it adopts the historical perspective in the analysis of the methodology of IT systems design. The analysis of the design, as noted earlier, is undertaken both from the point of view of the design process (methodology pragmatics) as well as the result of the process (the pragmatic aspect of the methodology of management information systems). The author consistently strives to show the relationships between the development of the methodics of the analysis and design of IT systems with the development, on the one hand, of the technology aspects of the system development, on the other – management information systems in commercial methodics of process and project management ...

Fragment of the review of prof. dr hab. Dariusz Dziuba

...The presented work is a monograph which presents the author's original approach towards the issue of IT systems management and the development of management information systems. The author undertakes an ambitious task of answering the questions whether and in what way the development of project management methods influences the development of IT systems, and simultaneously he raises the question whether we deal here with a reflexive relationship – or the development of information technology stimulates the development of design methods. There is no other scientific work on the Polish market which would consider the problems of IT project management and the development of IT systems which would adopt the approach which is so important for the research progress in terms of the IT applications ...

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