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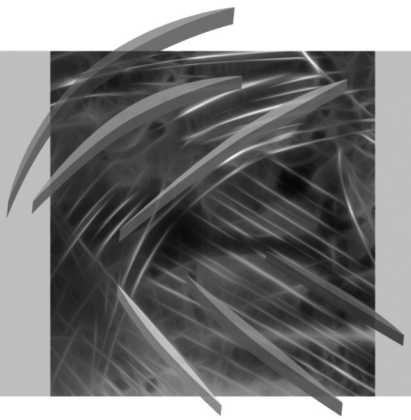

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Information Systems in Business

Witold Chmielarz
University of Warsaw, Warszawa, Poland
e-mail: vitec@post.pl

THE INTEGRATION AND CONVERGENCE IN THE INFORMATION SYSTEMS DEVELOPMENT – THEORETICAL OUTLINE

Abstract: The main objective of this article is to present the idea of the development of information systems consisting in the integration and convergence approach. It seems that this is a solution of classification of management information systems development problems – appearing in the literature in this field. After definitions of the main concepts used in the analysis, the author presents the development of information systems through the prism of three main development paths: the increasing complexity of logical systems structure, functional integration and the expansion of the infrastructure of network systems. The meeting of tendencies and all the development paths occurs at a corporate level.

Keywords: information system, integration of information systems, the development of information systems, classification and typology of information systems.

1. Introduction

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 brought something new to the sphere. The tradition of writing on the subject was started by the scientific circles from Wrocław [Hellwig (Ed.) 1971, 1975]. Next, although the IT business environment continued to increase, the publications on the subject were created mainly with a view to satisfy the current needs of existing curricula, rarely setting their standards. But on the other hand we have the academics who handled this complex situation very well in several subsequent publications [Niedzielska (Ed.) 1998; Nowicki (Ed.) 2005, 2006; Kisielnicki, Sroka 2005; Olszak, Sroka (Eds.) 2003; Flakiewicz 2002]. In recent years we had to pay attention to the works [Olszak, Ziemba (Eds.) 2007; Januszewski 2008; Kisielnicki 2008, Krupa 2006; Nowicki, Turek (Eds.) 2010]. Re-

cent publications were inspired by the latest achievements of series of publications existing for many years on English-speaking markets [Turban et al. 2008; Laudon, Laudon 2010].

Almost in all of these outstanding publications we can see a different classification or typology of the development of management information systems. Sometimes the IT systems are presented in different forms or orders, and they are characterized 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 adopt a different point 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 acting 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 functioning under the same environmental conditions, regardless of adopted specific innovative solutions. Information system is treated here as an ordered collection of programs 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 information technologies are the result of historical development, emerging at three main paths of development: increasing complexity of logical systems 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 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.

In my view, the era of modern information systems supporting management starts from Management Information Systems (MIS) in the mid-sixties. The development of the information systems was neither simple nor smooth. Many theoreticians and practitioners dealt with this issue. The presentation of their achievements 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.

2. The 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 have dealt with it since the early eighties of the last century, and its development was treated as a direct implication of technological progress.

2.1. Transactional Processing Data Systems – early fifties – 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 [Chmielarz 2005a]. These were undoubtedly the first attempts of creating a tool which indirectly could be used 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 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 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 program 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. 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.

2.2. Management Information Systems – MIS – 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. According to [Turban 1993, p. 24], "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 transformations. 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,
– databases with the database management system,
– applications – e.g. subsystems, application software consisting of a collection of instructions, whose task is to provide a user with a defined functionality.

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 a 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, 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.

2.3. Decision Support Systems – DSS – 1978

The basic definition of the decision support systems [Turban 1993 p. 85] describes it as "information systems based upon computer and communication infrastructure supporting the activities of people involved in the decision-making process." 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 his/her disposal tools for developing a decision, apart from intuition, knowledge, skills and information. The tools usually take the form of programmes consisting of mathematical, statistical and econometric models, 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 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,
- management system of model database – the software containing all tools which are necessary to handle and manipulate models,
- procedure base (solver) – programme or software package used to solve particularly complex mathematical problems arising from the constructed models,
- 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, external data downloaded and entered "manually" from economic environment.

As the author has already mentioned, such architecture allowed for the first time to develop, not the data to make a decision, but the suggestions of a decision which would be best from the point of view of an assumed criterion or a collection of possible user's decisions. 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 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 the future, or in a spatial layout are also important in this case.

Apart from undoubtedly greater opportunities of the application of the decision support systems there occurs one significant problem. 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 reflection of the reality.

2.4. Executive Information Systems (EIS), Executive Support Systems – (ESS) – 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 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 was able to evaluate at a first glance 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.

In turn, the ESS systems, which are a kind of a mirror reflection of EIS systems, 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.

2.5. Expert Systems ES – I generation – 1975, II generation – 1985

The expert system is described 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" [Freyenfeld 1984, p. 37]. This old definition seems to be the best explanation of the functioning of expert systems. The first ES systems 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 observe 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 Reengineering – 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:

– 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 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.

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, and 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 chance 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.

2.6. Business Intelligence Systems (BIS) – 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, scientists started to build new model constructs by improving the structure or functionality of the previous ones. Such a situation 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 is 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. 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 [Gołuchowski 2007; Olszak 2007].

2.7 "Internal" integration of management information systems

Obviously, the information systems have not evolved 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.

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, 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 [Adamczyk, Chmielarz 2005]:

– 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,
– 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 an 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 have developed through functional integration.

3. Development through functional integration of management information 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. 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 within 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 new features to already existing ones in a manner adapted to the current level of the development of information technology.

3.1. Material Resource Planning – MRP – 1964

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. 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. Production control systems were next. In 1957 American Production & Inventory Control Society (APICS) was founded in the USA. It aimed at developing the methods of using computers in the management of manufacturing organizations. In the late 50s 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 interoperational (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.

3.2. Manufacture 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 the 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 of 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. Enterprise Resource Planning – ERP – 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 90s 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 integration 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 (as 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. 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 90s 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. 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 70s (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 the needs of a user. 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. Customer Relationship Management – CRM – the idea of subordinating the system to the needs of the recipient (not the producer or distributor) was the most popular among them. Another system of such type was the system used to manage relations with suppliers (Vendor Relationship Management – VRM), or the one that covers the entire process of logistics (Supply Chain Management). The researchers specified such a class of systems in which the Internet was the dominating sphere and the basic functions of the system were moved to that sphere– eERP (electronic Enterprise Resource Management – ERP operating in the Internet). It widened the choice in a large group of integrated systems and reduced the average cost of its implementation. However, it also undermined the faith in the only proper (so far) integration on the platform of integrated systems. And it

reminded analysts of the existence of the development path through the development of network infrastructure, which was neglected for a long time.

4. Development path through infrastructure and spatial network expansions

Simultaneously, and in parallel, almost imperceptibly, the development of network systems [Chmielarz 2007, 2005b] 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 spatially. The construction of such systems in specialized sectors (airline tickets, banking, tourism, healthcare, etc.) started already in the 60s. 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 70s, 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.

4.1. Systems based on private networks (early 70s–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 [Layland 1995], and its aim is to streamline and automate the process [Abt 1998]. 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 on 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 corporations, bringing together business partners (suppliers, subcontractors, distributors, etc.),

– industry (vertical) – typical of 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 – 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.

4.2. Systems based on the commercial networks (early 90s–1999)

Second generation of commercial networks was based on the development of information technology, progressive standardization, communicating on the platform of commercial VAN (Value-Added Network) networks – a medium which enables apart from transmission [Niedźwiedziński 2004], 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 [Laudon, Laudon 2010]. In parallel with the private networks of such type, the approach has become the most common among large organizations. The disadvantages of solutions based on the transfer of electronic documents, such as [OECD 1998]: the range limited to large, wealthy companies, the use limited to transactions between companies, very high costs and inflexibility caused by the standards, resulted in low popularity of network-based systems. The only positive exception was Minitel [Wielki 2000], 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. [Benjamin, Malone, Yates 1989]. In some scientific and economic circles it was considered to be the most important precursor of the Internet.

4.3. Internet-based systems (since 1995)

Although the history of the origin and forming 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 on 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-90s. They were 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 started to create groups and mailing lists, electronic periodicals (newsletters) and the so-called autoresponders. 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) on the Internet, which 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 mid-2003 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 began in 2004. It is characterized by a number of phenomena both on 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 on 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 [Fox, Madden 2006] 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 specialistic, 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 (for example 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

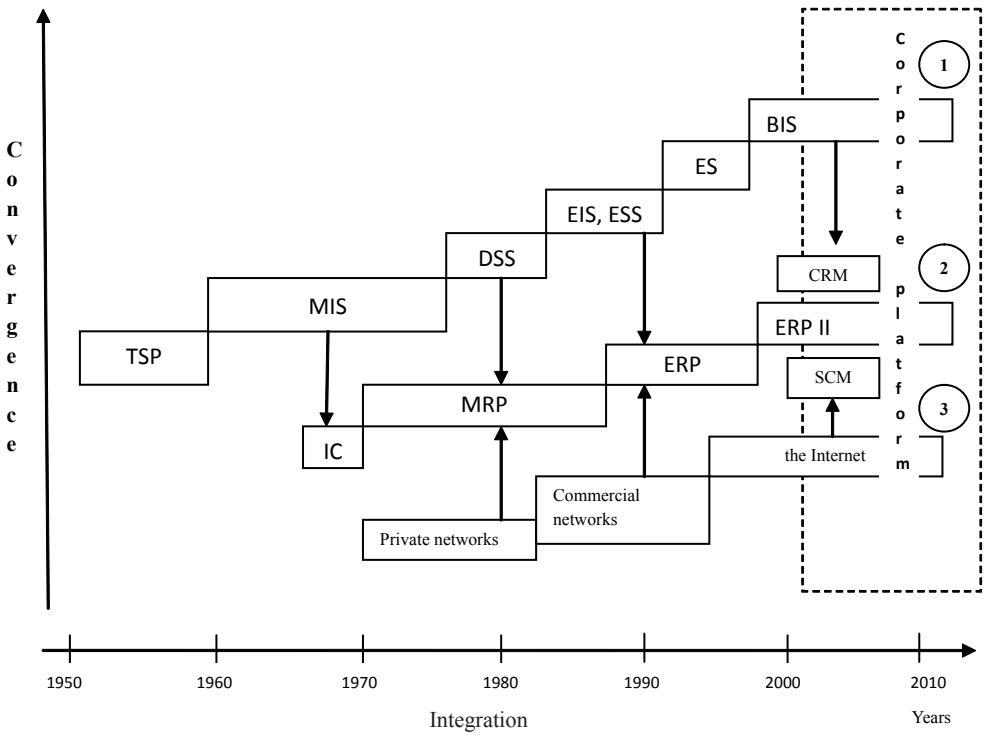
the company's innovation. Next tools belonging to Web 2.0 technology are *podcasts* and *videocasts*. They are sound or sound-and-image files, available for downloading from the Internet (e.g. in the form of mp3 file), then played on the user's computer. They can be used to expand and stimulate cooperation 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 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.

5. Instead of the ending – the phenomenon of convergence and re-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 on 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 (interorganizational) 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 or-*

der 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 is 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 [Olszak, Ziemba (Eds.) 2007]. 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 heterogeneous applications; integration of communication between particular users and providing them with personalized information and knowledge [Ziemba 2009].



Legend: 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.

Figure 1. Development paths of information systems supporting management

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 1. In order to present the analysed phenomenon more clearly, the author has illustrated only basic 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 clearly visible – possibly 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.

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INTEGRACJA I KONWERGENCJA W ROZWOJU SYSTEMÓW INFORMATYCZNYCH – SZKIC TEORETYCZNY

Streszczenie: Głównym celem artykułu jest przedstawienie idei rozwoju systemów informacyjnych opartej na podejściu integracyjno-konwergencyjnym. Wydaje się, że rozwiązuje ono pojawiające w się w literaturze problemy dotyczące klasyfikacji systemów. Po zdefiniowaniu głównych pojęć używanych w analizach zaprezentowano rozwój systemów informatycznych poprzez pryzmat trzech jego głównych ścieżek rozwoju: komplikacji struktury logicznej systemów, integracji funkcjonalnej oraz rozszerzeń infrastrukturalnych systemów sieciowych. Do spotkania tych tendencji oraz wszystkich ścieżek rozwoju dochodzi na płaszczyźnie korporacyjnej.